

Technical Memorandum

Aamjiwnaang First Nation Community Air Monitoring Station

Results for 2011



Ontario Ministry of the Environment
Southwestern Region Technical Support Unit
Air Pesticides and Environmental Planning Section
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Executive Summary

The Aamjiwnaang First Nation community air monitoring station was established in late 2008 in partnership between the provincial and federal governments and the Aamjiwnaang First Nation (AFN). The station was equipped to monitor a range of air contaminants, some on an hourly basis while others were sampled for 24 hours every 6 or every 12 days depending upon the monitor. The data may be used for long-term air quality studies and to assist in community health assessments.

Monitoring began at the station in September of 2008, and a report summarizing the first year of operation was released in January of 2011. This report, the third, covers the calendar year 2011. For most cases, the data is summarised in two pages. These summaries are designed to make the important information quickly available to readers. Insofar as is possible, they follow a consistent format. Further elaboration of any the information is available upon request.

Hourly data are presented for

- Sulphur dioxide (SO₂)
- Total reduced sulphur (TRS)
- Nitrogen dioxide (NO₂)
- Ground-level ozone (O₃)
- Fine particulate matter (PM_{2.5})
- Specific volatile organic compounds (VOC)

Data from non-continuous sampling are presented for

- Suspended particulate (TSP)
 - Certain TSP constituents – primarily metals
- A broader range of VOC

The ministry also monitored for PAH but technical problems at our lab have delayed analysis. The results will be released as soon as they are available.

Monitoring results were compared with Ontario's Ambient Air Quality Criteria (AAQC) where such existed. The results were also compared to the Air Quality Index (AQI) classifications for SO₂, TRS, NO₂, O₃, and PM_{2.5} - the parameters on which the AQI is based. Measurements were made of the other AQI constituent, carbon monoxide (CO), but as they remained below the detection limit all year, no results will be presented. Wherever possible, these monitoring results were compared to other ministry stations in Southwestern Ontario. Comparison sites were chosen at which most of the same substances were monitored and which reflected a similar urban environment.

Results are reported in two different concentration units. Particulate, metal, PAH, and canister VOC results are reported in micrograms per cubic metre (µg/m³), while most of the hourly results are reported in parts per billion (ppb). This is done for two reasons. The reporting results are given in the units in which they are reported by either the measuring instrument or the analysing laboratory. As well, these units are consistent with those used in the previous report and the ministry's annual report *Air Quality in Ontario* allowing for easier comparison. Where results are reported in ppb, and are to be compared to ministry standards and AAQC (both of which are published in Φg/m³) the ministry's values are converted to ppb assuming a temperature of 20° C and an atmospheric pressure of 1013 hPa.

A small but important point in the results is that there were some differences in how calculations were made for certain substances. These differences are discussed briefly in the "Data Averaging" appendix.

Another significant change occurred with the adoption of several new air standards by the ministry in July of 2011. It is the ministry's practice to phase standards in over five years to allow industry to

adjust processes and acquire new technology, where necessary. However, the standards are based upon AAQC which, as target values, are available immediately for comparisons. Several of these are relevant to these measurements. These are benzene, benzo(a)pyrene (as a surrogate for all PAH), 1,3-butadiene, chromium, manganese and nickel.

The AAQC are based upon the potential adverse health or other effects of each substance. Scientific studies of carcinogens generally yield risk estimates based upon lifetime exposures. As such, they have AAQC with longer averaging periods, generally stated as annual averages. This is the case for the first three of the new list: benzene, benzo(a)pyrene, and 1,3-butadiene. In some cases, a shorter term AAQC will also be given for these substances. This is a screening level that is meant to be used to determine if longer-term evaluation such as monitoring is necessary. Others substances are believed to have a discernable impact at less than lifetime exposures and so their AAQC reflect a shorter averaging period. Chromium, manganese and nickel fall into this category.

Results for this report are similar to those in the previous report. Results for AQI parameters showed lower averages for NO₂, SO₂, TRS, and PM_{2.5}, but a higher average value for O₃. As with the previous report, exceedances were only seen for PM_{2.5} (15 versus 37 in the previous calendar year) and O₃ (28 versus 2 in 2010).

The averages TSP concentration rose from the previous year and included one exceedance of the AAQC, Metal concentrations and maxima were all lower than 2010, where available. No exceedances were measured.

PAH results are not currently available due to a temporary loss of capability at the MOE lab. It is expected that results will be available by the end of 2011.

The hourly target list for VOC remained unchanged from the previous year. Most averages were up a bit from the previous year, hexane being the most changed. Maxima were also up for the majority of the compounds as well. As with the previous report only benzene (23 times) and 1,3-butadiene showed exceedances of the 24-hour AAQC and none showed exceedances of the annual AAQC.

The ministry, in cooperation with Environment Canada takes 24-hour VOC samples using canisters every twelfth day. Thirty samples were taken during 2011. Of the 160 species for which the canister samples were analysed, 50 have AAQC and 49 of these were measured. Only 7 of these ever reached more than 1% of their respective 24-hour AAQC and only benzene exceeded it. Six of the substances also have annual AAQC and, of these, only benzene exceeded this level.

Sulphur Dioxide

Sulphur dioxide (SO₂) is emitted from industrial facilities and sources that burn sulphur-containing fuel, notably electric power generators. It contributes to acid rain, and can have human health impacts including eye and respiratory tract irritation and lung damage at higher concentrations. The ministry has a half-hour standard of 310 ppb (for a particular source) and a 1 hour AAQC of 250 ppb. This report uses the AAQC for comparisons as they have been developed for use in assessing air quality whereas standards are meant to assess the contribution of any single source emissions.

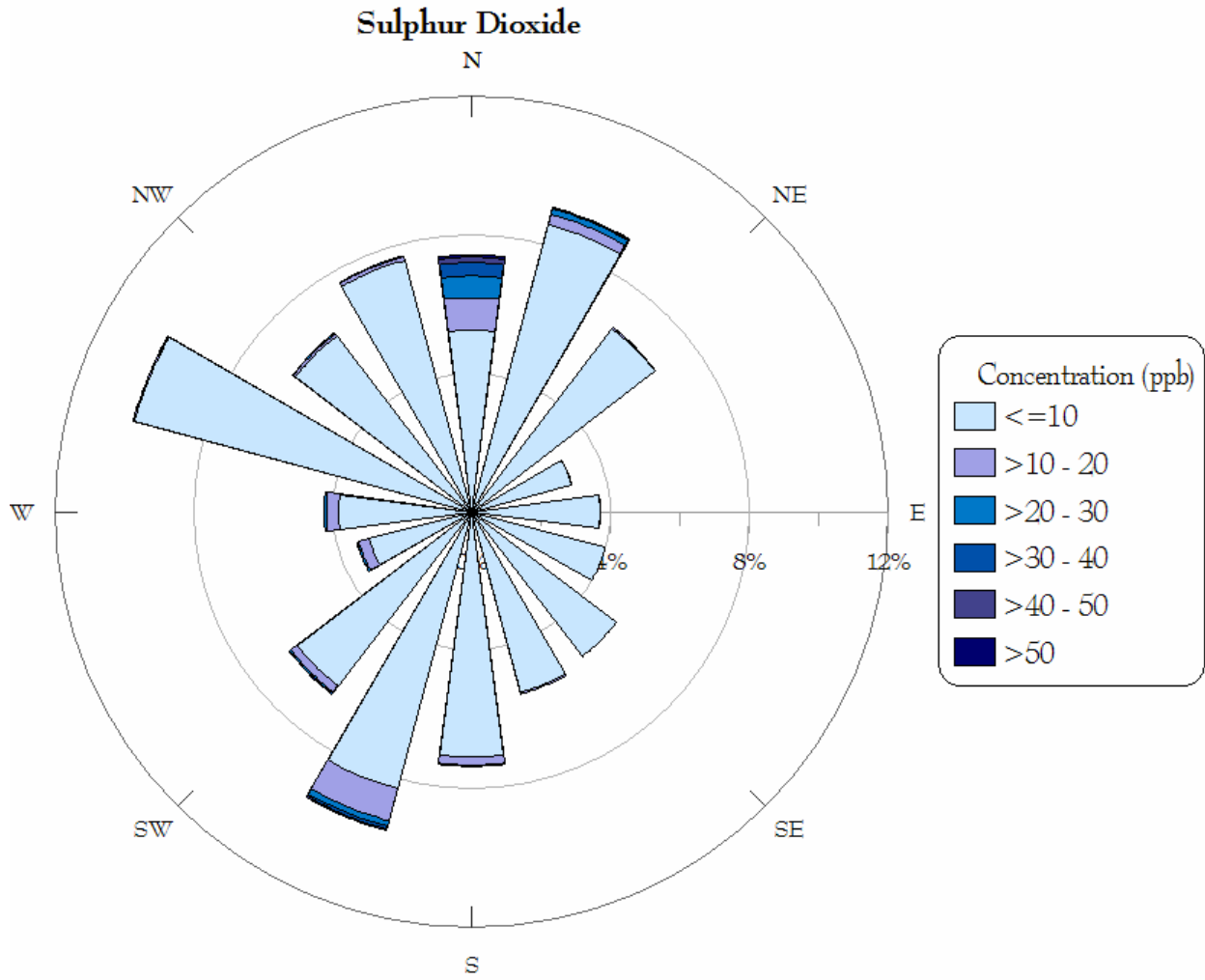
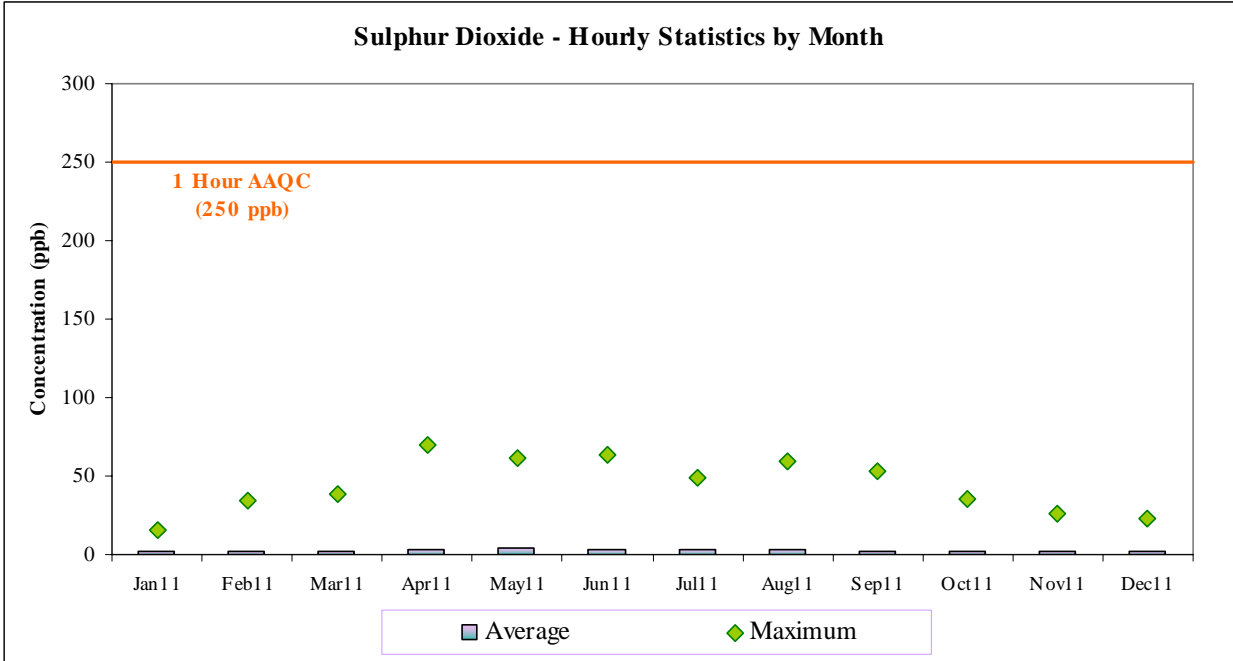
Report Values	Average (ppb)	Maximum (ppb)	AAQC Exceedances
<i>AFN Station</i>			
2011	2.5	70	0
2010	2.8	75	0
2009	3.0	101	0
<i>Other Stations, Current Report Period</i>			
Sarnia AQI	5.3	94	0
Windsor West AQI	3.4	75	0
London AQI	No longer available		

