Air Quality in Ontario

Report for 2011

Ontario

Acknowledgements

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2011 Report Highlights

ONTARIO AIR QUALITY IS IMPROVING

- The 2011 air quality report marks 41 years of long-term reporting on the state of air quality in Ontario. This report summarizes province-wide trends for key airborne pollutants impacting Ontario's air quality.
- Overall, air quality has improved significantly over the past 10 years, especially for nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2) - pollutants emitted by vehicles and industry, as well as fine particulate matter ($PM_{2.5}$), which may be emitted directly or from other emissions such as SO_2.
- Ozone is a secondary pollutant formed when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight. Ozone annual means have increased by 7 per cent from 2002 to 2011, however, ozone summer means continue to show improvement and have decreased by 9 per cent over the same period.

Decreasing Provincial Ambient Concentrations	
NO_2	↓ 41% (2002-2011)
CO	↓ 35% (2002-2011)
SO_2	↓ 52% (2002-2011)
$PM_{2.5}$	↓ 30% (2003-2011)

ONTARIO EMISSIONS ARE DECREASING

- Emissions of nitrogen oxides (NO_X), CO and SO_2 continue to decrease due in part to Ontario's air quality initiatives such as the phase-out of coal-fired generating stations, emissions trading regulations (O. Reg. 397/01 and O. Reg. 194/05), emissions controls at Ontario smelters, and Drive Clean emissions testing, which supports the federal vehicle emission standards and lower sulphur content in transportation fuels.

Decreasing Provincial Emissions (2001-2010)	
NO_x	↓ 36%
CO	↓ 24%
SO_2	↓ 55%
$PM_{2.5}$	↓ 33%

- Transboundary influences, mainly from the U.S., account for approximately half of Ontario's smog. Emission reductions in Ontario and the U.S. have contributed to decreases in $PM_{2.5}$ and summer ozone levels. Winter and annual ozone levels are increasing due to a global rise in ozone levels.

THE ONTARIO AMBIENT AIR QUALITY CRITERIA (NO_2, CO, SO_2, and O_3)

- During 2011, the provincial Ambient Air Quality Criteria (AAQC) for NO_2, CO and SO_2 were not exceeded in any regions of Ontario where ambient air monitoring exists.
- The provincial one-hour AAQC for O_3 was exceeded at 28 of the 40 ambient air monitoring sites in 2011 for at least one hour, and these exceedances exclusively occurred in summer from May to September.

THE CANADA-WIDE STANDARDS (CWS) ($PM_{2.5}$ and Ozone)

- For a fourth year in a row, the CWS for $PM_{2.5}$ was not exceeded in Ontario. The $PM_{2.5}$ CWS 3-year metrics are trending downwards from 2005 to 2011.
- Six of the 21 designated sites met the CWS for ozone in 2011. For the first time, Barrie, London, Mississauga, and Sudbury met the CWS for ozone. The ozone CWS 3-year metrics are trending downwards from 2005 to 2011.

Table of Contents

1.0 Introduction

This annual report, the 41st in a series, summarizes the state of ambient air quality in Ontario during 2011 and examines 10-year trends. It reports on the measured levels of six common air pollutants: ground-level ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and total reduced sulphur (TRS) compounds. The report also summarizes the results from the Air Quality Index (AQI) and Smog Alert programs. The annual statistics and 10- and 20-year trends of ambient air quality data are presented in the attached appendix.

Ontario continues to benefit from one of the most comprehensive air monitoring systems in North America, comprised of 40 monitoring sites across the province that undergo regular maintenance and strict data quality assurance and quality control (QA/QC) procedures to ensure a high standard of data quality. The data, which are collected continuously at these sites, are used to determine the current state of air quality and reported in near real-time on the ministry's website at www.airqualityontario.com.

The Ministry of the Environment uses this information to:

- inform the public about Ontario's ambient air quality;
- assess Ontario's air quality and evaluate long-term trends;
- identify areas where criteria and standards are exceeded;
- provide the basis for air policy/program development;
- determine the impact from U.S. and Canadian sources on Ontario's air quality;
- provide scientists with air quality data to link environmental and human health effects to pollution levels; and
- provide smog advisories for public health protection.

2.0 Ground-Level Ozone

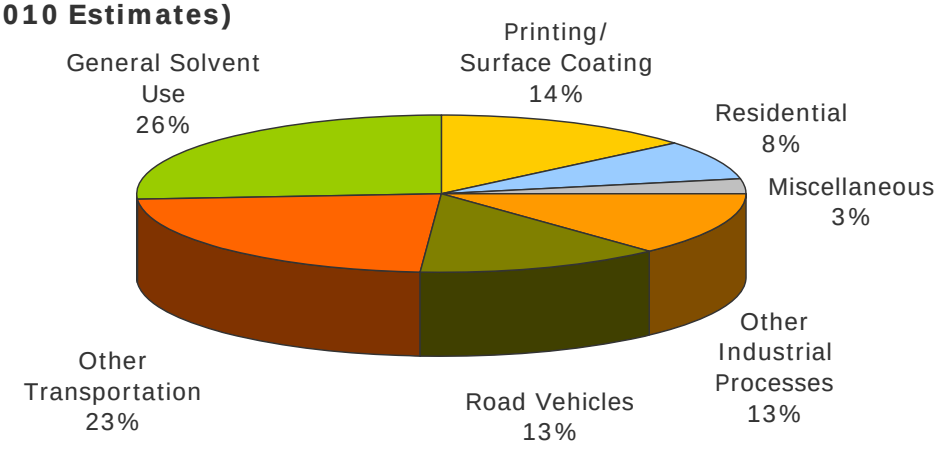
Ground-level ozone is a gas formed when nitrogen oxides (NO_X) and volatile organic compounds (VOCs) react in the presence of sunlight. While ozone at ground level is a major environmental and health concern, the naturally occurring ozone in the stratosphere is beneficial as it shields the earth from harmful ultraviolet radiation.

2.1 Characteristics, sources and effects

Ozone is a colourless, odourless gas at typical ambient concentrations, and is a major component of smog. Ozone is not generally emitted directly into the atmosphere; the formation and transport of ozone are strongly dependent on meteorological conditions and emissions of chemical precursors. Changing weather patterns contribute to differences in ozone concentrations hourly, daily, seasonally and year-to-year. In Ontario, elevated concentrations of ground-level ozone are typically recorded on hot and sunny days from mainly May to September, between noon and early evening.

Figure 2.1 shows the 2010 estimates of Ontario's VOC emissions from point, area and transportation sources. Transportation sectors accounted for approximately 36 per cent of VOC emissions. General solvent use was the second largest source of VOC emissions, accounting for approximately 26 per cent. Figure 2.2 shows the 2010 estimates of Ontario's NO_X emissions from point, area and transportation sources. Transportation sectors accounted for approximately 71 per cent of NO_X emissions (NPRI, 2012).

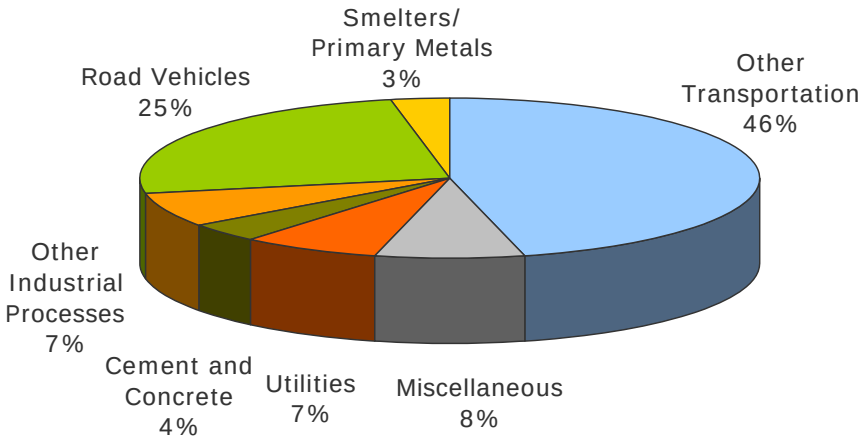
Figure 2.1
Ontario Volatile Organic Compounds Emissions by Sector (Emissions from Point / Area / Transportation Sources, 2010 Estimates)



Note: Provincial total 409 kilotonnes.
Excludes open and natural sources.

Data Source: NPRI, 2012.

Figure 2.2
Ontario Nitrogen Oxides Emissions by Sector (Emissions from Point/Area/Transportation Sources, 2010 Estimates)



Note: Provincial total 383 kilotonnes.
Excludes open and natural sources.

Data Source: NPRI, 2012.

Ozone irritates the respiratory tract and eyes. Exposure to ozone in sensitive people can result in chest tightness, coughing and wheezing. Children who are active outdoors during the summer, when ozone levels are highest, are particularly at risk. Individuals with pre-existing respiratory disorders, such as asthma and chronic obstructive pulmonary disease (COPD), are also at risk. Ozone has been linked to increased hospital admissions and premature deaths. Ozone also causes agricultural crop loss each year in Ontario, with visible leaf damage in many crops, garden plants and trees, especially during the summer months.

2.2 Monitoring results for 2011

During 2011, ozone was monitored at 40 Ontario Ministry of the Environment AQI monitoring stations. The highest annual mean was 32.8 parts per billion (ppb), measured at Grand Bend and Port Stanley, transboundary-influenced sites on the eastern shore of Lake Huron and the northern shore of Lake Erie, respectively. The lowest annual mean, 20.1 ppb, was measured at Toronto West, an urban site located near a major transportation corridor, Highway 401 and directly impacted by local nitric oxide (NO) emissions from vehicles. Generally, ozone concentrations are lower in urban areas because ozone is reduced by reacting with NO emitted by vehicles and other local combustion sources.

Ground-level ozone concentrations continued to exceed the provincial one-hour ambient air quality criterion (AAQC) of 80 ppb across the province. In 2011, Ontario's one-hour AAQC for ozone was exceeded at 28 of the 40 AQI stations for at least one hour, and these exceedances exclusively occurred

from May to September, which is considered as the summer period in this report. The maximum one-hour ozone concentrations ranged from a low of 60 ppb recorded in Thunder Bay to 115 ppb recorded at Grand Bend. Windsor Downtown recorded the most instances (42) when ozone exceeded Ontario's one-hour AAQC.

Figure 2.3 shows the geographical distribution of one-hour ozone exceedances across Ontario in 2011. Generally, higher numbers of one-hour ozone exceedances were recorded in southwestern Ontario, on the eastern shore of Lake Huron and the northern shore of Lake Erie, than over central and eastern Ontario. There were no ozone exceedances in the north. As stated in the *Transboundary Air Pollution in Ontario* report, elevated ozone levels in southwestern Ontario are generally attributed to the long-range transport of pollutants into Ontario from the United States. Transboundary air pollution is combined with local emissions of smog-related pollutants, and can impact various areas of the province during a smog episode (Yap, Reid, De Brou, & Bloxam, 2005).

Figure 2.3
Geographical Distribution of One-Hour Ozone Exceedances Across Ontario in 2011

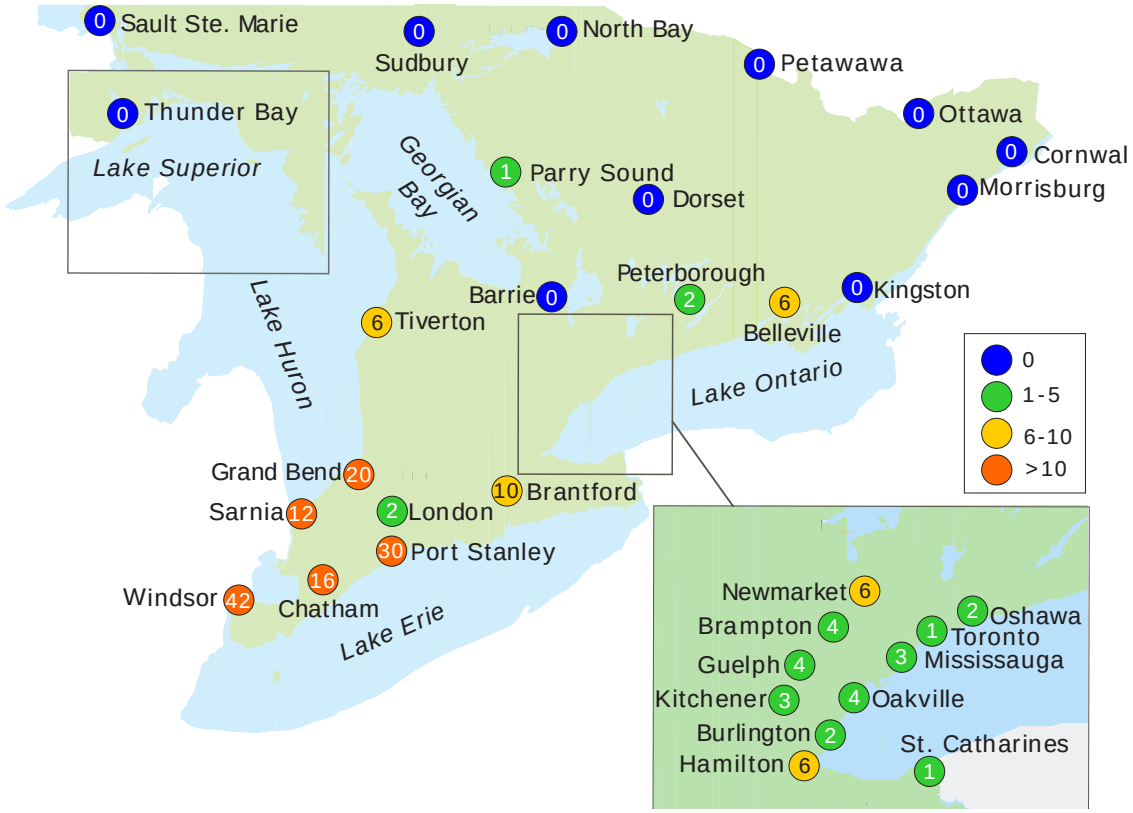
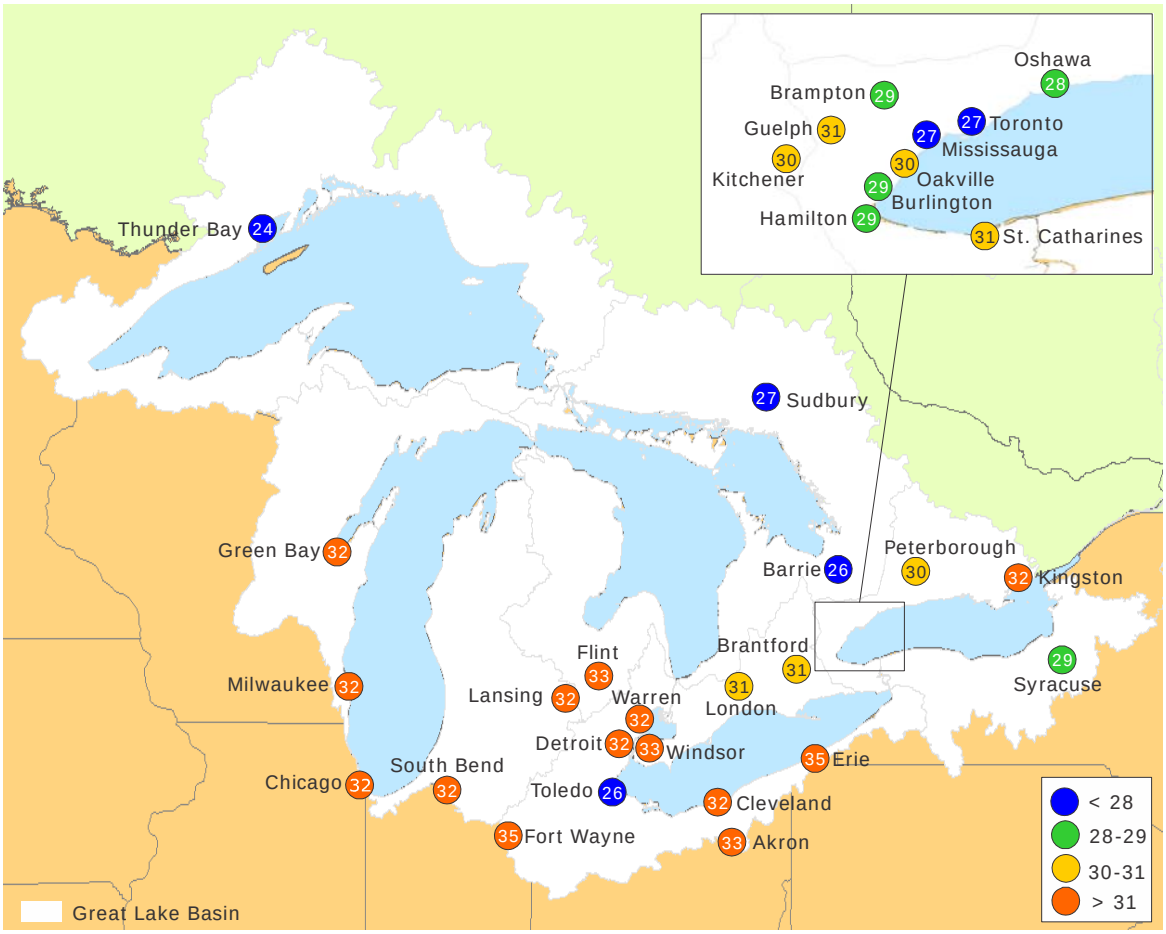


Figure 2.4 shows ozone summer (May – September) means of hourly concentrations in 2011 for cities with population greater than 100,000 in the Great Lakes Basin, including 18 sites in Ontario and 14 sites in the U.S.

Ozone summer means were generally lower in central and northern Ontario than southwestern Ontario and the U.S. Relatively high ozone concentrations at the Windsor and Kingston sites were largely impacted by transboundary pollution, whereas relatively low ozone levels at urban sites like Toronto were reduced by reactions with NO emitted by local vehicles.

Figure 2.4
Geographical Distribution of Ozone Summer Means (ppb) in 2011 in the Great Lakes Basin



Data Source: AQS, 2012.

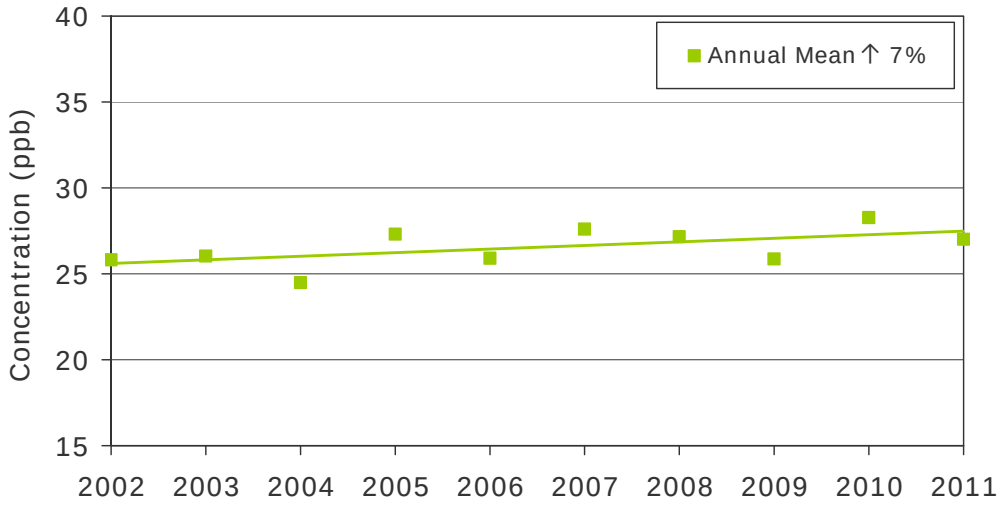
2.3 Trends

The trend of the ozone annual means is shown in Figure 2.5 for the 10-year period of 2002 to 2011. The data show an increasing trend (7 per cent) in the ozone annual means over the 10-year period.

Table 2.1 shows the spatial variability of ozone annual means in 2011 and trends of annual means from 2002 to 2011 at North Bay in northeastern Ontario; Ottawa in eastern Ontario; Toronto in central Ontario; and Windsor in southwestern Ontario. Ozone annual means and trends throughout the

10-year period differ at these four sites: the ozone annual means at North Bay and Ottawa slightly increased by approximately 2 per cent, while Toronto increased by 11 per cent and Windsor increased by 28 per cent. The increase in the ozone annual means at the Windsor site may be generally attributed to the reduction of NO_X emissions and the changeover in vehicle fleet which in turn lessened the effect of ozone titration by NO in the urban centre.

Figure 2.5
Trend of Ozone Annual Means Across Ontario (2002-2011)



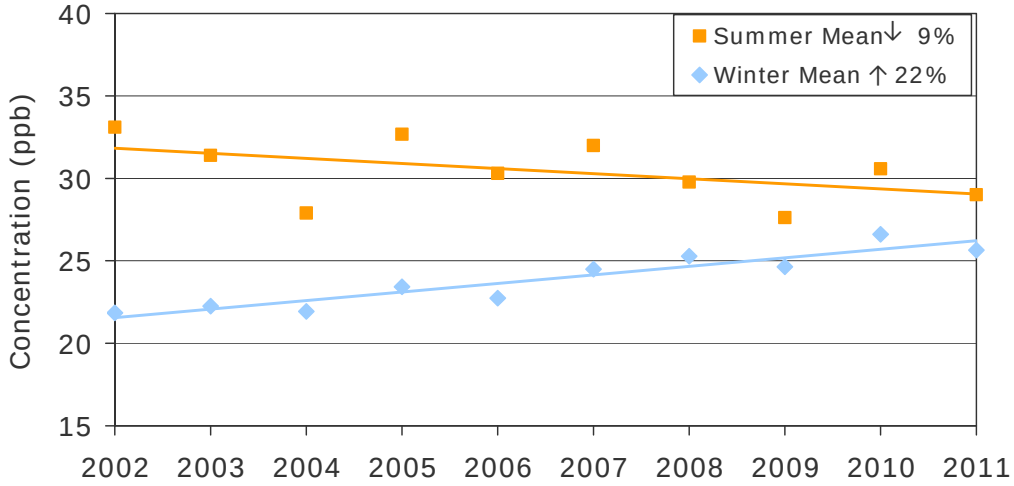
Note: Ten-year trend is a composite annual mean based on data from 36 monitoring sites.

Table 2.1: Ozone Annual Means (ppb) in 2011 and Per Cent Change from 2002-2011 at Four Select Cities.

City	Ozone Annual Mean (ppb) in 2011	Per Cent Change of Ozone Annual Mean (2002-2011)
North Bay	26.7	↑ 2%
Ottawa	24.2	↑ 2%
Toronto	25.4	↑ 11%
Windsor	27.2	↑ 28%

The trend of ozone summer means and ozone winter means, as recorded at Ontario's 36 air monitoring sites with sufficient data, is shown in Figure 2.6 for the 10-year period of 2002 to 2011. The ozone summer means have decreased by approximately 9 per cent, whereas the ozone winter means have increased by approximately 22 per cent over the past 10 years (2002 to 2011). Although the ozone winter means increased over the past 10 years, the provincial one-hour AAQC of 80 ppb for ozone was not exceeded at any of the 40 AQI sites during the winter of 2011. The increase in winter means, as shown in Figure 2.6, resulted in the overall increasing trend of ozone annual means.

Figure 2.6
Trend of Ozone Summer and Winter Means (ppb) Across Ontario (2002-2011)



Note: Ten-year trends are composite means for the summer and winter months based on data from 36 monitoring sites.
Summer: May - September; Winter: January - April, October - December.

Elevated ozone concentrations in Ontario are typically recorded during the summer months due to the local production of pollution, and transboundary pollution under certain weather conditions. The decrease in summer means over the past 10 years is largely due to the progressive reductions of NO_X emissions in Ontario and the U.S. resulting in the decrease in local ozone formation and transboundary influences especially during the summer months. In contrast, local ozone production is at its lowest in winter, and the increasing ozone winter means are mainly attributed to the rising global background concentrations, and lessened NO titration effects as a result of the reduced NO_X emissions. The increase in ozone annual means can be attributed to the reductions in local NO_X emissions, the rising global background ozone concentrations, and the variability in meteorological conditions (Yap et al., 2005).

2.4 The Canada-wide Standard for Ozone

In 2000, the Canadian Council of Ministers of the Environment (CCME) developed a Canada-wide Standard (CWS) for ozone as a result of the pollutant's adverse effects on human health and the environment. As referenced in the *Guidance Document on Achievement Determination* (*GDAD*), the CWS for ozone is 65 ppb, which is based on eight-hour running average time and the 4th highest annual ambient measurement averaged over three consecutive years (Canadian Council of Ministers of the Environment, 2002).

Table 2.2 displays the calculated ozone CWS 3-year metric for designated sites where populations are greater than 100,000 across Ontario from 2005 to 2011. In 2011, six of the 21 designated sites met the CWS of 65 ppb for ozone. The communities in Barrie, London, Mississauga and Sudbury met the CWS for ozone for the first time in 2011, indicating, once again, that air quality in Ontario has improved recently. The downward trend of ozone CWS metrics from 2005 to 2011 (Table 2.2) is consistent with the declining summer means (Figure 2.6) since CWS metrics are calculated from the 4th highest ozone concentrations that are usually recorded during the summer months.

Table 2.2: Ozone CWS Metric (ppb) for Designated Sites Across Ontario

City	2003 – 2005	2004 – 2006	2005 – 2007	2006 – 2008	2007 – 2009	2008 – 2010	2009 – 2011	Change over time
Windsor Downtown	82	81	89	85	81	74	75	↓ 11%
Chatham	n/a	86	86	80	78	73	72	↓ 18%
London	74	70	73	72	69	67	65	↓ 11%
Brantford	n/r	n/r	n/r	n/r	n/r	n/r	72	-
Kitchener	79	74	77	74	71	68	66	↓ 15%
Guelph	79	77	79	75	73	70	69	↓ 13%
St. Catharines	81	75	81	76	73	67	67	↓ 17%
Hamilton Downtown	77	72	76	74	71	69	67	↓ 11%
Hamilton Mountain	82	76	80	76	74	71	70	↓ 14%
Burlington	75	72	76	74	71	68	66	↓ 11%
Oakville	81	74	80	77	75	71	69	↓ 13%
Mississauga	80	75	80	77	66	66	65	↓ 20%
Brampton	80	75	79	76	74	69	68	↓ 14%
Toronto	81	75	80	78	76	74	71	↓ 10%
Oshawa	n/a	77	80	76	74	70	68	↓ 14%
Barrie	72	69	72	71	70	67	62	↓ 11%
Peterborough	81	72	73	71	73	73	71	↓ 8%
Kingston	77	77	89	85	81	77	74	↓ 24%
Ottawa Downtown	69	67	71	68	65	61	58	↓ 15%
Sudbury	76	74	77	71	69	66	65	↓ 18%
Thunder Bay	58	57	57	55	53	54	54	↓ 7%

Notes:
The CWS for ozone is 65 ppb, which is based on eight-hour running average time and the 4th highest annual ambient measurement averaged over three consecutive years.
CWS metrics are calculated as per the GDAD.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
Red font indicates an exceedance of the CWS.
n/a indicates data are not sufficient to calculate metrics.
n/r indicates site not designated for CWS reporting. Brantford was added as a CWS designated site in 2009-2011.
A linear regression is applied to derive per cent change over time.

3.0 Particulate Matter in the Air

Airborne particulate matter is the general term used to describe a mixture of microscopic solid particles and liquid droplets suspended in air. Particulate matter is classified according to its aerodynamic size, mainly due to the different health effects associated with particles of different diameters. Fine particulate matter, denoted as $PM_{2.5}$, refers to respirable particles that are less than 2.5 microns in diameter. Due to their small size, they can penetrate deep into the respiratory system. To put this in perspective, $PM_{2.5}$ is approximately 30 times smaller than the average diameter of a human hair.

Particles originate from many different industrial and transportation sources, as well as natural sources. They may be emitted directly from a source or formed in the atmosphere by the transformation of gaseous emissions. This chapter discusses the monitoring results from Ontario's ambient continuous $PM_{2.5}$ monitoring network.

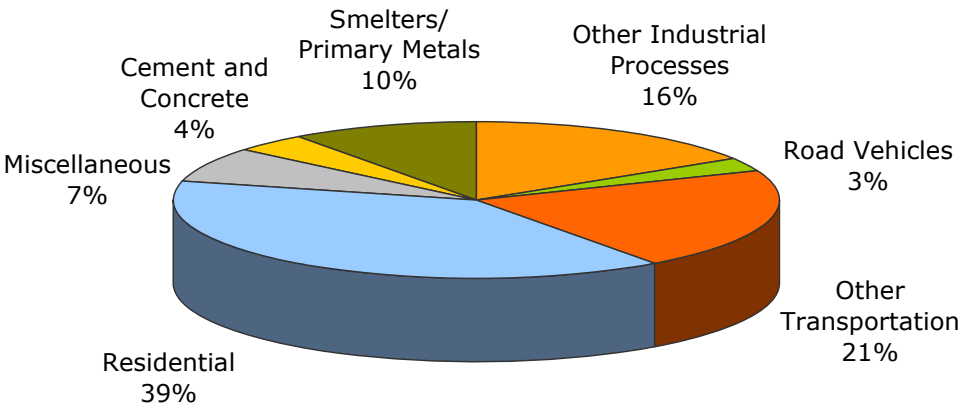
3.1 Characteristics, sources and effects

Particulate matter includes aerosols, smoke, fumes, dust, fly ash and pollen. Its composition varies with origin, residence time in the atmosphere, time of year and environmental conditions. Fine particulate matter may be emitted directly to the atmosphere as a by-product of fuel combustion. Major sources of $PM_{2.5}$ include motor vehicles, smelters, power plants, industrial facilities, residential fireplaces and wood stoves, agricultural burning and forest fires, or may be formed indirectly in the atmosphere through a series of complex chemical reactions.

Figure 3.1 shows the 2010 estimates of Ontario's primary $PM_{2.5}$ emissions from point, area and transportation sources. The residential and transportation sectors accounted for 39 per cent and 24 per cent of $PM_{2.5}$ emissions, respectively, whereas industrial processes accounted for 29 per cent (NPRI, 2012). The major contributor to residential emissions is fuel wood combustion in fireplaces and wood stoves.

Significant amounts of $PM_{2.5}$ in southern Ontario are referred to as secondary $PM_{2.5}$ being formed in the atmosphere from gaseous precursors such as SO_2 and NO_2, and of transboundary origin. During periods of elevated concentrations of $PM_{2.5}$ in Ontario, it is estimated that there are significant contributions from the U.S., specifically affecting border communities such as: Windsor and Port Stanley, on the northern shore of Lake Erie; Grand Bend and Tiverton, on the eastern shores of Lake Huron; and Parry Sound, on the eastern shore of Georgian Bay (Yap et al., 2005).

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector (Emissions from Point / Area / Transportation Sources, 2010 Estimates)



Note: Provincial total 62 kilotonnes.
Excludes open and natural sources.

Data Source: NPRI, 2012.

3.2 Monitoring results for 2011

In 2011, Ontario's 40 air monitoring sites were equipped with a Tapered Element Oscillating Microbalance (TEOM) instrument maintained at 30°C with a Sample Equilibration System (SES) to measure $PM_{2.5}$ concentrations on an hourly basis. As shown in Figure 3.2, the 2011 annual mean $PM_{2.5}$ concentrations ranged from 3.4 micrograms per cubic metre ($\mu g/m^3$) in Petawawa to 10.5 $\mu g/m^3$ in Sarnia. The 24-hour maximum $PM_{2.5}$ concentrations ranged from 14 $\mu g/m^3$ in Petawawa to 52 $\mu g/m^3$ in Thunder Bay. The 24-hour maximum $PM_{2.5}$ concentration at Thunder Bay was recorded on July 19, 2011 due to smoke from forest fires in northwestern Ontario, which is considered as an exceptional event and not the norm for air quality in Thunder Bay. The $PM_{2.5}$ reference level of 30 $\mu g/m^3$ (based on the CWS) for a 24-hour period was exceeded at 7 of the 40 sites in 2011 on at least one occasion.

Figure 3.3 shows $PM_{2.5}$ annual concentrations for 2011 for cities with population greater than 100,000 in the Great Lakes Basin, including 18 sites in Ontario and 8 sites in the U.S. $PM_{2.5}$ annual means were generally lower in Ontario, especially in the northern part of the province, than in the U.S. Relatively higher annual $PM_{2.5}$ concentrations in Windsor and Hamilton are combined effects of transboundary pollution and local industrial emissions (Yap et al., 2005).

Figure 3.2
$PM_{2.5}$ Annual Means ($\mu g/m^3$) Across Ontario (2011)

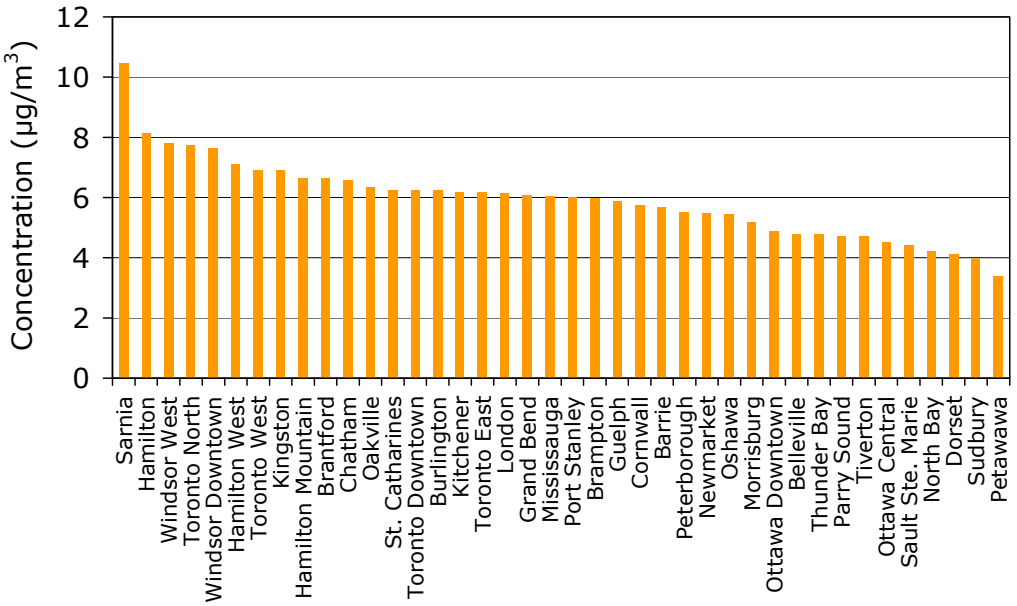
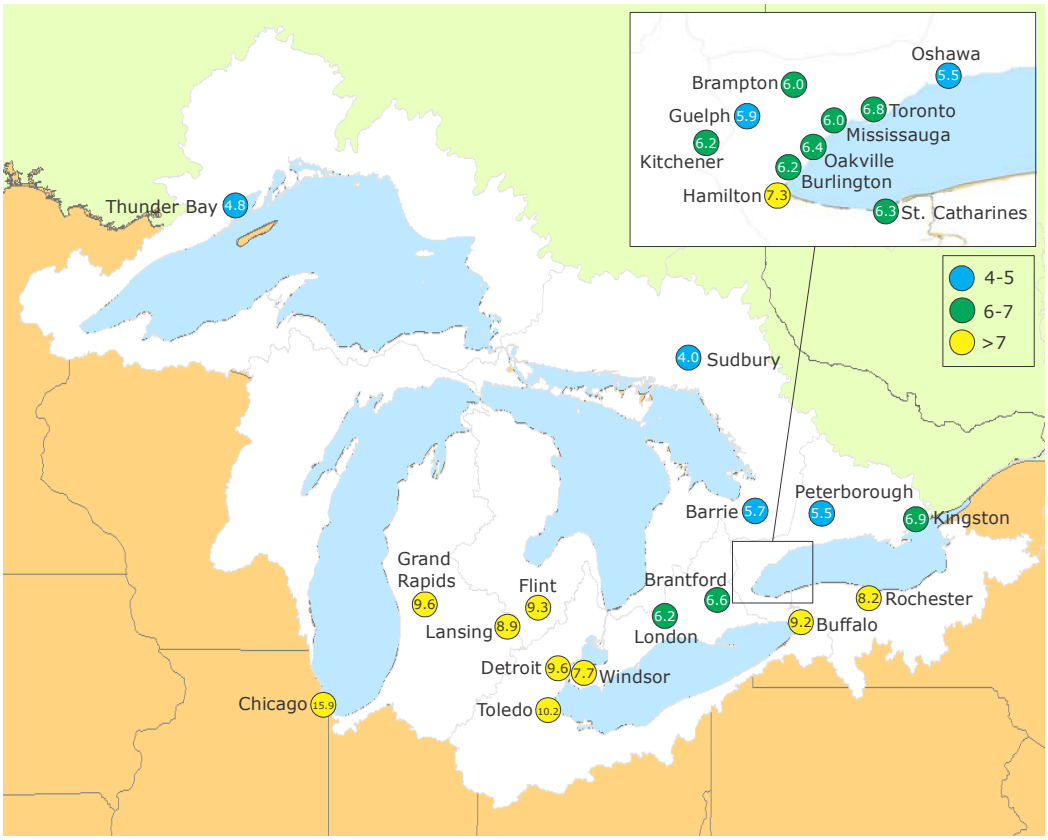


Figure 3.3
Geographical Distribution of $PM_{2.5}$ Annual Means ($\mu g/m^3$) in 2011 in the Great Lakes Basin

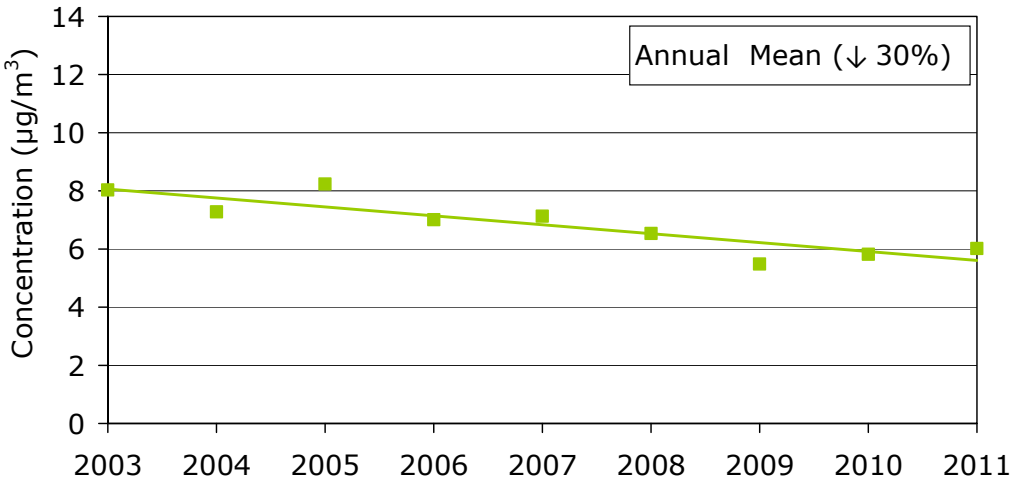


Data Source: AQS, 2012.

