Air Quality in Ontario
2009 Report

Ontario

Acknowledgements
This report has been prepared by the staff of the Environmental Monitoring and Reporting Branch of the Ontario Ministry of the Environment. Environment Canada's National Air Pollution Surveillance program is also acknowledged for providing air monitoring instrumentation to the province of Ontario.

Cette publication hautement spécialisée n'est disponible qu'en anglais en vertu du règlement 441/97, qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec le ministère de l'Environnement au Centre d'information, 416-325-4000 ou 1-800-565-4923.

For alternate format requests, please contact the Public Information Centre.

For more information contact:
Ontario Ministry of the Environment
Public Information Centre
telephone: 416-325-4000
toll free: 1-800-565-4923
TTY Line: 1-800-515-2759
email: picemail.moe@ontario.ca
www.Ontario.ca/Environment

PIBS 8035e

2009 Report Highlights

AIR QUALITY IS IMPROVING

- The 2009 air quality report marks 39 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 years, especially for nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2) - pollutants emitted by vehicles and industry.

Decreasing Provincial Ambient Concentrations in the Past Decade

Pollutant	2000-2009
NO_2	↓ 40%
CO	↓ 64%
SO_2	↓ 54%

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 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 technologies, and lower sulphur content in transportation fuels.

Decreasing Provincial Emissions*

Pollutant	1999-2008
NO_x	↓ 32%
CO	↓ 29%
SO_2	↓ 35%

* 2009 emissions data not yet available.

- Transboundary influences including the U.S. account for approximately half of Ontario's smog. Emission reductions in Ontario and the U.S. have contributed to decreases in fine particulate matter ($PM_{2.5}$) and peak ozone concentrations.

THE ONTARIO STANDARDS (NO_2, CO, SO_2)

- The provincial standards for NO_2, CO and SO_2 were not exceeded at any of the ambient air monitoring locations in Ontario during 2009.

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

- For a second year in a row, the CWS for $PM_{2.5}$ was not exceeded in Ontario.
- Most areas of Ontario are still above the CWS for ozone with the exception of two municipalities: Thunder Bay and Ottawa. Ottawa is the first southern Ontario municipality to meet this CWS.

Table of Contents

1.0 Introduction

This annual report, the 39th in a series, summarizes the state of ambient air quality in Ontario during 2009 and examines air pollution trends. It reports on the measured levels of six common pollutants: 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, and includes a comparative study of air quality information collected from 53 cities around the world. 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 via an Air Quality Index (AQI) hourly reporting system (www.airqualityontario.com).

The Ministry of the Environment uses this information to:

- inform the public about Ontario's 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 contribution 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. Although ozone is not generally emitted directly into the atmosphere, the formation and transport of ozone are strongly dependent on meteorological conditions. 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 May to September, between noon and early evening.

Figure 2.1 shows the 2008 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 25 per cent. Figure 2.2 shows the 2008 estimates of Ontario's NO_x emissions from point, area and transportation sources. Transportation sectors accounted for approximately two-thirds, or 68 per cent, of NO_x emissions. Utilities that use fossil fuels to generate electricity were the second largest source of NO_x emissions, accounting for approximately 9 per cent.

Figure 2.1
Ontario Volatile Organic Compounds Emissions by Sector (Emissions from Point/Area/Transportation Sources, 2008 Estimates)

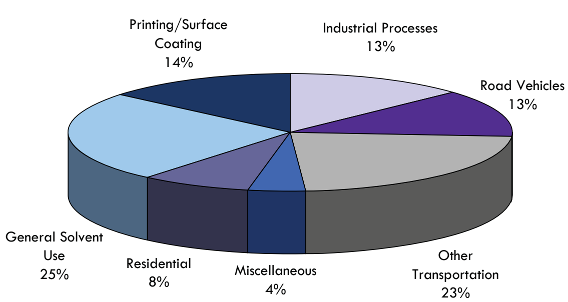
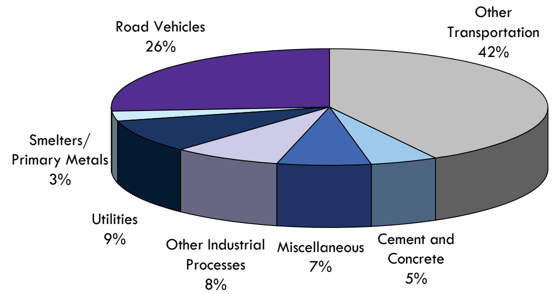