No exceedances were recorded during this monitoring period. Both the average and maximum value of sulphur dioxide were lower than in either of the previous two years suggesting a downward trend at the station. They were also lower than those measured at the Sarnia AQI station, and comparable to those of the Windsor West AQI station though higher than the London measurements. This is to be expected as the London area does not have the same industrial base as Windsor or Sarnia.

The highest average was seen during the summer, perhaps because of the greater demand for electricity. These results are similar to those in the previous report. This year, all the SO₂ measurements led to a “very good” SO₂ AQI sub-index. The month by month results are shown graphically on the next page.

The pollution rose shown on the next page illustrates how SO₂ concentration varies with wind direction. There are small differences in the wind pattern from those seen previously but the more important feature of the diagram is that the sources to the west and south of the station had less influence on the station than in the previous reporting period. The sources to the north of the station appear to be largely unchanged.

Month by Month Statistics - 2011								
	Concentration		AAQC Exceedances	AQI Sub-index				
	Average (ppb)	Maximum (ppb)		Very Good	Good	Moderate	Poor	Very Poor
Jan	2.0	16	0	100%	0%	0%	0%	0%
Feb	1.7	34	0	100%	0%	0%	0%	0%
Mar	2.1	39	0	100%	0%	0%	0%	0%
Apr	3.4	70	0	100%	0%	0%	0%	0%
May	4.5	61	0	100%	0%	0%	0%	0%
Jun	2.9	64	0	100%	0%	0%	0%	0%
Jul	3.1	49	0	100%	0%	0%	0%	0%
Aug	2.6	59	0	100%	0%	0%	0%	0%
Sep	1.9	53	0	100%	0%	0%	0%	0%
Oct	1.8	35	0	100%	0%	0%	0%	0%
Nov	1.9	26	0	100%	0%	0%	0%	0%
Dec	2.0	23	0	100%	0%	0%	0%	0%



Total Reduced Sulphur

Total Reduced Sulphur (TRS) is a group of sulphur-based compounds including hydrogen sulphide and various mercaptans. The ministry does not have a 1-hour AAQC so values were compared to 27 ppb, the highest concentration which would cause a "Moderate" AQI. This level is equivalent to the values used to evaluate the other AQI parameters. As a mixture, TRS may have a variety of sources: some natural such as swamps and bogs, others from various industrial sectors where sulphur-containing substances are common such as petrochemical refineries and sewage treatment plants.

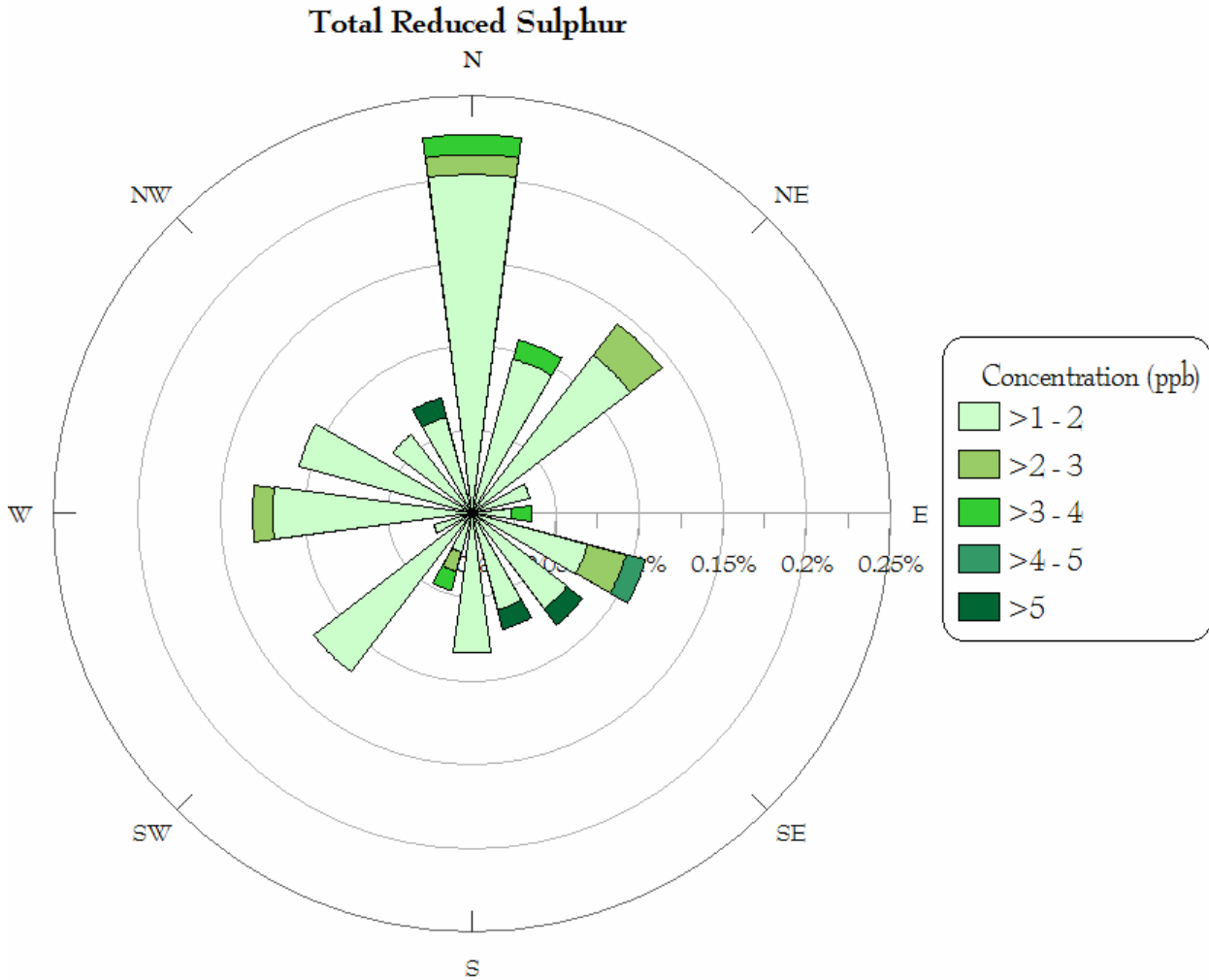
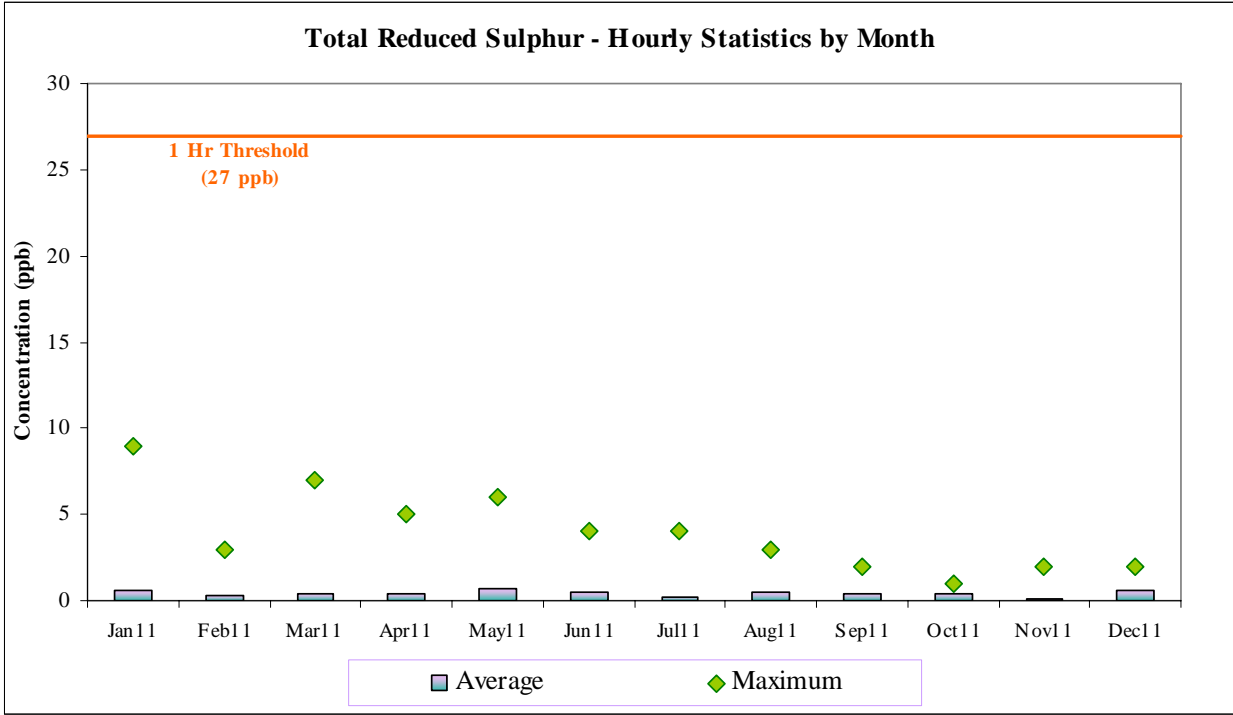
Report Values	Average (ppb)	Maximum (ppb)	AAQC Exceedances
<i>AFN Station</i>			
2011	0.4	9	0
2010	0.8	25	0
2009	0.9	14	0
<i>Other Stations, Current Report Period</i>			
Sarnia AQI	0.2	4	0
Windsor West AQI	0.2	18	0
London AQI	TRS is not measured in London		