3.3 Trends

The trend of $PM_{2.5}$ annual means, as recorded at 34 air monitoring sites with sufficient data, is shown in Figure 3.4 for the nine-year period of 2003 to 2011. Annual means of $PM_{2.5}$ have decreased approximately 30 per cent since 2003.

Figure 3.4
Trend of $PM_{2.5}$ Annual Means ($\mu g/m^3$) Across Ontario (2003-2011)

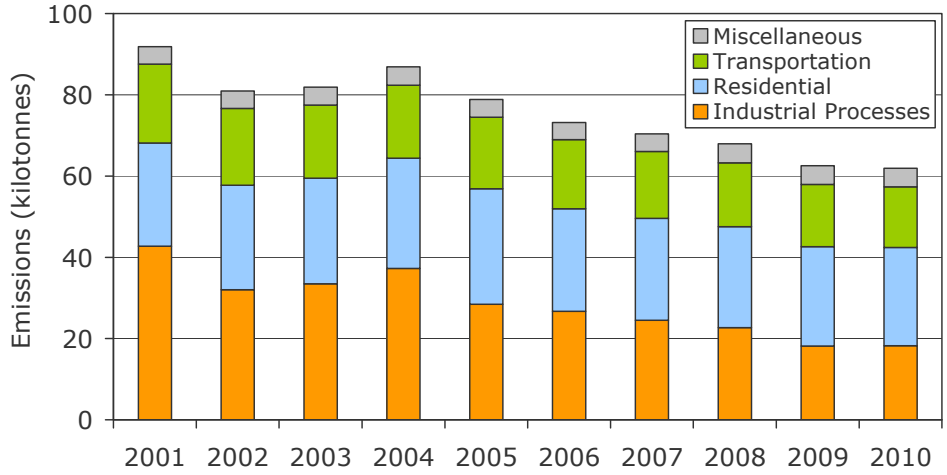


Note: The trend is a composite mean based on data from 34 monitoring sites.

Overall, provincial $PM_{2.5}$ emissions have decreased approximately 33 per cent from 2001 to 2010, as shown in Figure 3.5 (NPRI, 2012; NPRI, 2010; P. Georges, personal communication, April 1, 2010). Fine particulate emissions from industrial processes have been reduced by over 57 per cent over the 10-year period from 2001 to 2010. Emissions from the transportation sector show a gradual decrease of 23 per cent over this time period with the phase-in of new vehicles/engines having more stringent emission standards over the same period.

Table 3.1 shows $PM_{2.5}$ annual means in 2011 and trends of annual means from 2002 to 2011 at North Bay in northeastern Ontario; Ottawa in eastern Ontario; Toronto in central Ontario; and Windsor in southwestern Ontario. Spatial differences are apparent: the $PM_{2.5}$ annual means in 2011 in Windsor, an urban industrial centre, were higher than those reported at Toronto, Ottawa and North Bay, indicating influences from transboundary pollution and local emission sources. $PM_{2.5}$ annual means at North Bay, Ottawa, Toronto and Windsor decreased by approximately 27 per cent, 40 per cent, 30 per cent and 18 per cent, respectively.

Figure 3.5
Trend of Ontario $PM_{2.5}$ Emissions in Kilotonnes (2001-2010)



Note: Excludes open and natural sources.

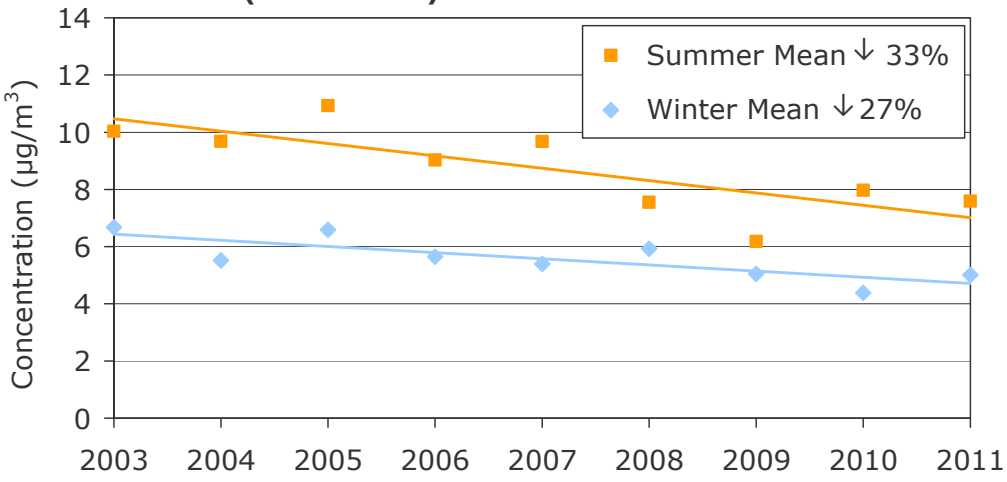
References: NPRI, 2012; NPRI, 2010; and P. Georges, personal communication, April 1, 2010.

Table 3.1: $PM_{2.5}$ Annual Means ($\mu g/m^3$) in 2011 and Per Cent Change from 2002-2011 at Four Select Cities.

City	$PM_{2.5}$ Annual Mean ($\mu g/m^3$) in 2011	Per Cent Change of $PM_{2.5}$ Annual Mean (2002-2011)
North Bay	4.2	↓ 27%
Ottawa	4.9	↓ 40%
Toronto	6.2	↓ 30%
Windsor	7.6	↓ 18%

Figure 3.6 shows the trend of the $PM_{2.5}$ summer means and $PM_{2.5}$ winter means as recorded at 34 air monitoring sites for the period of 2003 to 2011. There has been a decreasing trend in both the $PM_{2.5}$ summer and winter means during the nine-year period. The $PM_{2.5}$ summer means have decreased by approximately 33 per cent and the $PM_{2.5}$ winter means by approximately 27 per cent, which coincides with a combined reduction of primary $PM_{2.5}$ emissions (as shown in Figure 3.5) and secondary $PM_{2.5}$ formation. Figure 3.6 indicates that the summer means were consistently higher than the winter means, which can be attributed to the formation of secondary $PM_{2.5}$ under favourable synoptic patterns with lighter winds and prevailing south-westerly flows, and the potential loss of $PM_{2.5}$ with the TEOM during cooler temperatures. The ministry is replacing the TEOM $PM_{2.5}$ monitor with a new monitoring method to provide more comprehensive cold weather measurements.

Figure 3.6
Trend of $PM_{2.5}$ Summer and Winter Means ($\mu g/m^3$) Across Ontario (2003-2011)



Note: Ten-year trends are composite means for the summer and winter months based on data from 34 monitoring sites.
Summer: May - September; Winter: January - April, October - December.

3.4 The Canada-wide Standard for $PM_{2.5}$

In 2000, the CCME developed a CWS for $PM_{2.5}$ as a result of the pollutant's adverse effects on human health and the environment. As referenced in the *GDAD*, the CWS for $PM_{2.5}$ is 30 $\mu g/m^3$, 24-hour averaging time, based on the 98th percentile annual ambient measurement averaged over three consecutive years (Canadian Council of Ministers of the Environment, 2002).

Table 3.2 displays the calculated $PM_{2.5}$ CWS 3-year metric for designated CWS sites where populations are greater than 100,000 across Ontario from 2005 to 2011. The 2011 concentrations ranged from 12 $\mu g/m^3$ reported for Sudbury to 22 $\mu g/m^3$ reported for Hamilton Downtown and Kingston. The CWS of 30 $\mu g/m^3$ was not exceeded at any of the CWS designated sites. The $PM_{2.5}$ CWS 3-year metrics are trending downwards from 2005 to 2011. The 2011 $PM_{2.5}$ CWS 3-year metrics are markedly lower than those metrics reported in 2005, at all locations.

Table 3.2
$PM_{2.5}$ CWS Metric ($\mu g / m^3$) for Designated Sites Across Ontario

City	2003 – 2005	2004 – 2006	2005 – 2007	2006 – 2008	2007 – 2009	2008 – 2010	2009 – 2011	Change over time
Windsor Downtown	31	29	29	25	23	21	21	↓ 36%
Chatham	n/a	28	28	25	23	20	19	↓ 35%
London	30	28	26	23	22	20	17	↓ 42%
Brantford	n/r	n/r	n/r	n/r	n/r	n/r	20	-
Kitchener	34	30	29	25	22	19	18	↓ 49%
Guelph	34	30	28	24	21	19	18	↓ 50%
St. Catharines	29	30	31	27	23	20	19	↓ 39%
Hamilton Downtown	34	32	32	29	25	23	22	↓ 38%
Hamilton Mountain	32	31	29	26	23	21	19	↓ 42%
Burlington	30	29	28	25	22	21	19	↓ 38%
Oakville	34	30	28	24	21	19	18	↓ 50%
Mississauga	34	32	29	27	19	19	17	↓ 54%
Brampton	31	29	28	24	22	19	17	↓ 46%
Toronto	33	31	30	25	22	20	19	↓ 46%
Oshawa	n/a	29	29	25	21	19	18	↓ 43%
Barrie	30	29	28	24	21	18	17	↓ 47%
Peterborough	28	29	28	23	20	17	17	↓ 46%
Kingston	n/a	n/a	30	28	24	23	22	↓ 28%
Ottawa Downtown	30	26	25	20	17	15	14	↓ 57%
Sudbury	n/a	20	21	18	16	13	12	↓ 44%
Thunder Bay	n/a	n/a	16	15	14	13	14	↓ 15%

Notes:
The CWS for $PM_{2.5}$ is 30 $\mu g/m^3$, 24-hour average time, based on the 98th percentile annual ambient measurement averaged over three consecutive years.
CWS metrics are calculated as per the GDAD.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
Red font indicates an exceedance of the CWS.
n/a indicates data are not sufficient to calculate metrics.
n/r indicates site not designated for CWS reporting. Brantford was added as a CWS designated site in 2009-2011.
A linear regression is applied to derive per cent change over time.

4.0 Other Air Pollutants

This chapter discusses characteristics, sources and effects of NO_2, CO and SO_2, as well as their ambient concentrations in 2011, and trends of ambient concentrations and emissions, where appropriate.

4.1 NITROGEN DIOXIDE

4.1.1 Characteristics, sources and effects

Nitrogen dioxide is a reddish-brown gas with a pungent odour, which transforms in the atmosphere to form gaseous nitric acid and nitrates. It plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. Nitrogen dioxide also reacts in the air to form organic compounds, which contribute to the formation of fine particulate matter in the atmosphere.

All combustion in air produces NO_X, of which NO_2 is a component. Major sources of NO_X emissions include the transportation sector, industrial processes and utilities. Ontario's NO_X emission estimates by sector are displayed in Figure 2.2 of Section 2.1.

Nitrogen dioxide can irritate the lungs and lower their resistance to respiratory infection. People with asthma and bronchitis have increased sensitivity to NO_2. Nitrogen dioxide chemically transforms into nitric acid in the atmosphere and, when deposited, contributes to the acidification of lakes and soils in Ontario. Nitric acid can also corrode metals, fade fabrics, degrade rubber, and damage trees and crops.

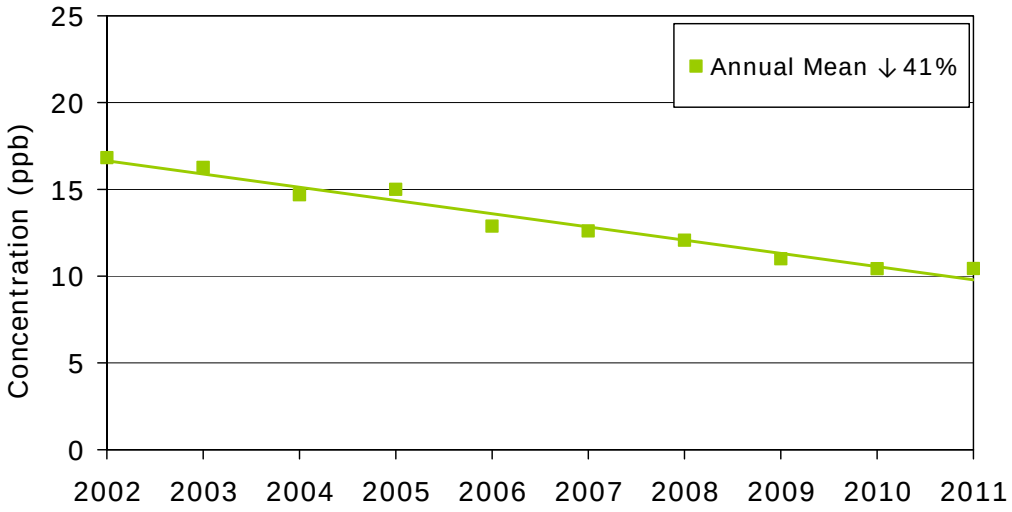
4.1.2 Monitoring results for 2011

The Toronto West site, located in an area of Toronto influenced by significant vehicular traffic, recorded the highest annual mean (19.1 ppb) for NO_2 during 2011, whereas Tiverton, a rural site, recorded the lowest NO_2 annual mean (2.5 ppb). The highest NO_2 means are recorded in large urbanized areas, such as the Greater Toronto Area (GTA) of southern Ontario. The Toronto North air monitoring station recorded the highest 24-hour average concentration (44 ppb), and Windsor West had the highest one-hour concentration (93 ppb) in 2011. The provincial 24-hour criterion of 100 ppb and one-hour criterion of 200 ppb for NO_2 were not exceeded at any of the monitoring locations in Ontario during 2011.

4.1.3 Trends

Figure 4.1 shows the trend of annual means for NO_2 concentrations from 2002 to 2011. The annual means for NO_2 concentrations decreased by approximately 41 per cent over the last decade from 2002 to 2011.

Figure 4.1
Trend of NO_2 Annual Means (ppb) Across Ontario (2002-2011)

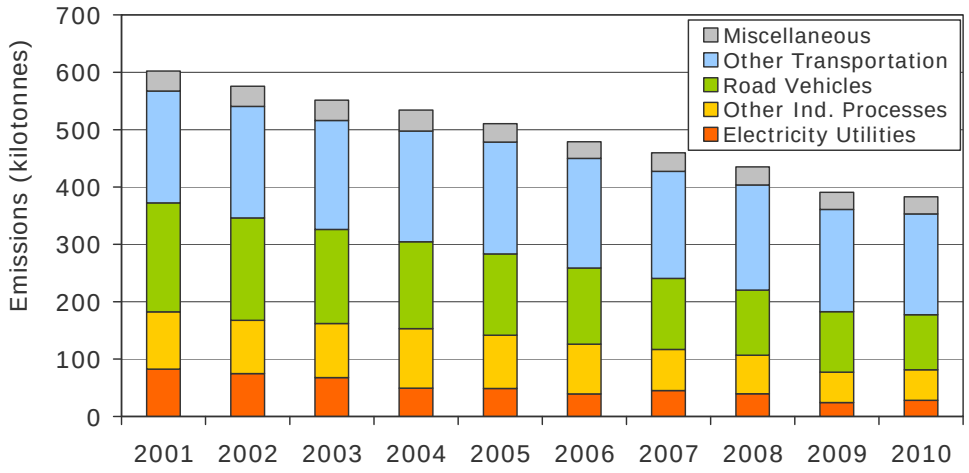


Note: The trend is a composite mean based on data from 21 monitoring sites.

Figure 4.2 displays the NO_X emission trend from 2001 to 2010. Overall, NO_X emissions have decreased approximately 36 per cent over the 10-year period (NPRI, 2012; NPRI, 2010; P. Georges, personal communication, April 1, 2010). Ontario's emissions trading regulations on sulphur dioxide and nitrogen oxides (O. Reg. 397/01 and O. Reg. 194/05) have contributed to the reduction in nitrogen oxides emissions in recent years. The NO_X emissions from on-road vehicles also decreased due to the phase-in of new vehicles having more stringent emission standards. The implementation of the Ontario's Drive Clean program in southern Ontario in 1999 also helped to further reduce the NO_X emissions from light duty gasoline vehicles.

Changes in the diurnal patterns of NO_2 concentrations at the Toronto East station can be seen in Figure 4.3 for years 2002 and 2011. The Toronto East station is located near a busy roadway and is greatly influenced by vehicular traffic, a major source of NO_X. This is evident during the morning rush-hour period (6 a.m. to 9 a.m.) when temperature inversions near the ground typically occur with light winds which in turn cause less dispersion and local build-up of pollutants. Overall, the diurnal patterns show a considerable decrease in NO_2 concentrations measured in 2011 when compared to previous years. The reduction in NO_X emissions over time is mainly due to a cleaner vehicle fleet in the GTA, and, in part, due to Ontario's Drive Clean program. NO_2 concentrations at 8 a.m. have decreased by 24 per cent between 2002 and 2011.

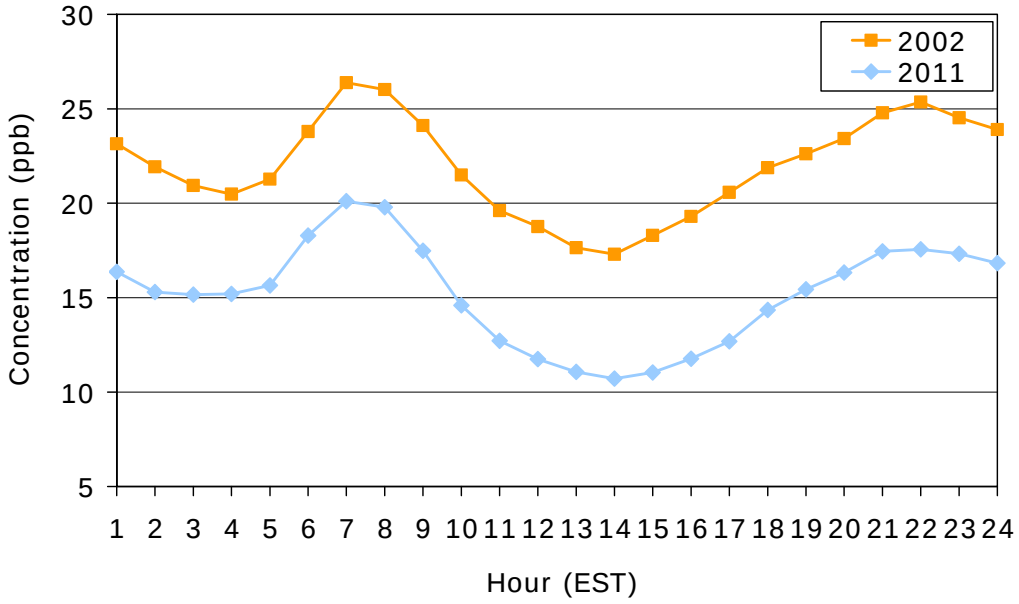
Figure 4.2
Trend of Ontario NO_X Emissions in Kilotonnes (2001-2010)



Note: Excludes open and natural sources.

References: NPRI, 2012; NPRI, 2010; and P. Georges, personal communication, April 1, 2010.

Figure 4.3
Diurnal Trend of NO_2 Concentrations (ppb) at Toronto East (2002 and 2011)

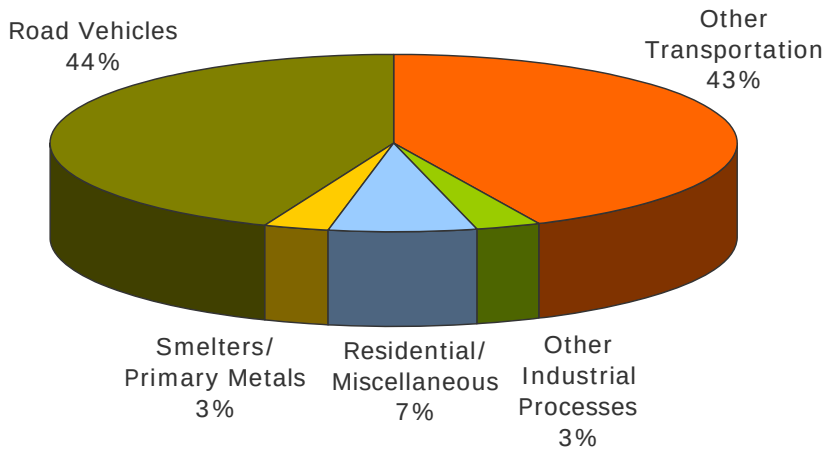


4.2 CARBON MONOXIDE

4.2.1 Characteristics, sources and effects

Carbon monoxide is a colourless, odourless, tasteless and, at high concentrations, poisonous gas. This gas can enter the bloodstream and reduce oxygen delivery to the organs and tissues. People with heart disease are particularly sensitive to CO. Exposure to high CO levels is linked with the impairment of vision, work capacity, learning ability and performance of complex tasks. Carbon monoxide is produced primarily by the incomplete combustion of fossil fuels. As displayed in Figure 4.4, the transportation sector accounted for 87 per cent of all CO emissions (NPRI, 2012).

Figure 4.4
Ontario CO Emissions by Sector (Emissions from Point/Area/ Transportation Sources, 2010 Estimates)



Note: Provincial total 2,329 kilotonnes.
Excludes open and natural sources.

Data Source: NPRI, 2012.

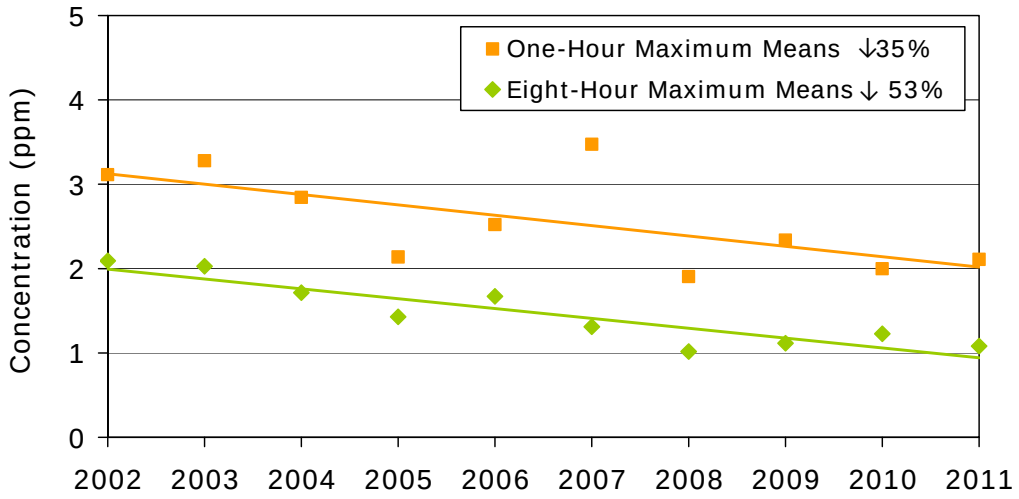
4.2.2 Monitoring results for 2011

In 2011, the highest one-hour maximum CO value, 3.77 parts per million (ppm) and the highest eight-hour maximum CO value, 1.46 ppm, were measured at the Windsor Downtown site. Typically, higher CO concentrations are recorded in urban centres as a result of vehicle emissions. Ontario's one-hour (30 ppm) and eight-hour (13 ppm) AAQC for CO were not exceeded at any of the monitoring sites in 2011.

4.2.3 Trends

Figure 4.5 shows the trend of annual means of the one-hour and eight-hour maximums for CO concentrations from 2002 to 2011. As shown in Figure 4.5, ambient CO concentrations, as measured by the annual means of the one-hour and eight-hour maximums, decreased by approximately 35 per cent and 53 per cent, respectively, over the 10-year period of 2002 to 2011 due to reductions in CO emissions from the transportation sector and to a lesser degree, the industrial sector. Figure 4.6 shows that CO emissions have been reduced by approximately 24 per cent from 2001 to 2010 (NPRI, 2012; NPRI, 2010; P. Georges, personal communication, April 1, 2010).

Figure 4.5
Trends of CO Annual Means of One-Hour and Eight-Hour Maximums (ppm) Across Ontario (2002-2011)



Note: Trends are composite means based on data from 4 sites.
Ontario one-hour AAQC = 30 ppm; eight-hour AAQC = 13 ppm.

4.3 SULPHUR DIOXIDE

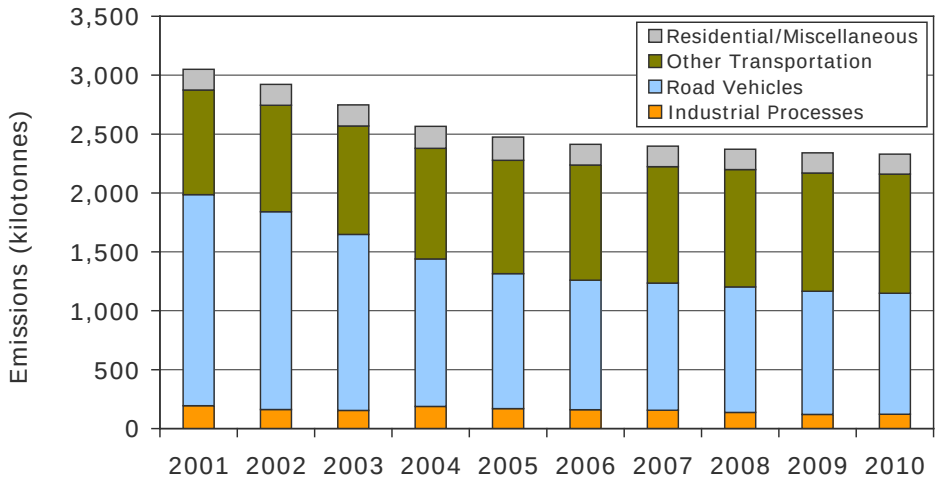
4.3.1 Characteristics, sources and effects

Sulphur dioxide is a colourless gas that smells like burnt matches. Sulphur dioxide can also be oxidized in the atmosphere to form sulphuric acid aerosols. In addition, sulphur dioxide is a precursor to sulphates, one of the main components of airborne fine particulate matter.

Electric utilities and smelters are the major sources of SO_2 emissions in Ontario, accounting for approximately 67 per cent of the provincial SO_2 emissions, as shown in Figure 4.7. Other industrial processes (e.g. petroleum refining, cement and concrete manufacturing) accounted for an additional 24 per cent. The transportation sector and miscellaneous sources

accounted for the remaining 9 per cent of all SO_2 emissions in the province according to 2010 estimates (NPRI, 2012).

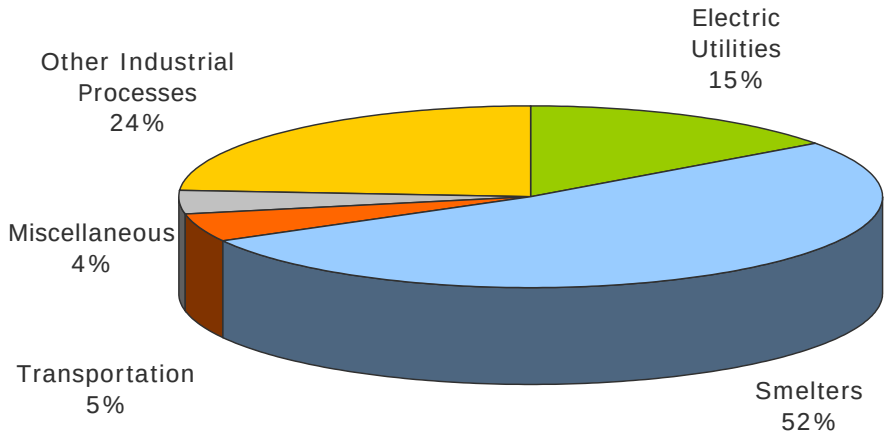
Figure 4.6
Trend of Ontario CO Emissions in Kilotonnes (2001-2010)



Note: Excludes open and natural sources.

References: NPRI, 2012; NPRI, 2010; and P. Georges, personal communication, April 1, 2010.

Figure 4.7
Ontario SO_2 Emissions by Sector (Emissions from Point/Area/ Transportation Sources, 2010 Estimates)



Note: Provincial total 268 kilotonnes.
Excludes open and natural sources.

Data Source: NPRI, 2012.

Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, and the exacerbation of respiratory and cardiovascular disease. People with asthma, chronic lung disease or heart

disease are the most sensitive to SO_2. Sulphur dioxide damages trees and crops. Sulphur dioxide, like NO_2, is also a precursor of acid rain, which contributes to the acidification of soils, lakes and streams, accelerated corrosion of buildings, and reduced visibility. Sulphur dioxide also leads to the formation of fine particulate matter or $PM_{2.5}$, which have health implications and contribute to climate change.

4.3.2 Monitoring results for 2011

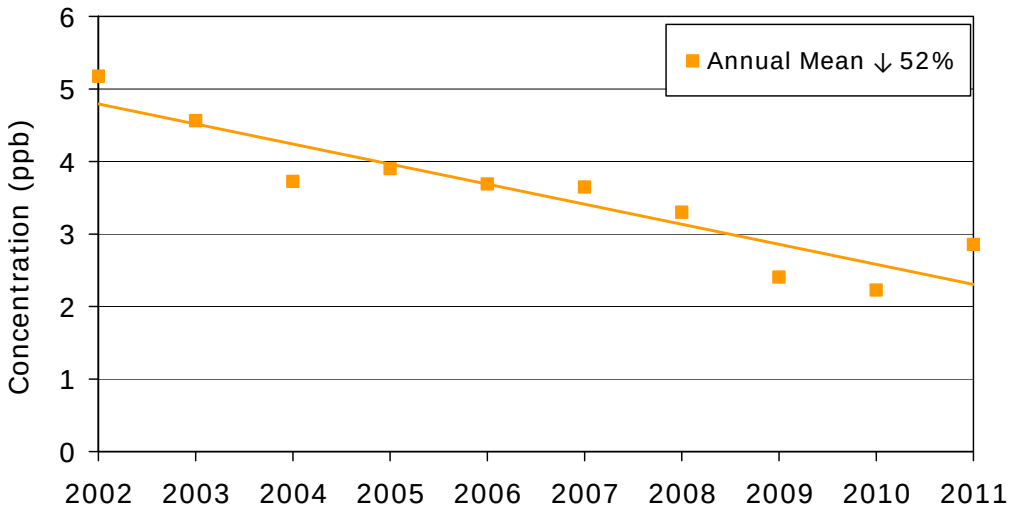
Sarnia recorded the highest annual mean (3.9 ppb) and 24-hour maximum concentration (53 ppb) of SO_2 during 2011, whereas Hamilton Downtown recorded the highest one-hour maximum (117 ppb). The highest concentrations of SO_2 historically have been recorded in the vicinity of large industrial facilities such as smelters and utilities. The provincial one-hour, 24-hour and annual AAQC of 250 ppb, 100 ppb and 20 ppb, respectively, for SO_2 were not exceeded at any of the ambient air monitoring sites in 2011.

4.3.3 Trends

Figure 4.8 shows the trend of annual means for SO_2 concentrations from 2002 to 2011. Over the 10-year period, SO_2 concentrations have decreased by approximately 52 per cent. Overall, provincial SO_2 emissions have reduced by approximately 55 per cent from 2001 to 2010, as shown in Figure 4.9 (NPRI, 2012; NPRI, 2010; P. Georges, personal communication, April 1, 2010). The reduction of SO_2 emissions over the years is the result of various initiatives which include, but are not limited to:

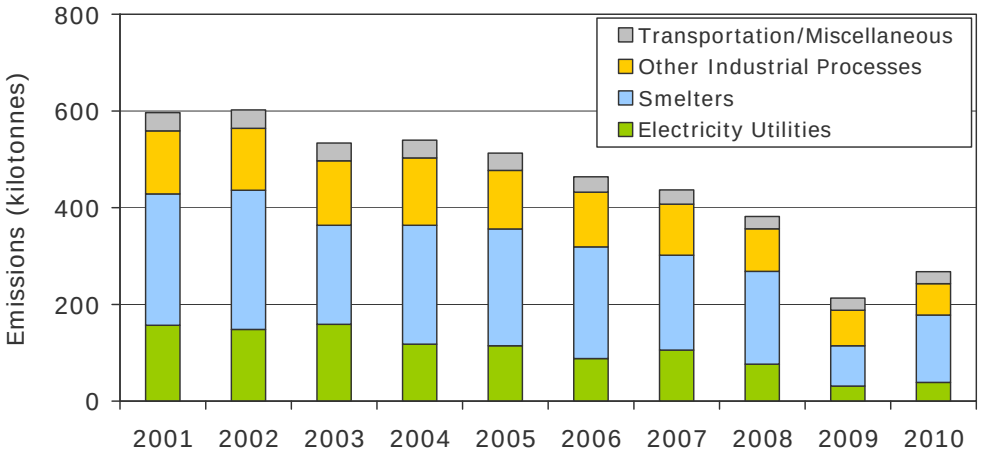
i) Control orders for Ontario smelters;
ii) Countdown Acid Rain program and Canada-wide Acid Rain Strategy;
iii) Ontario's emissions trading regulations on sulphur dioxide and nitrogen oxides (O. Reg. 397/01 and O. Reg. 194/05);
iv) Phase-out of coal-fired generating stations, with Lakeview Thermal Generating Station shut down in 2005; and
v) Low sulphur content in transportation fuels.

Figure 4.8
Trend of SO_2 Annual Means (ppb) Across Ontario (2002-2011)



Note: Ten-year trend is a composite mean based on 9 sites.

Figure 4.9
Trend of Ontario SO_2 Emissions in Kilotonnes (2001-2010)



Note: Excludes open and natural sources.