Figure 2.2
Ontario Nitrogen Oxides Emissions by Sector (Emissions from Point/Area/Transportation Sources, 2008 Estimates)



Ozone irritates the respiratory tract and eyes. Exposure to ozone can result in chest tightness, coughing and wheezing in sensitive people. 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 2009

During 2009, ozone was monitored at all 40 Ontario Ministry of the Environment AQI monitoring stations. The highest annual mean was 31.4 parts per billion (ppb), measured at Tiverton, a rural location considered to be a transboundary-influenced site situated on the eastern shore of Lake Huron. The lowest annual mean, 19.5 ppb, was measured at Toronto West, an urban site located near a major 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 reaction 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 2009, Ontario's one-hour AAQC for ozone was exceeded at 34 of the 40 AQI stations for at least one hour. The maximum one-hour ozone concentrations ranged from 59 ppb recorded in Thunder Bay to 98 ppb recorded at Grand Bend, another transboundary influenced site. Port Stanley and Parry Sound, sites also impacted significantly by U.S. emissions, recorded the most instances (14) when ozone exceeded Ontario's one-hour AAQC. The six sites that did not record any hours of ozone above 80 ppb in 2009 were Windsor West, London, St. Catharines, Hamilton West, Petawawa and Thunder Bay.

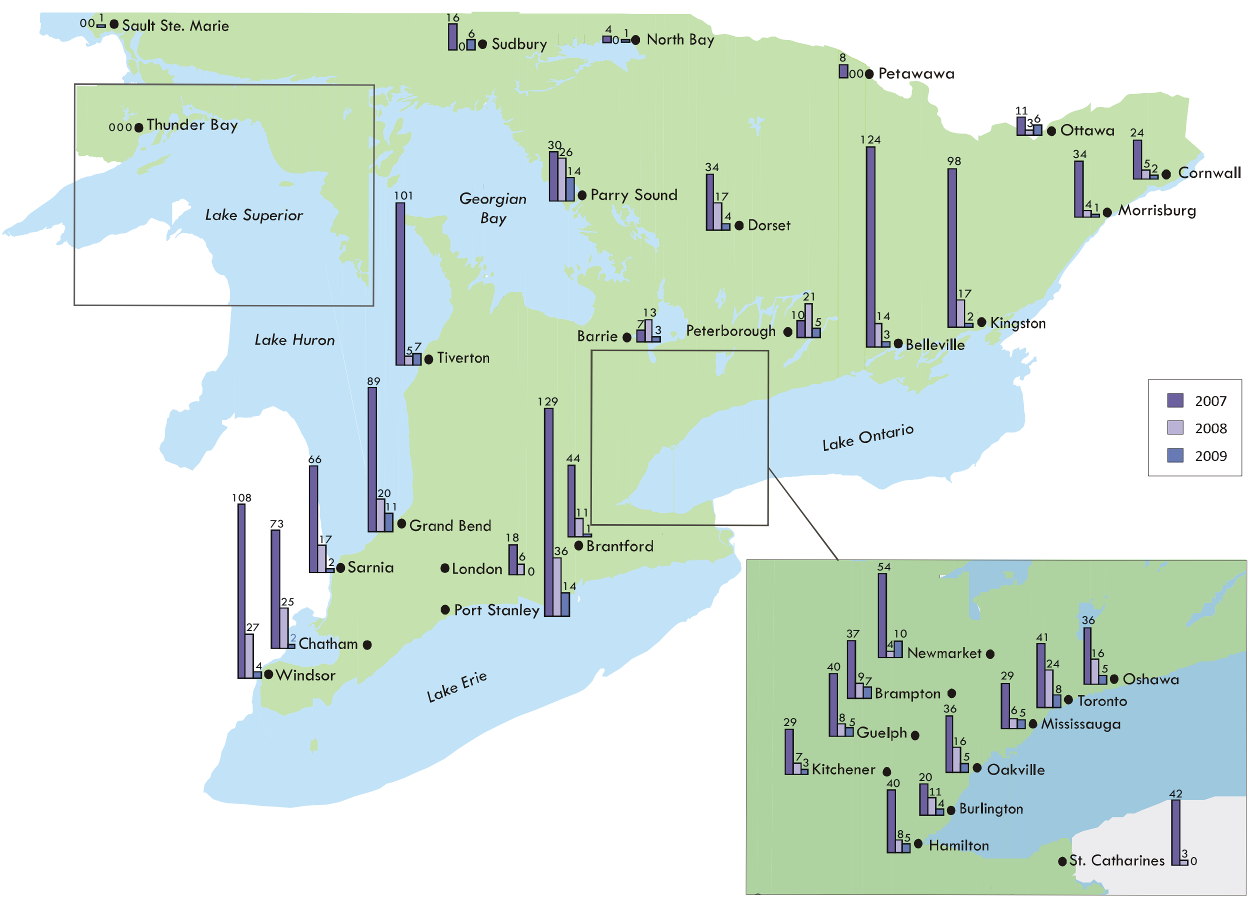
The geographical distribution of the number of ozone exceedances across Ontario for 2007 to 2009 is shown in Figure 2.3. There are two reasons for substantially lower numbers of ozone exceedances in 2008 and 2009 when compared to 2007: the relatively cool, wet, unsettled weather; and, lower emissions of NO_x and VOCs for Ontario and the neighbouring U.S. states. As in past years, the higher numbers of one-hour ozone exceedances were recorded on the northern shores of Lake Erie and the eastern shores of Lake Huron and Georgian Bay; however, the number of ozone exceedances is much lower in 2009. As stated in the Transboundary Air Pollution in Ontario report, elevated ozone levels in these areas are generally attributed to the long-range transport of pollutants into Ontario from the United States. Transboundary air pollution then combines with local emissions of smog-related pollutants to potentially impact various areas of the province during a smog episode.