No exceedances of the comparison value were measured in 2011. Both the average and maximum values were down over the previous two years. However the average was higher than either of the comparison stations and the maximum was higher than the value for the Sarnia AQI station. This result reflects the relative proximity of sources to the AFN station compared to the Sarnia AQI site. The average was also slightly higher than that at the Windsor West station but the maximum was somewhat lower.

Monthly values are given in the second table and illustrated on the next page. Three months had one hour each during which the TRS AQI sub-index was "good", while the remainder were "very good". Levels appeared to decline over the year varied only a little though the colder months have higher maxima, perhaps related to increased use of sulphur-containing fuels.

Month by Month Statistics - 2011								
	Concentration		AAQC Exceedances	AQI Sub-index				
	Average (ppb)	Maximum (ppb)		Very Good	Good	Moderate	Poor	Very Poor
Jan	0.6	9	0	99.87%	0.13%	0%	0%	0%
Feb	0.3	3	0	100%	0%	0%	0%	0%
Mar	0.4	7	0	99.87%	0.13%	0%	0%	0%
Apr	0.4	5	0	100%	0%	0%	0%	0%
May	0.7	6	0	99.86%	0.14%	0%	0%	0%
Jun	0.5	4	0	100%	0%	0%	0%	0%
Jul	0.2	4	0	100%	0%	0%	0%	0%
Aug	0.4	3	0	100%	0%	0%	0%	0%
Sep	0.4	2	0	100%	0%	0%	0%	0%
Oct	0.4	1	0	100%	0%	0%	0%	0%
Nov	0.1	2	0	100%	0%	0%	0%	0%
Dec	0.6	2	0	100%	0%	0%	0%	0%

A pollution rose for values greater than 1 ppb is shown on the next page. (The low values were left off so they did not overwhelm the few higher values). It suggests that there is not a dominant source of TRS but rather there may be a number of smaller sources in the area.



Nitrogen Dioxide

Nitrogen Dioxide (NO₂) is a common combustion product. This is a consequence of the large amount of nitrogen in the atmosphere. The main sources are motor vehicle exhaust and stationary sources such as electric utilities and industrial boilers. NO₂ reacts in the atmosphere to form a number of compounds, some of which have adverse health or environmental effects. It is an ozone precursor, a component of smog, and one of the causes of acid rain. The 1-hour AAQC for NO₂ is 200 ppb. This level is used here for evaluation.

Report Values	Average (ppb)	Maximum (ppb)	AAQC Exceedances
<i>AFN Station</i>			
2011	11.0	38	0
2010	14.4	80	0
2009	13.7	67	0
<i>Other Stations, Current Report Period</i>			
Sarnia AQI	8.6	55	0
Windsor West AQI	12.9	93	0
London AQI	8.3	50	0

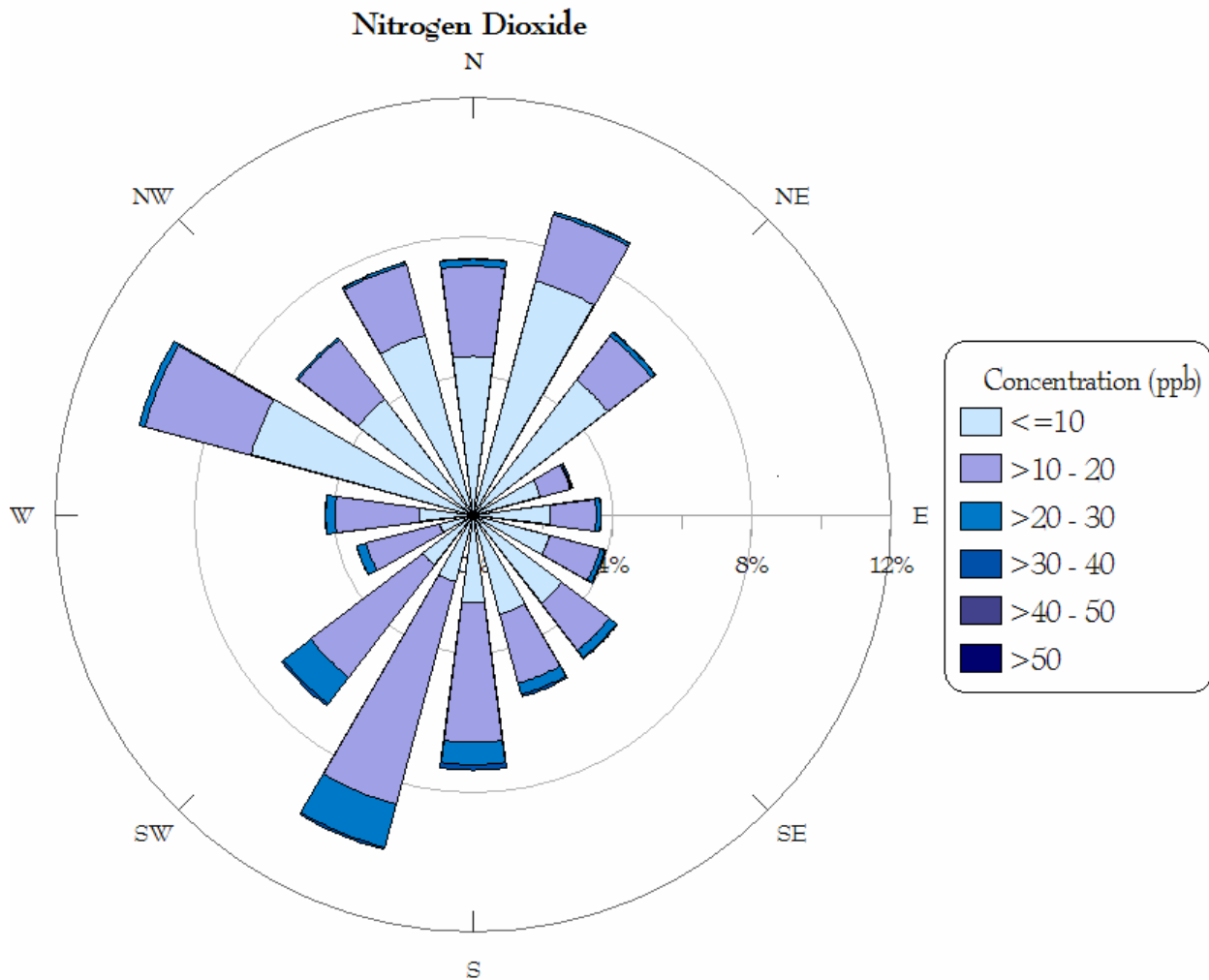
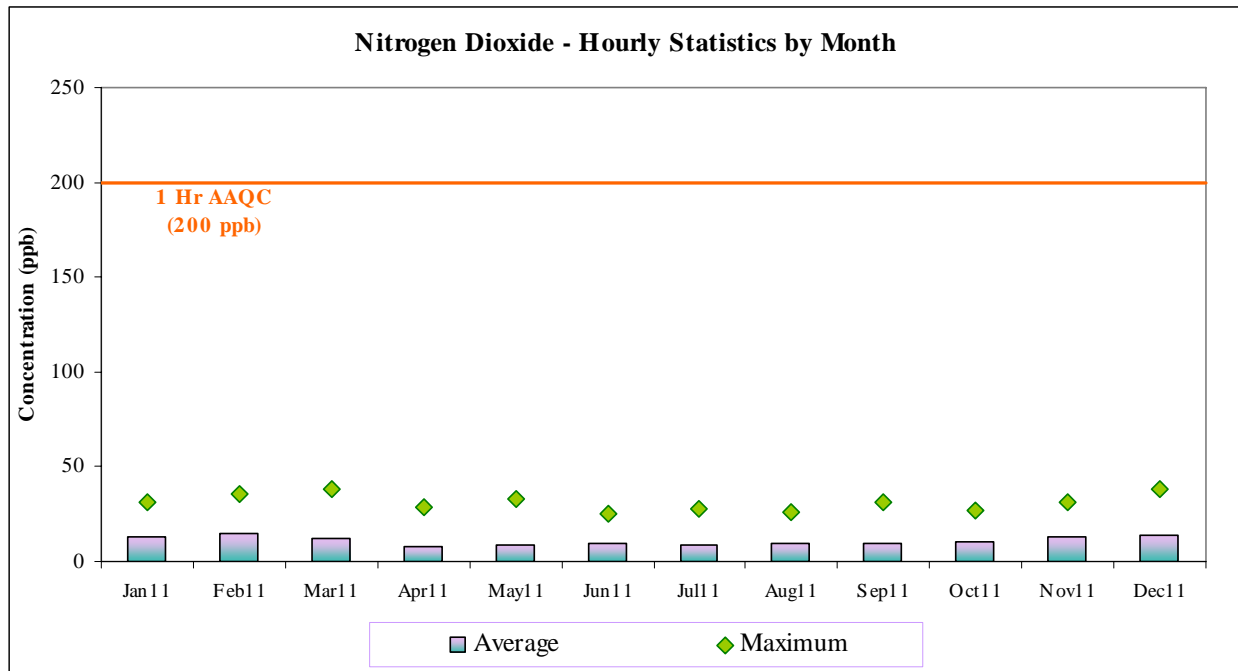
No exceedances of the AAQC were measured during 2011. Both the average and maximum concentration were lower than either of the previous two years. The average was higher than those seen in London or at the Sarnia AQI station, though lower than the value at the Windsor west station. The maximum was lower than any of the comparison stations.