References: NPRI, 2012; NPRI, 2010; and P. Georges, personal communication, April 1, 2010.

5.0 Air Quality Index and Smog Advisories

This chapter focuses on the Air Quality Index (AQI) and smog advisories. The ministry's AQI program was established in 1988, and originally included ozone, NO_2, SO_2, CO, suspended particles (SP) and TRS compounds. On August 23, 2002, the ministry replaced SP in the AQI with $PM_{2.5}$, commonly known as fine particulate matter, making Ontario the first province in Canada to do so. These fine particles penetrate deep into the lungs and are closely linked to respiratory impacts. Fine particulate matter reporting provides a more accurate representation of Ontario's air and allows people to make more informed decisions to protect their health. In association with the AQI program, the ministry launched the Air Quality Advisory program in 1993. In 2000, this program was expanded to the Smog Alert program under which smog advisories are issued.

5.1 Air Quality Indices

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2011, 40 of these sites formed the basis of the AQI network. The Air Quality Office of the Environmental Monitoring and Reporting Branch continuously obtains near real-time data for criteria air pollutants from these 40 sites.

Figure 5.1
Air Quality Index (AQI) Monitoring Sites in Ontario (2011)

The AQI network, shown in Figure 5.1, provides the public with air quality information, every hour, 24 hours a day, from across the province. The AQI is based on pollutants that have adverse effects on human health and the environment, including O_3, $PM_{2.5}$, NO_2, CO, SO_2 and TRS compounds. At the end of each hour, the concentration of each pollutant measured at each site is converted into a number ranging from zero upwards using a common scale or index. The calculated number for each pollutant is referred to as a sub-index.

At a given air monitoring site, the highest sub-index for any given hour becomes the AQI reading for that hour. The index is a relative scale, in that the lower the index, the better the air quality. The index values, corresponding categories, and potential health and environmental effects are shown in Table 5.1.

If the AQI value is below 32, the air quality is categorized as good. For AQI values in the 32-49 range (moderate category), there may be some adverse effects for very sensitive people. For index values in the 50-99 range (poor category), the air quality may have adverse effects for sensitive members of human and animal populations, and may cause significant damage to vegetation and property. With an AQI value of 100 or more (very poor category), the air quality may have adverse effects for a large proportion of those exposed.

Computed AQI values are released to the public every hour on the ministry's website at www.airqualityontario.com. The public can also access the index values by calling the ministry's air quality information Interactive Voice Response (IVR) system. (To access an English recording, call 1-800-387-7768, or in Toronto, call 416-246-0411. For a French recording, call 1-800-221-8852.) Air quality forecasts, based on regional meteorological conditions and current pollution levels in Ontario and bordering U.S. states, are also provided daily on the ministry's website and IVR system.

Table 5.1: Air Quality Index Pollutants and Their Impacts*

Index	Category	Ozone (O_3)	Fine Particulate Matter ($PM_{2.5}$)	Nitrogen Dioxide (NO_2)	Carbon Monoxide (CO)	Sulphur Dioxide (SO_2)	Total Reduced Sulphur (TRS) Compounds
0-15	Very Good	No health effects are expected in healthy people	Sensitive populations may want to exercise caution	No health effects are expected in healthy people	No health effects are expected in healthy people	No health effects are expected in healthy people	No health effects are expected in healthy people
16-31	Good	No health effects are expected in healthy people	Sensitive populations may want to exercise caution	Slight odour	No health effects are expected in healthy people	Damages some vegetation in combination with ozone	Slight odour
32-49	Moderate	Respiratory irritation in sensitive people during vigorous exercise; people with heart/lung disorders at some risk; damages very sensitive plants	People with respiratory disease at some risk	Odour	Blood chemistry changes, but no noticeable impairment	Damages some vegetation	Odour
50-99	Poor	Sensitive people may experience irritation when breathing and possible lung damage when physically active; people with heart/lung disorders at greater risk; damages some plants	People with respiratory disease should limit prolonged exertion; general population at some risk	Air smells and looks brown; some increase in bronchial reactivity in asthmatics	Increased symptoms in smokers with heart disease	Odour; increasing vegetation damage	Strong odour
100-over	Very Poor	Serious respiratory effects, even during light physical activity; people with heart/lung disorders at high risk; more vegetation damage	Serious respiratory effects even during light physical activity; people with heart disease, the elderly and children at high risk; increased risk for general population	Increasing sensitivity for asthmatics and people with bronchitis	Increasing symptoms in non-smokers with heart diseases; blurred vision; some clumsiness	Increasing sensitivity for asthmatics and people with bronchitis	Severe odour; some people may experience nausea and headaches

* Note that the information in this table is subject to change.

Table 5.2 shows the percentage distribution of hourly AQI readings for the 40 monitoring sites by the AQI category and the number of days with at least one hour AQI value greater than 49. Air quality readings in the very good and good categories ranged from approximately 90 per cent at Windsor and Sarnia to 99 per cent at Thunder Bay. On average, the AQI sites in 2011 reported air quality in the very good and good categories approximately 95 per cent of the time and moderate to poor categories about 5 per cent of the time. This is an improvement relative to the year 2010, when air quality sites on average reported air quality in the very good and good categories approximately 93 per cent of the time and moderate to poor air quality about 7 per cent of the time.

Table 5.2: Air Quality Index Summary (2011)

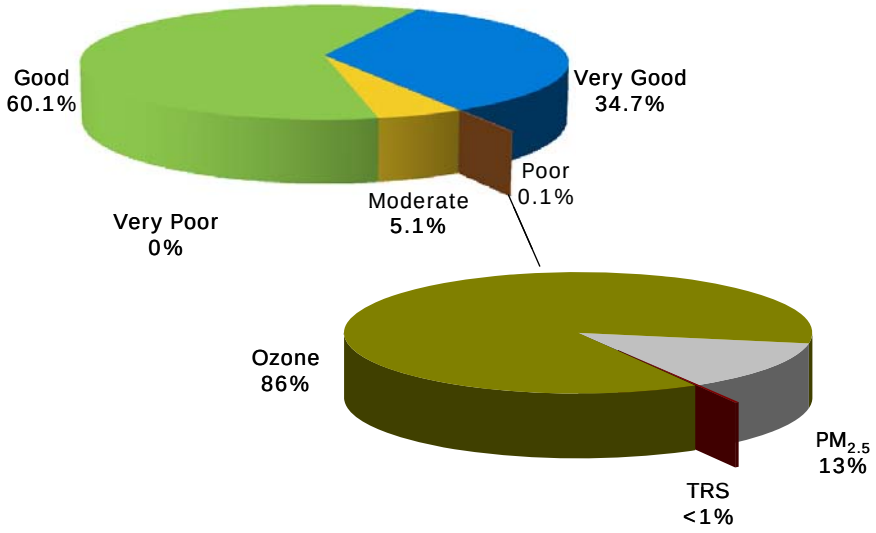
City/Town	No. of Valid Hours	Percentage of Valid Hours AQI in Range					No. of Days At Least 1 Hour > 49
		Very Good	Good	Moderate	Poor	Very Poor	
		0-15	16-31	32-49	50-99	100+	
Windsor Downtown	8756	36.8	52.8	9.9	0.5	0	13
Windsor West	8728	37.2	53.3	9.2	0.4	0	9
Chatham	8755	31.0	61.2	7.7	0.2	0	6
Sarnia	8750	20.6	69.3	10.0	0.1	0	7
Grand Bend	8753	19.9	72.8	7.0	0.2	0	8
London	8730	37.7	56.7	5.5	<0.1	0	1
Port Stanley	8755	21.2	70.1	8.4	0.3	0	7
Tiverton	8537	21.8	73.1	5.1	0.1	0	3
Brantford	8684	29.6	61.8	8.5	0.1	0	2
Kitchener	8740	32.8	61.3	5.9	<0.1	0	1
St. Catharines	8740	32.7	60.8	6.5	<0.1	0	1
Guelph	8726	30.7	62.9	6.3	<0.1	0	1
Hamilton Downtown	8751	35.9	55.3	8.7	0.2	0	8
Hamilton Mountain	8754	30.1	61.3	8.5	0.1	0	3
Hamilton West	8747	38.0	56.1	5.9	0.1	0	2
Toronto Downtown	8753	40.3	54.9	4.8	<0.1	0	1
Toronto East	8751	45.3	50.6	4.1	<0.1	0	1
Toronto North	8749	40.2	53.8	6.0	<0.1	0	1
Toronto West	8709	51.9	44.1	4.0	<0.1	0	1
Burlington	8738	37.9	57.4	4.7	<0.1	0	1

Table 5.2: Air Quality Index Summary (2011) - Continued

City/Town	No. of Valid Hours	Percentage of Valid Hours AQI in Range					No. of Days At Least 1 Hour > 49
		Very Good	Good	Moderate	Poor	Very Poor	
		0-15	16-31	32-49	50-99	100+	
Oakville	8633	35.5	59.0	5.4	<0.1	0	1
Oshawa	8748	36.7	59.8	3.5	<0.1	0	2
Brampton	8755	37.2	57.1	5.7	<0.1	0	2
Mississauga	8628	41.3	55.0	3.6	<0.1	0	1
Barrie	8675	38.7	58.3	3.1	0	0	0
Newmarket	8758	33.4	61.6	4.9	0.1	0	2
Parry Sound	8752	27.9	67.4	4.7	<0.1	0	1
Dorset	8733	35.3	61.8	2.8	0	0	0
Ottawa Downtown	8674	44.4	53.8	1.8	0	0	0
Ottawa Central	8754	41.9	56.5	1.5	0	0	0
Petawawa	8658	38.9	59.4	1.7	0	0	0
Kingston	8637	24.8	69.5	5.7	0	0	0
Belleville	8749	34.4	61.3	4.2	0.1	0	4
Morrisburg	8749	33.9	63.0	3.1	0	0	0
Cornwall	8749	35.3	62.1	2.7	0	0	0
Peterborough	8713	32.7	63.0	4.2	<0.1	0	1
Thunder Bay	8595	38.8	59.8	1.2	0.2	0	1
Sault Ste. Marie	8726	34.4	62.8	2.9	0	0	0
North Bay	8759	36.9	60.4	2.7	0	0	0
Sudbury	8745	31.9	65.7	2.4	0	0	0

Figure 5.2 shows the provincial average for the percentages of time the AQI was in the various air quality categories as recorded by all sites across the province in 2011. The pie diagram at the top left shows the category percentages. The pie diagram at the bottom right breaks down the poor air quality (0.1 per cent) into percentages of pollutants associated with the AQI above 49. Approximately 86 per cent of the poor AQI values were due to ozone, 13 per cent were due to fine particulate matter, and less than 1 per cent due to TRS compounds. Among the poor AQI values, approximately 98 per cent occurred in summer from May to September, while the remaining 2 per cent occurred in April and October.

Figure 5.2
Air Quality Index Summary (2011)



5.2 Smog Advisories

Under the Smog Alert program, smog advisories are issued to the public in advance when AQI values are expected to be greater than 49 due to elevated, widespread and persistent levels of O_3 and/or $PM_{2.5}$. Generally, smog advisories are issued 24 hours in advance; however, if elevated smog conditions occur suddenly, and weather conditions conducive to elevated smog levels are expected to continue for several hours, a smog advisory is issued effective immediately. Note that a smog advisory is a forecast and does not necessarily mean elevated smog is a certainty since it is based on weather forecasts.

Smog advisories are available to the public and media via:

i) The ministry's website at www.airqualityontario.com;
ii) Smog alerts emailed directly to everyone who subscribes to the ministry's Smog Alert network at the above website; and
iii) The ministry's air quality information IVR system. (To access an English recording, call 1-800-387-7768, or in Toronto, call 416-246-0411. For a French recording, call 1-800-221-8852.)

5.2.1 2011 Smog Advisories

In 2011, Ontarians experienced five smog advisories covering just nine days. Four of the five smog advisories occurred during the traditional smog season (May 1 to September 30 inclusive), while one smog advisory was issued on October 11, 2011 covering one day for Hamilton due to elevated $PM_{2.5}$ concentrations. In 2010, the ministry issued three smog advisories covering 12 days. The number and duration of smog advisories are highly dependent on meteorological conditions.

GLOSSARY

Air Quality Index	-	real-time information system that provides the public with an indication of air quality in cities, towns and in rural areas across Ontario.
AQI station	-	continuous monitoring station used to inform the public of general ambient air quality levels over an entire region (not a localized area) on a real-time basis; station reports on criteria pollutant levels that are not unduly influenced by a single emission source, but rather are the result of emissions from multiple sources, including those in neighbouring provinces and states.
Ambient air	-	outdoor or open air.
Carbon monoxide	-	a colourless, odourless, tasteless, and at high concentrations, poisonous gas.
Continuous pollutants	-	pollutants for which a continuous record exists; effectively, pollutants that have hourly data (maximum 8,760 values per year except leap year – e.g. 2004 where maximum values for the year are 8,784).
Continuous station	-	where pollutants are measured on a real-time basis and data determined hourly (for example ozone, sulphur dioxide).
Criterion	-	maximum concentration or level (based on potential effects) of pollutant that is desirable or considered acceptable in ambient air.
Diurnal	-	recurring every day; actions that are completed in 24 hours and repeated every 24 hours.
Exceedance	-	violation of the air pollutant concentration levels established by environmental protection criteria or other environmental standards.
Fine Particulate Matter	-	particles smaller than 2.5 microns in aerodynamic diameter, which arise mainly from fuel combustion, condensation of hot vapours and chemically-driven gas-to-particle conversion processes; also referred to as $PM_{2.5}$ or respirable particles. These are fine enough to penetrate deep into the lungs.

Fossil fuels	-	natural gas, petroleum, coal and any form of solid, liquid or gaseous fuel derived from organic materials for the purpose of generating heat.
Ground-level ozone	-	colourless gas formed from chemical reactions between nitrogen oxides and volatile organic compounds (VOCs) in the presence of sunlight near the Earth's surface.
Micron	-	a millionth of a metre.
Nitrogen dioxide	-	a reddish-brown gas with a pungent and irritating odour.
Oxidation	-	a chemical reaction where a substance gains an oxygen; for example, in the atmosphere, sulphur dioxide is oxidized by hydroxyl radicals to form sulphate.
Particulate matter	-	refers to all airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 44 microns.
Percentile value	-	percentage of the data set that lies below the stated value; if the 70 percentile value is 0.10 ppm, then 70 per cent of the data are equal to or below 0.10 ppm.
Primary pollutant	-	pollutant emitted directly to the atmosphere.
Secondary pollutant	-	pollutant formed from other pollutants in the atmosphere.
Smog	-	a contraction of smoke and fog; colloquial term used for photochemical smog, which includes ozone, and may include fine particulate matter, and other contaminants; tends to be a brownish haze.
Smog advisory	-	smog advisories are issued to the public when there is a strong likelihood that widespread, elevated and persistent smog levels are expected.
Stratosphere	-	atmosphere 10 to 40 kilometres above the Earth's surface.

Glossary continued

Stratospheric ozone	-	ozone formed in the stratosphere from the conversion of oxygen molecules by solar radiation; ozone found there absorbs much ultraviolet radiation and prevents it from reaching the Earth.
Sulphur dioxide	-	a colourless gas that smells like burnt matches.
Troposphere	-	atmospheric layer extending from the surface up to about 10 kilometres above the Earth's surface.

ACRONYMS

AAQC	-	Ambient Air Quality Criteria (Ontario)
AQI	-	Air Quality Index
CCME	-	Canadian Council of Ministers of the Environment
CO	-	carbon monoxide
CWS	-	Canada-wide Standard
GTA	-	Greater Toronto Area
IVR	-	Interactive Voice Response
NO	-	nitric oxide
NO_2	-	nitrogen dioxide
NO_X	-	nitrogen oxides
O_3	-	ozone
$PM_{2.5}$	-	fine particulate matter
SES (TEOM)	-	Sample Equilibration System
SO_2	-	sulphur dioxide
TEOM	-	Tapered Element Oscillating Microbalance
TRS	-	total reduced sulphur
VOCs	-	volatile organic compounds
kt	-	kilotonnes
$\mu g/m^3$	-	micrograms (of contaminant) per cubic metre (of air) – by weight
ppb	-	parts (of contaminant) per billion (parts of air) – by volume
ppm	-	parts (of contaminant) per million (parts of air) – by volume

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APPENDICES

The Appendices are intended for use in conjunction with the 2011 Annual Air Quality in Ontario report. The Appendices briefly describe the provincial Air Quality Index (AQI) network, quality assurance and quality control procedures, and the Ministry of the Environment's air quality database. It also includes a series of tables displaying station locations and a listing of the summary statistics including means, maximums, percentile values and the number of exceedances of the Ontario ambient air quality criteria (AAQC) for each pollutant. In addition, trends for select pollutants are displayed for 10- and 20-year periods.

MONITORING NETWORK OPERATIONS

Network Description

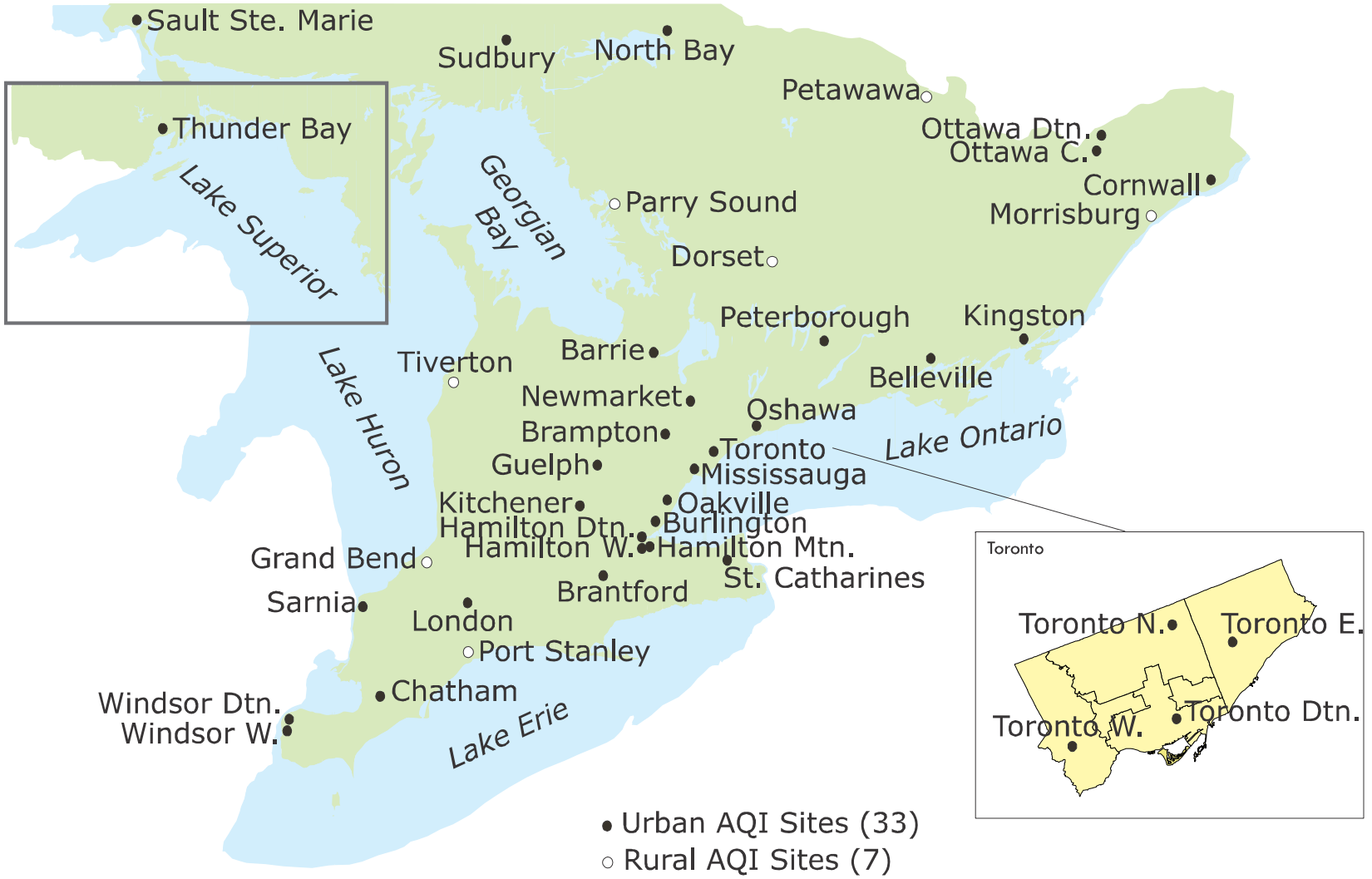
In 2011, the Environmental Monitoring and Reporting Branch (EMRB) operated 40 ambient air monitoring sites across Ontario. Monitoring site locations for the AQI network are illustrated in Map 1. The AQI network was comprised of 133 continuous monitoring instruments at 40 sites. These instruments have the capability of recording minute data (approximately 70 million data points per year) that are used to scan and validate the continuous hourly data.

Quality Assurance and Quality Control

Day-to-day maintenance and support of the instruments are administered by EMRB staff. Instrumentation precision is verified by daily automatic internal zero and span checks. Data analysts and station operators review span control charts to confirm instrument precision using a telemetry system. A quarterly quality assurance and quality control (QA/QC) review is performed on the ambient data set in order to highlight anomalies and administer corrective action in a timely manner.

The air monitoring station operators routinely inspect and maintain monitoring equipment and stations with mandatory bi-monthly on-site visits where secondary transfer standards are used to calibrate instrumentation. Station activity is recorded using FieldWorker Inc. software, an electronic documentation solution; this information is transferred directly to the ministry's database. The instrumentation used throughout the provincial air

Map 1
Air Quality Index (AQI) Monitoring Sites in Ontario (2011)



monitoring network has been standardized to Thermo Electron Corporation analyzers in an effort to streamline parts inventory and leverage common hardware used within each analyzer. The following is a summary of the instrumentation deployed within the network:

- Ozone – TE49C/I
- Fine Particulate Matter – TEOM 1400AB/SES
- Nitrogen Oxides – TE42C/I
- Carbon Monoxide – TE48C/I
- Total Reduced Sulphur – TE43C/CDN101
- Sulphur Dioxide – TE43C/I

EMRB operates a laboratory with gas reference standards that adhere to those of the U.S. National Institute of Standards and Technology (NIST) and the Air Quality Research Division of Environment Canada. The secondary transfer standards used by station operators are referenced and certified to EMRB's NIST primary standards on a quarterly basis. Primary weighed filter standards from Environment Canada are used to calibrate the TEOM twice a year.

The Ontario ambient air quality monitoring network undergoes constant maintenance to ensure a high standard of quality control. Continuous real-time data are consistently reviewed, assessed and validated by EMRB staff. Immediate actions are taken to correct any inconsistencies that may affect the validity of the data. These measures ensure ambient air monitoring data are valid, complete, comparable, representative and accurate. As a result, the 2011 ambient air quality monitoring network had greater than 99 per cent valid data from over one million hourly data points.

Continuous $PM_{2.5}$ Monitoring Network Upgrade

As part of a national initiative, funded by Environment Canada, Ontario will be upgrading its $PM_{2.5}$ monitoring network at a cost of 1.5 million dollars. The new $PM_{2.5}$ monitors will be deployed across the AQI network in 2012 and commence reporting in 2013. The new monitors will address issues with cold weather $PM_{2.5}$ measurements and reduce long-term operation costs.

The ministry historically relied on the non-continuous Federal Reference Method (FRM) for $PM_{2.5}$ monitoring, which produces 24-hour averaged measurements on a 3-day or 6-day cycle. The FRM is resource-intensive and requires sample setup and laboratory analysis and can take up to several

months to report $PM_{2.5}$ data. Continuous particulate matter (PM) monitoring is essential for reporting hourly ambient concentrations; however, it comes with technical challenges. The Tapered Element Oscillating Microbalance (TEOM) technology was developed for continuous real-time PM monitoring (Patashnick and Rupprecht, 1991) and received United States Environmental Protection Agency (USEPA) Class III Federal Equivalent Method (FEM) designation in 1990 for PM_{10} reporting (USEPA, 2011). The Class III FEM is a designation for measuring ambient concentrations of specified air pollutants in accordance with Title 40, Part 53 of the Code of Federal Regulations (40 CFR Part 53).

Ontario was the first province in Canada to report continuous real-time $PM_{2.5}$ concentrations to the public in 2002 under the AQI program when continuous measurements of $PM_{2.5}$ became a priority for provincial and federal governments. TEOM was the most innovative method at the time for continuous real-time $PM_{2.5}$ monitoring, and continues to be used by many jurisdictions across North America. However, studies indicate that $PM_{2.5}$ measurements by the TEOM are found to be lower than those by FRM when temperatures are low (Rizzo et al., 2003; Motallebi et al., 2003; Zhu et al., 2007; Tortajada-Genaro, L.-A. and E. Borrás, 2011).

Over the last decade, continuous $PM_{2.5}$ monitoring technologies have evolved dramatically to address the technical issues associated with cold weather $PM_{2.5}$ measurements. To ensure consistency and comparability in $PM_{2.5}$ monitoring and reporting, in 2006, the USEPA published criteria for designating a continuous $PM_{2.5}$ monitor as Class III FEM (Federal Register, 2006). Manufacturers are required to collocate their $PM_{2.5}$ monitors with FRM measurements and pass rigorous tests following the USEPA guidelines to receive the Class III FEM $PM_{2.5}$ designation (Federal Register, 2006). Six continuous $PM_{2.5}$ monitors received the Class III FEM designation as of October 12, 2011.

After extensive evaluation of four designated Class III FEM $PM_{2.5}$ monitors, Ontario selected the Thermo Scientific Synchronized Hybrid Ambient Real-time Particulate (SHARP) 5030 to replace the TEOM monitors currently deployed in the AQI network. Ontario will be upgrading its $PM_{2.5}$ monitoring network to the USEPA Class III FEM to standardize the monitoring methods and ensure consistency of data quality across Canada.

Data Base

The ambient air quality data used in this report are stored in the ministry's air quality information system (AQUIS). A statistical pattern test is used to identify data anomalies, such as unusual pollutant concentrations. Each pollutant has a predetermined concentration range based on historical data. Values outside this range are flagged for further investigation.

Data obtained from automated ambient air monitoring instruments that operate continuously to produce an average measurement for every hour for a possible total of 8,760 measurements in a given year. Hourly parameters measured include O_3, $PM_{2.5}$, $NO/NO_2/NO_x$, CO, SO_2 and TRS compounds. A valid annual mean requires at least 6,570 hourly readings. In addition, the 2nd and 3rd quarters of the year should have 75 per cent valid data for ozone, whereas for $PM_{2.5}$, each quarter of the year should have 75 per cent valid data (Canadian Council of Ministers of the Environment, 2002).

NETWORK DESCRIPTIVE TABLE, ANNUAL STATISTICS AND TRENDS

The AQI network for 2011 is summarized in Table 1. The table displays the station name, numerical identifier and pollutants measured. The numerical identifier is the station (ID) number, the first digit of which identifies the geographic region in which the station is located.

Table 1 also identifies the *type* of air monitoring site: ambient, road-side, Canada-wide Standard (CWS), and/or National Air Pollution Surveillance (NAPS). Ambient sites represent the general air quality of an area without any direct influence of local industrial sources. Road-side sites are within approximately 100 m of a major roadway with daily traffic volumes greater than 10,000 vehicles per day.

The 2011 statistical data and 10-year trends for various continuous pollutants are provided in Appendices A and B, respectively. To be included in the 10-year trend analysis, a site must have valid annual means for a minimum of 8 years over the 10-year period from 2002-2011. The 20-year trends for ozone, NO_2 and SO_2 are provided in Appendices C-E. To be included in the 20-year trend analysis, a site must have valid annual means for a minimum of 15 years over the 20-year period from 1992-2011. A linear regression was applied to each of the trends presented in Appendices B-E to calculate the per cent change in concentrations over time.

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Table 1

2011 Ontario Continuous Ambient Air Monitoring Network

ID	STATION NAME	STATION LOCATION	YEAR	LATITUDE (D:M:S)	LONGITUDE (D:M:S)	AIR INTAKE (AGL)	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	SO_2	CO	TRS
12008	WINDSOR DOWNTOWN	467 UNIVERSITY AVE. W.	1969	42°18'56.8"	-83°02'37.2"	8	A/RS/C/N	Y	T	T	T	T	T	.
12016	WINDSOR WEST	COLLEGE AVE./SOUTH ST.	1975	42°17'34.4"	-83°04'23.3"	4	A/N	Y	T	T	T	T	.	T
13001	CHATHAM	435 GRAND AVE. W.	2005	42°24'13.3"	-82°12'29.9"	15	A/C/N	Y	T	T	T	.	.	.
14064	SARNIA	FRONT ST. N./CN TRACKS, CENTENNIAL PARK	1978	42°58'56.2"	-82°24'18.3"	3	A/N	Y	T	T	T	T	.	T
15020	GRAND BEND	POINT BLAKE CONSERVATION AREA	1991	43°19'59.1"	-81°44'34.4"	5	A/N	Y	T	T	T	.	.	.
15025	LONDON	900 HIGHBURY AVE. N.	1995	43°00'24.2"	-81°12'23.1"	4	A/C/N	Y	T	T	T	.	.	.
16015	PORT STANLEY	43665 DEXTER LINE, ELGIN WATER T. PLANT	2002	42°40'19.5"	-81°09'46.4"	5	A/N	Y	T	T	.	.	.	.
18007	TIVERTON	4th CONCESSION/BRUCE RD. 23	1979	44°18'52.1"	-81°32'59.0"	4	A/N	Y	T	T	T	.	.	.
21005	BRANTFORD	324 GRAND RIVER AVE.	2004	43°08'19.0"	-80°17'33.5"	5	A/C/N	Y	T	T	T	.	.	.
26060	KITCHENER	WEST AVE./HOMEWOOD AVE.	1990	43°26'37.8"	-80°30'13.7"	5	A/C/N	Y	T	T	T	.	.	.
27067	ST. CATHARINES	ARGYLE CRES., PUMP STN.	1987	43°09'36.2"	-79°14'05.1"	4	A/C/N	Y	T	T	T	.	.	.
28028	GUELPH	EXHIBITION ST./CLARK ST. W.	2000	43°33'05.8"	-80°15'51.0"	4	A/C/N	Y	T	T	T	.	.	.
29000	HAMILTON DOWNTOWN	ELGIN ST./KELLY ST.	1987	43°15'28.0"	-79°51'42.0"	4	A/RS/C/N	Y	T	T	T	T	T	T
29114	HAMILTON MOUNTAIN	VICKERS RD./E. 18TH ST.	1985	43°13'45.9"	-79°51'46.0"	3	A/C/N	Y	T	T	T	T	.	.
29118	HAMILTON WEST	MAIN ST. W./HWY 403	1985	43°15'26.8"	-79°54'27.9"	3	A/RS	Y	T	T	T	.	.	.
31103	TORONTO DOWNTOWN	BAY ST./WELLESLEY ST. W.	2000	43°39'46.7"	-79°23'17.2"	10	A/RS/C/N	Y	T	T	T	.	.	.
33003	TORONTO EAST	KENNEDY RD./LAWRENCE AVE. E.	1970	43°44'52.5"	-79°16'26.6"	4	A/RS/C/N	Y	T	T	T	.	.	.
34020	TORONTO NORTH	HENDON AVE./YONGE ST.	1988	43°46'53.8"	-79°25'03.8"	5	A/RS/C/N	Y	T	T	T	.	.	.
35125	TORONTO WEST	125 RESOURCES RD.	2003	43°42'34.0"	-79°32'36.6"	8	A/RS/C/N	Y	T	T	T	T	T	.
44008	BURLINGTON	NORTH SHORE BLVD. E./LAKESHORE RD.	1979	43°18'54.4"	-79°48'09.5"	5	A/C/N	Y	T	T	T	.	.	.
44017	OAKVILLE	EIGHTH LINE/GLENASHTON DR., HALTON RESERVOIR	2003	43°29'12.9"	-79°42'08.2"	12	A/C/N	Y	T	T	T	.	.	.
45026	OSHAWA	2000 SIMCOE ST. N., DURHAM COLLEGE	2005	43°56'45.4"	-78°53'41.7"	7	A/RS/C/N	Y	T	T	T	.	.	.
46089	BRAMPTON	525 MAIN ST. N., PEEL MANOR	2000	43°41'55.5"	-79°46'51.3"	5	A/C/N	Y	T	T	T	.	.	.
46108	MISSISSAUGA	3359 MISSISSAUGA RD. N., U of T MISSISSAUGA	2007	43°32'49.1"	-79°39'31.3"	5	A/C/N	Y	T	T	T	T	.	.
47045	BARRIE	83 PERRY ST.	2001	44°22'56.5"	-79°42'08.3"	5	A/C/N	Y	T	T	T	.	.	.
48006	NEWMARKET	EAGLE ST. W./McCAFFREY RD.	2001	44°02'39.5"	-79°28'59.7"	5	A/N	Y	T	T	T	.	.	.
49005	PARRY SOUND	7 BAY ST.	2001	45°20'16.3"	-80°02'17.4"	5	A/N	Y	T	T	T	.	.	.
49010	DORSET	1026 BELLWOOD ACRES RD.	1981	45°13'27.4"	-78°55'58.6"	3	A/N	Y	T	T	.	.	.	.
51001	OTTAWA DOWNTOWN	RIDEAU ST./WURTEMBURG ST.	1971	45°26'03.6"	-75°40'33.6"	4	A/C/N	Y	T	T	T	T	T	.
51002	OTTAWA CENTRAL	960 CARLING AVE.	2007	45°22'57.1"	-75°42'51.1"	5	A/N	Y	T	T	T	.	.	.