2.3 Trends

The trend of the composite mean one-hour maximum ozone concentrations is shown for the 30-year period of 1980 to 2009 in Figure 2.4. For this period, the annual composite mean of the one-hour maximum concentrations ranges from a low of 83 ppb, recorded in 2009, the lowest on record, to a high of 140 ppb, recorded in 1988. The data show random year-to-year fluctuations but an overall decreasing trend (21 per cent) in the annual composite means of the one-hour maximum ozone concentrations from 1980 to 2009 is evident. Over the past 10 years (2000 to 2009), the annual composite means of the one-hour maximum concentrations of ozone have decreased by approximately 16 per cent on average; most of this change has occurred over the last six years. Again, this overall decrease is largely due to the progressive

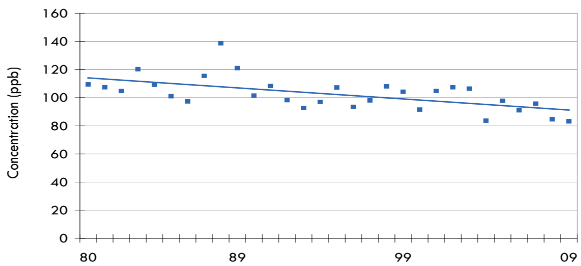
Figure 2.3

Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario (2007, 2008, 2009)



reductions of NO_x emissions in Ontario and the U.S. resulting in the decrease of ozone production during the summer months, thus lowering the ozone maximums.

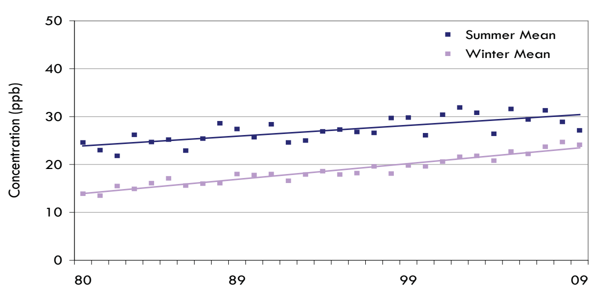
Figure 2.4
Trend of Ozone One-Hour Maximum Concentrations in Ontario (1980-2009)



Note: Based on data from 19 ambient ozone sites operated over 30 years.
Ontario 1h AAQC = 80 ppb.