A month by month summary of the NO₂ concentrations is given in the table below. No strong seasonal influences are apparent although there is a slight decline during the summer. This may be influenced by NO₂'s interaction with ozone. The NO₂ AQI subindex was always in the "very good" range – an improvement over the previous year.

The pollution rose on the next page illustrates how the NO₂ concentration varied with wind direction. Higher concentrations are seen from all directions though they are more frequent when the wind is coming from the south. In addition to local sources, long range

atmospheric transport may also contribute to local concentrations.

Month by Month Statistics - 2011								
	Concentration		AAQC Exceedances	AQI Sub-index				
	Average (ppb)	Maximum (ppb)		Very Good	Good	Moderate	Poor	Very Poor
Jan	13.3	31	0	100%	0%	0%	0%	0%
Feb	14.9	36	0	100%	0%	0%	0%	0%
Mar	11.8	38	0	100%	0%	0%	0%	0%
Apr	8.2	29	0	100%	0%	0%	0%	0%
May	8.9	33	0	100%	0%	0%	0%	0%
Jun	10.0	25	0	100%	0%	0%	0%	0%
Jul	9.1	28	0	100%	0%	0%	0%	0%
Aug	9.6	26	0	100%	0%	0%	0%	0%
Sep	9.7	31	0	100%	0%	0%	0%	0%
Oct	10.5	27	0	100%	0%	0%	0%	0%
Nov	12.6	31	0	100%	0%	0%	0%	0%
Dec	14.3	38	0	100%	0%	0%	0%	0%



Ground-level Ozone

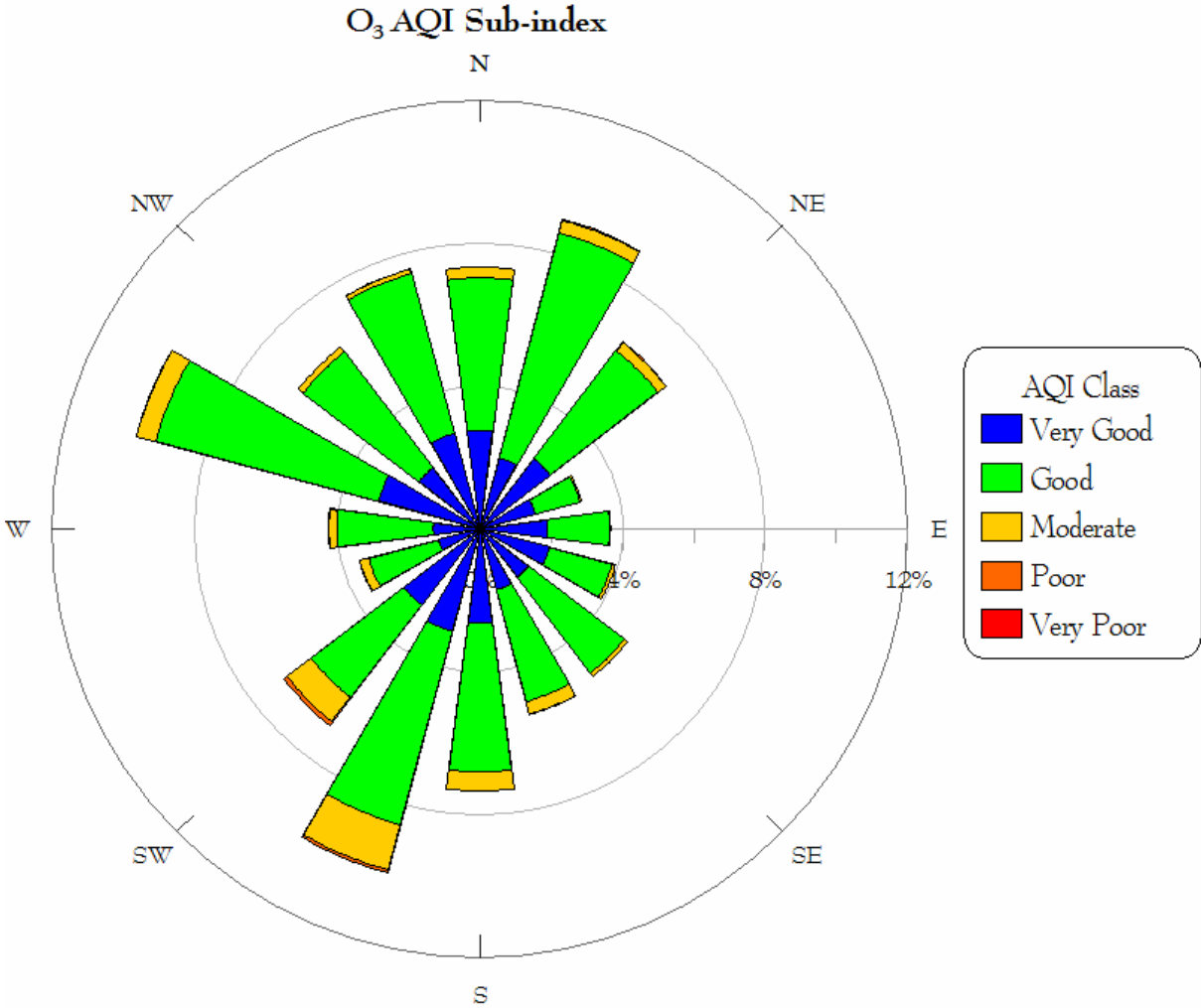
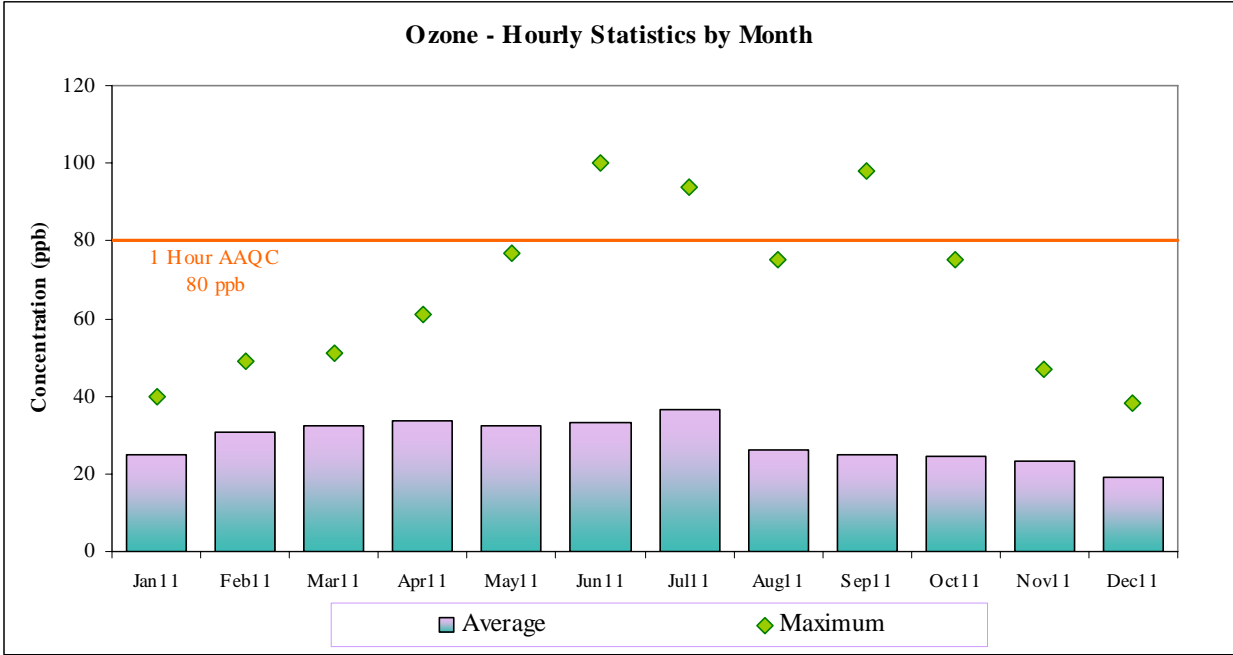
Unlike many other air contaminants, ozone (O₃) is not emitted to the atmosphere. It is formed in the presence of sunlight in reactions between nitrogen oxides and volatile organic compounds. This is a relatively slow process and some of the gases that form ground level ozone may have first travelled hundreds of kilometres. Strong sunlight and warm conditions speed up production and so high levels usually occur in the summer. This process also causes ozone concentrations to rise during the day and fall at night. Ground-level ozone is a major component of smog and can have human health impacts, particularly respiratory tract irritation. It also adversely affects certain plants. An in-depth discussion of this is included in the ministry report on transboundary air pollution: http://www.ene.gov.on.ca/environment/en/resources/STD01_076512.html. The ministry's 1-hour AAQC for O₃ is 80 ppb. This level is used for evaluation in this report.

Report Values	Average (ppb)	Maximum (ppb)	AAQC Exceedances
<i>AFN Station</i>			
2011	28.6	100	28
2010	26.8	86	2
2009	24.1	91	1
<i>Other Stations, Current Report Period</i>			
Sarnia AQI	29.6	94	12
Windsor West AQI	26.4	101	31
London AQI	26.8	83	2

Both the average and maximum concentrations were higher than in the previous two years and there were 28 exceedances of the 1-hour AAQC. The average concentration was slightly higher lower than two of the three comparison stations in the region but the maximum was higher than two of the three. However year to year variation for ozone is greatly dependant on wind and weather patterns. A more thorough discussion of ozone formation is found in the annual air reports at <http://www.ene.gov.on.ca/environment/en/resources/results/index.htm?txtSearchType=library&txtSearchValue=Air%20Quality%20-%20Annual%20Reports>.