Table 1
2011 Ontario Continuous Ambient Air Monitoring Network (continued)

ID	STATION NAME	STATION LOCATION	YEAR	LATITUDE (D:M:S)	LONGITUDE (D:M:S)	AIR INTAKE (AGL)	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	SO_2	CO	TRS
51010	PETAWAWA	PETAWAWA RESEARCH FOREST FACILITY	2007	45°59'48.2"	-77°26'28.3"	6	A/N	Y	T	T	.	.	.	.
52022	KINGSTON	752 KING ST. W.	2006	44°12'58.5"	-76°31'41.9"	13	A/C/N	Y	T	T	T	.	.	.
54012	BELLEVILLE	2 SIDNEY ST., WATER TREATMENT PLANT	2002	44°09'01.9"	-77°23'43.8"	10	A/N	Y	T	T	T	.	.	.
56010	MORRISBURG	COUNTY RD. 2, MORRISBURG WATER TOWER	2005	44°53'59.1"	-75°11'23.8"	5	A/N	Y	T	T	.	.	.	.
56051	CORNWALL	BEDFORD ST./3RD ST. W.	1970	45°01'04.7"	-74°44'06.8"	4	A/N	Y	T	T	T	.	.	.
59006	PETERBOROUGH	10 HOSPITAL DR.	1998	44°18'06.9"	-78°20'46.4"	10	A/C/N	Y	T	T	T	.	.	.
63203	THUNDER BAY	421 JAMES ST. S.	2004	48°22'45.8"	-89°17'24.6"	15	A/RS/C/N	Y	T	T	T	.	.	.
71078	SAULT STE. MARIE	SAULT COLLEGE	2004	46°31'59.5"	-84°18'35.7"	8	A/N	Y	T	T	T	T	.	T
75010	NORTH BAY	CHIPPEWA ST. W., DEPT. NATIONAL DEFENCE	1979	46°19'23.5"	-79°26'57.4"	4	A/RS/N	Y	T	T	T	.	.	.
77219	SUDBURY	1222 RAMSEY LAKE RD.	2004	46°28'32.5"	-80°57'46.6"	3	A/C/N	Y	T	T	.	T	.	.
TOTAL								40	40	40	35	10	4	4

Notes:

ID - station identfication number

Year - year station began monitoring

Air intake - height of air intake above ground (m)

Type - type of monitoring site: A = ambient, RS = road-side, C = CWS, N = NAPS

AQI - Air Quality Index site

T - telemetry

O_3 - ground-level ozone

$PM_{2.5}$ - fine particulate matter

NO_2 - nitrogen dioxide

CO - carbon monoxide

SO_2 - sulphur dioxide

TRS - total reduced sulphur

Table A1
2011 Ozone (O_3) Statistics

Unit: parts per billion (ppb)
O_3 1-hour AAQC is 80 ppb

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criterion
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
12008	Windsor Downtown	467 University Ave. W.	8734	7	18	26	34	48	74	27.2	100	65	42
12016	Windsor West	College Ave./South St.	8704	7	18	25	33	47	72	26.4	101	59	31
13001	Chatham	435 Grand Ave. W.	8561	14	22	29	36	46	67	29.7	92	59	16
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8700	13	22	29	36	46	68	29.7	94	57	12
15020	Grand Bend	Point Blake Conservation Area	8743	17	26	33	39	47	69	32.8	115	60	20
15025	London	900 Highbury Ave. N.	8689	11	20	26	33	43	62	26.8	83	57	2
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8750	17	26	32	38	48	71	32.8	94	67	30
18007	Tiverton	4th Concession/Bruce Rd. 23	8523	18	26	32	38	45	65	32.1	89	63	6
21005	Brantford	324 Grand River Ave.	8679	10	21	29	36	46	65	28.7	94	68	10
26060	Kitchener	West Ave./Homewood Ave.	8727	11	20	27	34	44	61	27.6	87	59	3
27067	St. Catharines	Argyle Cres., Pump Stn.	8734	10	21	28	35	45	63	28.0	83	59	1
28028	Guelph	Exhibition St./Clark St. W.	8667	11	22	29	36	45	64	28.9	94	61	4
29000	Hamilton Downtown	Elgin St./Kelly St.	8745	8	18	25	32	42	62	25.4	92	60	5
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8752	11	21	28	35	46	65	28.8	95	65	6
29118	Hamilton West	Main St. W./Hwy 403	8743	5	17	24	31	40	60	24.2	88	56	3
31103	Toronto Downtown	Bay St./Wellesley St. W.	8724	8	18	25	32	42	61	25.4	88	58	1
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8703	5	16	23	30	40	61	23.3	82	57	1
34020	Toronto North	Hendon Ave./Yonge St.	8744	6	16	23	30	40	61	23.6	85	57	1
35125	Toronto West	125 Resources Rd.	8659	2	11	19	27	38	61	20.1	87	53	1
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8682	7	18	26	33	43	60	25.9	85	57	2
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8616	9	20	27	33	43	63	26.8	95	60	4
45026	Oshawa	2000 Simcoe St. N., Durham College	8742	11	20	26	33	41	61	26.6	85	50	2
46089	Brampton	525 Main St. N., Peel Manor	8731	7	19	26	33	44	64	26.1	88	62	4
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8596	4	17	24	31	41	59	24.1	87	57	3
47045	Barrie	83 Perry St.	8659	7	18	25	33	42	57	25.3	67	52	0
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	8675	11	21	28	34	44	63	27.8	84	64	6

Table A1
2011 Ozone (O_3) Statistics (continued)

Unit: parts per billion (ppb)
O_3 1-hour AAQC is 80 ppb

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criterion
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
49005	Parry Sound	7 Bay St.	8737	14	24	30	36	44	61	29.7	81	59	1
49010	Dorset	1026 Bellwood Acres Rd.	8729	9	21	28	34	43	55	27.0	72	47	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8609	9	17	24	30	39	52	24.2	66	46	0
51002	Ottawa Central	960 Carling Ave.	8689	9	19	25	32	40	52	24.8	64	48	0
51010	Petawawa	Petawawa Research Forest Facility	8625	10	20	27	33	42	53	26.7	67	50	0
52022	Kingston	752 King St. W.	8605	15	24	30	36	44	62	30.3	80	64	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8740	11	21	28	34	43	61	27.9	86	62	6
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8741	11	21	28	34	42	55	27.2	76	55	0
56051	Cornwall	Bedford St./3rd St. W.	8741	9	20	26	33	41	54	26.1	72	55	0
59006	Peterborough	10 Hospital Dr.	8703	12	21	28	34	43	62	27.9	86	60	2
63203	Thunder Bay	421 James St. S.	8584	7	19	26	32	41	50	25.2	60	46	0
71078	Sault Ste. Marie	Sault College	8722	13	22	28	34	43	54	27.8	80	50	0
75010	North Bay	Chippewa St. W., Dept. National Defence	8753	10	20	27	33	42	56	26.7	74	52	0
77219	Sudbury	1222 Ramsey Lake Rd.	8700	14	23	29	34	43	55	28.7	67	51	0

Table A2

2011 Fine Particulate Matter ($PM_{2.5}$) Statistics

Unit: micrograms per cubic metre ($\mu g/m^3$)

$PM_{2.5}$ 24-hour Reference Level is 30 $\mu g/m^3$

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Reference Level
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	24h
12008	Windsor Downtown	467 University Ave. W.	8546	1	4	6	9	16	29	7.6	42	30	0
12016	Windsor West	College Ave./South St.	8503	1	4	6	10	16	30	7.8	57	31	2
13001	Chatham	435 Grand Ave. W.	8680	1	3	5	8	14	27	6.6	63	30	1
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8696	4	6	9	12	20	32	10.5	84	33	2
15020	Grand Bend	Point Blake Conservation Area	8703	1	3	4	7	14	26	6.1	48	27	0
15025	London	900 Highbury Ave. N.	8520	1	3	5	8	13	26	6.2	39	27	0
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8657	1	3	5	7	13	26	6.0	47	30	1
18007	Tiverton	4th Concession/Bruce Rd. 23	8500	0	2	3	6	11	20	4.7	38	21	0
21005	Brantford	324 Grand River Ave.	8581	1	3	5	8	15	28	6.6	45	28	0
26060	Kitchener	West Ave./Homewood Ave.	8641	1	3	5	8	14	26	6.2	52	25	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8684	1	3	5	8	13	24	6.3	37	23	0
28028	Guelph	Exhibition St./Clark St. W.	8651	0	2	4	7	13	25	5.9	42	28	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8446	1	4	6	10	18	35	8.1	65	37	1
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8640	1	3	5	8	15	29	6.7	84	29	0
29118	Hamilton West	Main St. W./Hwy 403	8680	1	3	5	8	16	30	7.1	60	28	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8641	0	3	5	8	14	24	6.2	45	21	0
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8642	1	3	5	8	14	24	6.2	37	21	0
34020	Toronto North	Hendon Ave./Yonge St.	8566	1	3	6	10	17	31	7.7	47	30	0
35125	Toronto West	125 Resources Rd.	8610	1	3	5	9	15	26	6.9	45	24	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8603	1	3	5	8	14	24	6.2	42	23	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8511	1	3	5	8	14	25	6.4	46	25	0
45026	Oshawa	2000 Simcoe St. N., Durham College	8560	0	2	4	7	12	23	5.5	38	22	0
46089	Brampton	525 Main St. N., Peel Manor	8537	0	3	4	7	13	24	6.0	50	24	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8487	1	3	5	8	13	23	6.0	37	21	0
47045	Barrie	83 Perry St.	8616	1	2	4	7	13	23	5.7	49	26	0
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	8717	0	2	4	7	13	24	5.5	52	23	0

Table A2

2011 Fine Particulate Matter ($PM_{2.5}$) Statistics (continued)

Unit: micrograms per cubic metre ($\mu g/m^3$)

$PM_{2.5}$ 24-hour Reference Level is 30 $\mu g/m^3$

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Reference Level
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	24h
49005	Parry Sound	7 Bay St.	8685	0	2	3	6	11	22	4.7	49	24	0
49010	Dorset	1026 Bellwood Acres Rd.	8662	0	2	3	5	10	20	4.1	45	22	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8640	0	2	4	6	11	21	4.9	40	22	0
51002	Ottawa Central	960 Carling Ave.	8655	0	2	3	6	10	18	4.5	51	20	0
51010	Petawawa	Petawawa Research Forest Facility	8618	0	1	3	4	8	14	3.4	45	14	0
52022	Kingston	752 King St. W.	8559	1	3	5	8	15	31	6.9	49	37	1
54012	Belleville	2 Sidney St., Water Treatment Plant	8696	0	2	4	6	11	21	4.8	46	19	0
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8716	1	2	4	6	11	22	5.2	35	22	0
56051	Cornwall	Bedford St./3rd St. W.	8713	1	3	4	7	12	23	5.7	43	24	0
59006	Peterborough	10 Hospital Dr.	8677	1	2	4	7	12	23	5.5	48	23	0
63203	Thunder Bay	421 James St. S.	8532	0	2	4	6	10	20	4.8	84	52	1
71078	Sault Ste. Marie	Sault College	8633	0	2	3	5	10	21	4.4	46	29	0
75010	North Bay	Chippewa St. W., Dept. National Defence	8702	0	2	3	5	9	19	4.2	54	24	0
77219	Sudbury	1222 Ramsey Lake Rd.	8712	0	2	3	5	9	19	4.0	38	22	0

Notes:

Measurements taken by Tapered Element Oscillating Microbalance (TEOM) sampler operated at 30 degrees Celsius with a Sample Equilibrium System (SES).

INS indicates there was insufficient data in any one quarter to calculate a valid annual mean.

The $PM_{2.5}$ reference level is 30 $\mu g/m^3$ for a 24-hour period (based on CWS).

Table A3

2011 Nitric Oxide (NO) Statistics

Unit: parts per billion (ppb)

ID	City/Town	Location	Valid h	PERCENTILES							Maximum	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8740	0	1	2	4	9	46	4.5	238	51
12016	Windsor West	College Ave./South St.	8497	0	1	1	3	7	41	3.8	374	90
13001	Chatham	435 Grand Ave. W.	8687	0	1	1	2	4	13	1.9	127	22
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8703	0	2	3	3	5	19	3.14	140	40
15020	Grand Bend	Point Blake Conservation Area	8740	0	0	0	0	1	4	0.3	20	3
15025	London	900 Highbury Ave. N.	8715	1	1	2	3	6	28	3.3	140	31
18007	Tiverton	4th Concession/Bruce Rd. 23	8529	0	1	1	1	2	4	0.9	55	5
21005	Brantford	324 Grand River Ave.	8680	0	0	0	1	3	19	1.2	95	14
26060	Kitchener	West Ave./Homewood Ave.	8686	0	0	1	1	3	36	2.0	112	22
27067	St. Catharines	Argyle Cres., Pump Stn.	8733	0	0	1	1	4	36	2.3	133	47
28028	Guelph	Exhibition St./Clark St. W.	8671	1	1	1	1	3	33	2.4	124	30
29000	Hamilton Downtown	Elgin St./Kelly St.	8641	0	1	1	3	11	60	4.8	225	55
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8732	0	0	1	2	5	26	2.3	105	31
29118	Hamilton West	Main St. W./Hwy 403	8743	0	1	2	4	16	73	6.4	212	71
31103	Toronto Downtown	Bay St./Wellesley St. W.	8698	0	1	1	3	8	36	3.4	123	29
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8700	1	1	3	6	17	75	7.6	218	60
34020	Toronto North	Hendon Ave./Yonge St.	8654	0	1	3	5	14	61	6.2	181	62
35125	Toronto West	125 Resources Rd.	8698	0	2	5	12	33	105	12.4	253	71
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8589	0	1	1	3	10	57	4.6	191	52
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8619	0	0	1	2	6	36	2.7	177	40
45026	Oshawa	2000 Simcoe St. N., Durham College	8688	0	1	1	2	5	25	2.3	64	31
46089	Brampton	525 Main St. N., Peel Manor	8723	0	1	1	3	9	66	4.6	217	65
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8542	0	1	1	2	8	57	4.1	172	56
47045	Barrie	83 Perry St.	8664	0	0	1	2	8	57	3.8	302	39
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	8703	0	1	1	1	4	28	2.2	147	25

Table A3

2011 Nitric Oxide (NO) Statistics (continued)

Unit: parts per billion (ppb)

ID	City/Town	Location	Valid h	PERCENTILES							Maximum	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h
49005	Parry Sound	7 Bay St.	8749	0	0	1	1	2	9	0.9	47	7
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8467	0	0	1	1	4	20	1.8	126	17
51002	Ottawa Central	960 Carling Ave.	8517	0	0	0	0	3	27	1.5	141	20
52022	Kingston	752 King St. W.	8626	0	0	0	0	1	6	0.5	39	7
54012	Belleville	2 Sidney St., Water Treatment Plant	8739	0	0	1	2	5	28	2.3	111	28
56051	Cornwall	Bedford St./3rd St. W.	8738	0	0	1	1	3	30	1.9	209	51
59006	Peterborough	10 Hospital Dr.	8705	0	1	1	2	4	27	2.2	87	21
63203	Thunder Bay	421 James St. S.	8584	1	2	2	4	15	45	5.9	142	35
71078	Sault Ste. Marie	Sault College	8721	1	1	1	2	4	14	2.0	64	11
75010	North Bay	Chippewa St. W., Dept. National Defence	8757	1	2	2	3	6	40	4.0	149	36

Note:

INS indicates there was insufficient data to calculate a valid annual mean.

Table A4

2011 Nitrogen Dioxide (NO_2) Statistics

Unit: parts per billion (ppb)

NO_2 1-hour AAQC is 200 ppb

NO_2 24-hour AAQC is 100 ppb

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criteria	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8740	5	8	12	17	27	46	14.5	69	40	0	0
12016	Windsor West	College Ave./South St.	8497	4	7	11	15	24	46	12.9	93	37	0	0
13001	Chatham	435 Grand Ave. W.	8687	1	3	5	8	14	27	6.6	49	23	0	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8703	2	4	6	11	19	32	8.6	55	30	0	0
15020	Grand Bend	Point Blake Conservation Area	8740	1	2	3	4	8	15	3.6	23	17	0	0
15025	London	900 Highbury Ave. N.	8715	3	4	6	9	17	34	8.3	50	28	0	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8529	1	1	2	3	5	13	2.5	24	12	0	0
21005	Brantford	324 Grand River Ave.	8680	2	3	4	7	13	27	6.1	53	23	0	0
26060	Kitchener	West Ave./Homewood Ave.	8686	2	4	6	9	16	35	7.7	51	29	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8733	3	5	6	10	17	32	8.5	46	31	0	0
28028	Guelph	Exhibition St./Clark St. W.	8671	2	3	5	8	16	32	7.3	50	26	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8641	4	8	11	16	25	42	13.5	64	37	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8732	3	5	7	12	20	37	9.9	56	30	0	0
29118	Hamilton West	Main St. W./Hwy 403	8743	4	7	10	16	26	42	13.1	56	42	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8698	6	9	13	18	27	42	14.9	54	36	0	0
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8700	5	9	13	18	30	44	15.2	60	41	0	0
34020	Toronto North	Hendon Ave./Yonge St.	8654	4	8	13	19	30	46	15.4	61	44	0	0
35125	Toronto West	125 Resources Rd.	8698	7	12	17	23	34	49	19.1	71	42	0	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8589	3	6	10	14	24	42	11.8	58	37	0	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8619	3	5	8	12	22	39	10.3	55	33	0	0
45026	Oshawa	2000 Simcoe St. N., Durham College	8688	2	3	5	8	15	33	7.0	47	32	0	0
46089	Brampton	525 Main St. N., Peel Manor	8723	3	5	8	13	25	43	11.3	61	39	0	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8542	3	5	8	12	21	40	10.6	62	35	0	0
47045	Barrie	83 Perry St.	8664	3	4	6	10	18	36	8.6	56	30	0	0
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	8703	2	4	5	9	17	37	8.1	64	39	0	0

Table A4

2011 Nitrogen Dioxide (NO_2) Statistics (continued)

Unit: parts per billion (ppb)

NO_2 1-hour AAQC is 200 ppb

NO_2 24-hour AAQC is 100 ppb

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criteria	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
49005	Parry Sound	7 Bay St.	8749	1	1	2	4	8	21	3.6	36	15	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8467	2	3	5	9	17	34	7.9	49	34	0	0
51002	Ottawa Central	960 Carling Ave.	8517	1	3	4	7	15	36	6.6	49	36	0	0
52022	Kingston	752 King St. W.	8626	2	2	3	5	9	23	4.6	48	19	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8739	2	3	4	7	13	29	6.3	47	26	0	0
56051	Cornwall	Bedford St./3rd St. W.	8738	2	3	4	7	14	35	6.5	59	40	0	0
59006	Peterborough	10 Hospital Dr.	8705	1	2	3	4	9	30	4.3	46	28	0	0
63203	Thunder Bay	421 James St. S.	8584	2	4	6	10	19	35	8.6	50	26	0	0
71078	Sault Ste. Marie	Sault College	8721	1	2	4	6	12	25	5.3	48	19	0	0
75010	North Bay	Chippewa St. W., Dept. National Defence	8757	2	3	4	7	17	43	7.4	61	32	0	0

Note:

INS indicates there was insufficient data to calculate a valid annual mean.

Table A5

2011 Nitrogen Oxides (NO_x) Statistics

Unit: parts per billion (ppb)

ID	City/Town	Location	Valid h	PERCENTILES							Maximum	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8740	6	10	14	21	36	86	18.9	272	78
12016	Windsor West	College Ave./South St.	8497	5	9	13	18	31	78	16.7	467	127
13001	Chatham	435 Grand Ave. W.	8687	2	4	6	9	17	37	8.4	154	34
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8703	3	6	9	13	23	48	11.7	196	69
15020	Grand Bend	Point Blake Conservation Area	8740	1	2	3	4	8	18	4.0	35	19
15025	London	900 Highbury Ave. N.	8715	4	6	8	12	22	56	11.6	190	48
18007	Tiverton	4th Concession/Bruce Rd. 23	8529	1	2	3	4	6	15	3.4	76	15
21005	Brantford	324 Grand River Ave.	8680	2	3	5	8	15	41	7.3	148	30
26060	Kitchener	West Ave./Homewood Ave.	8686	3	4	6	10	19	61	9.6	149	46
27067	St. Catharines	Argyle Cres., Pump Stn.	8733	3	5	7	11	21	60	10.9	177	78
28028	Guelph	Exhibition St./Clark St. W.	8671	3	4	6	10	19	59	9.5	165	51
29000	Hamilton Downtown	Elgin St./Kelly St.	8641	5	9	13	20	36	94	18.3	288	87
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8732	3	5	9	14	25	60	12.2	156	53
29118	Hamilton West	Main St. W./Hwy 403	8743	5	8	13	20	41	106	19.5	259	107
31103	Toronto Downtown	Bay St./Wellesley St. W.	8698	7	10	15	21	34	75	18.4	161	64
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8700	6	11	17	24	45	114	22.8	260	101
34020	Toronto North	Hendon Ave./Yonge St.	8654	5	10	16	24	43	100	21.5	241	104
35125	Toronto West	125 Resources Rd.	8698	8	15	23	35	64	142	31.5	309	103
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8589	4	7	11	17	33	95	16.4	242	87
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8619	3	5	9	14	27	69	13.0	217	64
45026	Oshawa	2000 Simcoe St. N., Durham College	8688	2	4	6	9	19	53	9.2	107	53
46089	Brampton	525 Main St. N., Peel Manor	8723	3	6	10	16	34	104	15.9	278	90
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8542	4	6	10	15	29	93	14.7	228	79
47045	Barrie	83 Perry St.	8664	3	5	7	12	25	87	12.4	344	56
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	8703	3	4	7	10	21	59	10.3	197	57

Table A5

2011 Nitrogen Oxides (NO_x) Statistics (continued)

Unit: parts per billion (ppb)

ID	City/Town	Location	Valid h	PERCENTILES							Maximum	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h
49005	Parry Sound	7 Bay St.	8749	1	2	3	4	9	27	4.5	65	17
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8467	2	4	6	11	21	50	9.7	167	45
51002	Ottawa Central	960 Carling Ave.	8517	1	3	4	8	18	61	8.1	145	54
52022	Kingston	752 King St. W.	8626	2	3	4	5	10	28	5.3	87	26
54012	Belleville	2 Sidney St., Water Treatment Plant	8739	3	4	5	8	17	52	8.7	148	53
56051	Cornwall	Bedford St./3rd St. W.	8738	2	3	5	8	17	61	8.4	268	88
59006	Peterborough	10 Hospital Dr.	8705	2	3	4	6	13	47	6.6	99	41
63203	Thunder Bay	421 James St. S.	8584	4	6	9	15	32	75	14.5	182	61
71078	Sault Ste. Marie	Sault College	8721	2	3	5	8	15	36	7.2	112	30
75010	North Bay	Chippewa St. W., Dept. National Defence	8757	4	5	7	10	24	79	11.5	200	66

Note:

INS indicates there was insufficient data to calculate a valid annual mean.

Table A6

2011 Carbon Monoxide (CO) Statistics

Unit: parts per million (ppm)

CO 1-hour AAQC is 30 ppm

CO 8-hour AAQC is 13 ppm

ID	City/Town	Location	Valid h	PERCENTILES						Mean	Maximum		No. of Times Above Criteria	
				10%	30%	50%	70%	90%	99%		1h	8h	1h	8h
12008	Windsor Downtown	467 University Ave. W.	8651	0.16	0.20	0.23	0.27	0.38	0.69	0.26	3.77	1.46	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8677	0	0.16	0.21	0.26	0.40	0.84	0.22	1.83	1.15	0	0
35125	Toronto West	125 Resources Rd.	8568	0.07	0.14	0.18	0.23	0.33	0.61	0.20	1.39	0.76	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8371	0.19	0.23	0.27	0.32	0.40	0.57	0.29	1.45	0.96	0	0

Table A7

2011 Sulphur Dioxide (SO_2) Statistics

Unit: parts per billion (ppb)

SO_2 1-hour AAQC is 250 ppb

SO_2 24-hour AAQC is 100 ppb

SO_2 1-year AAQC is 20 ppb

ID	City/Town	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criteria		
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h	1y
12008	Windsor Downtown	467 University Ave. W.	8741	0	1	2	3	9	27	3.5	61	17	0	0	0
12016	Windsor West	College Ave./South St.	8581	0	1	1	3	9	25	3.4	75	19	0	0	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8700	1	1	2	3	12	56	5.3	94	53	0	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8748	0	1	1	3	16	48	5.2	117	29	0	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8750	1	1	2	3	10	32	4.1	99	43	0	0	0
35125	Toronto West	125 Resources Rd.	8703	1	1	1	2	3	6	1.5	17	5	0	0	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8554	0	1	1	1	2	7	1.3	24	5	0	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8264	0	0	0	0	1	3	0.4	13	3	0	0	0
71078	Sault Ste. Marie	Sault College	8722	0	0	0	0	1	17	0.8	54	11	0	0	0
77219	Sudbury	1222 Ramsey Lake Rd.	8733	0	0	0	1	2	25	1.5	113	18	0	0	0

Table A8

2011 Total Reduced Sulphur (TRS) Compounds Statistics

Unit: parts per billion (ppb)

ID	City/Town	Location	Valid h	PERCENTILES							Maximum	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h
12016	Windsor West	College Ave./South St.	8705	0	0	0	0	1	2	0.2	18	2
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	7624	0	0	0	0	1	2	0.2	4	1
29000	Hamilton Downtown	Elgin St./Kelly St.	8745	0	0	0	1	1	3	0.5	28	4
71078	Sault Ste. Marie	Sault College	8720	0	0	1	1	1	1	0.5	4	1

Table B1: 10-Year Trend for O_3

Annual Mean (ppb)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	21.9	22.9	20.2	25.3	24.6	27.0	26.9	24.8	28.0	27.2	↑ 28%
12016	Windsor West	20.2	22.9	22.6	25.6	24.3	25.3	25.9	24.9	26.7	26.4	↑ 24%
14064	Sarnia	26.5	24.7	23.8	27.4	26.7	28.6	28.7	26.6	30.7	29.7	↑ 20%
15020	Grand Bend	29.8	30.7	25.8	32.5	29.7	31.7	31.3	29.6	35.0	32.8	↑ 14%
15025	London	25.3	26.9	23.6	26.1	25.1	27.2	27.0	25.1	28.2	26.8	↑ 8%
16015	Port Stanley	INS	34.9	32.2	34.6	32.4	34.3	34.3	30.9	34.6	32.8	↓ 3%
18007	Tiverton	34.7	33.2	28.1	31.8	29.0	34.3	32.6	31.4	33.8	32.1	↑ 1%
21005	Brantford	n/a	INS	26.2	27.9	27.0	28.9	28.4	26.5	29.4	28.7	↑ 7%
26060	Kitchener	27.3	28.1	24.8	28.0	26.6	28.6	28.1	27.0	29.4	27.6	↑ 5%
27067	St. Catharines	24.1	25.3	23.6	26.3	26.2	28.1	27.5	25.6	28.3	28.0	↑ 16%
28028	Guelph	28.4	24.4	25.9	28.6	26.8	28.1	27.9	27.3	30.7	28.9	↑ 11%
29000	Hamilton Downtown	20.4	21.7	20.1	23.3	23.2	24.8	25.1	24.3	26.9	25.4	↑ 29%
29114	Hamilton Mountain	27.7	28.4	24.6	28.2	27.5	29.2	29.0	27.2	29.7	28.8	↑ 7%
29118	Hamilton West	20.5	22.0	19.2	21.2	20.9	23.0	23.3	21.8	24.5	24.2	↑ 20%
31103	Toronto Downtown	24.0	23.6	22.8	24.5	22.6	25.7	26.0	24.6	26.1	25.4	↑ 11%
33003	Toronto East	21.0	21.8	19.9	22.4	22.0	23.2	21.6	22.1	23.0	23.3	↑ 10%
34020	Toronto North	25.1	23.6	22.5	24.5	23.3	24.5	22.7	22.1	24.8	23.6	↓ 3%
35125	Toronto West	n/a	18.7	17.6	20.3	19.0	21.1	20.7	19.5	20.6	20.1	↑ 11%
44008	Burlington	26.3	22.8	21.0	23.9	23.5	24.6	24.9	24.1	26.6	25.9	↑ 10%
44017	Oakville	25.1	INS	24.6	27.7	26.1	27.5	27.0	25.5	28.0	26.8	↑ 8%
45026	Oshawa	23.2	24.1	23.3	28.6	25.1	28.0	27.0	25.5	28.0	26.6	↑ 15%
46089	Brampton	26.2	25.1	25.1	26.8	25.5	26.8	26.6	25.2	27.5	26.1	↑ 3%
46108	Mississauga	23.1	24.8	20.6	23.1	22.4	23.3	24.6	24.0	25.9	24.1	↑ 9%
47045	Barrie	26.1	23.2	24.8	26.9	24.1	25.9	26.5	24.3	26.8	25.3	↑ 3%
48006	Newmarket	31.4	29.6	28.3	30.8	28.8	31.7	29.5	28.6	31.5	27.8	↓ 3%
49005	Parry Sound	INS	INS	31.1	33.8	30.7	31.8	32.1	29.7	31.3	29.7	↓ 7%
49010	Dorset	32.4	30.1	28.8	32.3	28.9	29.9	29.3	27.7	28.6	27.0	↓ 12%
51001	Ottawa Downtown	24.9	24.7	21.7	23.3	23.6	24.7	23.3	23.4	25.7	24.2	↑ 2%
54012	Belleville	INS	30.9	28.1	29.4	29.2	32.0	29.8	28.5	30.0	27.9	↓ 3%
56010	Morrisburg	n/a	INS	28.0	27.8	28.0	29.2	27.9	26.1	28.6	27.2	↓ 2%
56051	Cornwall	24.8	25.9	23.8	27.7	27.5	28.3	26.6	25.5	27.9	26.1	↑ 7%
59006	Peterborough	30.5	29.7	27.1	31.2	24.9	27.6	28.2	27.7	30.5	27.9	↓ 4%
63203	Thunder Bay	23.4	26.1	22.0	22.3	23.5	24.2	23.0	24.2	25.7	25.2	↑ 6%
71078	Sault Ste. Marie	24.2	26.8	27.0	30.2	29.1	29.7	28.9	27.8	28.4	27.8	↑ 9%
75010	North Bay	26.8	27.0	25.2	28.0	26.7	27.1	27.7	26.1	28.0	26.7	↑ 2%
77219	Sudbury	29.2	28.5	27.8	31.0	28.4	28.1	27.9	25.9	28.7	28.7	↓ 4%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data in the 2nd and/or 3rd quarter to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.
Station 46108 replaced station 46109 as the Mississauga site in 2009.
Station 46109 replaced station 46110 as the Mississauga site in 2004.
Station 63203 replaced station 63200 as the Thunder Bay site in 2004.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

Table B2: 10-Year Trend for O_3 Summer Means (May - September)

Summer Mean (ppb)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	33.0	32.3	26.3	35.6	32.6	36.3	34.1	30.4	34.6	33.8	↑ 7%
12016	Windsor West	32.6	32.3	29.6	35.8	31.9	33.5	32.1	29.5	31.8	31.9	↓ 3%
14064	Sarnia	35.9	31.8	26.6	34.1	32.0	34.2	33.0	28.6	34.3	32.9	→ 0%
15020	Grand Bend	36.8	33.6	29.8	36.3	33.5	34.9	32.4	29.7	37.8	33.9	↓ 1%
15025	London	35.3	33.9	28.5	33.9	31.2	33.2	31.6	28.4	32.5	30.7	↓ 9%
16015	Port Stanley	45.5	41.2	35.7	42.3	38.5	40.4	38.8	33.2	38.9	35.5	↓ 16%
18007	Tiverton	41.6	37.6	29.8	33.3	30.4	38.3	34.0	30.3	33.3	31.7	↓ 16%
21005	Brantford	n/a	INS	28.9	33.5	31.8	33.6	31.0	27.5	31.6	31.1	↓ 3%
26060	Kitchener	36.2	34.3	29.8	34.3	32.0	34.2	31.0	28.8	31.6	30.2	↓ 14%
27067	St. Catharines	33.4	31.7	28.3	33.6	32.6	33.9	31.2	27.7	32.0	31.2	↓ 4%
28028	Guelph	34.7	29.7	29.5	34.0	31.5	33.1	30.4	28.7	32.5	31.3	↓ 4%
29000	Hamilton Downtown	29.2	28.3	24.9	30.4	29.2	30.8	29.8	28.2	31.6	28.7	↑ 7%
29114	Hamilton Mountain	38.2	35.0	29.7	36.7	33.7	36.1	33.6	31.0	34.4	32.3	↓ 9%
29118	Hamilton West	27.0	26.3	22.7	25.7	25.3	26.9	26.7	23.9	27.9	26.2	↑ 3%
31103	Toronto Downtown	31.6	31.1	28.3	31.9	28.7	33.2	30.9	27.9	31.1	29.5	↓ 3%
33003	Toronto East	27.1	28.3	24.5	30.6	27.2	28.3	24.9	25.2	26.7	27.4	↓ 4%
34020	Toronto North	33.3	29.2	26.3	30.2	28.6	29.9	26.4	25.6	28.0	27.5	↓ 13%
35125	Toronto West	24.7	24.1	21.4	26.5	24.3	25.9	24.8	22.5	24.3	23.6	↓ 1%
44008	Burlington	33.4	29.0	25.1	30.2	29.2	30.0	28.3	26.7	30.2	29.2	↓ 5%
44017	Oakville	32.7	35.5	28.6	34.4	31.7	32.8	30.8	28.2	31.5	29.9	↓ 11%
45026	Oshawa	INS	27.8	25.9	INS	28.0	31.5	28.3	26.4	29.5	28.5	↑ 5%
46089	Brampton	32.9	31.2	29.1	31.7	31.3	31.9	31.0	28.5	30.8	29.3	↓ 7%
46108	Mississauga	29.4	31.3	24.6	31.6	28.5	28.6	27.3	26.2	29.0	26.7	↓ 8%
47045	Barrie	31.3	25.7	27.3	30.7	28.1	28.6	30.0	25.0	27.9	26.2	↓ 8%
48006	Newmarket	38.1	34.7	32.3	36.1	33.7	36.0	32.1	30.9	34.4	30.5	↓ 13%
49005	Parry Sound	37.7	33.0	33.2	36.9	33.3	33.6	32.2	28.6	30.4	28.7	↓ 20%
49010	Dorset	34.8	29.5	28.5	33.0	29.2	30.0	27.2	25.0	25.2	23.8	↓ 27%
51001	Ottawa Downtown	30.6	29.0	23.5	27.2	26.5	28.2	24.9	24.6	26.1	25.1	↓ 13%
54012	Belleville	INS	37.7	33.0	35.6	34.1	37.0	32.3	30.6	34.2	29.9	↓ 14%
56010	Morrisburg	n/a	n/a	29.7	30.6	30.6	31.6	27.8	26.7	29.5	27.1	↓ 11%
56051	Cornwall	30.1	31.1	26.1	31.8	29.8	31.1	27.6	27.1	29.8	26.7	↓ 9%
59006	Peterborough	37.5	34.0	30.0	36.5	27.2	30.0	31.6	29.2	32.0	29.8	↓ 16%
63203	Thunder Bay	25.0	27.3	22.7	23.6	24.7	24.6	21.3	24.2	23.9	24.2	↓ 7%
71078	Sault Ste. Marie	25.3	28.0	27.3	32.0	31.4	31.5	28.4	27.5	27.2	26.4	↓ 1%
75010	North Bay	31.2	29.8	28.4	31.0	29.0	28.5	28.3	26.5	28.4	26.3	↓ 13%
77219	Sudbury	33.2	32.0	28.7	32.4	30.1	29.5	26.0	25.7	26.3	26.9	↓ 22%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data in the 2nd and/or 3rd quarter to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.
Station 46108 replaced station 46109 as the Mississauga site in 2009.
Station 46109 replaced station 46110 as the Mississauga site in 2004.
Station 63203 replaced station 63200 as the Thunder Bay site in 2004.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

Table B3: 10-Year Trend for O_3 Winter Means (January-April, October-December)

Winter Mean (ppb)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	INS	16.4	16.0	16.5	18.8	20.3	21.7	20.8	23.2	22.5	↑ 49%
12016	Windsor West	INS	16.1	17.7	18.2	18.8	19.4	21.5	21.6	22.8	22.5	↑ 41%
14064	Sarnia	INS	19.6	22.0	INS	23.0	24.7	25.5	25.2	28.1	27.4	↑ 38%
15020	Grand Bend	INS	28.7	22.7	29.8	26.8	29.4	30.5	29.5	33.0	32.1	↑ 25%
15025	London	INS	21.8	20.0	20.4	20.7	22.8	23.7	22.8	25.0	24.2	↑ 21%
16015	Port Stanley	INS	30.7	29.9	29.2	28.0	30.0	31.0	29.4	31.5	31.0	↑ 4%
18007	Tiverton	INS	29.7	INS	30.7	28.2	31.5	31.7	32.3	34.1	32.2	↑ 14%
21005	Brantford	INS	INS	24.1	23.9	23.6	25.5	26.6	25.8	27.8	27.1	↑ 17%
26060	Kitchener	INS	23.7	21.1	23.4	22.7	24.6	26.0	25.9	27.8	25.7	↑ 22%
27067	St. Catharines	22.8	20.8	20.2	20.9	21.7	24.1	24.9	24.1	25.6	25.8	↑ 25%
28028	Guelph	INS	20.8	23.4	24.8	23.4	24.8	26.1	26.4	29.3	27.2	↑ 30%
29000	Hamilton Downtown	INS	16.9	16.6	18.2	18.9	20.5	21.7	21.5	23.5	23.1	↑ 45%
29114	Hamilton Mountain	INS	23.7	21.1	22.1	23.0	24.2	25.7	24.5	26.3	26.3	↑ 21%
29118	Hamilton West	18.6	18.9	16.6	17.9	17.8	20.1	20.9	20.4	22.1	22.7	↑ 28%
31103	Toronto Downtown	16.7	18.2	18.7	19.1	18.2	20.4	22.2	22.4	22.4	22.6	↑ 36%
33003	Toronto East	19.2	17.2	16.6	17.5	18.2	19.5	19.3	19.9	20.4	20.4	↑ 17%
34020	Toronto North	15.4	19.7	19.7	20.4	19.4	20.7	20.1	19.5	22.5	20.8	↑ 21%
35125	Toronto West	21.1	14.6	14.9	15.8	15.1	17.7	17.7	17.4	18.0	17.7	↑ 5%
44008	Burlington	INS	18.5	18.1	19.3	19.3	20.7	22.5	22.3	23.9	23.5	↑ 35%
44017	Oakville	19.9	22.7	21.7	22.8	22.0	23.7	24.4	23.6	25.5	24.7	↑ 20%
45026	Oshawa	21.3	21.5	21.4	24.1	23.0	25.6	25.7	24.9	26.9	25.2	↑ 25%
46089	Brampton	18.3	20.8	22.3	23.3	21.4	23.1	23.4	22.8	25.2	23.8	↑ 23%
46108	Mississauga	22.4	20.2	18.0	17.0	18.0	19.2	22.8	22.5	23.7	22.5	↑ 19%
47045	Barrie	26.6	21.3	22.9	24.2	21.3	24.0	24.2	23.8	26.0	24.7	↑ 5%
48006	Newmarket	INS	26.0	25.4	27.0	25.3	28.6	27.6	27.1	29.4	25.8	↑ 7%
49005	Parry Sound	30.3	INS	29.6	31.6	28.9	30.6	32.0	30.5	31.9	30.4	↑ 4%
49010	Dorset	21.1	29.0	29.0	31.8	28.6	30.1	30.7	29.6	31.0	29.5	↑ 19%
51001	Ottawa Downtown	INS	20.8	20.4	20.7	21.4	22.0	22.2	22.6	25.5	23.6	↑ 21%
54012	Belleville	INS	26.1	24.6	25.1	25.8	28.4	28.0	26.9	27.0	26.4	↑ 8%
56010	Morrisburg	25.4	INS	26.6	25.7	26.2	27.5	27.9	25.7	28.0	27.5	↑ 8%
56051	Cornwall	INS	22.4	22.2	24.8	25.9	26.3	26.0	24.5	26.5	25.7	↑ 15%
59006	Peterborough	INS	26.6	25.0	27.3	23.3	25.9	26.0	26.7	29.5	26.6	↑ 8%
63203	Thunder Bay	23.7	25.4	21.9	21.7	22.6	23.9	24.3	24.2	27.1	26.1	↑ 13%
71078	Sault Ste. Marie	26.6	24.7	26.8	28.9	27.5	28.6	29.3	28.4	29.3	28.9	↑ 13%
75010	North Bay	INS	25.0	23.0	25.9	25.0	26.2	27.2	25.8	27.7	27.0	↑ 13%
77219	Sudbury	INS	25.9	27.2	30.0	27.2	27.2	29.3	26.0	30.5	30.0	↑ 10%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data in the 2nd and/or 3rd quarter to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.
Station 46108 replaced station 46109 as the Mississauga site in 2009.
Station 46109 replaced station 46110 as the Mississauga site in 2004.
Station 63203 replaced station 63200 as the Thunder Bay site in 2004.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