The trend of the ozone seasonal composite means (summer and winter) as recorded at 19 long-term ozone sites for the period 1980 to 2009 is shown in Figure 2.5. It shows that there has been an increasing trend in the ozone seasonal composite means during the 30-year period where the ozone summer composite means have increased by approximately 27 per cent and the winter composite means by approximately 69 per cent. The ozone seasonal composite means differ by 11 ppb in 1980 and only 3 ppb in 2009. For the 10-year period, 2000 to 2009, summer composite means remained fairly constant while the winter composite means increased by approximately 23 per cent. The increase in summer and winter ozone composite means appears to be largely related to the reductions in local NO_x emissions and the rising global background ozone concentrations. Potential contributions to the increases in the summer composite means over the long-term may also be related to meteorological factors.

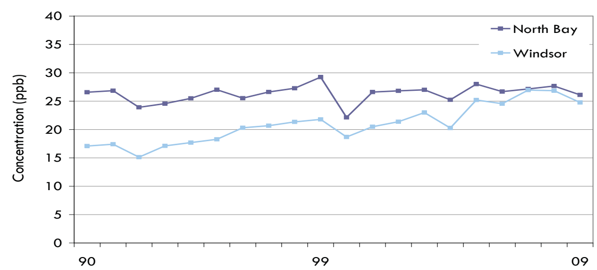
Figure 2.5
Trend of Ozone Seasonal Means at Sites Across Ontario (1980-2009)



Note: Based on data from 19 ozone sites operated over 30 years.
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).

In Figure 2.6, the annual means for ozone are compared for Windsor Downtown, located in southern Ontario, and North Bay, located in northeastern Ontario, from 1990 to 2009. Throughout the 20-year period, the annual ozone mean concentrations at North Bay were fairly constant whereas those reported for the Windsor Downtown site increased 62 per cent during the same period. The increase in the annual ozone mean concentrations at Windsor may be generally attributed to the reduction of NO_x emissions and changeover in vehicle fleet which in turn lessened the effect of NO_x titration in the urban centre. In 1990, the annual ozone mean concentration reported for Windsor was approximately 9 ppb lower than that reported for North Bay. By 2009, the difference in the annual ozone means between the two sites was only 1 ppb.

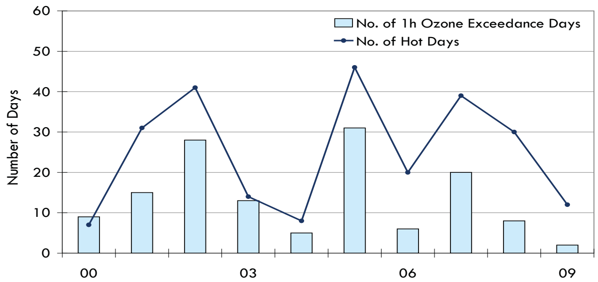
Figure 2.6
Ozone Annual Mean Concentrations at Windsor Downtown and North Bay (1990-2009)



Generally, the number of ozone exceedance days and the number of hot days recorded for each year are highly correlated and suggest a strong relationship between ground-level ozone and temperature. The distribution of ozone exceedance days (at least one hour greater than 80 ppb) and the number of hot days (days with maximum air temperatures greater than 30°C) at Windsor Downtown are shown in Figure 2.7. The high number of ozone exceedance days in 2002, 2005 and 2007 can be largely attributed to the relatively high number of hot days, which is favourable to the formation and transport of ozone, whereas the low number of exceedances days in 2004 and 2009 reflect weather conditions less conducive to the production of ground-level ozone.

Smog-causing pollutants come from many sources including fossil fuels to run our vehicles and produce energy. The easiest ways to reduce our contribution to smog are to reduce our use of gas-powered vehicles and conserve our energy use.

Figure 2.7
Trend of Ozone Exceedance Days and Hot Days at Windsor Downtown (2000-2009)



Notes: An ozone exceedance day has at least one hour > 80 ppb.
A *hot* day records a maximum air temperature greater than 30 degrees C.

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, the CWS for ozone is 65 ppb, eight-hour running average time, based on the 4th highest annual ambient measurement averaged over three consecutive years. Jurisdictions are required to meet the CWS by 2010 and commence reporting to the CCME on the achievement of the CWS for ozone by 2011. In the interim, comprehensive reporting on progress toward meeting the CWS for ozone commenced in 2006.

Table 2.1 displays the calculated CWS ozone metric for designated sites across Ontario from 2005 to 2009. All of the sites exceeded the CWS of 65 ppb for ozone, with the exception of Ottawa and Thunder Bay where their 2009 ozone concentrations, based on the CWS metric, were 65 ppb and 53 ppb, respectively. This is the first time a southern Ontario city, Ottawa, has met the CWS for ozone – another indication that air quality in Ontario has improved recently. The 2009 CWS ozone metrics are generally lower than the metrics reported for previous years.