Month by Month Statistics - 2011								
	Concentration		AAQC Exceedances	AQI Sub-index				
	Average (ppb)	Maximum (ppb)		Very Good	Good	Moderate	Poor	Very Poor
Jan	25.1	40	0	35.9%	64.1%	0.0%	0.0%	0.0%
Feb	30.8	49	0	16.7%	83.3%	0.0%	0.0%	0.0%
Mar	32.3	51	0	14.9%	84.4%	0.7%	0.0%	0.0%
Apr	33.7	61	0	12.6%	84.2%	3.2%	0.0%	0.0%
May	32.4	77	0	26.1%	64.7%	9.2%	0.0%	0.0%
Jun	33.1	100	14	30.5%	53.8%	13.8%	1.9%	0.0%
Jul	36.5	94	11	27.6%	47.8%	23.0%	1.5%	0.0%
Aug	26.3	75	0	49.0%	41.9%	9.1%	0.0%	0.0%
Sep	25.0	98	3	53.1%	43.3%	3.1%	0.5%	0.0%
Oct	24.6	75	0	46.7%	49.0%	4.3%	0.0%	0.0%
Nov	23.4	47	0	47.6%	52.4%	0.0%	0.0%	0.0%
Dec	19.1	38	0	67.6%	32.4%	0.0%	0.0%	0.0%

Because the chemicals that form ozone depend upon the prevailing winds, and many originate in industrial and developed areas, the summer winds bring more of the ozone precursors (or building blocks) to the region. This is seen in the pollution rose where higher frequencies of moderate (yellow) and poor (orange) air quality are associated with southerly wind directions.



Fine Particulate Matter

Fine particulate matter, sometimes called respirable particulate or PM_{2.5}, is the fraction of atmospheric particulate that is smaller than 2½ microns in diameter. These particles are important because their small size enables them to bypass the body's natural defences and reach the deepest parts of the lung. PM_{2.5} often forms from chemical processes in the atmosphere and acts much like a gas due to its small size. As a result, fine particulate may be measured hundreds of kilometres from its source. The ministry does not have a 1-hour AAQC or standard for PM_{2.5}. As a result, "exceedances" for PM_{2.5} were determined relative to the top of the "Moderate" AQI range, 45 µg/m³, though unlike many of the other AQI parameters the PM_{2.5} AQI sub-index is based upon a 3-hour running average. This process is consistent with that used for the other AQI pollutants and so gives an equivalent measure of the number of undesirable periods. For consistency, other statistics were also calculated for 3-hour averages.

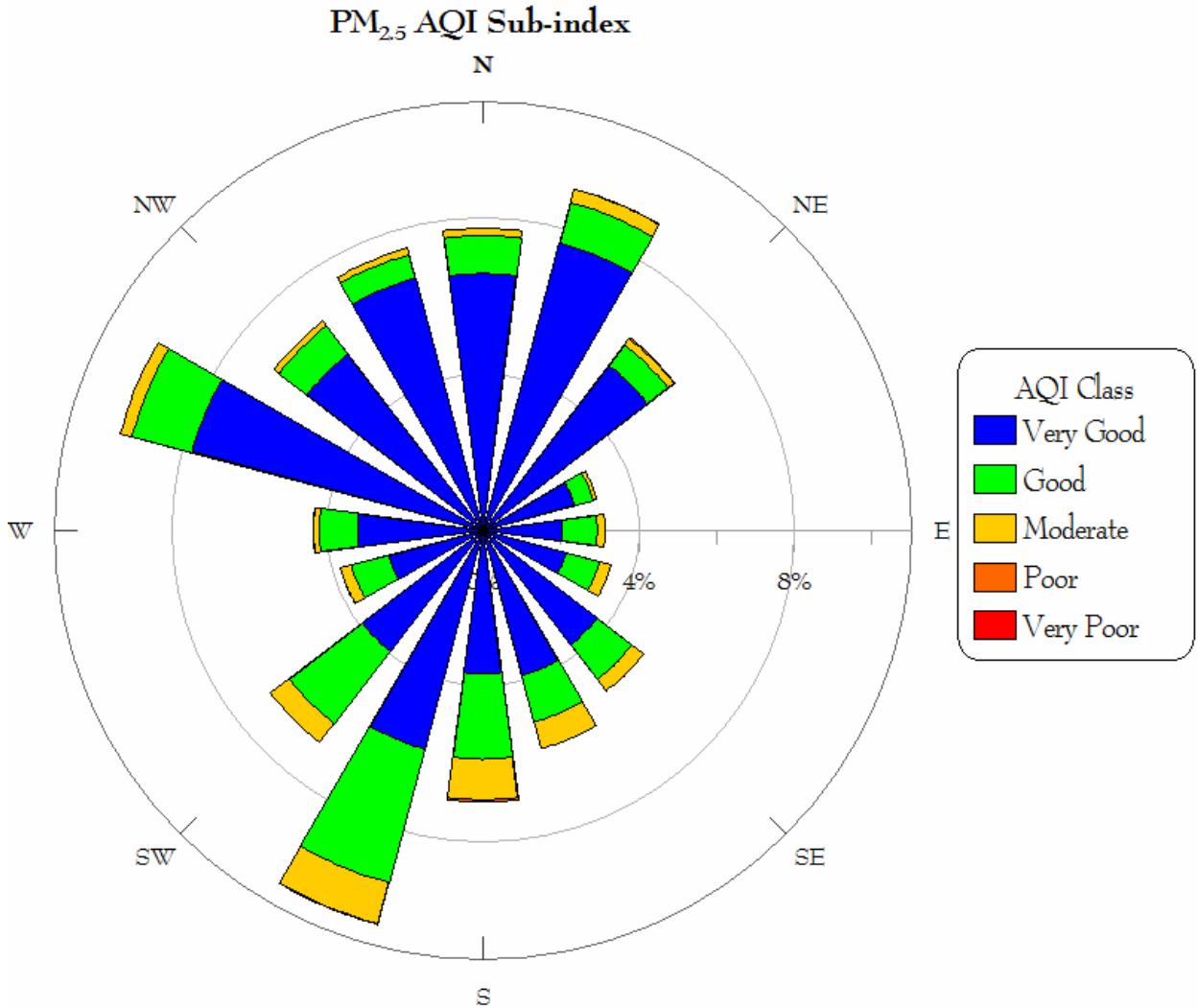
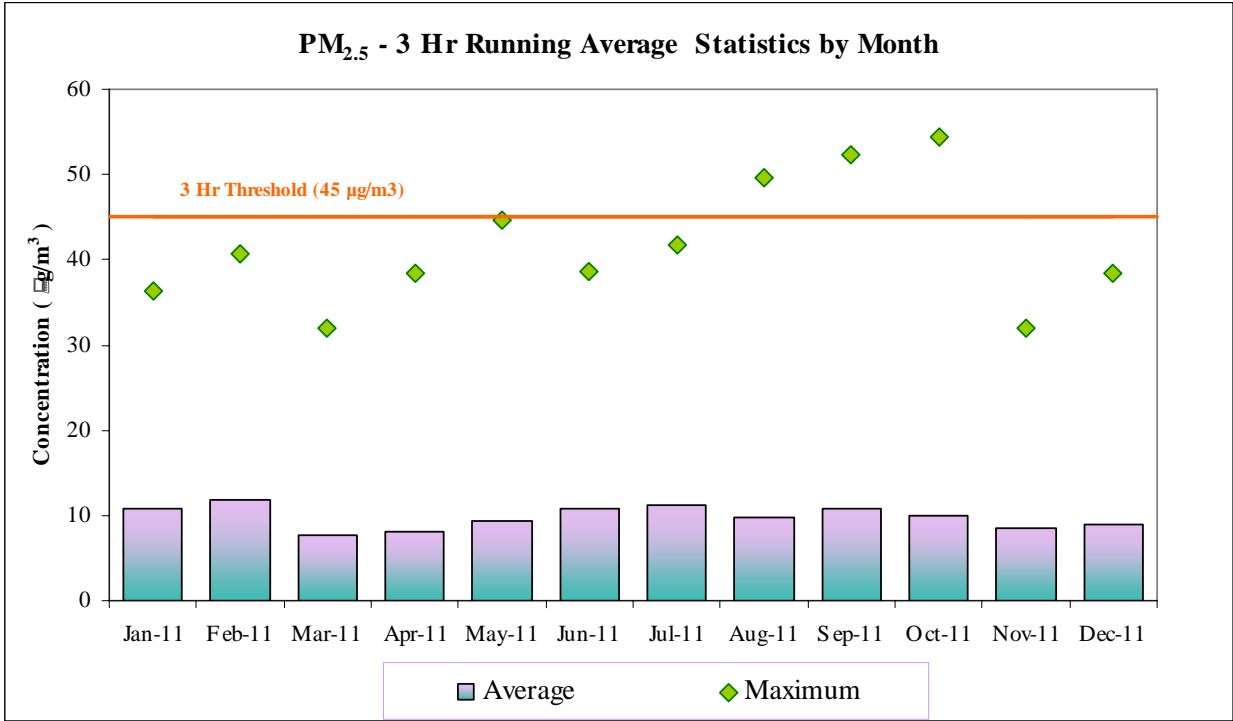
Annual Values (3 hr)	Average (µg/m ³)	Maximum (µg/m ³)	Exceedances
<i>AFN Station</i>			
2011	9.8	54.3	15
2010	10.2	73.0	37
2009	10.1	51.0	19
<i>Other Stations, Current Report Period</i>			
Sarnia AQI	10.4	52.7	1
Windsor West AQI	7.8	40.7	0
London AQI	6.2	35.3	0

The average value was lower than that seen in the previous two years, and the maximum was lower than the year before though slightly higher than the 2009 value. The number of exceedances was lower than either of the previous two years. The average was lower than the value seen at the Sarnia station though the maximum was marginally higher and had many more exceedances. It was also higher than the Windsor West and London stations in average and maxima.