Table B4: 10-Year Trend for $PM_{2.5}$

Annual Mean ($\mu g/m^3$)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	n/a	8.5	8.6	10.4	8.2	9.5	8.3	7.2	7.7	7.6	↓ 18%
12016	Windsor West	n/a	9.6	9.5	10.5	9.2	9.8	8.9	7.4	7.8	7.8	↓ 24%
14064	Sarnia	n/a	11.9	12.2	12.9	11.3	12.2	11.4	9.8	10.4	10.5	↓ 18%
15020	Grand Bend	n/a	INS	7.0	7.4	6.5	6.7	6.8	5.8	6.1	6.1	↓ 18%
15025	London	n/a	7.9	7.8	8.8	6.9	6.5	6.8	5.7	INS	6.2	↓ 30%
16015	Port Stanley	n/a	8.0	7.5	8.6	7.3	7.2	6.7	5.6	5.9	6.0	↓ 31%
18007	Tiverton	n/a	6.5	5.8	6.6	5.6	5.6	5.0	4.0	4.5	4.7	↓ 34%
21005	Brantford	n/a	INS	7.5	8.9	7.6	7.7	6.8	5.8	6.5	6.6	↓ 25%
26060	Kitchener	n/a	8.1	8.1	9.5	7.7	8.0	7.1	5.8	6.3	6.2	↓ 32%
27067	St. Catharines	n/a	7.8	7.3	8.6	7.9	8.2	7.4	6.0	6.5	6.3	↓ 23%
28028	Guelph	n/a	7.3	7.8	8.8	7.0	7.5	6.5	5.6	5.7	5.9	↓ 31%
29000	Hamilton Downtown	n/a	10.6	8.9	10.0	9.1	8.9	8.3	6.8	7.7	8.1	↓ 27%
29114	Hamilton Mountain	n/a	9.6	9.3	9.8	8.1	7.8	7.3	6.3	6.2	6.7	↓ 39%
29118	Hamilton West	n/a	INS	8.4	9.6	8.2	8.3	7.6	6.1	6.8	7.1	↓ 28%
31103	Toronto Downtown	n/a	8.4	7.1	8.5	7.3	7.3	6.6	5.6	6.0	6.2	↓ 30%
33003	Toronto East	n/a	8.8	7.4	8.4	7.6	7.8	6.7	5.9	6.7	6.2	↓ 29%
34020	Toronto North	n/a	8.3	7.7	9.4	7.6	7.8	7.3	5.9	6.2	7.7	↓ 22%
35125	Toronto West	n/a	9.8	9.8	10.0	8.2	8.4	7.5	6.1	6.5	6.9	↓ 39%
44008	Burlington	n/a	8.6	7.9	9.1	7.6	7.3	6.9	5.9	6.2	6.2	↓ 33%
44017	Oakville	n/a	INS	8.1	8.9	7.4	7.6	6.7	5.3	5.7	6.4	↓ 35%
46089	Brampton	n/a	8.2	7.7	8.9	7.2	7.4	6.8	5.6	5.8	6.0	↓ 34%
46108	Mississauga	n/a	7.9	8.0	9.2	7.6	7.2	7.1	5.8	6.1	6.0	↓ 32%
47045	Barrie	n/a	7.5	6.9	8.1	6.7	6.9	6.1	5.2	5.4	5.7	↓ 31%
48006	Newmarket	n/a	7.3	6.4	7.7	6.4	6.6	6.0	5.1	5.6	5.5	↓ 28%
49005	Parry Sound	n/a	INS	5.3	6.1	5.3	5.5	4.7	3.9	4.4	4.7	↓ 26%
49010	Dorset	n/a	5.9	4.7	5.8	4.5	5.0	4.5	3.6	4.0	4.1	↓ 32%
51001	Ottawa Downtown	n/a	7.2	6.5	7.7	6.1	6.0	5.3	4.6	4.5	4.9	↓ 40%
54012	Belleville	n/a	6.9	6.4	7.0	6.2	6.2	6.1	4.9	4.3	4.8	↓ 35%
56010	Morrisburg	n/a	INS	6.2	7.0	6.8	6.2	5.7	5.0	5.3	5.2	↓ 26%
56051	Cornwall	n/a	INS	6.8	7.6	6.5	6.4	6.1	5.4	5.7	5.7	↓ 24%
59006	Peterborough	n/a	6.7	5.9	7.5	6.3	6.4	6.0	4.9	5.1	5.5	↓ 24%
63203	Thunder Bay	n/a	INS	4.2	4.4	4.8	4.4	4.2	3.8	4.1	4.8	↓ 2%
71078	Sault Ste. Marie	n/a	INS	4.5	5.4	5.2	5.3	4.4	4.0	4.1	4.4	↓ 19%
75010	North Bay	n/a	5.5	4.5	5.6	4.9	5.0	4.6	3.8	3.8	4.2	↓ 27%

Notes:

Ontario standardized the $PM_{2.5}$ monitoring method in 2003; therefore, data are reported from 2003 for consistency.

n/a indicates pollutant not monitored.

INS indicates there was insufficient data in any one quarter to calculate a valid annual mean.

Table B5: 10-Year Trend for NO

Annual Mean (ppb)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	10.9	INS	10.5	7.8	7.2	6.4	5.9	5.6	4.7	4.5	↓ 64%
12016	Windsor West	13.0	INS	11.3	8.3	7.2	6.5	5.1	5.4	6.1	3.8	↓ 71%
14064	Sarnia	7.1	5.0	3.7	3.8	3.7	3.2	3.2	2.8	2.2	3.1	↓ 62%
15025	London	INS	INS	6.0	5.5	4.4	3.6	3.1	2.8	2.9	3.3	↓ 56%
21005	Brantford	n/a	INS	2.8	3.8	2.5	1.8	1.3	1.7	1.3	1.2	↓ 70%
26060	Kitchener	3.8	INS	4.9	4.4	3.5	2.7	2.5	2.1	2.5	2.0	↓ 58%
29000	Hamilton Downtown	10.4	11.7	9.6	9.9	8.0	7.7	6.5	5.8	5.0	4.8	↓ 60%
31103	Toronto Downtown	8.2	8.7	7.6	7.2	7.0	5.9	5.0	5.1	4.1	3.4	↓ 59%
33003	Toronto East	16.1	17.0	16.0	14.4	12.5	10.8	9.2	7.8	7.8	7.6	↓ 63%
34020	Toronto North	12.4	12.4	10.5	10.8	10.0	8.3	7.7	7.1	5.7	6.2	↓ 57%
35125	Toronto West	n/a	30.2	26.6	26.1	20.1	17.5	16.2	13.5	13.4	12.4	↓ 65%
44008	Burlington	11.8	14.0	11.1	12.3	9.8	8.8	6.5	5.9	5.0	4.6	↓ 69%
44017	Oakville	INS	INS	5.3	5.2	4.3	3.9	4.0	3.5	3.6	2.7	↓ 45%
45026	Oshawa	10	9.33	8.22	INS	3.8	3.2	3.2	3.0	2.3	2.3	↓ 90%
46089	Brampton	9.1	10.4	8.7	8.9	9.1	6.0	5.8	6.5	3.7	4.6	↓ 58%
47045	Barrie	7.3	9.3	7.3	7.1	8.0	5.5	5.5	5.1	4.3	3.8	↓ 54%
48006	Newmarket	4.6	4.0	3.1	3.5	3.0	2.2	2.6	3.2	2.3	2.2	↓ 49%
51001	Ottawa Downtown	INS	5.8	3.2	3.3	3.0	3.4	2.7	2.4	1.6	1.8	↓ 67%
54012	Belleville	INS	6.1	5.6	4.5	3.0	3.2	3.0	1.9	2.3	2.3	↓ 73%
59006	Peterborough	3.8	3.4	n/a	n/a	2.5	2.3	3.0	1.9	1.7	2.2	↓ 50%
75010	North Bay	6.7	6.4	8.8	3.7	4.4	3.5	3.8	4.2	3.4	4.0	↓ 55%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table B6: 10-Year Trend for NO_2

Annual Mean (ppb)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	19.1	INS	18.3	16.9	17.2	17.2	15.2	14.4	15.6	14.5	↓ 25%
12016	Windsor West	19.6	INS	17.6	17.1	15.7	16.1	16.2	13.2	14.5	12.9	↓ 32%
14064	Sarnia	17.5	13.1	11.7	12.7	11.0	11.3	10.8	8.2	8.0	8.6	↓ 50%
15025	London	INS	INS	13.7	14.1	12.3	11.7	10.8	9.0	8.8	8.3	↓ 44%
21005	Brantford	n/a	INS	8.6	10.1	8.8	7.7	6.9	7.3	5.8	6.1	↓ 39%
26060	Kitchener	11.9	INS	13.1	12.9	10.8	9.7	9.0	8.6	7.7	7.7	↓ 44%
29000	Hamilton Downtown	20.9	21.3	16.8	19.3	17.0	17.0	14.7	13.6	12.7	13.5	↓ 41%
31103	Toronto Downtown	23.3	23.2	20.1	20.7	19.2	18.2	17.0	16.5	16.1	14.9	↓ 37%
33003	Toronto East	22.0	21.3	19.8	20.1	17.4	17.2	16.5	14.9	14.8	15.2	↓ 36%
34020	Toronto North	21.0	20.4	17.3	19.2	17.4	16.7	16.5	15.8	14.3	15.4	↓ 29%
35125	Toronto West	n/a	26.2	24.8	26.6	22.3	22.1	20.8	19.0	20.1	19.1	↓ 30%
44008	Burlington	17.9	17.3	15.3	17.2	16.2	16.0	13.6	12.5	12.2	11.8	↓ 35%
44017	Oakville	INS	INS	13.5	14.5	12.5	13.0	12.0	11.1	9.2	10.3	↓ 31%
45026	Oshawa	17.2	16.2	14.2	INS	8.9	8.1	8.5	7.4	7.2	7.0	↓ 68%
46089	Brampton	16.3	17.6	16.2	16.9	15.2	13.9	13.1	13.3	10.7	11.3	↓ 37%
47045	Barrie	14.4	14.8	13.3	13.8	12.6	11.5	10.8	9.9	8.7	8.6	↓ 44%
48006	Newmarket	11.5	10.2	9.9	8.5	9.0	8.3	8.0	7.8	7.2	8.1	↓ 33%
51001	Ottawa Downtown	INS	13.7	11.1	9.8	8.6	8.7	11.4	8.6	7.4	7.9	↓ 38%
54012	Belleville	INS	10.5	9.4	8.2	4.5	6.4	7.3	6.0	5.5	6.3	↓ 44%
59006	Peterborough	9.8	8.3	n/a	n/a	6.3	6.4	7.0	5.6	5.0	4.3	↓ 51%
75010	North Bay	10.1	10.1	9.2	6.8	7.7	7.4	7.5	8.2	7.6	7.4	↓ 25%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table B7: 10-Year Trend for NO_X

Annual Mean (ppb)

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	29.2	INS	29.3	24.9	24.4	23.6	21.1	20.0	20.2	18.9	↓ 38%
12016	Windsor West	32.5	INS	29.1	25.6	22.8	22.6	21.3	18.6	20.6	16.7	↓ 47%
14064	Sarnia	24.6	18.1	15.7	16.8	14.7	14.5	13.9	11.0	10.2	11.7	↓ 54%
15025	London	INS	INS	19.4	19.4	16.7	15.3	13.9	11.9	11.7	11.6	↓ 46%
21005	Brantford	n/a	INS	11.6	13.7	11.3	9.5	8.2	9.1	7.2	7.3	↓ 46%
26060	Kitchener	15.5	INS	18.2	17.4	14.3	12.4	11.5	10.8	10.3	9.6	↓ 48%
29000	Hamilton Downtown	31.4	33.3	27.7	30.1	24.9	24.7	21.2	19.5	17.8	18.3	↓ 49%
31103	Toronto Downtown	31.5	32.2	28.1	28.2	26.1	24.2	22.1	21.6	20.3	18.4	↓ 43%
33003	Toronto East	37.7	37.9	36.3	34.7	29.9	28.0	25.7	22.7	22.6	22.8	↓ 47%
34020	Toronto North	33.4	33.1	28.3	30.4	27.5	25.0	24.3	22.8	20.0	21.5	↓ 40%
35125	Toronto West	n/a	56.9	51.2	52.4	42.4	39.6	37.0	32.5	33.5	31.5	↓ 48%
44008	Burlington	28.4	31.0	26.1	29.3	26.0	24.8	20.0	18.4	17.2	16.4	↓ 48%
44017	Oakville	INS	INS	18.3	19.5	16.7	16.9	16.1	14.6	12.8	13.0	↓ 34%
45026	Oshawa	27.2	25.5	22.5	INS	12.7	11.3	11.7	10.4	9.5	9.2	↓ 76%
46089	Brampton	25.1	28.1	25.0	25.9	24.2	19.9	18.9	19.9	14.4	15.9	↓ 45%
47045	Barrie	21.4	24.2	20.8	21.0	20.6	17.0	16.3	15.1	13.1	12.4	↓ 47%
48006	Newmarket	15.1	14.1	13.0	12.2	11.8	10.4	10.4	11.0	9.5	10.3	↓ 35%
51001	Ottawa Downtown	INS	20.1	14.7	13.7	11.5	12.0	14.0	11.0	9.0	9.7	↓ 48%
54012	Belleville	INS	15.8	14.4	12.6	7.5	9.6	10.2	7.9	7.8	8.7	↓ 52%
59006	Peterborough	13.5	11.7	n/a	n/a	8.8	8.6	10.0	7.5	6.7	6.6	↓ 51%
75010	North Bay	16.5	16.4	19.0	11.2	12.1	10.9	11.3	12.4	11.0	11.5	↓ 39%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table B8: 10-Year Trend for CO

1h Maximum (ppm)
CO 1-hour AAQC is 30 ppm

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	4.3	4.3	2.3	1.3	2.9	5.0	1.3	1.4	2.5	3.8	↓ 32%
15025	London	2.3	3.2	2.3	2.4	1.8	1.2	1.0	1.4	1.1	0.3	↓ 80%
29000	Hamilton Downtown	2.3	3.1	4.0	2.6	2.8	6.0	3.3	5.0	2.2	1.8	→ 0%
31103	Toronto Downtown	2.9	2.4	1.9	1.6	1.5	1.7	0.9	1.1	1.5	0.5	↓ 73%
35125	Toronto West	n/a	3.4	2.9	2.7	3.0	1.4	1.7	1.6	1.8	1.4	↓ 65%
51001	Ottawa Downtown	2.8	2.2	2.2	2.0	1.4	1.5	1.3	1.4	1.5	1.5	↓ 52%

Note:
n/a indicates pollutant not monitored.

Table B9: 10-Year Trend for SO_2

Annual Mean (ppb)
SO_2 1-year AAQC is 20 ppb

ID	City/Town	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change Over Time
12008	Windsor Downtown	5.7	5.9	4.8	4.9	5.0	5.5	4.5	3.5	3.5	3.5	↓ 41%
12016	Windsor West	7.9	6.4	4.6	5.1	4.9	5.2	4.7	3.6	3.2	3.4	↓ 55%
14064	Sarnia	10.4	7.1	8.2	7.8	8.3	8.0	7.7	4.5	3.9	5.3	↓ 50%
29000	Hamilton Downtown	4.9	5.0	4.0	5.3	4.8	4.2	4.3	3.3	3.3	5.2	↓ 18%
29114	Hamilton Mountain	4.8	5.3	n/a	n/a	3.3	3.5	3.0	3.0	2.9	4.1	↓ 37%
35125	Toronto West	n/a	2.9	2.7	2.3	2.0	1.5	1.4	1.2	0.9	1.5	↓ 69%
51001	Ottawa Downtown	2.9	INS	1.0	1.5	1.1	0.9	1.0	0.9	0.2	0.4	↓ 94%
71078	Sault Ste. Marie	1.7	2.0	0.9	1.5	1.4	1.8	1.2	0.6	0.7	0.8	↓ 59%
77219	Sudbury	3.1	2	INS	2.8	2.4	2.3	2.0	1.1	1.3	1.5	↓ 54%

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

Appendix C 20-Year Ozone Trends (1992-2011)