Table 2.1
CWS Ozone Metric for Designated Sites Across Ontario

City	O_3 CWS Metric 2003 – 2005 (ppb)	O_3 CWS Metric 2004 – 2006 (ppb)	O_3 CWS Metric 2005 – 2007 (ppb)	O_3 CWS Metric 2006 – 2008 (ppb)	O_3 CWS Metric 2007 – 2009 (ppb)
Windsor	82	81	89	85	81
Chatham	n/a	86	86	80	78
London	74	70	73	72	69
Kitchener	79	74	77	74	71
Guelph	79	77	79	75	73
St. Catharines	81	75	81	76	73
Hamilton Downtown	77	72	76	74	71
Hamilton Mountain	82	76	80	76	74
Burlington	75	72	76	74	71
Oakville	81	74	80	77	75
Mississauga	80	75	80	77	66
Brampton	80	75	79	76	74
Toronto	81	75	80	78	76
Oshawa	n/a	77	80	76	74
Barrie	72	69	72	71	70
Peterborough	81	72	73	71	73
Kingston	77	77	89	85	81
Ottawa Downtown	69	67	71	68	65
Sudbury	76	74	77	71	69
Thunder Bay	58	57	57	55	53

Notes:
The CWS for ozone is 65 ppb, eight-hour running average time, based on the 4th highest annual ambient measurement averaged over three consecutive years.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
Red font indicates an exceedance of the CWS.

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, also referred to as respirable particles, is denoted as $PM_{2.5}$ and refers to 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 things 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 $PM_{2.5}$ monitoring network.

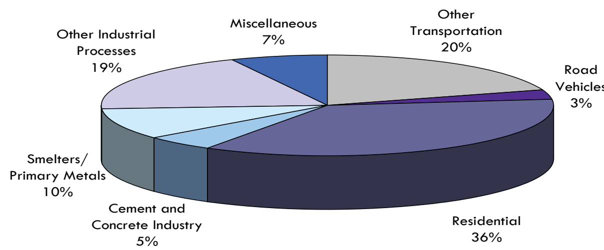
3.1 Characteristics, sources and effects

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 2008 estimates of Ontario's primary $PM_{2.5}$ emissions from point, area and transportation sources. The residential and transportation sectors accounted for 36 per cent and 23 per cent of $PM_{2.5}$ emissions, respectively, whereas industrial processes accounted for 34 per cent.

Significant amounts of $PM_{2.5}$ measured in southern Ontario are of secondary particulate formation 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 to border communities, such as Windsor, Port Stanley located on the northern shore of Lake Erie, Grand Bend and Tiverton located on the eastern shore of Lake Huron, and Parry Sound located on the eastern shore of Georgian Bay.

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector (Emissions from Point/Area/Transportation Sources, 2008 Estimates)



Exposure to $PM_{2.5}$ is associated with several serious health effects, including premature death. People with asthma, cardiovascular or lung disease, as well as children and elderly people, are considered to be the most sensitive to the effects of $PM_{2.5}$. Adverse health effects have been associated with exposure to $PM_{2.5}$ during both short periods such as a single day, and longer periods of a year or more. Fine particulate matter may also be responsible for environmental impacts such as corrosion, soiling, damage to vegetation and reduced visibility.