A month by month summary of PM_{2.5} concentrations is given in the second table and

Month by Month Statistics - 2011								
	Concentration (3-hr)		Exceedances	AQI Sub-index				
	Average (µg/m ³)	Maximum (µg/m ³)		Very Good	Good	Moderate	Poor	Very Poor
Jan	10.7	36	0	61.3%	29.4%	9.3%	0.0%	0.0%
Feb	11.9	41	0	58.0%	26.6%	15.3%	0.0%	0.0%
Mar	7.7	32	0	80.2%	17.5%	2.3%	0.0%	0.0%
Apr	8.0	38	0	78.1%	19.7%	2.2%	0.0%	0.0%
May	9.4	45	0	69.9%	25.1%	5.0%	0.0%	0.0%
Jun	10.8	39	0	67.5%	23.2%	9.4%	0.0%	0.0%
Jul	11.2	42	0	59.2%	36.0%	4.7%	0.0%	0.0%
Aug	9.8	50	2	73.2%	20.6%	5.8%	0.3%	0.0%
Sep	10.8	52	6	62.0%	29.8%	7.2%	0.9%	0.0%
Oct	9.9	54	7	69.1%	23.1%	7.2%	0.7%	0.0%
Nov	8.6	32	0	77.4%	17.5%	5.1%	0.0%	0.0%
Dec	8.9	38	0	72.0%	23.5%	4.5%	0.0%	0.0%

illustrated in the graph on the next page. The data shows that nearly all the "poor" conditions occurred in the late summer and early fall, as opposed to the previous year, when they occurred in the spring. The highest average occurred during February, however. Moderate levels were more frequent when the wind was from the south, but were seen with all wind directions.



Suspended Particulate & Metals

In addition to hourly measurements of respirable particulate, a twenty-four hour sample of suspended particulate (SP) was taken every 6th day. In addition to determining particulate mass concentrations, this method permits analysis for a variety of particulate constituents such as metals. Samples were taken midnight to midnight EST. During 2011 sixty samples were taken while technical problems led to one missed sample.

Some of the metal concentrations were so low they could not be quantified – less than the method detection limit (MDL). The table below includes the number of values for each test that are greater than the detection limit. Averages are not reported when more than half the samples in the reporting period are below this level.

Suspended Particulate Monitoring Results ($\mu\text{g}/\text{m}^3$)									
	2011			2010			2009		
	Average	Max	No > mdl	Average	Max	No > mdl	Average	Max	No > mdl
Suspended Particulate	15.325	296 ⁱ	54	12.241	95	56	15.386	54	55
Silicon	0.258	2.1	53	0.386	4.7	57	0.412	1.7	56
Calcium	0.517	2.1	57	0.713	6.7	56	0.796	4.2	56
Vanadium	-	0.013	13	-	0.058	19	0.004	0.046	32
Chromium	-	0.002	3	-	0.002	4	-	0.005	9
Manganese	-	0.012	13	-	0.027	10	-	0.014	26
Iron	0.107	0.52	56	0.140	1.4	57	0.151	0.63	56
Nickel	-	0.005	3	-	0.004	12	-	0.019	20
Copper	-	0.006	18	-	0.01	14	-	0.007	19
Zinc	0.006	0.026	44	0.007	0.044	38	0.014	0.093	47
Cadmium	-	0.008	11	-	0.006	27	0.004	0.006	48
Lead	-	0.012	3	-	0.009	12	0.006	0.01	50

Particulate concentrations for this reporting period were a bit higher than those of the previous year the average was nearly identical to that of 2009 except for one very high result. However, unlike the previous year there was a reported exceedance of the AAQC (see footnote). While this result has been included in the results, there is some question as to its validity. The other species measured on the filters were generally down from both of the previous years, both in average – when it could be calculated – and in maximum value.

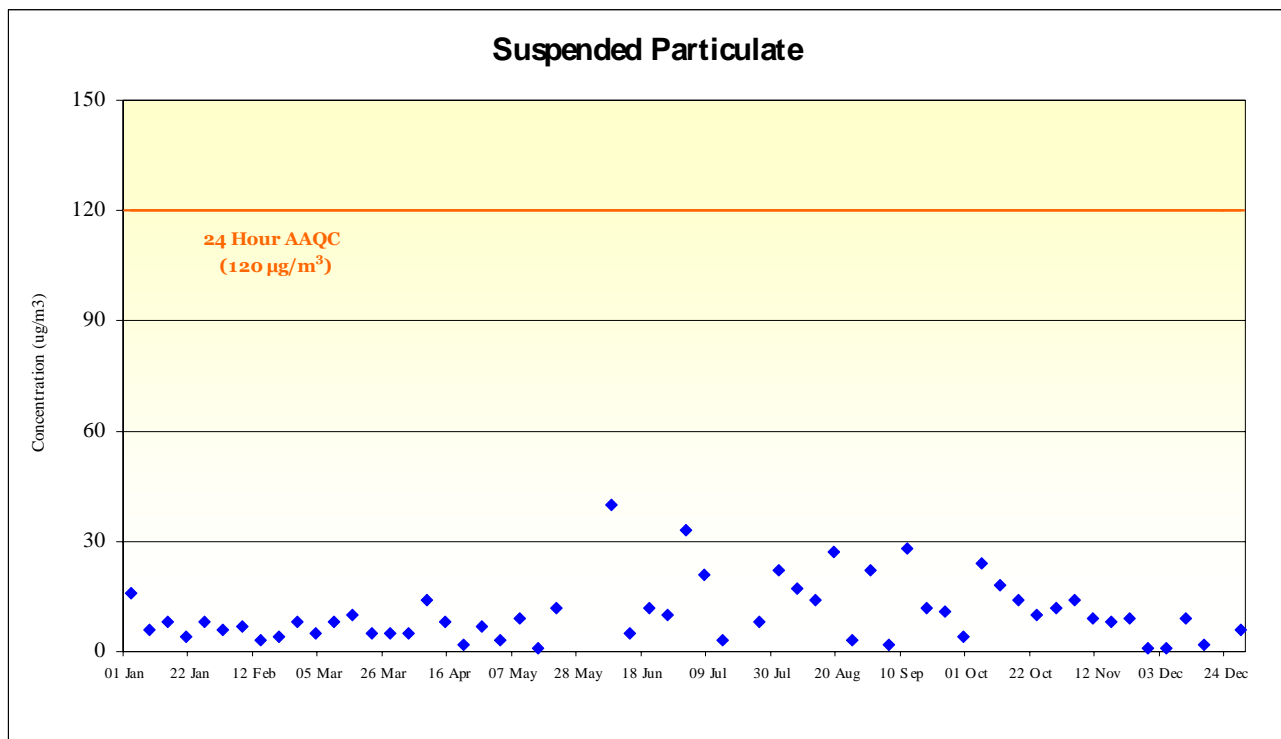
The ministry has 24-hour AAQC for TSP and for most of the determined particulate constituents. None of the AAQC were exceeded other than the one instance described above.

ⁱ The ministry's laboratory, which determined this value, has labelled the result as unusual. Results from the hourly particulate monitor at the AFN station averaged only $28 \mu\text{g}/\text{m}^3$ over the same period. This difference is much larger than would be expected for two co-located samplers. The second largest measurement for 2011 was $40 \mu\text{g}/\text{m}^3$ which is well below the AAQC.

Maximum Concentrations Compared to AAQC		
Test	AAQC ($\mu\text{g}/\text{m}^3$)	% of AAQC
TSP	120	246.67%
Silicon	-	-
Calcium	-	-
Vanadium	2	0.65%
Chromium	0.5	0.40%
Manganese	0.4	3.00%
Iron	4	13.00%
Nickel	0.2	2.27%
Copper	50	0.01%
Zinc	120	0.02%
Cadmium	0.025	32.00%
Lead	0.5	2.40%

Directional information is normally of limited use for 24-hour samples as the wind variation may allow sources in different directions to contribute to a single sample and it is not possible to separate their contribution.

Particulate levels were somewhat higher in the summer. Larger particulate is related in part to influences of agriculture and snow cover. This can be seen in the graph below. (The extreme point is not plotted so the graph may be scaled to better show the variation in other measurements). Particulate levels climb in early May, persist at higher levels until October and then slowly decline again.



Non-continuous Volatile Organic Compounds

In addition to the hourly VOC monitoring conducted by the ministry at AFN, Environment Canada (EC) collected twenty-four hour samples every twelfth day. 30 samples were collected and analysed during 2011. EC collected samples using specially prepared evacuated canisters and analysis was performed at their laboratory in Ottawa. This method permits determination of a much wider range of target compounds (160) and detection at much lower concentrations. 50 of these compounds have an AAQC. One, octane, has a 10-minute AAQC, and two others - decane and chlorobenzene - each have a 1-hour AAQC. The remainder have 24-hour AAQC. Of these, one, 1,1-dichloroethane, was not detected. The remaining 46 are compared to their respective AAQC in Table 1.

Environment Canada VOC Concentrations Compared to 24-hour AAQC							
Compound	24 Hr AAQC (µg/m³)	Maximum (% of AAQC)	Average (% of AAQC)	Compound	24 Hr AAQC (µg/m³)	Maximum (% of AAQC)	Average (% of AAQC)
Freon113	800000	0.0001%	0.0001%	1,2,4-Trichloro benzene	400	0.0137%	0.0027%
Freon114	700000	0.0000%	0.0000%	iso-Propylbenzene	400	0.0087%	0.0033%
Freon12	500000	0.0006%	0.0005%	Tetrachloroethylene	360	0.2098%	0.0249%
Freon22	350000	0.0003%	0.0002%	Chloromethane	320	3.1569%	0.8008%
1,1,1-Trichloroethane	115000	0.0000%	0.0000%	Dichloromethane	220	0.1644%	0.1058%
1-Decene	60000	0.0001%	0.0000%	1,2,4-Trimethylbenzene	220	0.1522%	0.0528%
Acetylene	56000	0.0022%	0.0009%	1,2,3-Trimethylbenzene	220	0.0482%	0.0185%
1-Octene	50000	0.0003%	0.0001%	1,3,5-Trimethylbenzene	220	0.0418%	0.0148%
1,2-Dichlorobenzene	30500	0.0002%	0.0000%	trans-1,2-Dichloroethylene	105	0.0104%	0.0036%
Heptane	11000	0.0038%	0.0018%	cis-1,2-Dichloroethylene	105	0.0055%	0.0011%
Hexane	7500	0.3839%	0.0409%	1,4-Dichlorobenzene	95	0.3005%	0.0256%
Methylterbutylether	7000	0.0001%	0.0000%	Bromoform	55	0.1709%	0.0357%
Cyclohexane	6100	0.1276%	0.0131%	Ethylene	40	27.4868%	7.8477%
Freon11	6000	0.0326%	0.0256%	Naphthalene	22.5	0.8027%	0.3563%
Chloroethane	5600	0.0012%	0.0005%	Trichloroethylene	12	0.9675%	0.1843%
Propylene	4000	0.1561%	0.0387%	1,3-Butadiene	10	3.8360%	0.9094%
1,2-Dichloropropane	2400	0.0013%	0.0007%	1,1-Dichloroethylene	10	0.0250%	0.0021%
Toluene	2000	0.1413%	0.0606%	Ethylene dibromide	3	0.1567%	0.0273%
Bromomethane	1350	0.0080%	0.0043%	Carbon tetrachloride	2.4	28.2625%	22.4706%
Ethylbenzene	1000	0.0584%	0.0226%	Benzene	2.3	124.7130%	52.3319%
m- & p-Xylene	730	0.1445%	0.0562%	1,2-Dichloroethane	2	6.5000%	3.4398%
o-Xylene	730	0.0499%	0.0197%	Chloroform	1	14.1200%	8.7677%
Styrene	400	0.1132%	0.0166%	Vinyl chloride	1	2.9800%	0.4293%

In cases where AAQC do not exist in the appropriate time scale, the ministry uses a method outlined in O.Reg 419 to calculate an equivalent concentration for comparison purposes. This benchmark level was determined for each of the three compounds with different AAQC averaging periods and the results were compared to these values. These are summarised in Table 2.