Figure C1
Ozone Annual Mean at Windsor Downtown

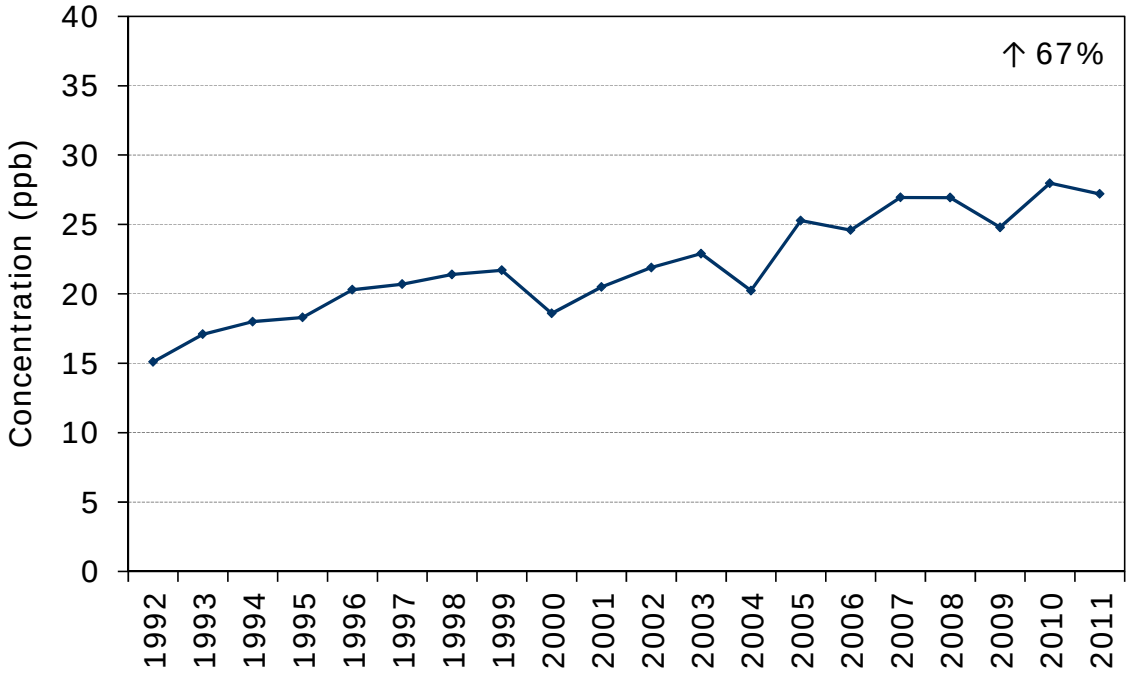


Figure C2
Ozone Annual Mean at Windsor West

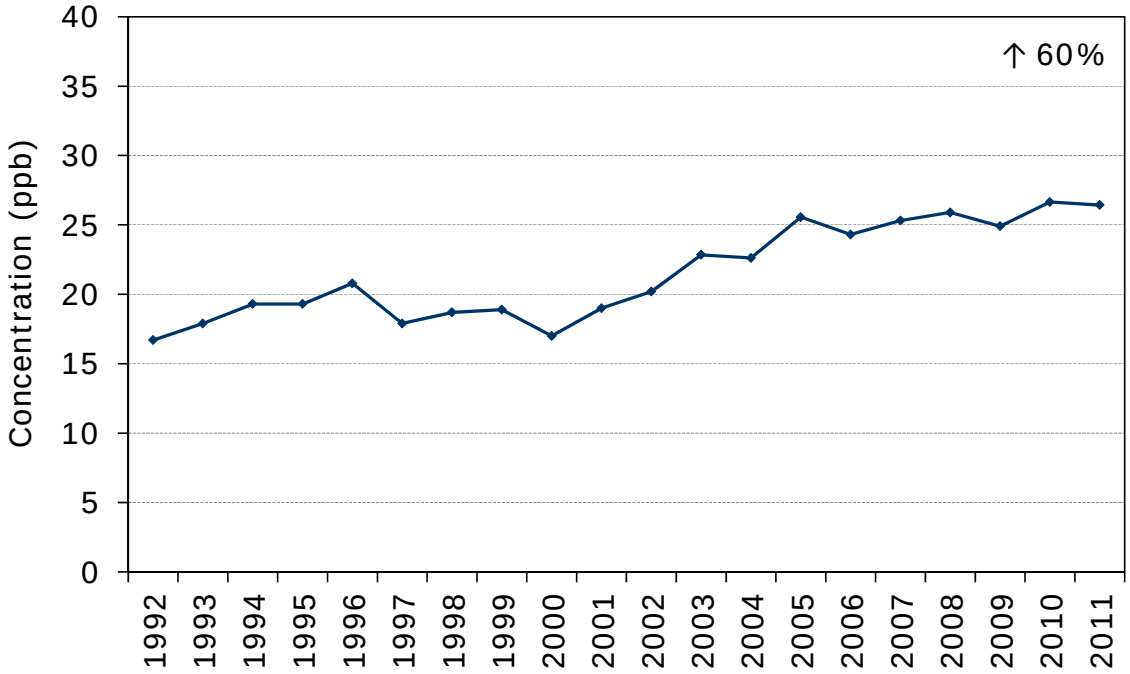


Figure C3
Ozone Annual Mean at Sarnia

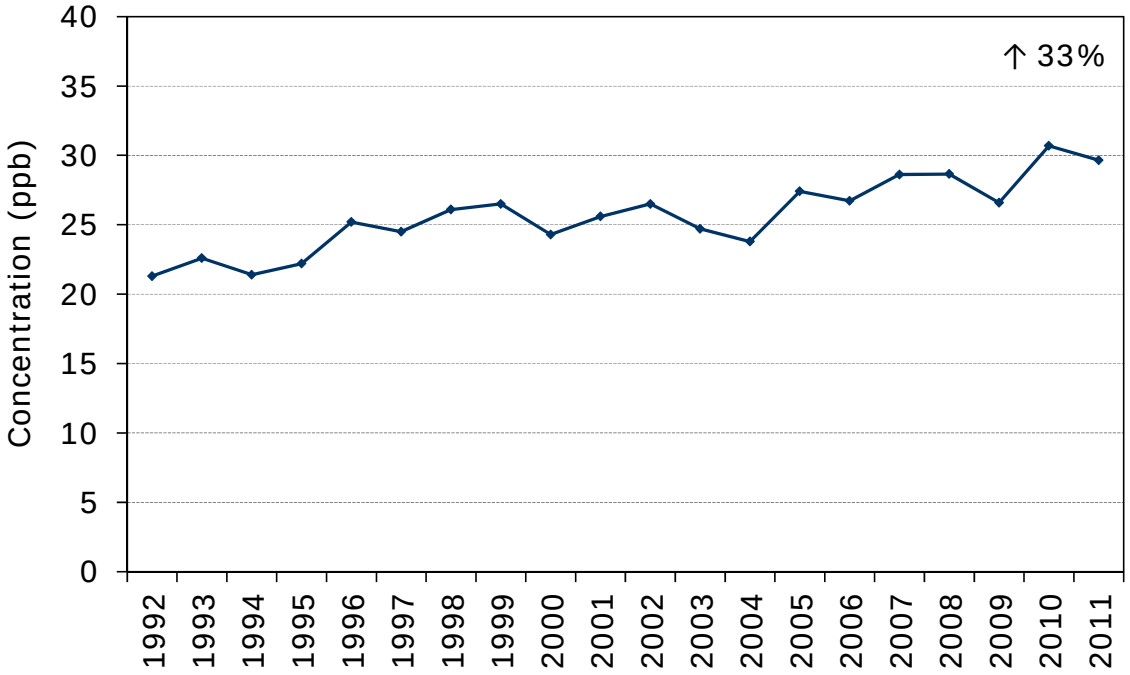


Figure C4
Ozone Annual Mean at Grand Bend

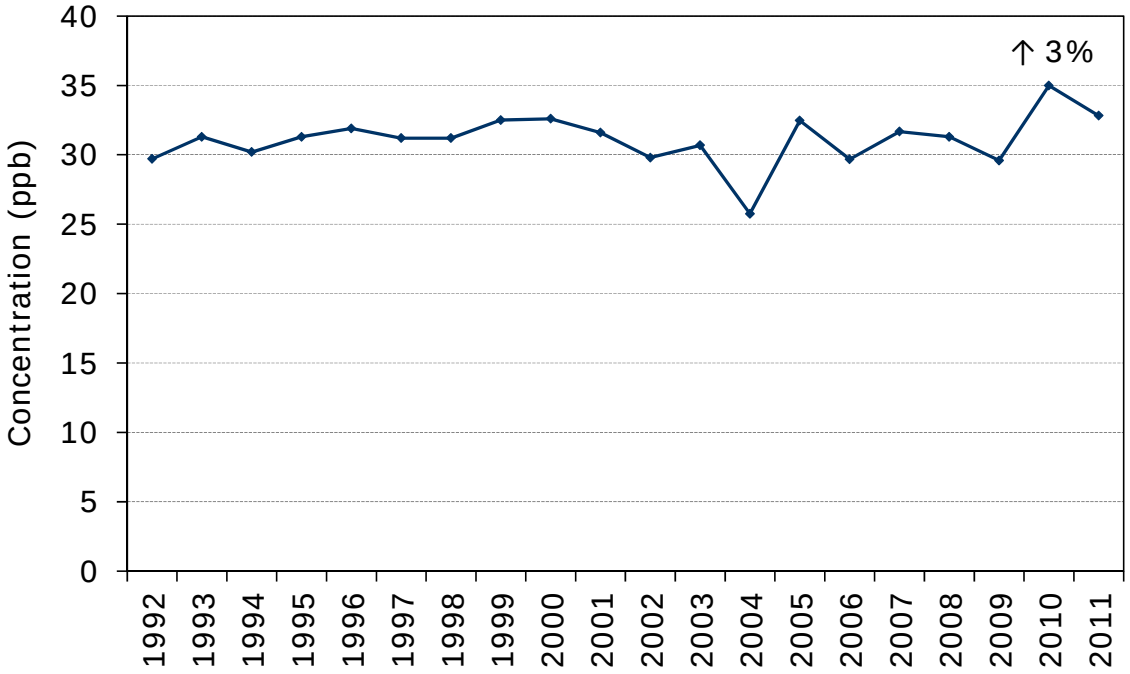


Figure C5
Ozone Annual Mean at London

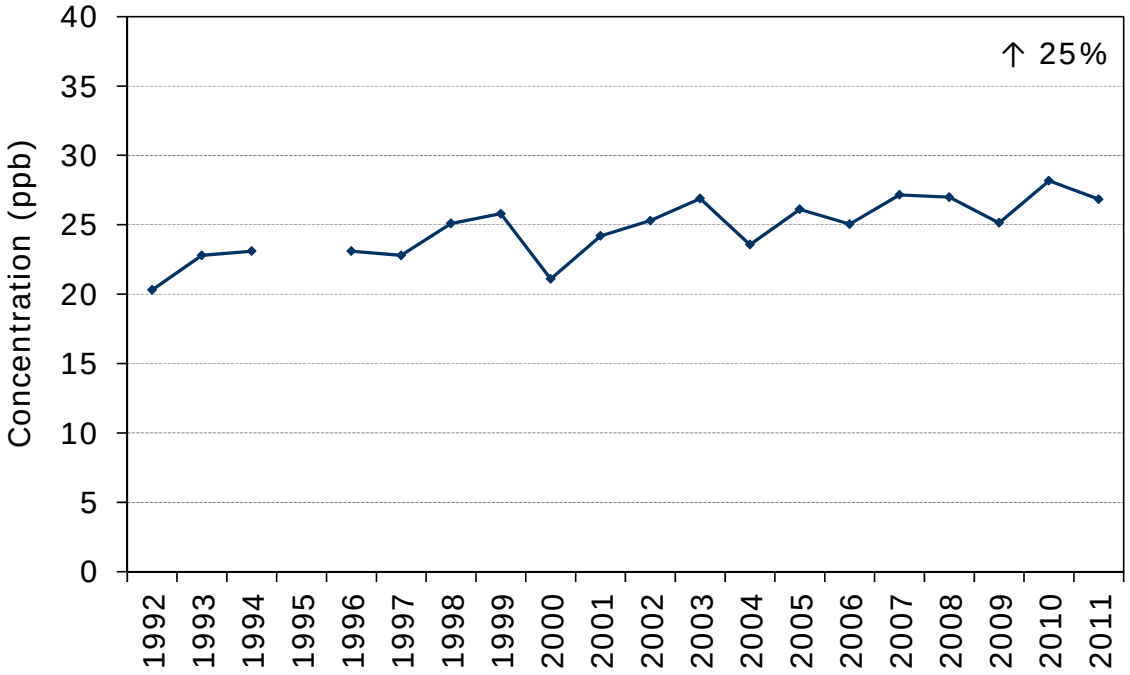


Figure C6
Ozone Annual Mean at Tiverton

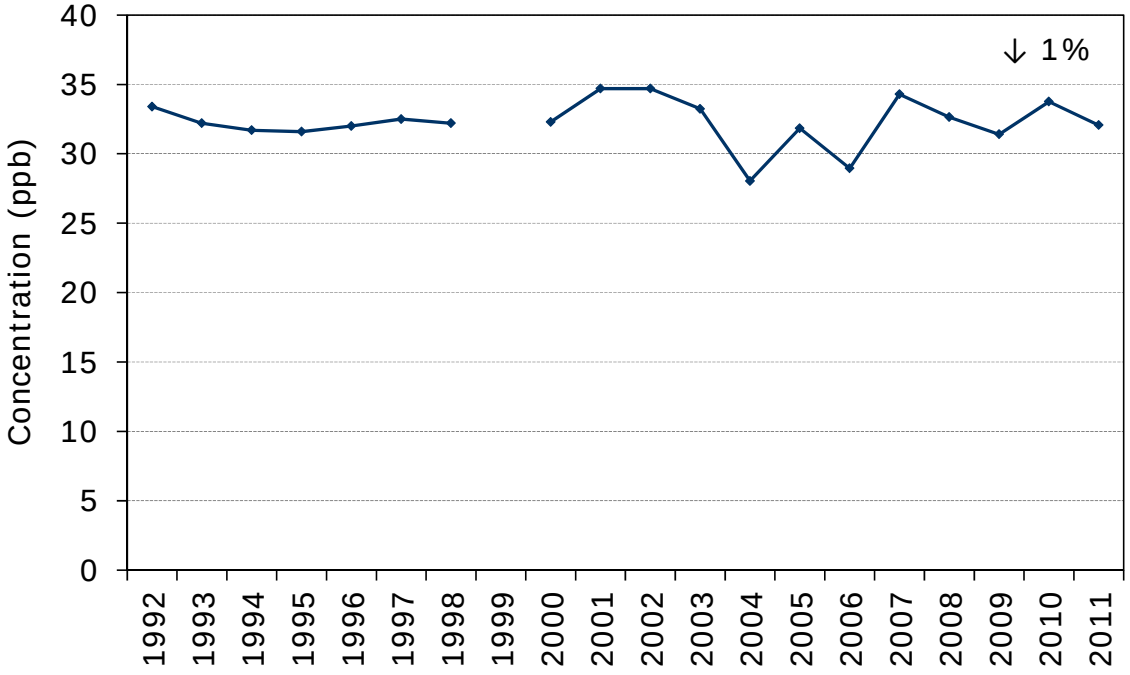


Figure C7
Ozone Annual Mean at Kitchener

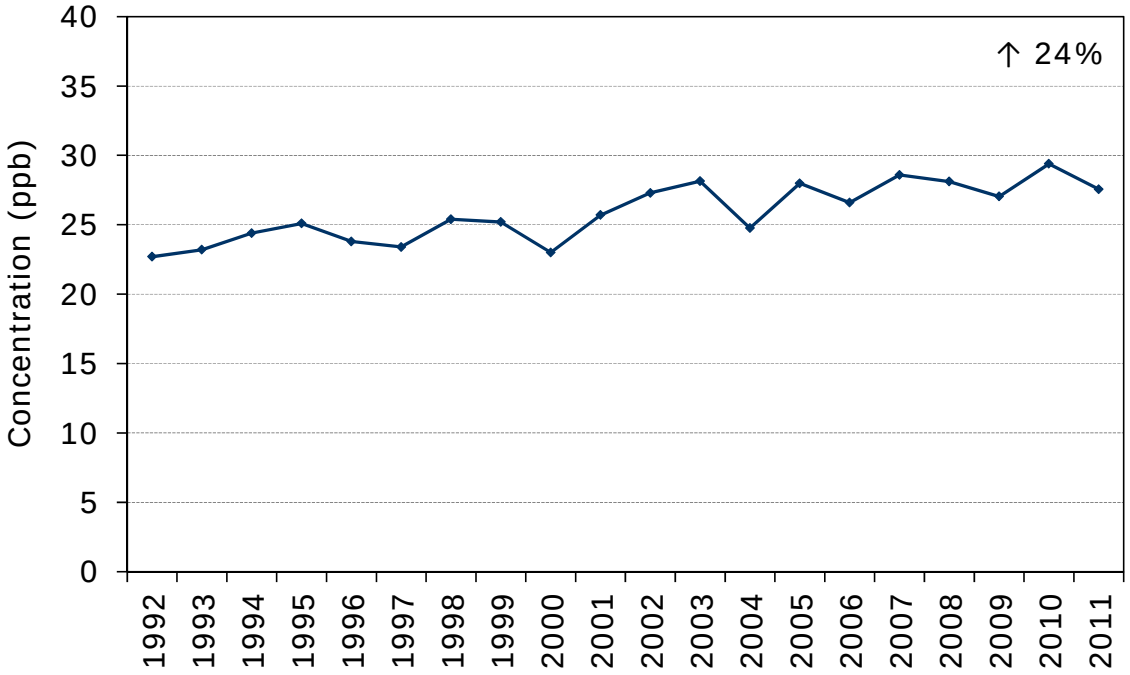


Figure C8
Ozone Annual Mean at St. Catharines

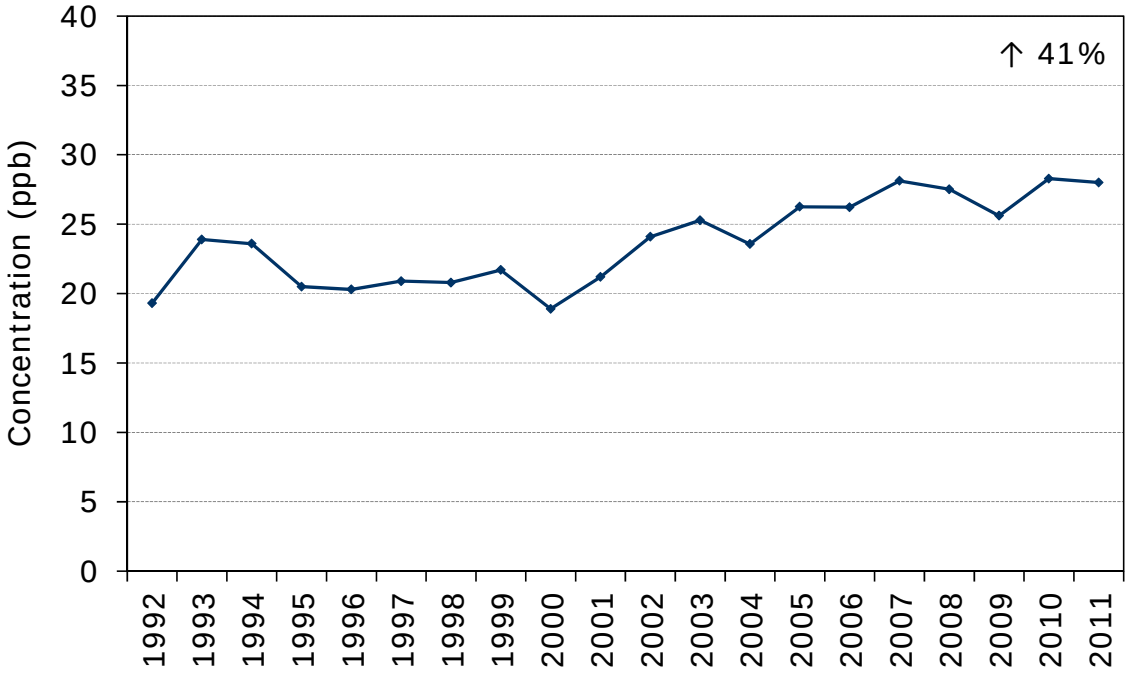


Figure C9
Ozone Annual Mean at Guelph

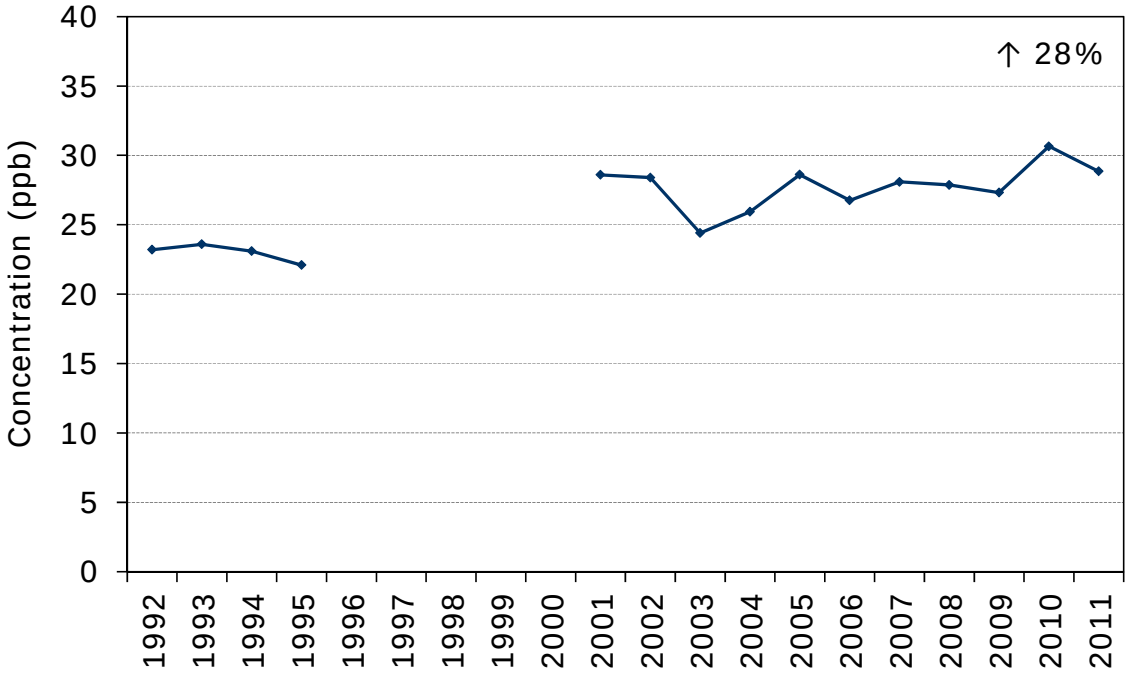


Figure C10
Ozone Annual Mean at Hamilton Downtown

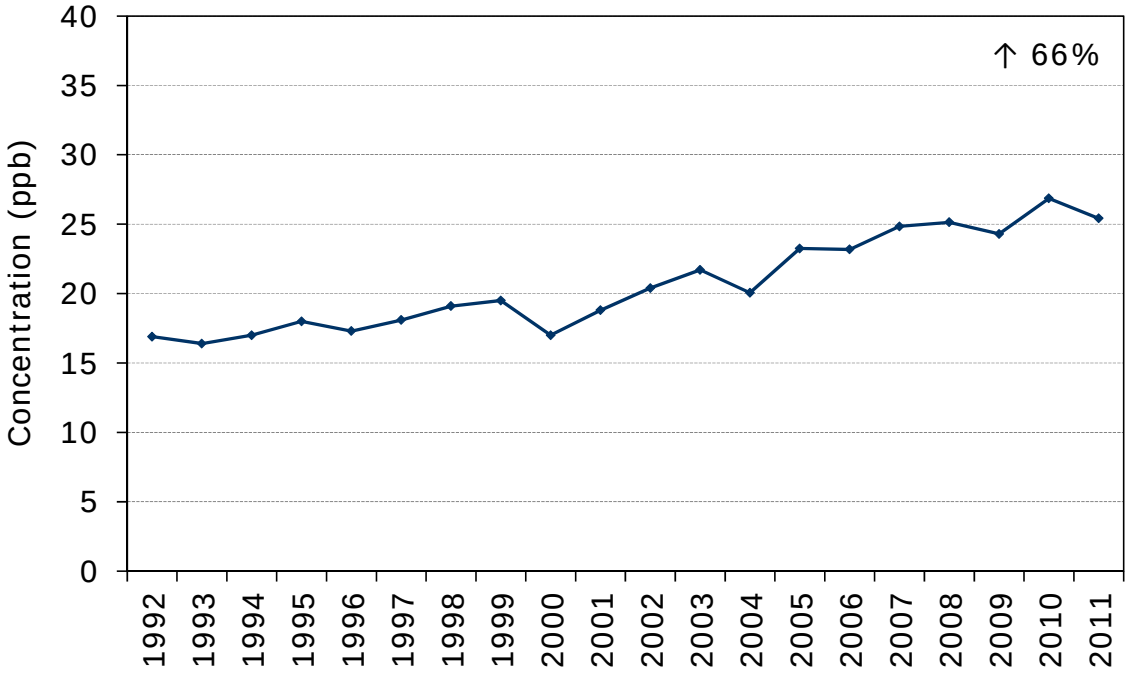


Figure C11
Ozone Annual Mean at Hamilton Mountain

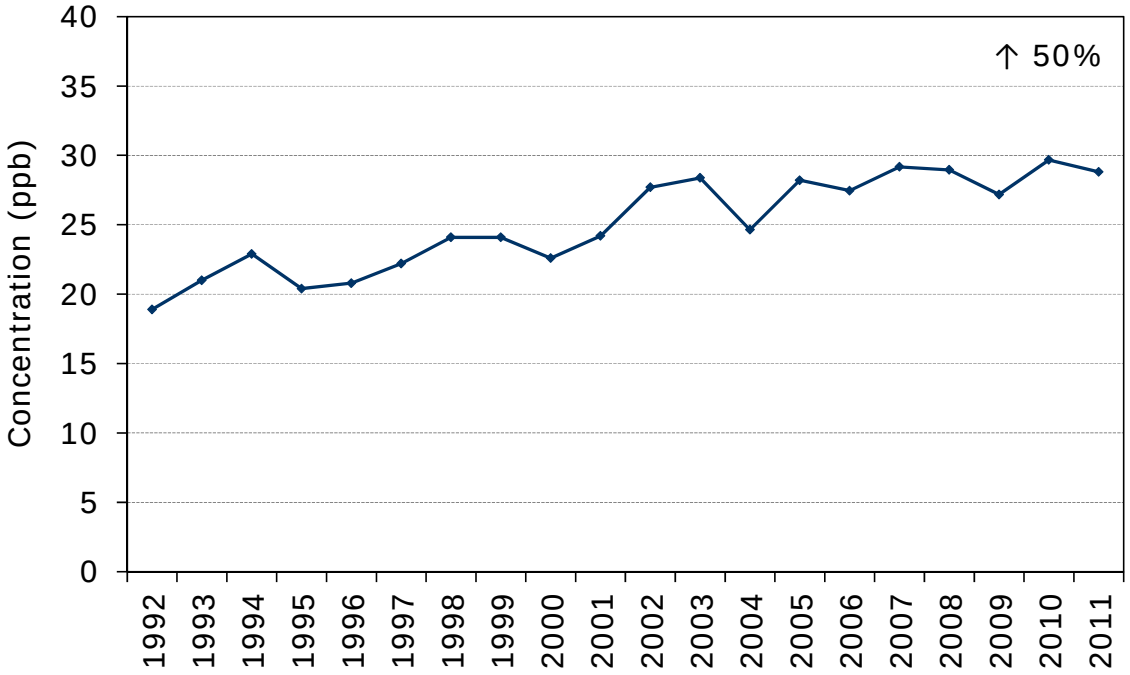


Figure C12
Ozone Annual Mean at Hamilton West

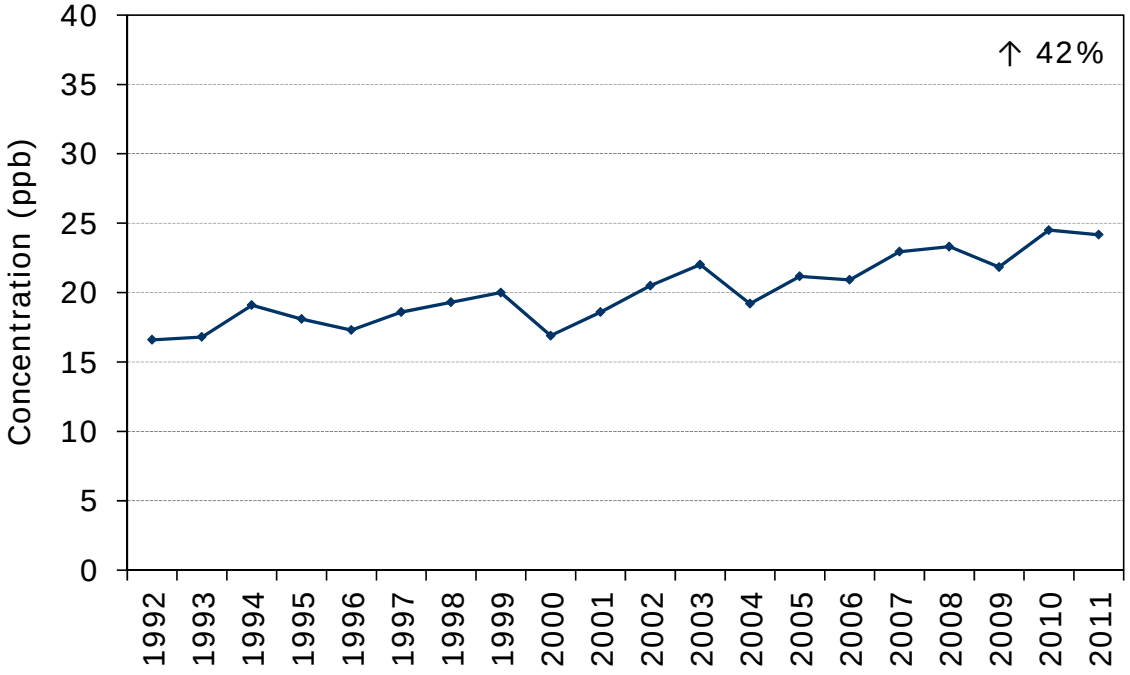


Figure C13
Ozone Annual Mean at Toronto Downtown

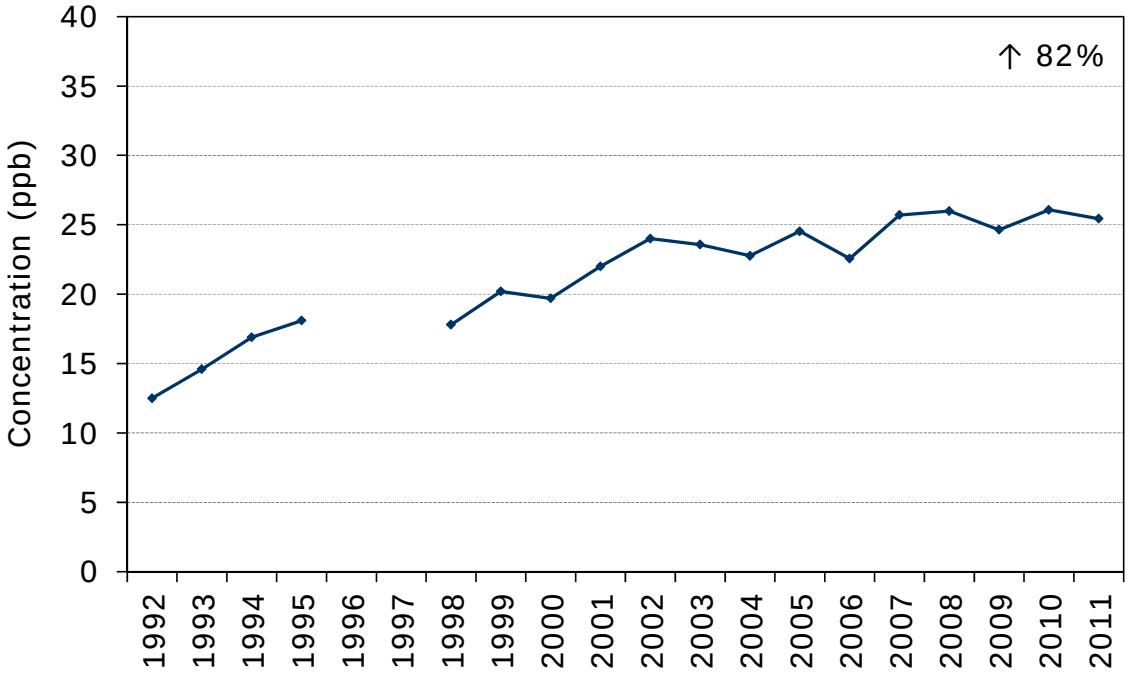


Figure C14
Ozone Annual Mean at Toronto East

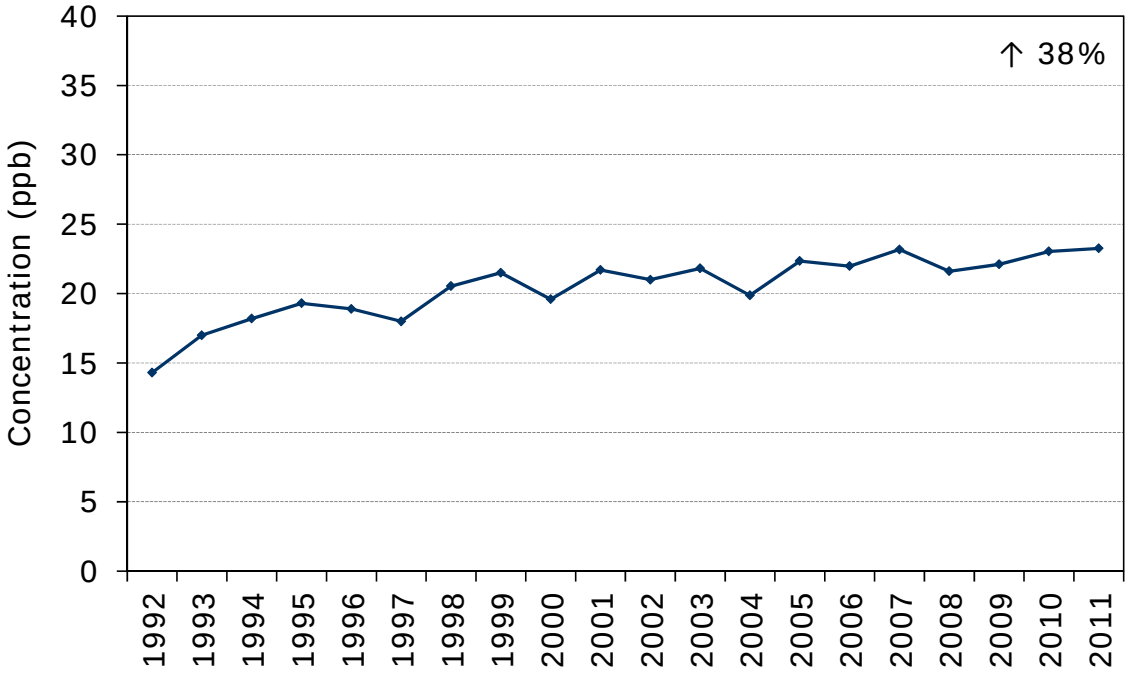


Figure C15
Ozone Annual Mean at Toronto North

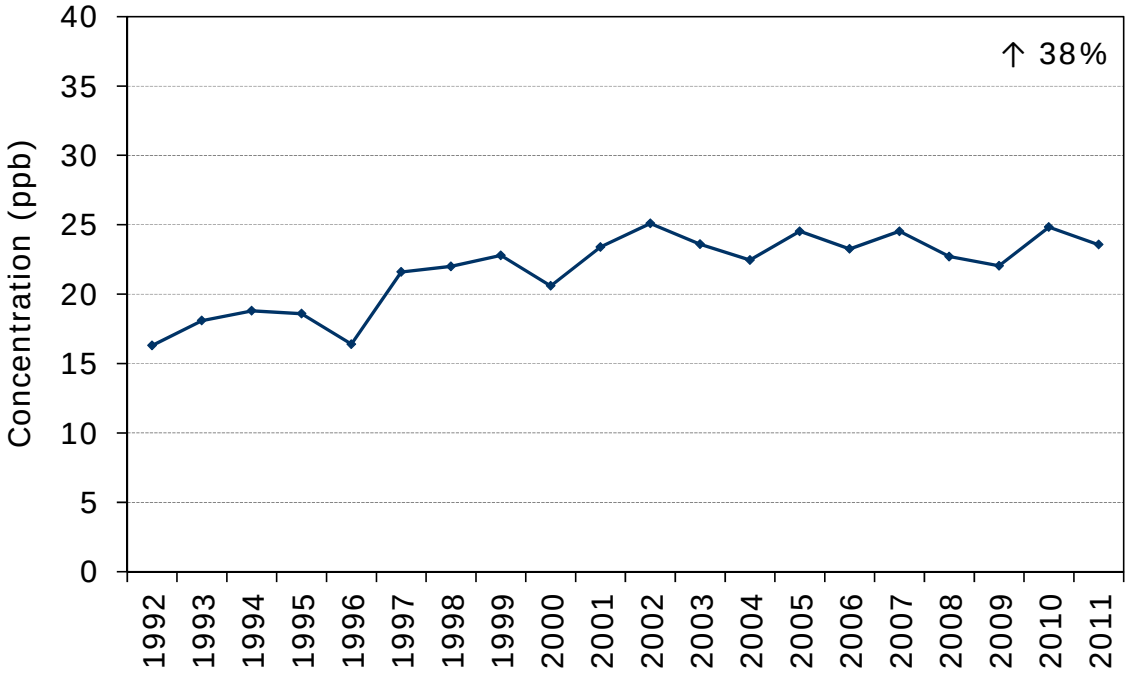


Figure C16
Ozone Annual Mean at Burlington

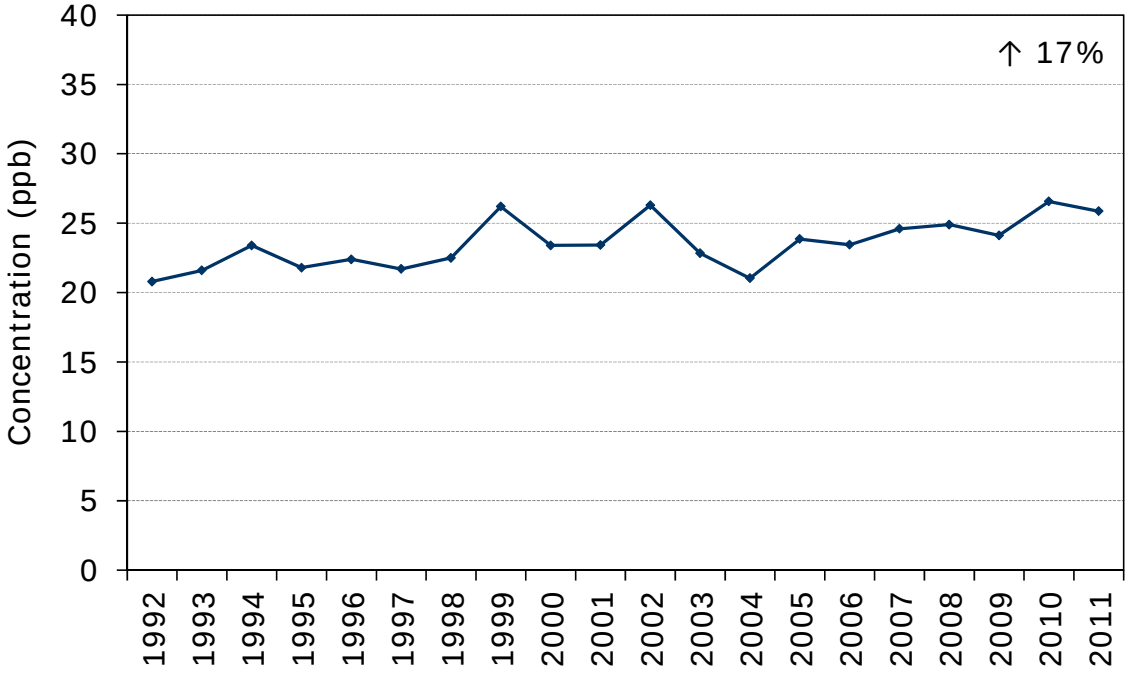


Figure C17
Ozone Annual Mean at Oakville

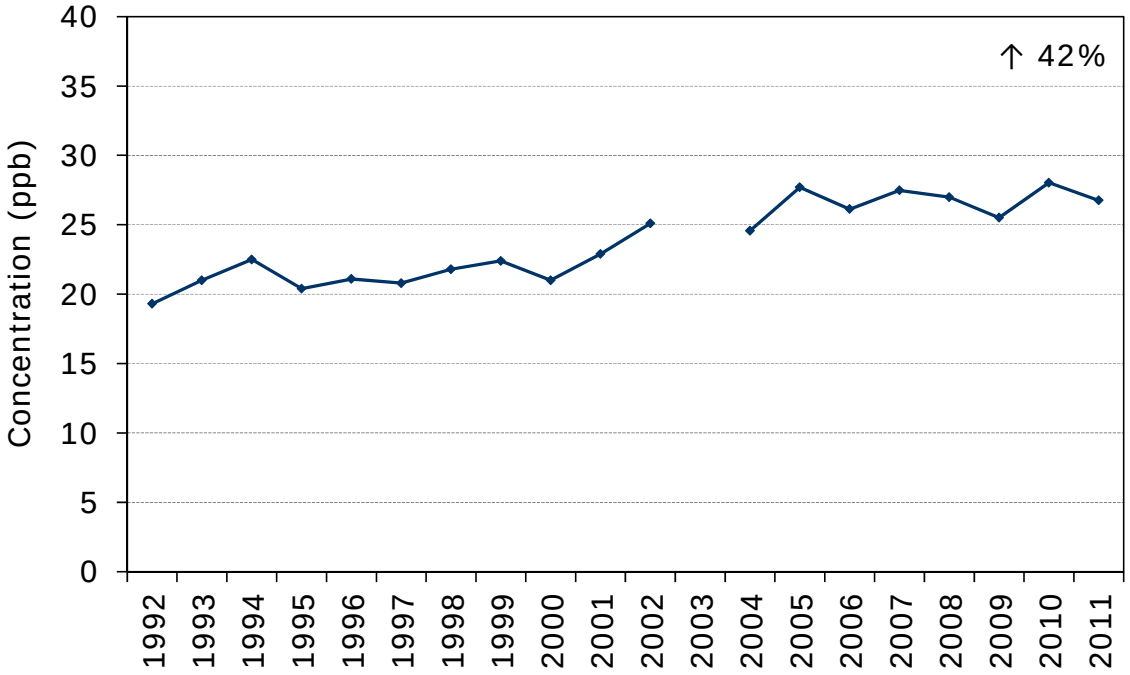


Figure C18
Ozone Annual Mean at Oshawa

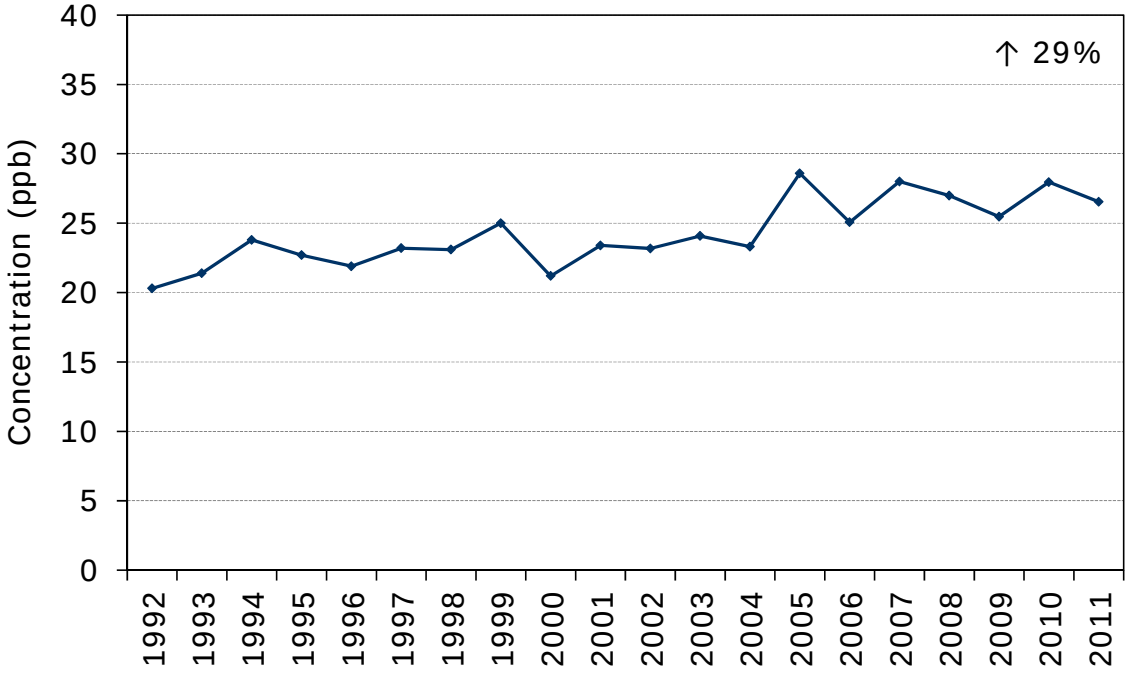


Figure C19
Ozone Annual Mean at Mississauga

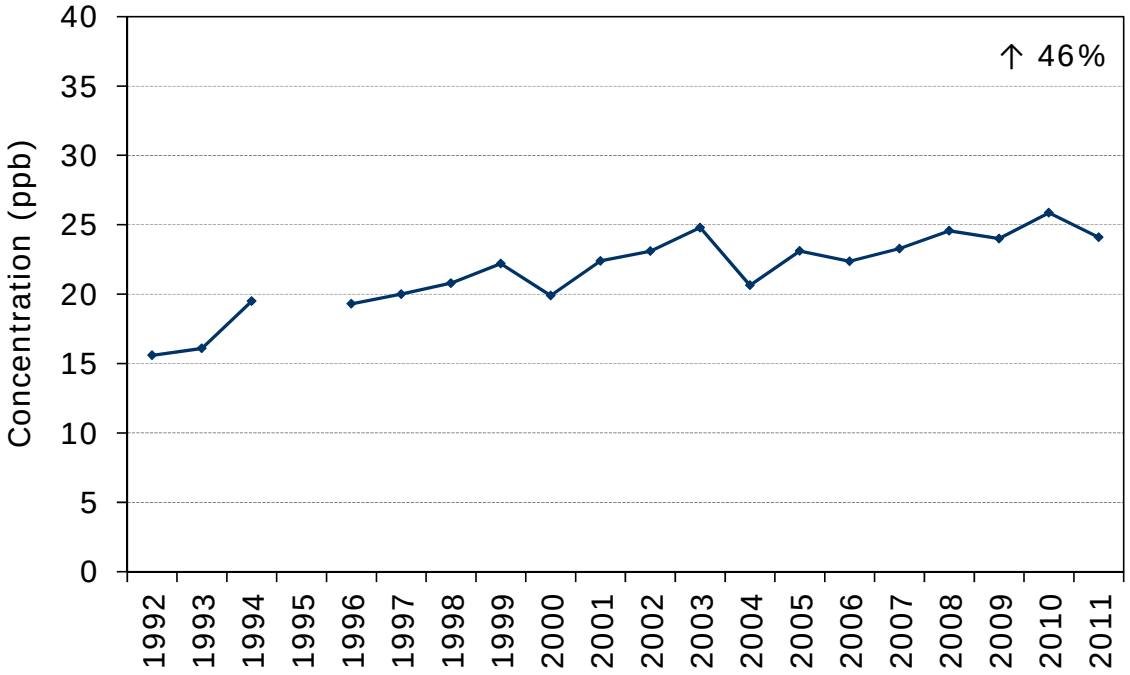


Figure C20
Ozone Annual Mean at Dorset

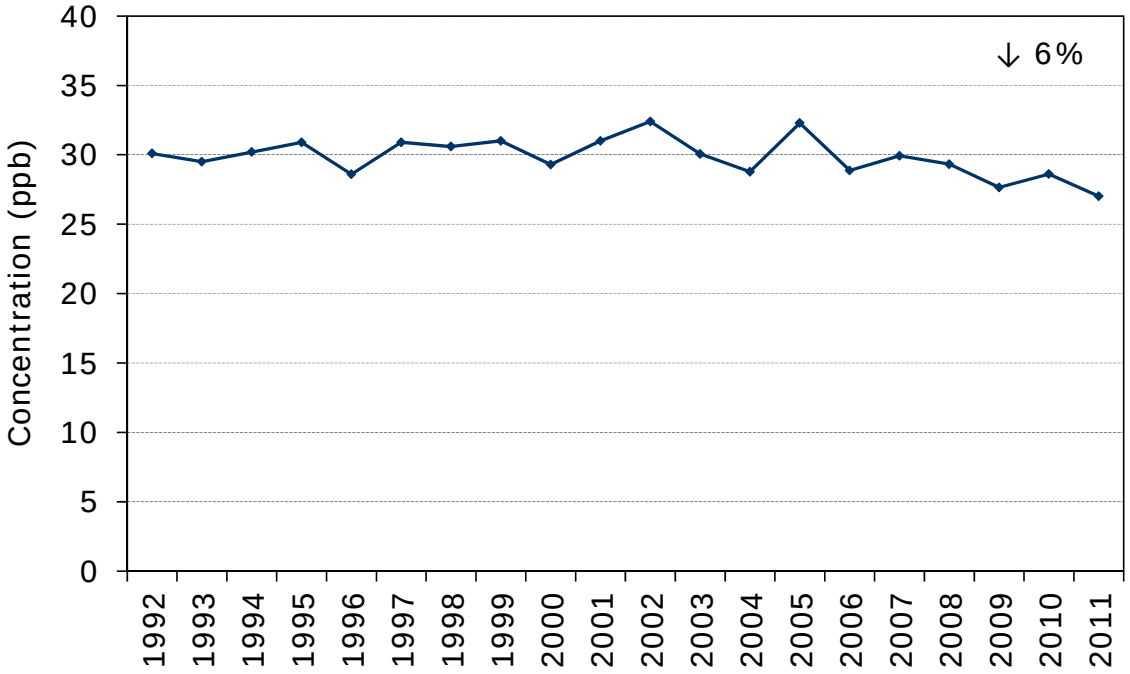


Figure C21
Ozone Annual Mean at Ottawa Downtown

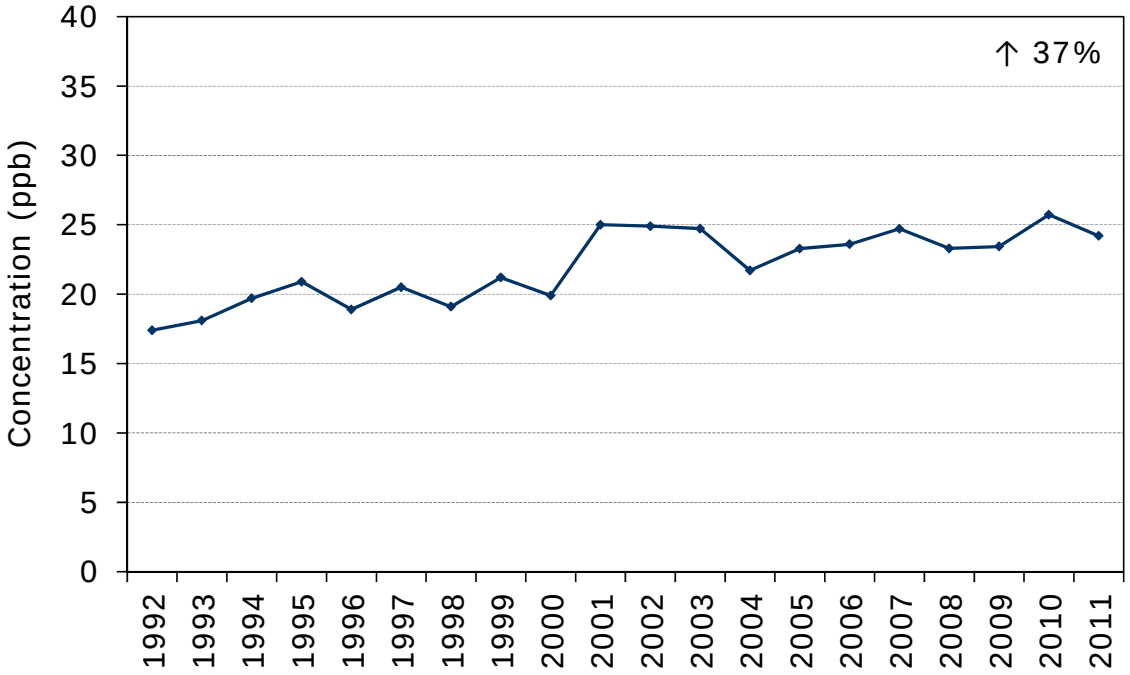


Figure C22
Ozone Annual Mean at Cornwall

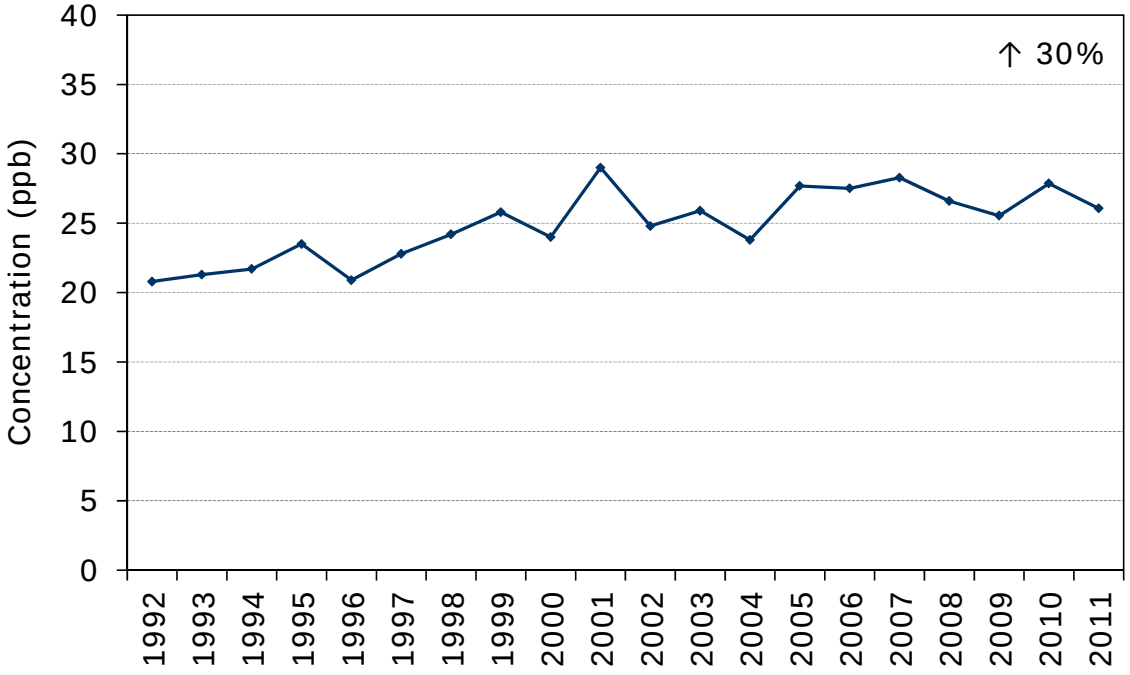


Figure C23
Ozone Annual Mean at Thunder Bay

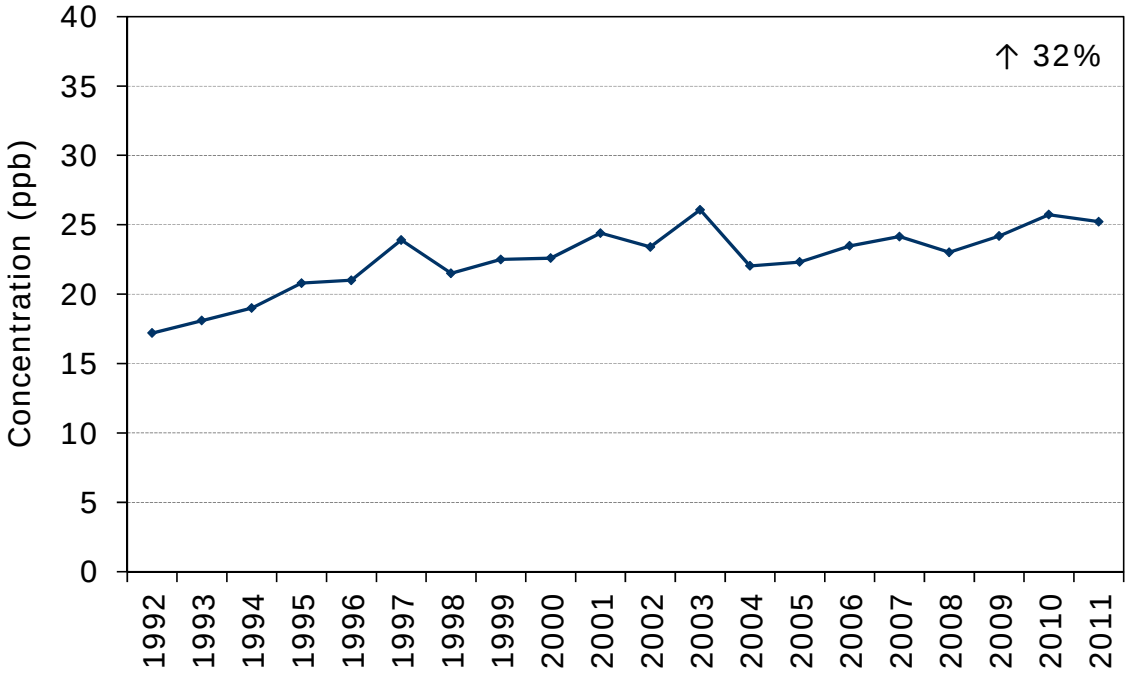


Figure C24
Ozone Annual Mean at Sault Ste. Marie

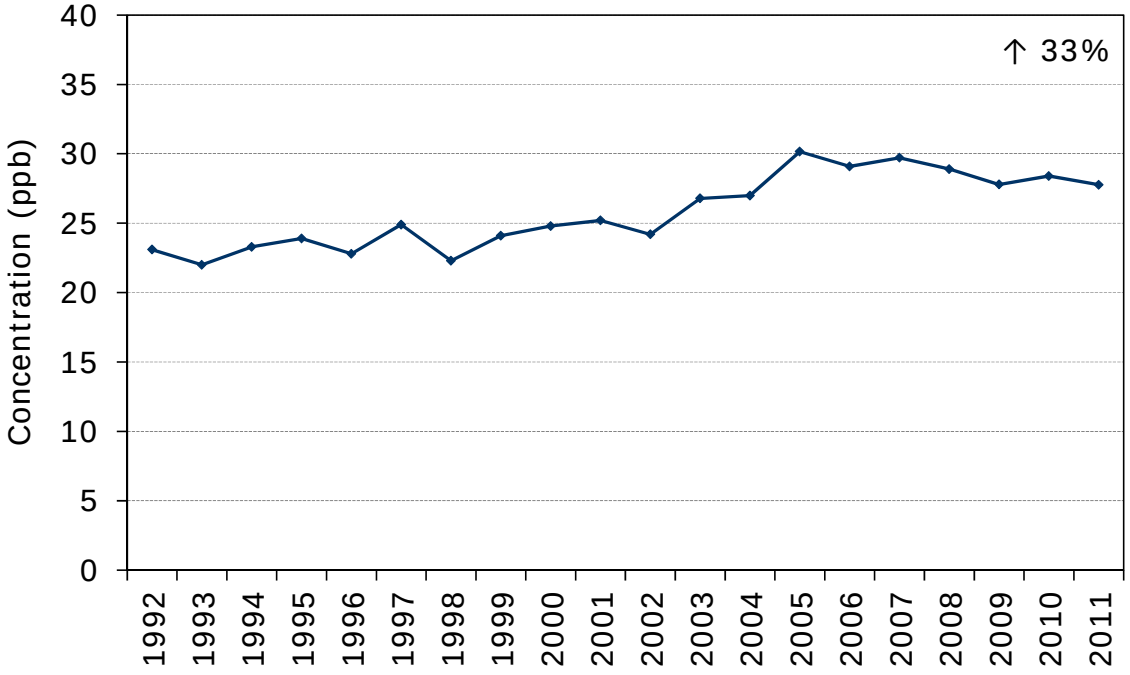


Figure C25
Ozone Annual Mean at North Bay

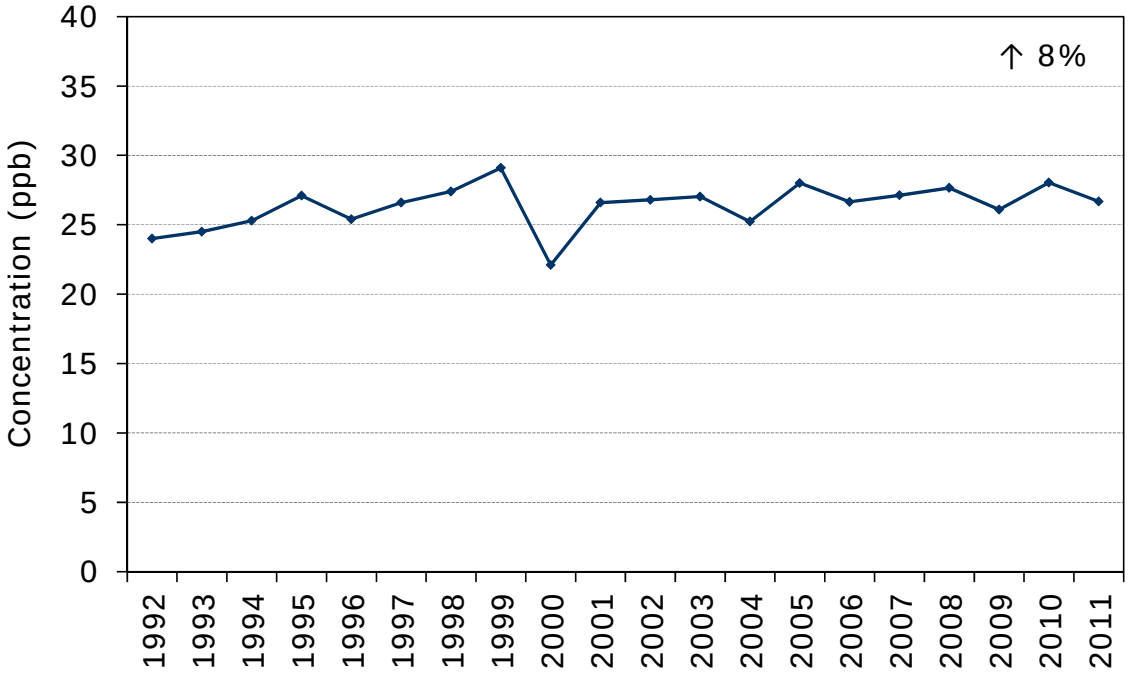
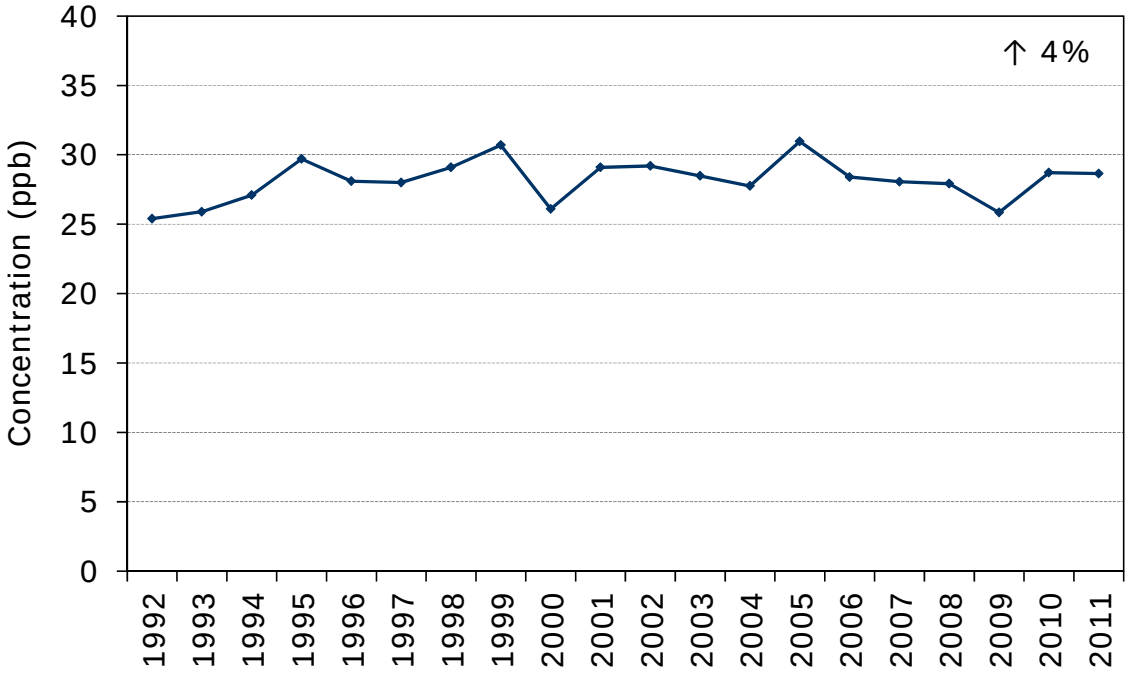


Figure C26
Ozone Annual Mean at Sudbury



Appendix D 20-Year NO_2 Trends (1992-2011)