Compound	AAQC ($\mu\text{g}/\text{m}^3$)	AAQC Averaging time	Equivalent 24 hour benchmark ($\mu\text{g}/\text{m}^3$)	Maximum (% of benchmark)	Average (% of benchmark)
Octane	61800	10 minutes	15000	0.0004%	0.0002%
Decane	60000	1 hour	25000	0.0004%	0.0001%
Chlorobenzene	3500	1 hour	1400	0.0005%	0.0003%

31 of the 49 maxima are lower than the previous year, and 33 of the averages are down as well. The largest increases in maximum value occurred for 1,2-dichlorobenzene and 1,4-dichlorobenzene but both of these remained well below their respective AAQC.

However one of the benzene samples exceeded the ministry's new 24-hour AAQC. This occurred on June 26 during which time the wind varied between the west and northeast. Nonetheless this is an improvement over the previous two years during which this value was exceeded 4 times in 2010 and 5 times in 2009.

In addition to the 24-hour AAQC listed above, six substance have annual AAQC as well. These are listed in Table 3 The annual averages are recapped in the table for ease of comparison. These values should be viewed as approximate, as they represent intermittent sampling.

Substance	Annual AAQC ($\Phi\text{g}/\text{m}^3$)	Average ($\Phi\text{g}/\text{m}^3$)		
		2011	2010	2009
1,3-Butadiene	2.0	0.0909	0.1843	0.1072
Benzene	0.45	1.2036	1.2336	1.3622
Vinyl chloride	0.2	0.0043	0.0050	0.0199
Dichloromethane	44.0	0.2327	0.2419	0.2490
Chloroform	0.45	0.0877	0.0820	0.0803
1,2-Dichloroethane	0.4	0.0688	0.0806	0.0632

The values seem fairly constant over the three years of available data. Decreases were seen this year five of the six substances, but three years are not sufficient to identify a trend for the level of changes seen here. As it did with the daily values, benzene exceeds the new annual AAQC.

Unlike previous years, data are not available for other nearby stations. Instead this years results for the compounds are compared to those from the previous two years in Table 4. The AAQC equivalents are included in the table for reference only.

Table 4 3 Year Comparison of Canister VOC Results

Compounds (All values in $\mu\text{g}/\text{m}^3$)	24 Hr AAQC	2011		2010		2009	
		Maximum	Average	Maximum	Average	Maximum	Average
Freon113	800000	0.7209	0.5971	0.6656	0.5806	0.7198	0.5945
Freon114	700000	0.1549	0.1182	0.1258	0.1084	0.1408	0.1121
Freon12	500000	2.8954	2.5451	2.8820	2.5318	3.2226	2.5554
Freon22	350000	0.9417	0.7459	0.9322	0.7048	1.0641	0.7178
1,1,1-Trichloroethane	115000	0.0503	0.0398	0.2060	0.0524	0.0670	0.0562
Octane	(15000)	0.2758	0.1143	1.0601	0.1481	0.5612	0.1731
1-Decene	60000	0.0395	0.0083	0.0333	0.0050	0.0336	0.0095
Decane	(25000)	0.2134	0.0724	1.0533	0.1248	0.4237	0.1292
Acetylene	56000	1.2344	0.5243	1.2513	0.5796	1.2159	0.5083
1-Octene	50000	0.1360	0.0358	0.1580	0.0373	0.1038	0.0370
1,2-Dichlorobenzene	30500	0.0545	0.0052	0.0067	0.0033	0.0094	0.0038
Heptane	11000	0.4216	0.2026	0.9616	0.2301	0.9570	0.3219
Hexane	7500	28.7922	3.0667	24.7470	2.8863	11.5532	1.7220
Methyltertbutylether	7000	0.0087	0.0003	0.0271	0.0009	0.0099	0.0003
Cyclohexane	6100	7.7861	0.7978	11.3910	1.5114	9.9159	1.5218
Freon11	6000	1.9530	1.5363	1.8344	1.6063	1.9214	1.5625
Chloroethane	5600	0.0657	0.0283	0.0596	0.0249	0.0966	0.0312
Propylene	4000	6.2454	1.5476	12.2688	2.4755	8.2430	1.7837
Chlorobenzene	(1400)	0.0164	0.0110	0.0283	0.0115	0.0426	0.0133
1,2-Dichloropropane	2400	0.0312	0.0164	0.5265	0.0314	0.0200	0.0131
Toluene	2000	2.8257	1.2127	5.0839	1.4233	5.4952	1.6958
Bromomethane	1350	0.1081	0.0579	0.1561	0.0541	0.0637	0.0521
Ethylbenzene	1000	0.5836	0.2264	1.3636	0.3005	1.1424	0.3316
m- & p-Xylene	730	1.0546	0.4106	1.5325	0.4623	1.3547	0.5437
o-Xylene	730	0.3643	0.1439	0.5666	0.1657	0.6081	0.2073
Styrene	400	0.4529	0.0665	0.6167	0.1392	81.8215	3.3632
1,2,4-Trichlorobenzene	400	0.0546	0.0110	0.0371	0.0107	0.0595	0.0151
iso-Propylbenzene	400	0.0349	0.0132	0.0535	0.0164	0.5809	0.0478
Tetrachloroethylene	360	0.7551	0.0897	0.4163	0.0821	0.2195	0.0706
Chloromethane	320	10.1021	2.5625	18.6917	3.1242	16.6220	3.4558
1,2,4-Trimethylbenzene	220	0.3348	0.1161	0.8809	0.1677	1.1731	0.2125
1,2,3-Trimethylbenzene	220	0.1060	0.0406	0.2523	0.0653	0.2005	0.0854
1,3,5-Trimethylbenzene	220	0.0920	0.0325	0.2443	0.0473	0.2047	0.0537
Dichloromethane	220	0.3617	0.2327	0.4172	0.2419	0.7809	0.2490
trans-1,2-Dichloroethylene	105	0.0109	0.0037	0.0163	0.0029	0.0173	0.0017
cis-1,2-Dichloroethylene	105	0.0058	0.0011	0.4183	0.0189	0.3576	0.0161
1,4-Dichlorobenzene	95	0.2855	0.0243	0.0452	0.0190	0.0548	0.0174
Bromoform	55	0.0940	0.0196	0.0388	0.0168	0.0342	0.0160
Ethylene	40	10.9947	3.1391	25.1868	4.9179	25.0431	4.2775
Naphthalene	22.5	0.1806	0.0802	0.3859	0.0878	0.2243	0.0889
Trichloroethylene	12	0.1161	0.0221	0.1089	0.0294	0.1160	0.0290
1,3-Butadiene	10	0.3836	0.0909	1.3790	0.1843	0.5383	0.1072
1,1-Dichloroethylene	10	0.0025	0.0002	0.0257	0.0014	0.0088	0.0007
Ethylene dibromide	3	0.0047	0.0008	0.0031	0.0006	0.0052	0.0009
Carbon tetrachloride	2.4	0.6783	0.5393	0.6700	0.5606	0.6219	0.5559
Benzene	2.3	2.8684	1.2036	4.1489	1.2336	5.8458	1.3622
1,2-Dichloroethane	2	0.1300	0.0688	0.2341	0.0806	0.0987	0.0632
Chloroform	1	0.1412	0.0877	0.1349	0.0820	0.1485	0.0803
Vinyl chloride	1	0.0298	0.0043	0.0284	0.0050	0.4186	0.0199

Volatile Organic Compounds – Hourly Measurements

Hourly levels of several volatile organic compounds (VOC) have been measured at the AFN station since its inception, using a gas chromatograph/mass spectrometer (GC/MS). The initial target list of compounds was chosen based upon the ministry's expectations of what might be detected in the area but has been changed to reflect results, dropping some substances that weren't seen in favour of new ones. Table 1 summarizes the 2011 results and compares them to the results from previous years, where available. No vinyl chloride, carbon disulphide, or acrylonitrile were detected and so these compounds are not included in the tables. Chloroform was added to the target list midway through 2011 but it was never detected.

Table 1 1-Hour VOC Measurements									
	2011			2010			2009		
Compound	Average (ppb)	Max (ppb)	Detected	Average (ppb)	Max (ppb)	Detected	Average (ppb)	Max (ppb)	Detected
Propylene	0.515	151.44	2.16%	0.378	234.02	0.50%	0.135	95.14	0.33%
Chloromethane	0.183	56.35	1.17%	0.025	71.00	0.07%	-	-	-
1,3-Butadiene	0.046	111.95	0.15%	0.003	19.29	0.01%	0.202	702.75	0.05%
Hexane	0.265	54.87	2.69%	0.001	2.64	0.06%	-	-	-
Cyclohexane	0.167	58.78	2.03%	0.191	50.08	1.38%	0.055	48.89	0.62%
Benzene	0.125	23.15	3.20%	0.065	24.02	1.90%	0.128	12.60	4.78%
Toluene	0.172	45.28	7.21%	0.124	29.63	4.83%	0.276	29.11	14.87%
Ethyl Benzene	0.066	17.10	3.39%	0.035	4.48	3.74%	0.079	18.76	6.82%
m&p-Xylene	0.049	11.16	3.20%	0.072	8.97	3.59%	0.149	29.20	6.57%
o-Xylene	0.035	6.72	2.89%	0.039	3.72	3.86%	0.085	19.83	6.49%
Styrene	0.001	1.24	0.09%	0.002	1.52	0.23%	0.014	6.11	0.85%

Only toluene was detected more than 5% of the time though many of the species were seen more often than in 2010, and most averages were slightly higher. This could be due to improvements in the instrument, variations in the wind direction or changes in processes at the local plants.