Figure D1
NO_2 Annual Mean at Windsor Downtown

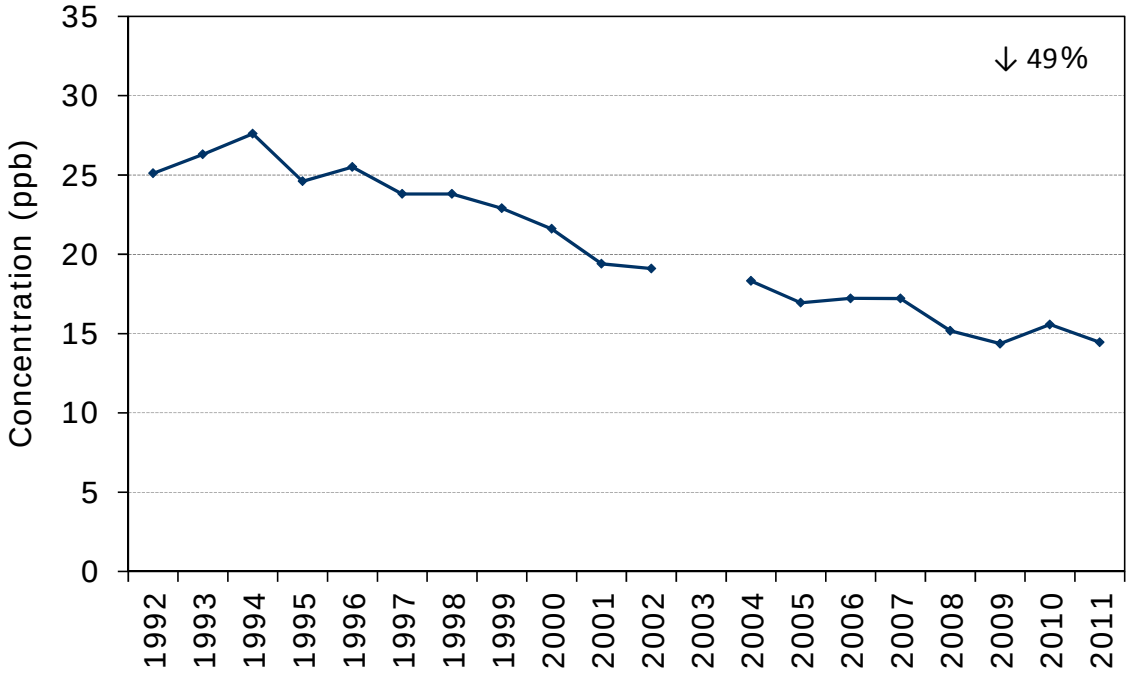


Figure D2
NO_2 Annual Mean at Sarnia

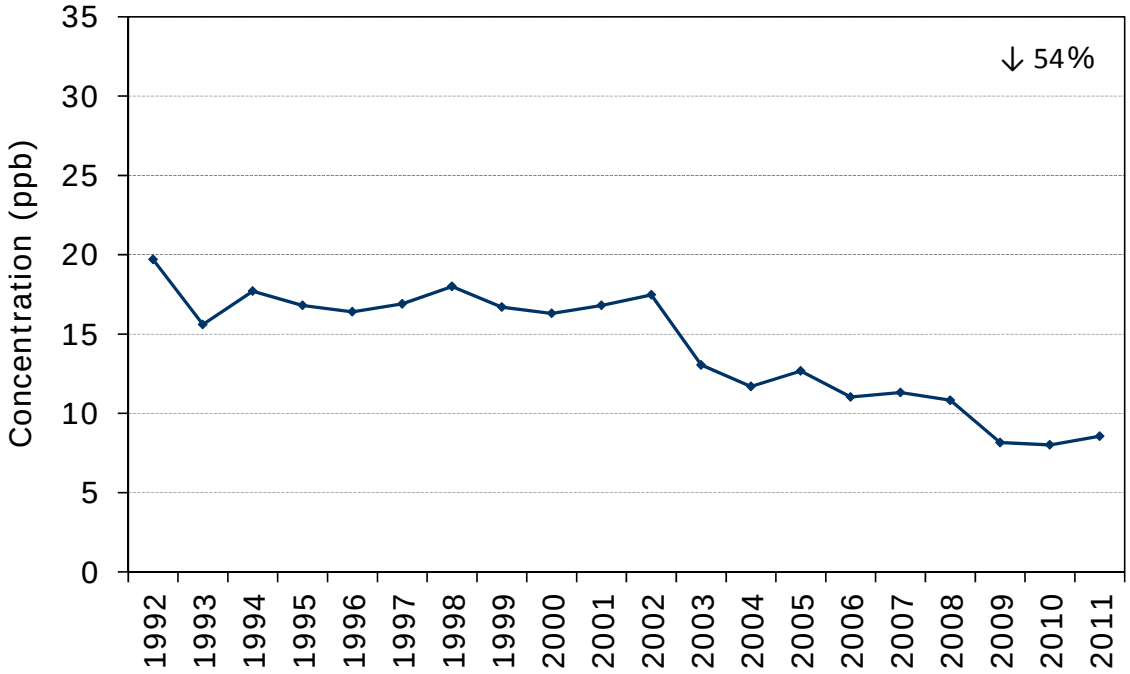


Figure D3
NO_2 Annual Mean at London

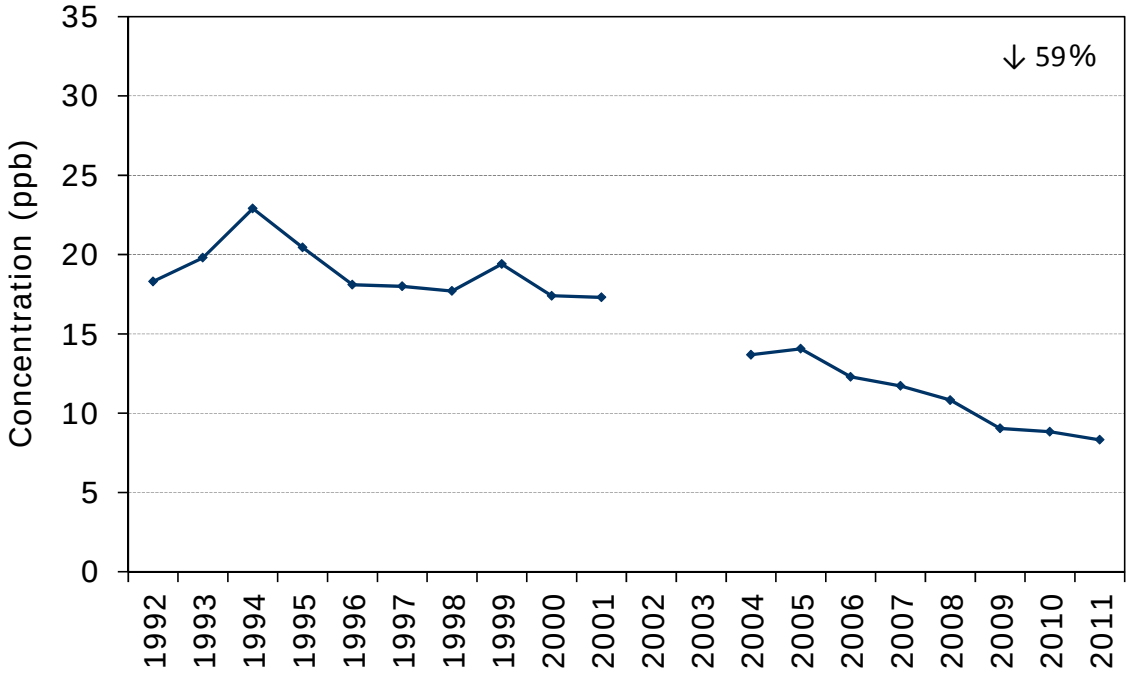


Figure D4
NO_2 Annual Mean at Kitchener

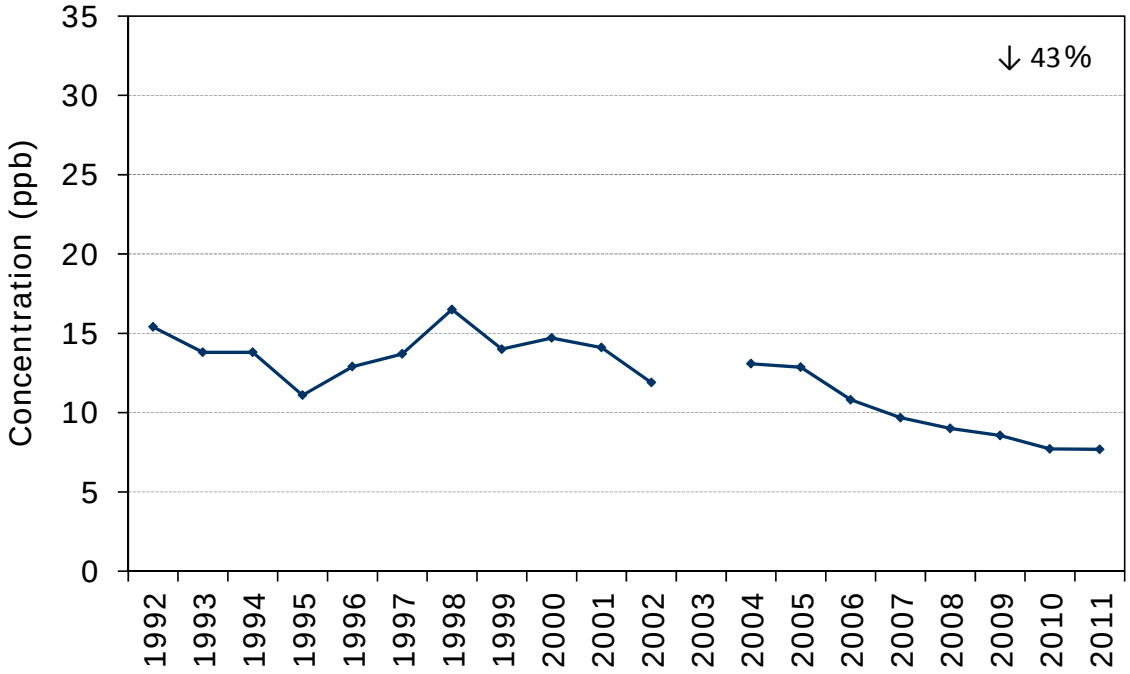


Figure D5
NO_2 Annual Mean at St. Catharines

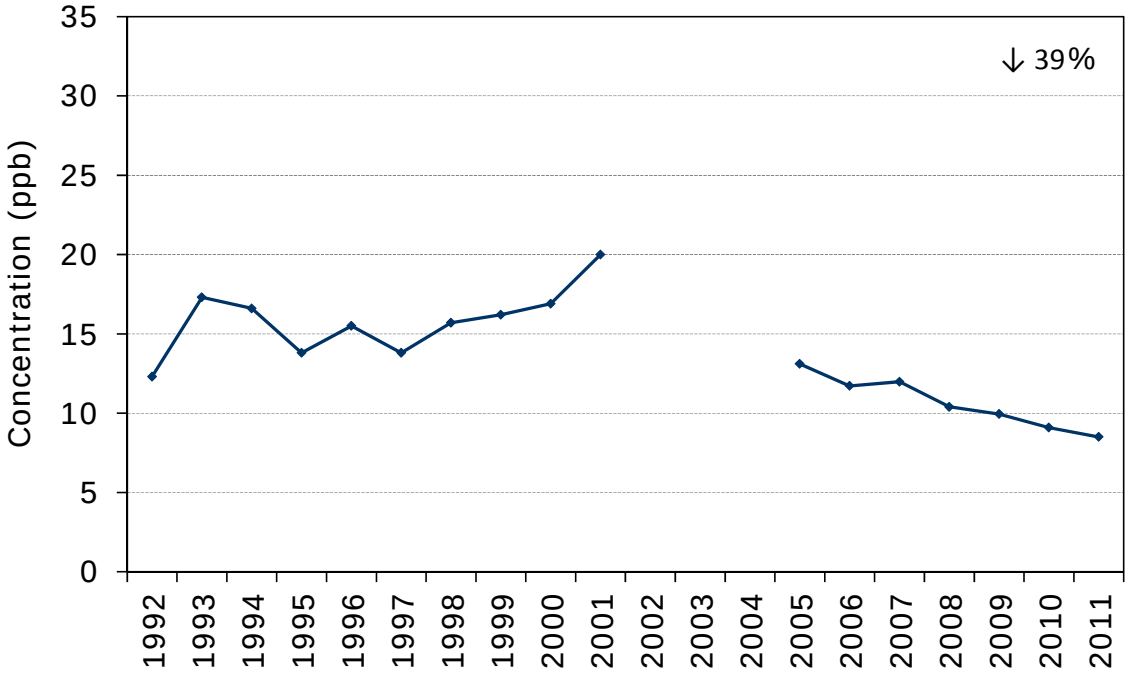


Figure D6
NO_2 Annual Mean at Hamilton Downtown

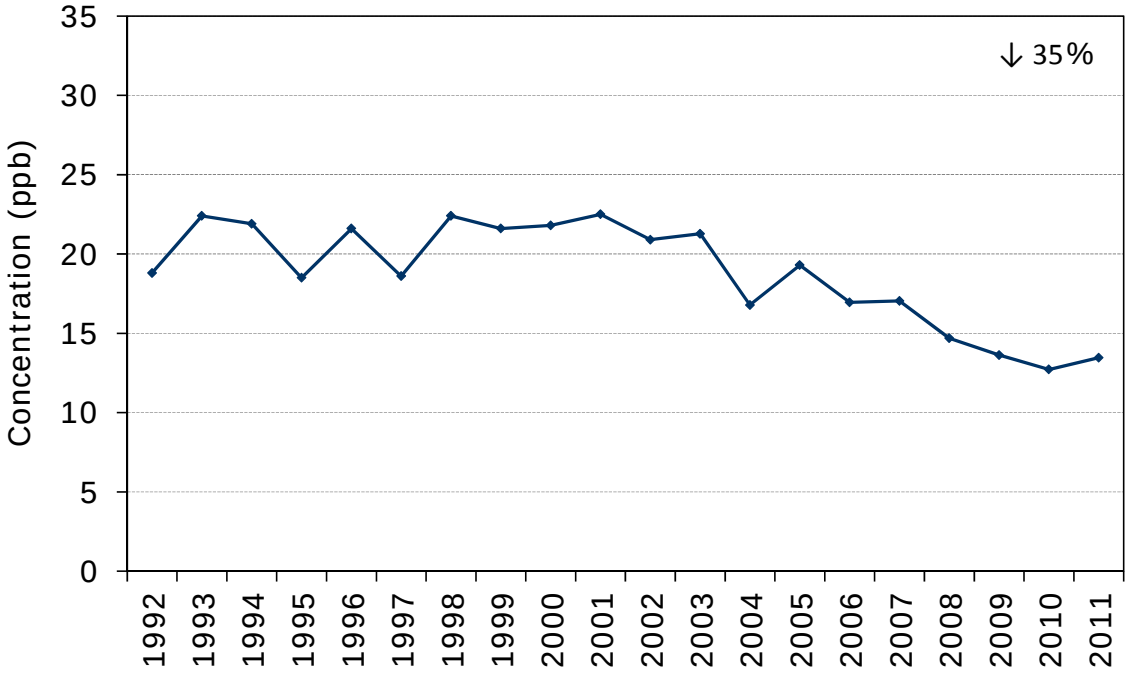


Figure D7
NO_2 Annual Mean at Hamilton Mountain

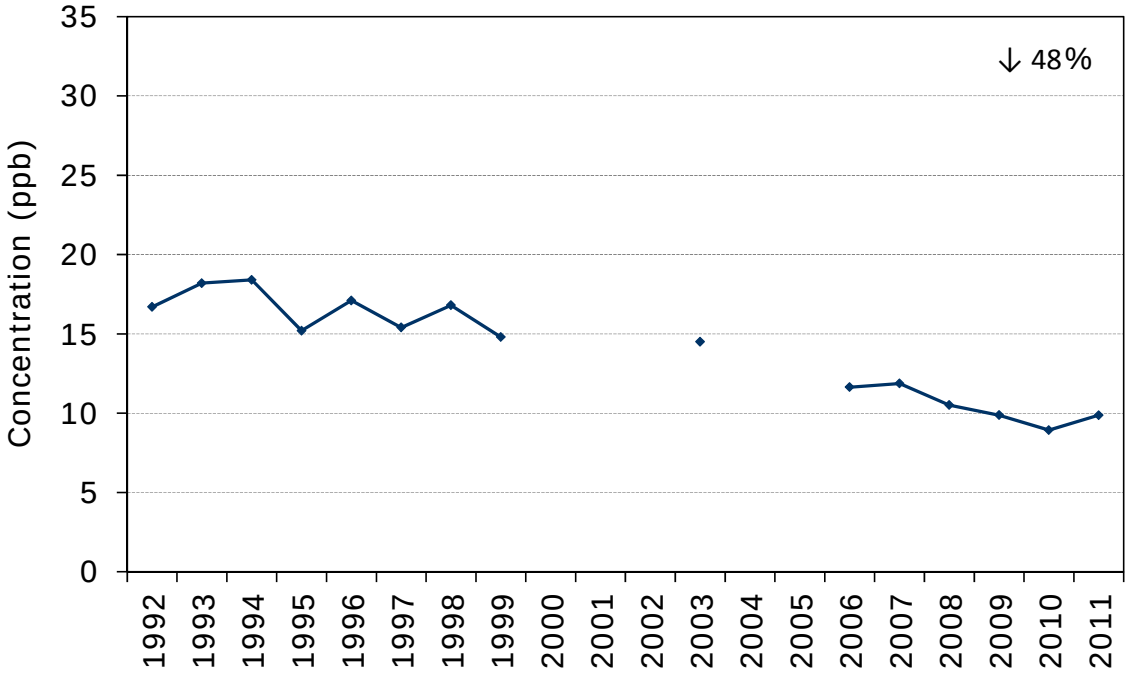


Figure D8
NO_2 Annual Mean at Toronto Downtown

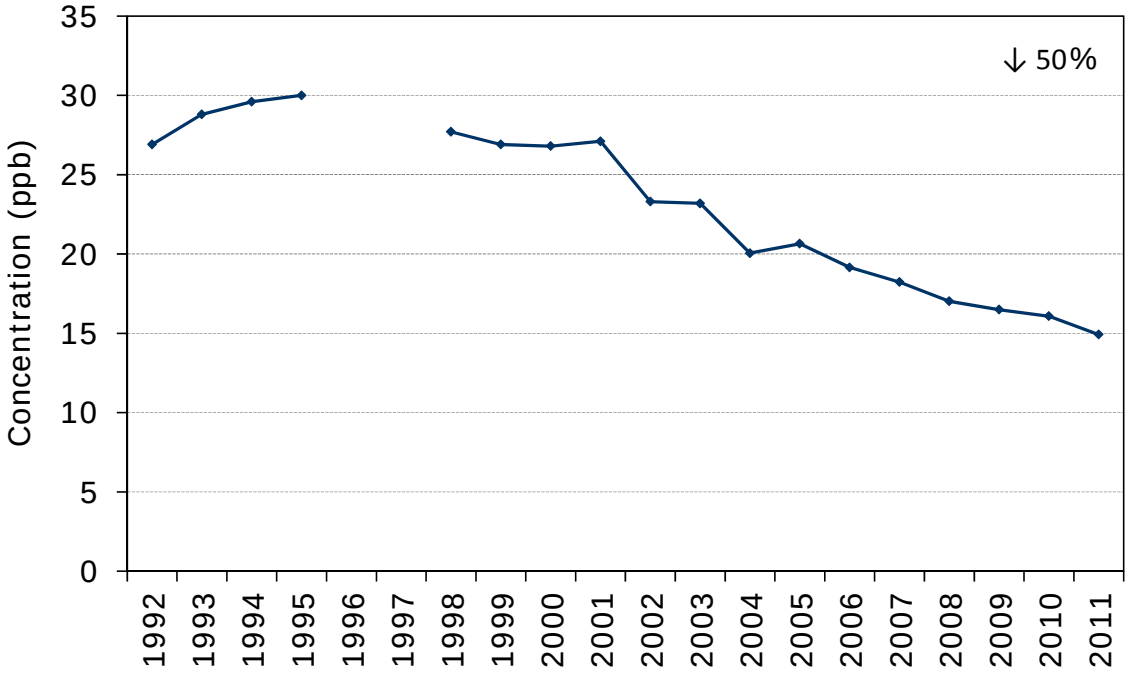


Figure D9
NO_2 Annual Mean at Toronto East

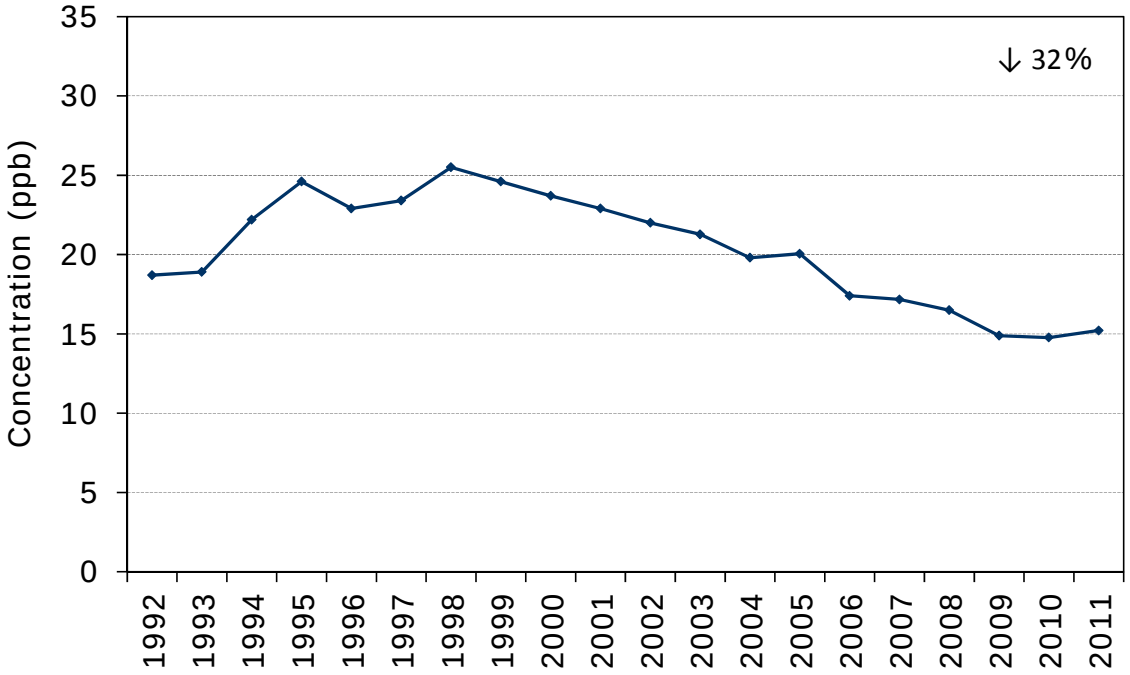


Figure D10
NO_2 Annual Mean at Toronto North

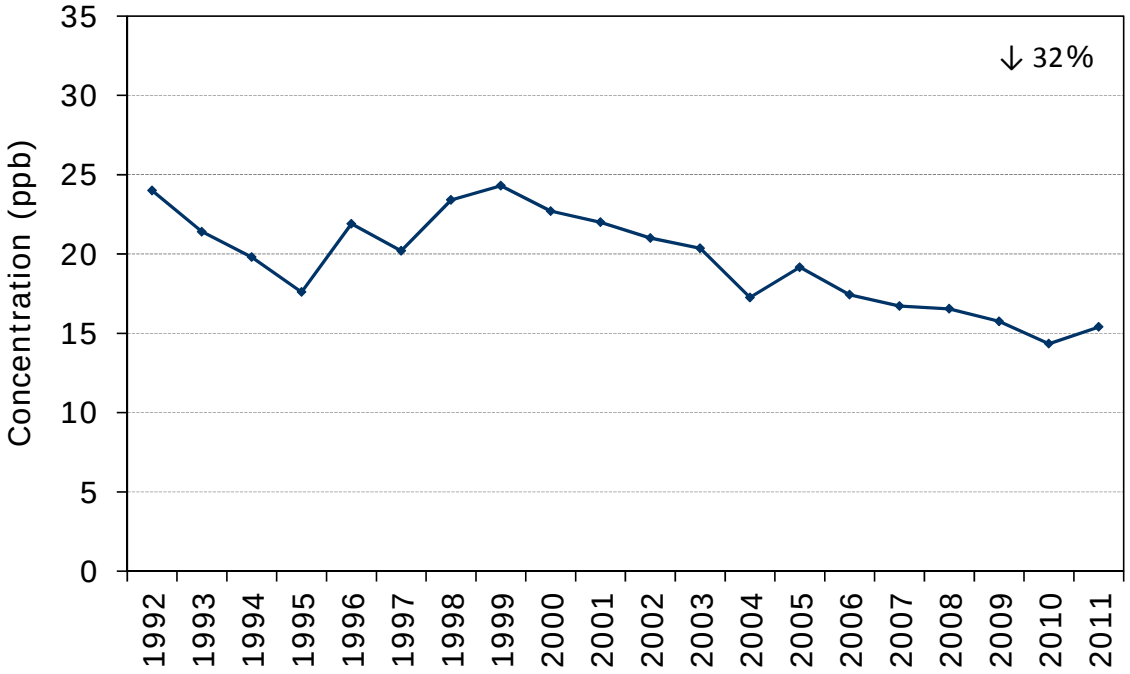


Figure D11
NO_2 Annual Mean at Burlington

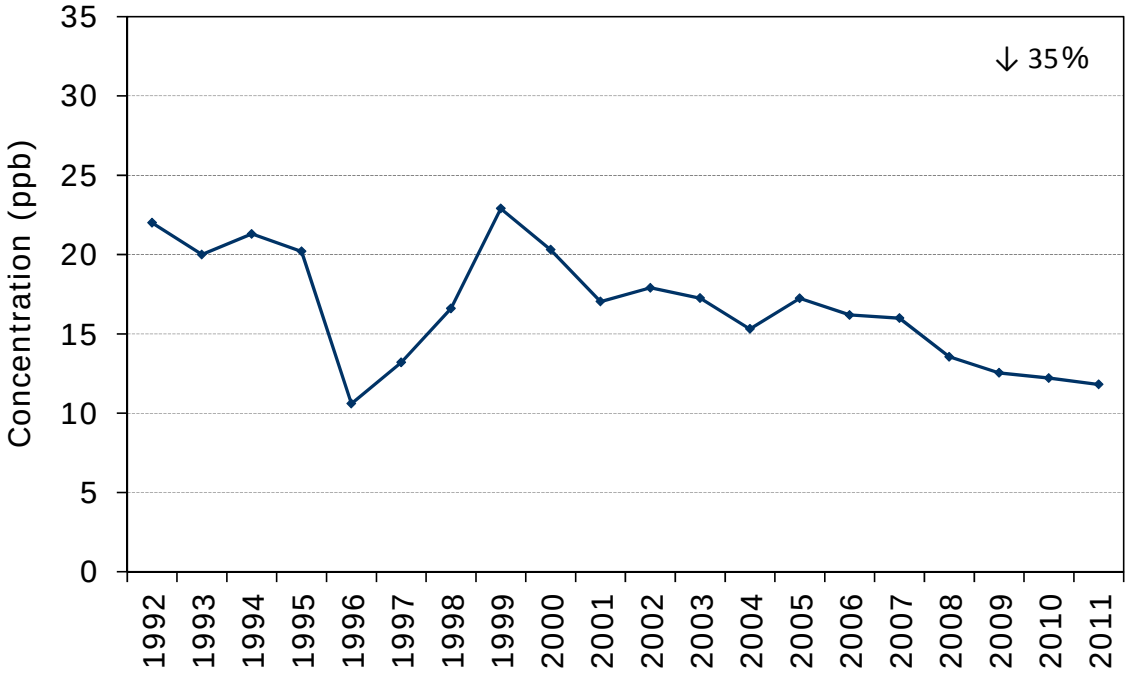


Figure D12
NO_2 Annual Mean at Oakville

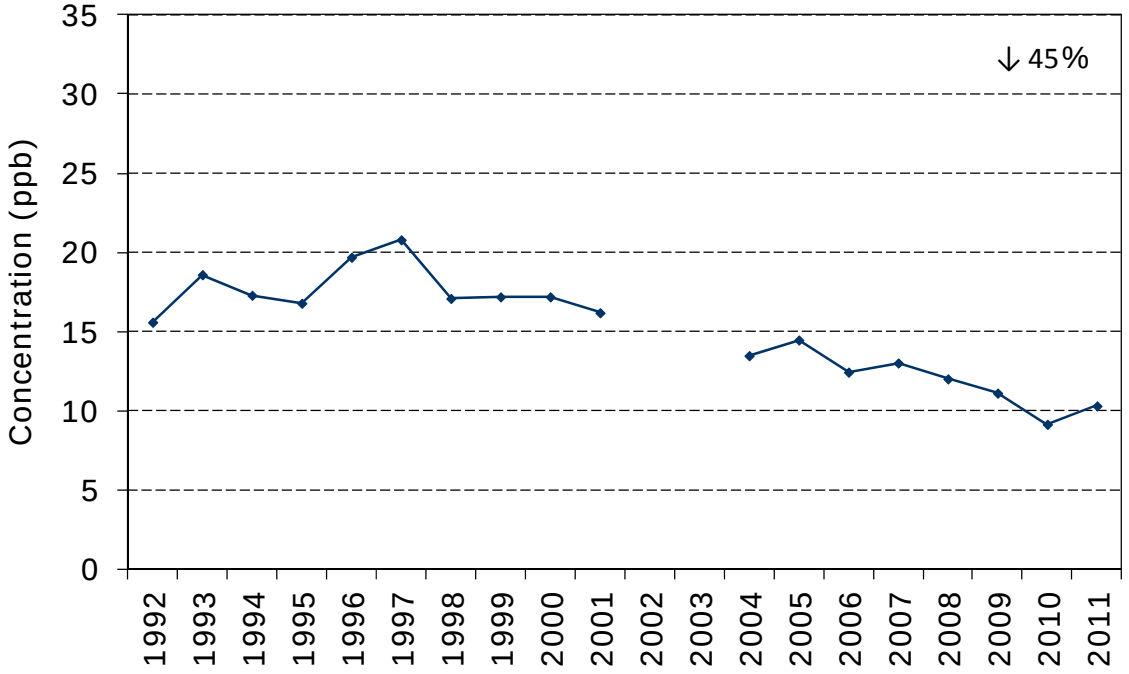


Figure D13
NO_2 Annual Mean at Oshawa

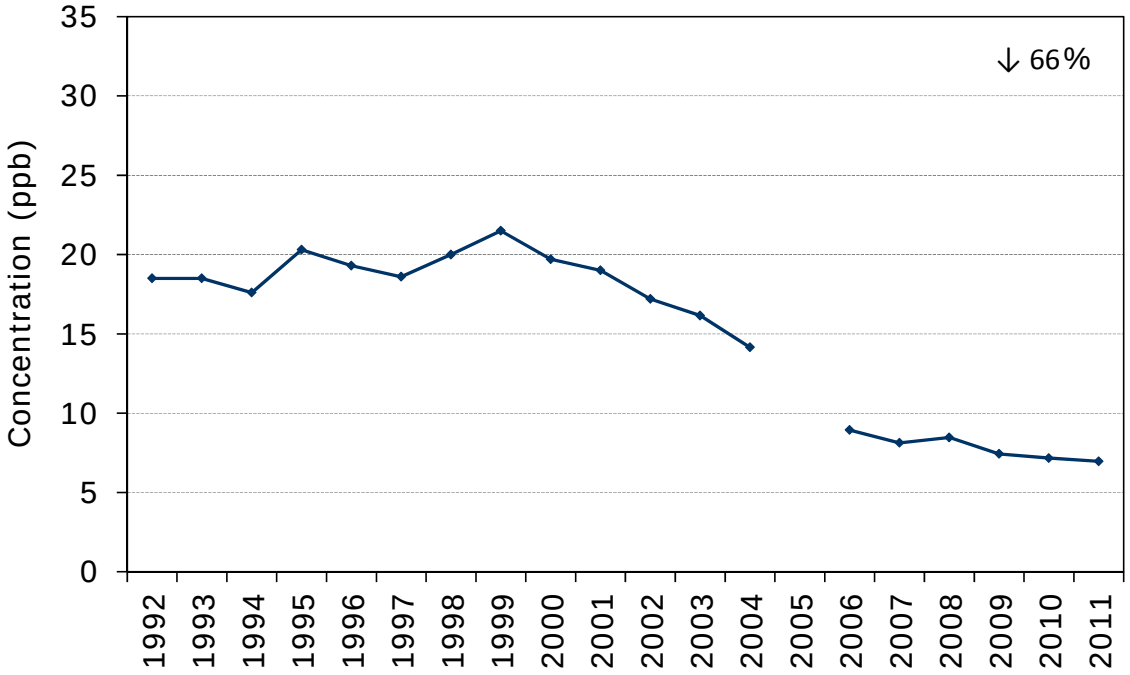
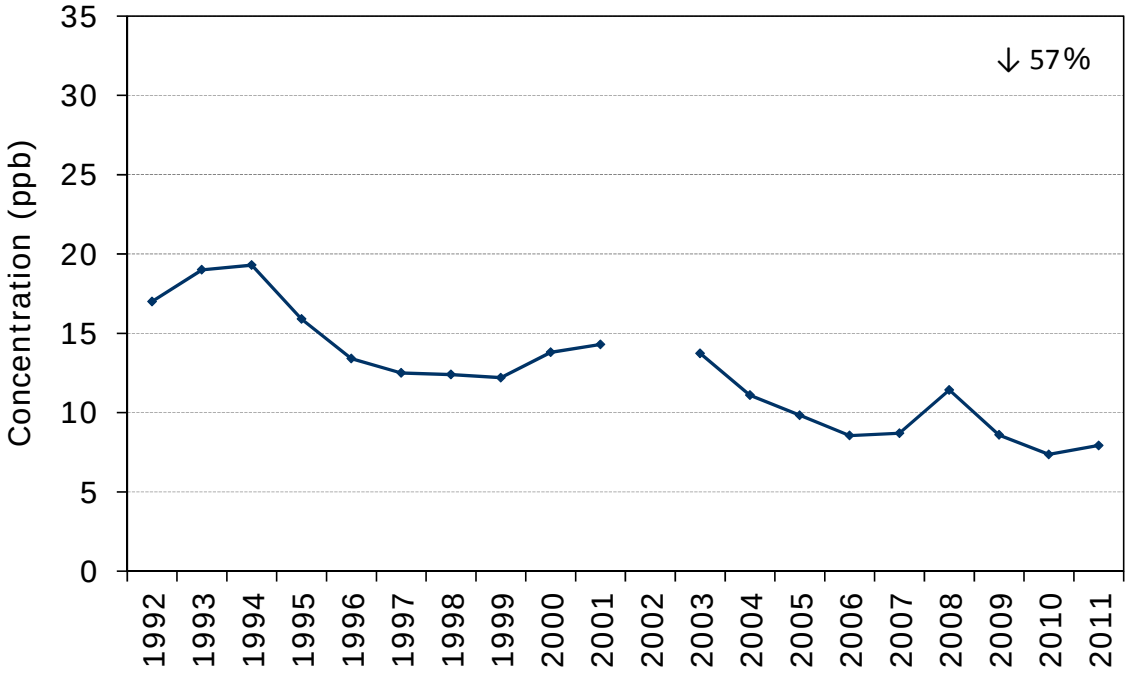


Figure D14
NO_2 Annual Mean at Ottawa Downtown



Appendix E 20-Year SO_2 Trends (1992-2011)

Figure E1
SO_2 Annual Mean at Windsor West

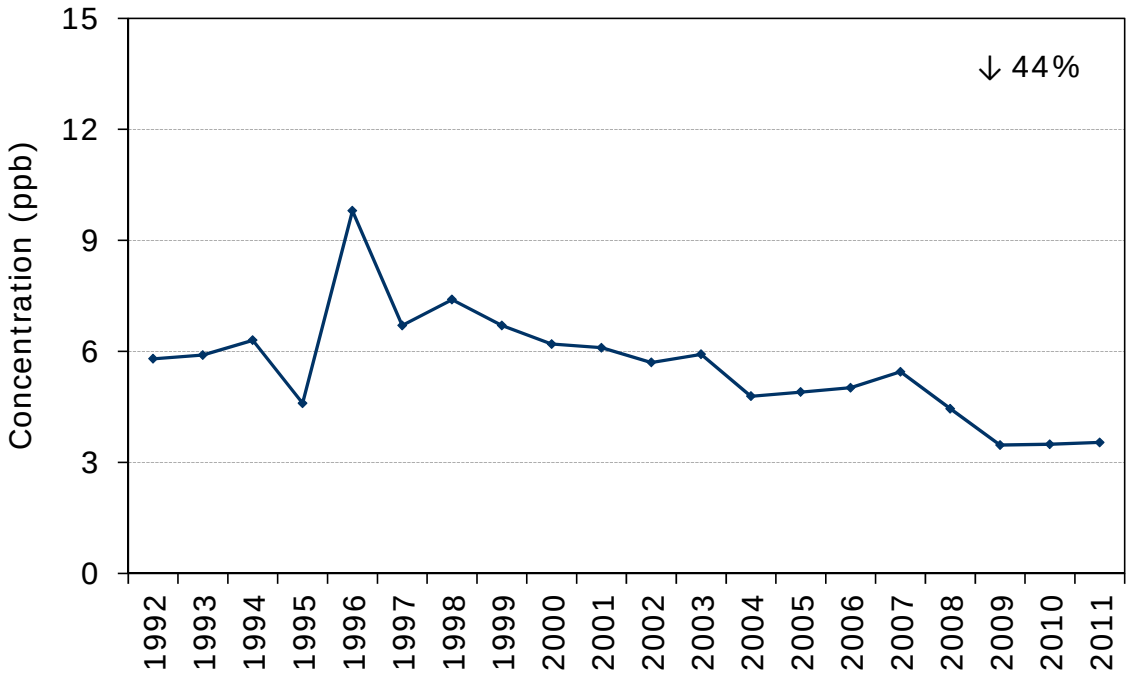


Figure E2
SO_2 Annual Mean at Windsor West

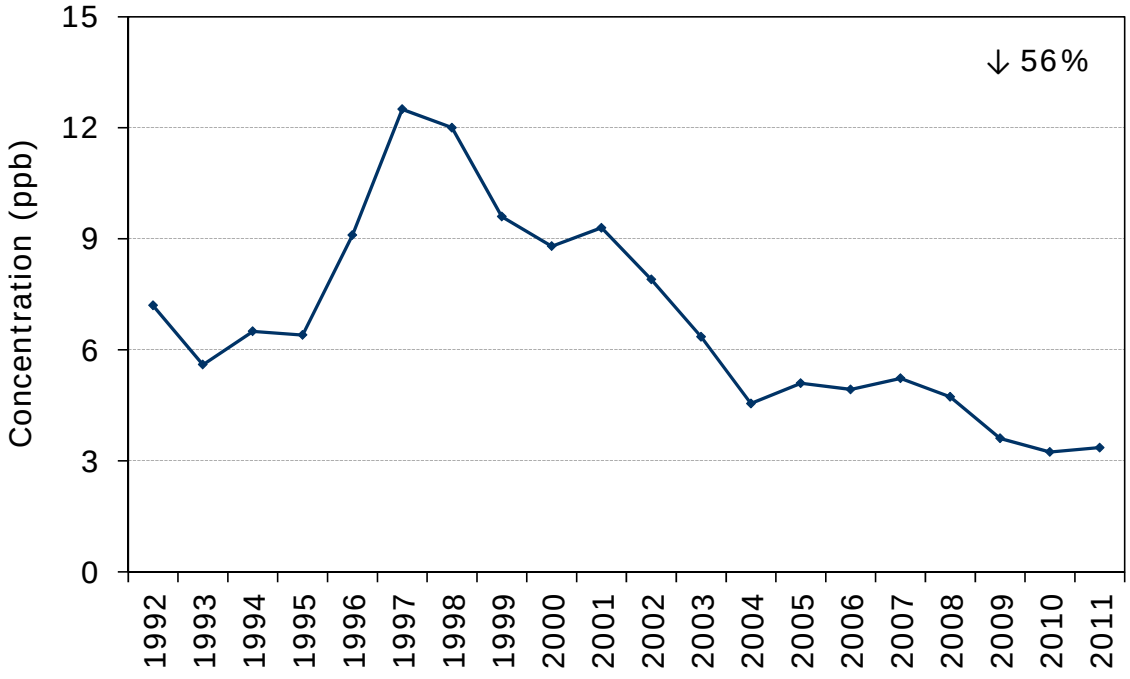


Figure E3
SO_2 Annual Mean at Sarnia

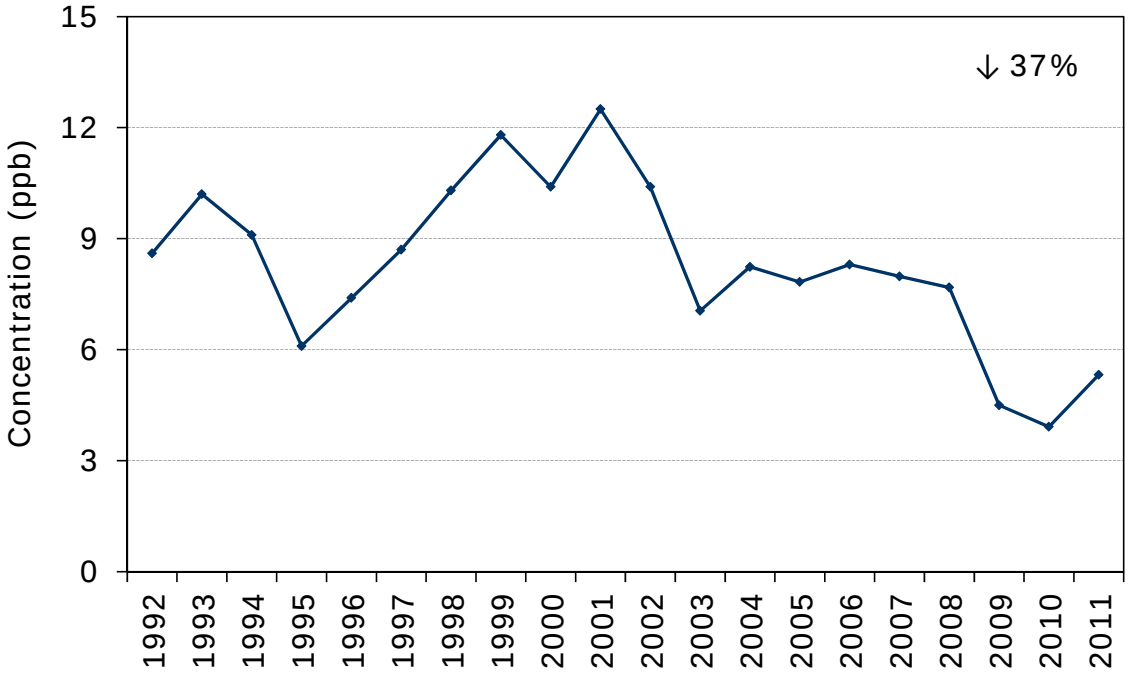


Figure E4
SO_2 Annual Mean at Hamilton Downtown

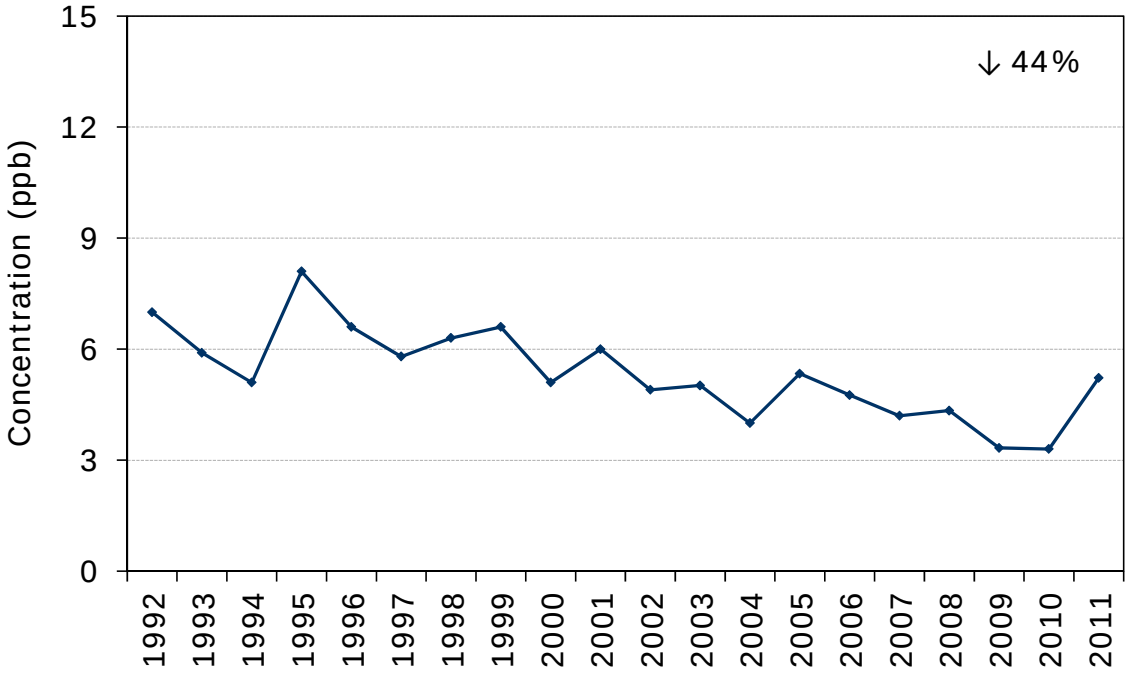


Figure E5
SO_2 Annual Mean at Hamilton Mountain

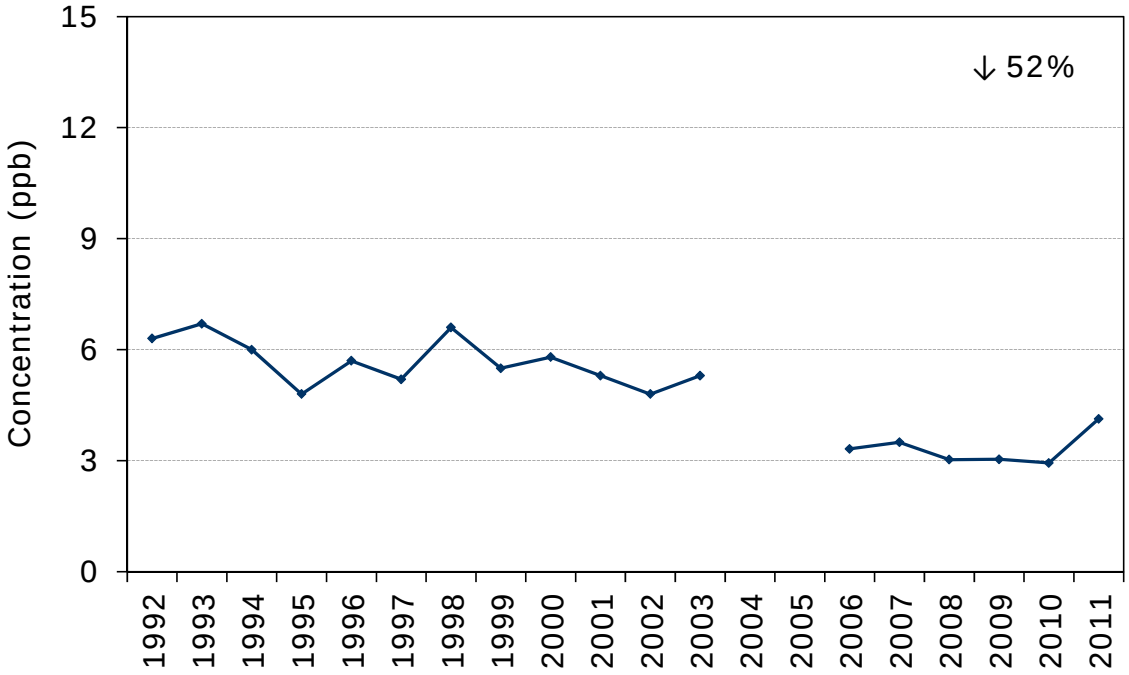


Figure E6
SO_2 Annual Mean at Ottawa Downtown

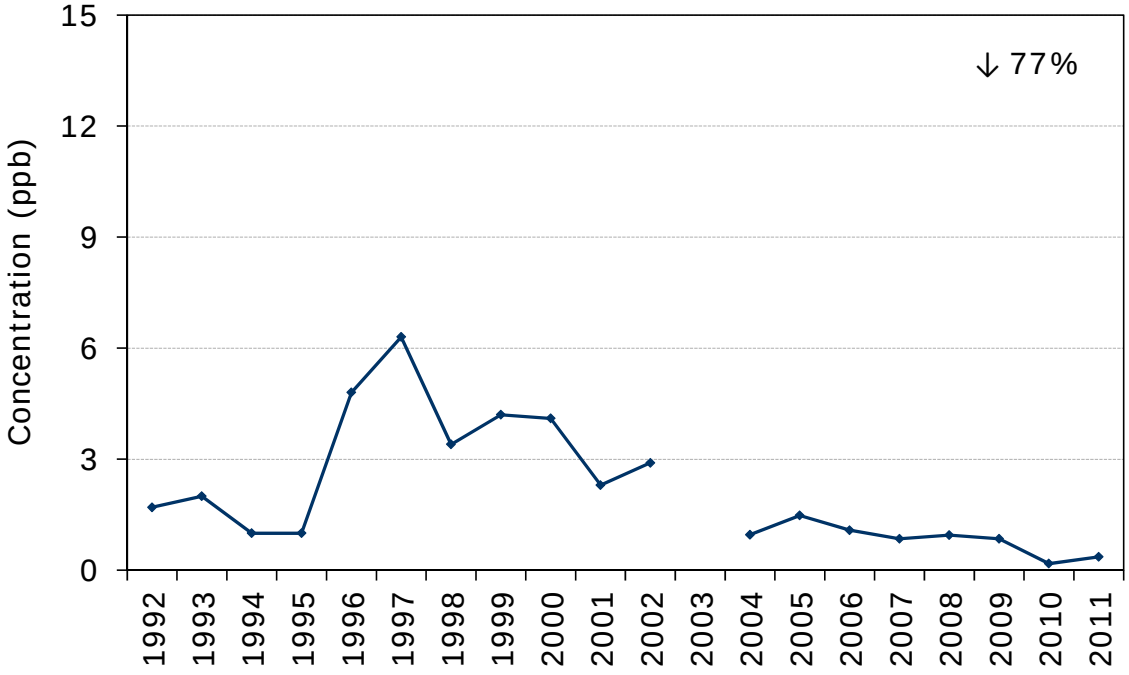


Figure E7
SO_2 Annual Mean at Sault Ste. Marie

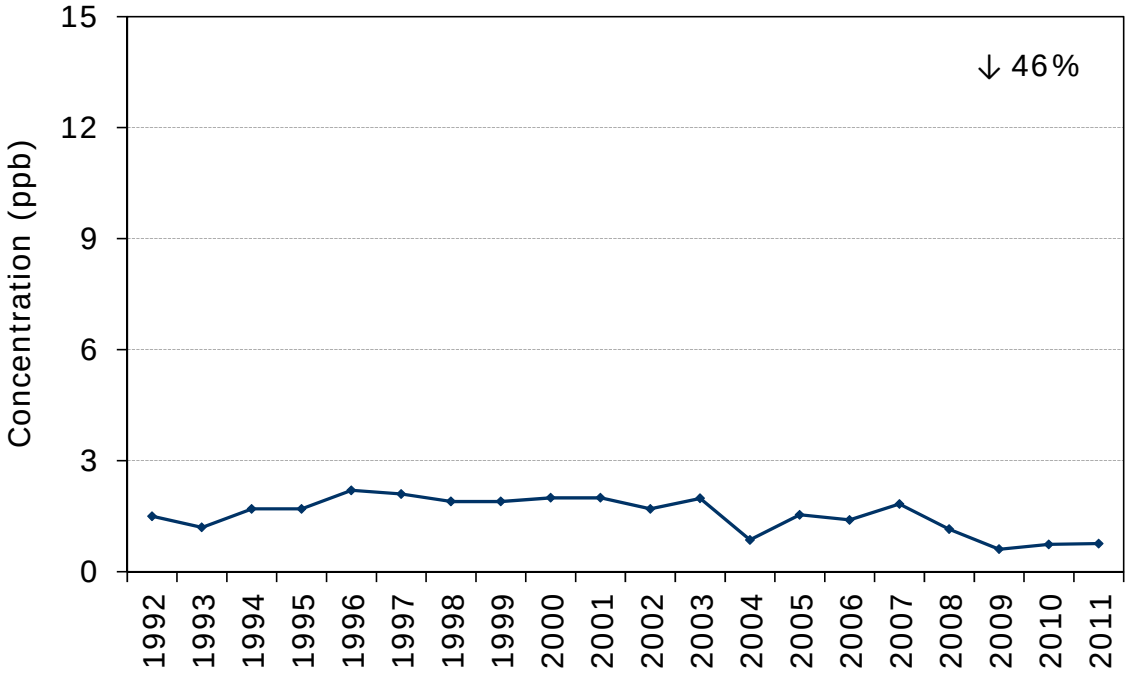


Figure E8
SO_2 Annual Mean at Sudbury

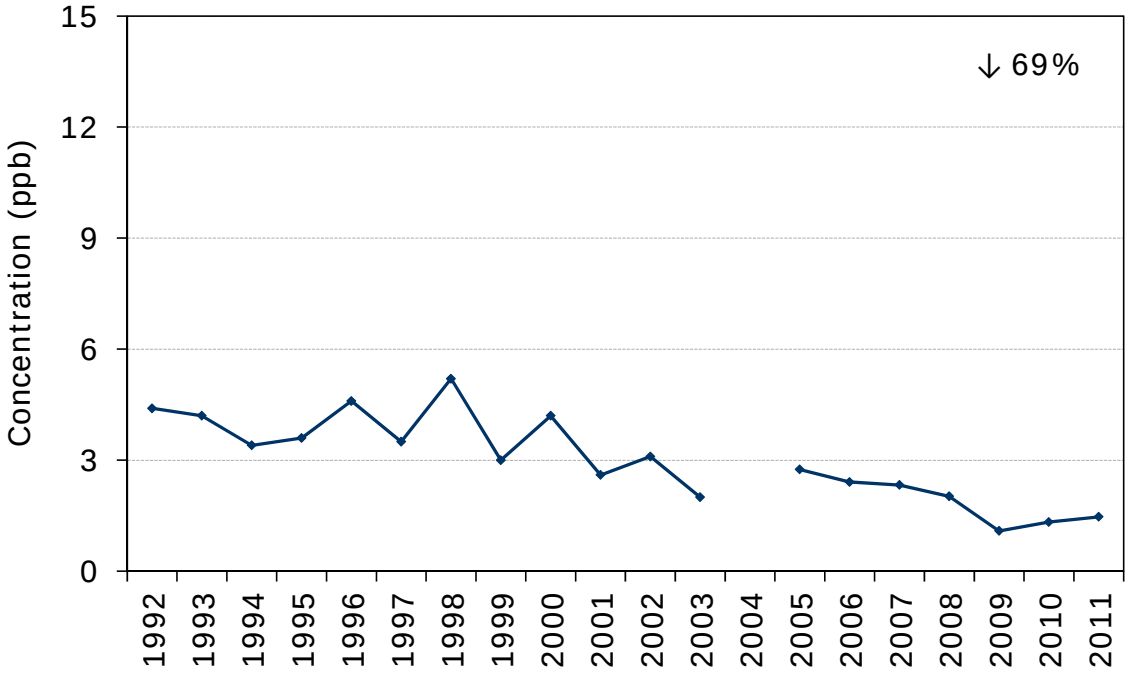


Table F1: Summary of Smog Advisories and Smog Advisory Days (2005-2011)

Forecast Region	2005		2006		2007		2008		2009		2010		2011	
	Smog Advisories	Smog Advisory Days	Smog Advisories	Smog Advisory Days	Smog Advisories	Smog Advisory Days	Smog Advisories	Smog Advisory Days	Smog Advisories	Smog Advisory Days	Smog Advisories	Smog Advisory Days	Smog Advisories	Smog Advisory Days
Algonquin	5	16	1	3	1	3	0	0	1	1	0	0	0	0
Bancroft-Bon Echo	7	21	1	3	4	13	2	3	2	4	1	5	0	0
Barrie-Orillia-Midland	13	39	5	11	8	21	3	7	2	4	1	4	1	1
Belleville-Quinte-Northumberland	13	42	5	12	9	24	4	8	2	4	2	8	1	1
Brockville-Leeds and Grenville	7	24	2	5	3	5	2	4	2	4	1	2	0	0
Burk's Falls Bayfield Inlet	8	24	2	4	1	3	0	0	1	1	0	0	0	0
City of Hamilton	13	45	5	11	10	31	6	13	2	4	2	8	2	2
City of Ottawa	7	25	2	5	2	4	1	1	2	4	1	2	0	0
City of Toronto	14	48	5	11	11	29	6	13	2	4	2	8	1	1
Cornwall-Morrisburg	7	25	2	5	3	5	2	4	2	4	1	2	0	0
Dufferin-Innisfil	13	44	5	11	9	27	3	7	2	4	1	5	1	1
Dunnville-Caledonia-Haldimand	13	45	5	11	12	31	4	11	2	4	2	8	1	1
Elgin	12	45	4	13	13	37	6	15	2	4	2	10	2	4
Elliot Lake-Ranger Lake	4	12	1	3	1	3	0	0	0	0	0	0	0	0
Greater Sudbury and Vicinity	7	20	2	4	1	3	0	0	1	1	0	0	0	0
Grey-Bruce	10	32	4	10	9	22	1	2	2	4	2	8	1	1
Haliburton	10	30	4	10	6	17	1	2	2	4	1	4	0	0
Halton-Peel	14	48	5	11	11	31	6	13	2	4	2	8	1	1
Huron-Perth	12	44	4	11	12	27	3	7	2	4	2	10	1	1
Kingston-Prince Edward	10	32	5	12	9	23	4	8	2	4	2	8	1	1
London-Middlesex	12	45	4	12	12	27	5	11	2	4	2	9	1	1
Manitoulin-Northshore-Killarney	6	18	2	4	1	3	0	0	1	1	0	0	0	0
Niagara	13	45	5	11	10	29	4	11	2	4	2	8	1	1
North Bay-West Nipissing	7	20	2	4	1	3	0	0	1	1	0	0	0	0
Oxford-Brant	13	46	5	11	12	31	4	11	2	4	2	8	1	1
Parry Sound-Muskoka-Huntsville	10	30	4	10	8	21	2	5	2	4	1	4	0	0
Peterborough-Kawartha Lakes	12	38	4	10	8	21	3	6	2	4	2	8	0	0
Prescott and Russell	7	25	2	5	2	4	1	1	2	4	1	2	0	0
Renfrew-Pembroke-Barry's Bay	5	17	1	3	2	5	0	0	2	4	1	2	0	0
Sarnia-Lambton	13	46	4	12	13	29	4	10	2	4	2	10	2	4
Sault Ste. Marie-Superior East	4	10	1	3	1	3	0	0	0	0	0	0	0	0
Simcoe-Delhi-Norfolk	13	46	5	11	12	31	4	11	2	4	2	10	1	1
Smiths Falls-Lanark-Sharbot Lake	6	19	2	5	2	4	1	1	2	4	1	2	0	0
Stirling-Tweed-South Frontenac	8	25	2	5	5	13	2	3	2	4	2	8	0	0
Waterloo-Wellington	13	45	5	11	11	29	3	7	2	4	2	8	1	1
Windsor-Essex-Chatham-Kent	13	46	4	14	13	38	5	12	3	5	2	10	4	8
York-Durham	14	48	5	11	11	29	5	9	2	4	2	8	1	1
ONTARIO	**15**	**53**	**6**	**17**	**13**	**39**	**8**	**17**	**3**	**5**	**3**	**12**	**5**	**9**

Note: A smog advisory day refers to a calendar day when a smog advisory is in effect.