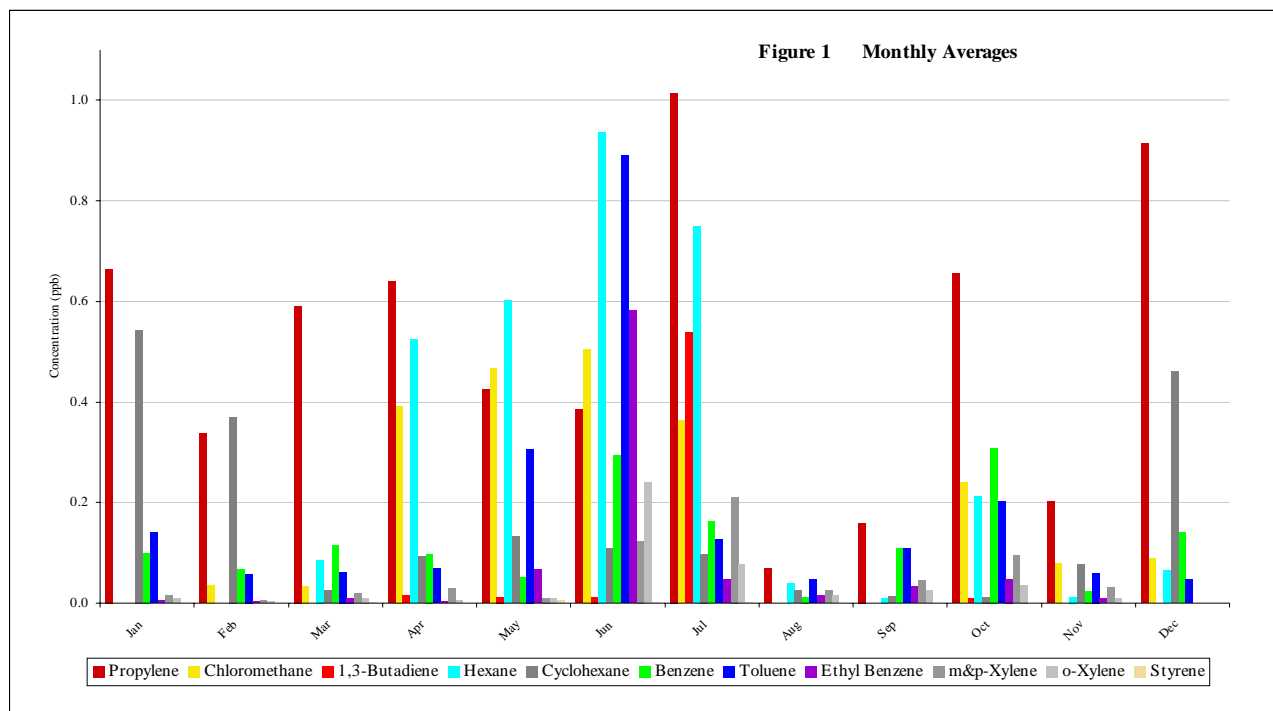
24-hour averages were calculated and compared with the 24-hour AAQC. These are summarized in Table 2. 1,3-butadiene (1 time) and benzene (23 times) exceeded their 24-hour AAQC. Since the ministry publishes its standards in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) but the instrument reports values in parts per billion, both values are included in the table. The measurements should be compared to the second (blue) line.

The annual averages were also compared to annual AAQC where they exist. Of the substances that were measured only benzene (AAQC=0.134 ppb) and 1,3-butadiene (AAQC=0.859 ppb) have annual AAQC. Neither were exceeded.

Table 3 summarizes the month to month variation in the 11 species that were seen. Some increased in late spring and early summer and then declined in late summer but this did not occur in all cases. The results are are illustrated in Figure 1.

	Propylene	Chloromethane	1,3-Butadiene	Hexane	Cyclohexane	Benzene	Toluene	Ethyl Benzene	m&p-Xylene	o-Xylene	Styrene
24-hr AAQC ($\mu\text{g}/\text{m}^3$)	4000	320	10	7500	6100	2.3	2000	1000	730	730	400
24-hr AAQC (ppb)	2287	152	4.3	2093	1743	0.7	522	226	165	165	92
#> AAQC	0	0	1	0	0	23	0	0	0	0	0
Maximum 24-hour Value (ppb)	23.88	6.22	12.30	11.07	5.23	3.30	3.75	4.04	2.39	1.90	0.08

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Propylene	0.665	0.338	0.591	0.638	0.425	0.385	1.014	0.068	0.159	0.656	0.202	0.914
Chloromethane	0.000	0.037	0.034	0.392	0.465	0.505	0.363	0.000	0.000	0.240	0.079	0.089
1,3-Butadiene	0.000	0.000	0.000	0.016	0.013	0.012	0.538	0.000	0.000	0.008	0.000	0.000
Hexane	0.000	0.000	0.085	0.524	0.601	0.935	0.748	0.040	0.010	0.213	0.012	0.065
Cyclohexane	0.543	0.370	0.025	0.093	0.131	0.108	0.098	0.026	0.014	0.012	0.076	0.461
Benzene	0.100	0.066	0.116	0.098	0.051	0.294	0.163	0.011	0.108	0.309	0.023	0.141
Toluene	0.140	0.058	0.062	0.068	0.306	0.890	0.127	0.047	0.108	0.203	0.060	0.046
Ethyl Benzene	0.006	0.003	0.010	0.004	0.067	0.583	0.047	0.016	0.033	0.048	0.009	0.000
m&p-Xylene	0.016	0.006	0.019	0.029	0.010	0.123	0.210	0.026	0.045	0.095	0.030	0.000
o-Xylene	0.008	0.004	0.011	0.005	0.010	0.240	0.078	0.016	0.026	0.036	0.010	0.000
Styrene	0.000	0.000	0.001	0.000	0.006	0.001	0.002	0.000	0.000	0.000	0.000	0.000



Terminology

Ambient Air Quality Criteria (AAQC): Desirable average concentrations for specific atmospheric contaminants. They usually reflect ½-hour, 1-hour, or 24-hour averages though occasionally other periods are determined to be more appropriate. They are based upon the most sensitive endpoint: health, environmental effects, odours, or soiling.

Air Quality Index (AQI): An indicator of air quality, based on air pollutants that have adverse effects on human health and the environment. The pollutants are ozone, fine particulate matter, nitrogen dioxide, carbon monoxide, sulphur dioxide and total reduced sulphur compounds. The air quality is reported as both a number (the index) and one of five classifications based upon the index: *Very Good, Good, Moderate, Poor, or Very Poor*. More information may be found by following the links on the ministry's air quality web site <http://www.airqualityontario.com/>

Air Quality Sub-index: A value related to the concentration of each of the AQI pollutants based upon their individual health and environmental effects. A sub-index is calculated every hour for each AQI pollutant measured at a station. The maximum is reported as the AQI for that station for that hour.

Detection Limit (DL): The smallest amount of a substance which an instrument can differentiate from 0. This is related to the Method Detection Limit (**MDL**) which is the lowest amount of a substance that an entire analysis method (media preparation, sampling, extraction, and instrumental analysis) can reliably determine.

Exceedance: An concentration of some pollutant that is higher than the standard or other benchmark for that substance.

Micrograms per Cubic Metre ($\mu\text{g}/\text{m}^3$): A concentration unit used to report pollutant concentrations in the atmosphere. One microgram is a millionth of a gram

Micron (μm): One millionth of a metre = one thousandth of a millimetre = about three millionths of a foot

98th Percentile: The value in a set or series below which 98% of the measurements are found. This cannot be measured, only determined once measurements are complete.

Part per Billion (ppb): A concentration unit used by various instruments to report gas concentrations in the atmosphere. This is the approximate equivalent of 50 drops of water in an Olympic size swimming pool. Similarly "**ppm**" means "part per million" a unit which is 1000 times larger.

Point of Impingement Standard (POI): The maximum allowable average concentration of a particular pollutant which may be caused by a source or sources at one location. This level must exclude the background or contributions from other sources. Averaging periods are usually ½ hour or 24 hours but may be different in certain cases.

Polycyclic Aromatic Hydrocarbons (PAH): A class of molecules composed of fused six-sided carbon rings (looking a bit like honeycomb from the front). They form during most combustion processes when conditions do not allow all the carbon to be oxidized.

Volatile Organic Compounds (VOC): Organic (containing carbon) chemicals that exist as a gas (at least partially), at normal environmental temperatures and pressures.

Data Averaging

There are ministry protocols that have been established for dealing with concentrations that are reported as "0". In general if an instrument has a well defined detection limit ("DL") which is the lowest concentration at which it can say a substance is present, then anything below that will be recorded as 0. However, the "real" value of that concentration could be anywhere below this level (DL) and 0. There is no way of knowing.

A standard practice in situations such as this, is to use half of the DL when calculating averages. This usually offers a reasonably good estimate if the number of values below DL is relatively small. In addition, since the uncertainty of the average grows with the number of these values, an average will not be reported if more than half of these values are below DL. This protocol is followed for the PAH, non-continuous VOC, and suspended particulate and metals.

However this is not the practice that is followed for the continuous monitors. The ministry has been reporting results from AQI monitors for years and including 0 as 0 in average calculations. The ministry has chosen to use the same methodology in this report so that these results may be compared to those found in AQI reports. While most real-time instruments will record a 0 from time to time, this decision will only have a noticeable impact on SO₂, and TRS which usually exhibit very low levels.

This practice was also adopted for the real time VOC monitor but for very different reasons. Because of the nature of the instrument, we have not been able to determine a detection limit for each of the species involved. Therefore there is no value of which one can take half for use in performing calculations. In addition, since detectable levels are seen infrequently, averages could not be presented as they cannot be considered representative. This would greatly limit our ability to discuss the results.