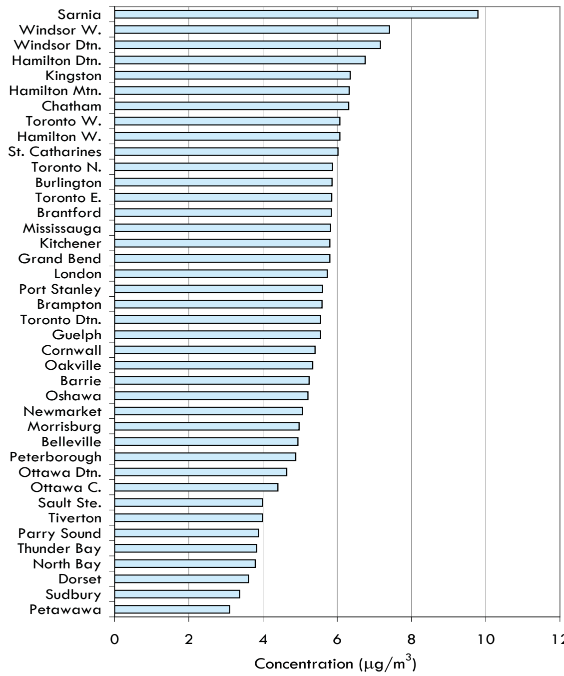
3.2 Monitoring results in 2009

In 2009, each of Ontario's 40 ambient air monitoring sites operated a Tapered Element Oscillating Microbalance (TEOM) instrument at 30°C with a Sample Equilibration System (SES) to measure the $PM_{2.5}$ concentrations on an hourly basis. As shown in Figure 3.2, the 2009 annual mean $PM_{2.5}$ concentrations ranged from 3.1 micrograms per cubic metre ($\mu g/m^3$) in Petawawa to 9.8 $\mu g/m^3$ in Sarnia. The 24-hour maximum $PM_{2.5}$ concentrations measured at urban sites ranged from 13 $\mu g/m^3$ reported in Sudbury to 40 $\mu g/m^3$ at Kingston; and at rural sites ranged from 15 $\mu g/m^3$ at Parry Sound to 43 $\mu g/m^3$ in Grand Bend. The $PM_{2.5}$ reference level of 30 $\mu g/m^3$ for a 24-hour period was exceeded at 22 of the 40 sites in 2009. Kingston and Cornwall recorded two days, the highest number of days in Ontario, with 24-hour $PM_{2.5}$ concentrations greater than 30 $\mu g/m^3$.

Spare the Air Tip!

When possible, use public transportation instead of your car. You could also walk or ride your bicycle, as long as smog levels are not too high.

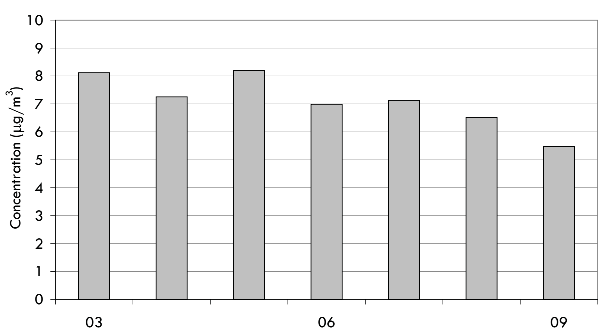
Figure 3.2
Annual Mean $PM_{2.5}$ Concentrations Across Ontario (2009)



3.3 Trends

The $PM_{2.5}$ annual composite mean during 2009 was 5.5 $\mu g/m^3$, which is a decrease of 1 $\mu g/m^3$ when compared to 2008. Since 2003, there has been a 27 per cent decrease in composite annual means as shown in Figure 3.3. The slight increase in the 2005 annual composite mean is related to the high incidence of smog episodes experienced in the 2005 smog season which resulted in the issuance of 15 smog advisories covering 53 days.

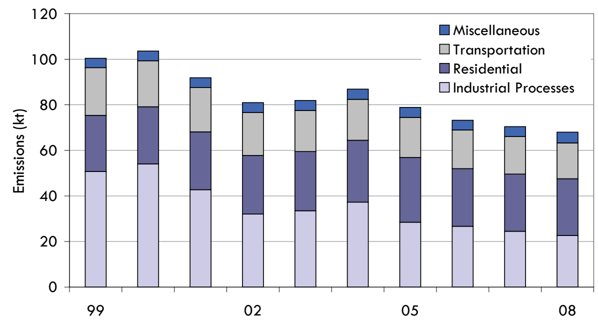
Figure 3.3
Provincial Annual Composite Mean $PM_{2.5}$ Concentrations (2003-2009)



Note: Data are based on 36 ambient $PM_{2.5}$ sites operated over seven years.

Overall, provincial $PM_{2.5}$ emissions have decreased approximately 32 per cent from 1999 to 2008, as shown in Figure 3.4. Fine particulate matter emissions from industrial processes have been reduced by over 50 per cent over the 10-year period from 1999 to 2008. Emissions from the transportation sector show a gradual decrease with the phase-in of new vehicles/ engines having more stringent emission standards over the same period.

Figure 3.4
Ontario $PM_{2.5}$ Emission Trend (1999-2008)



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 Guidance Document on Achievement Determination, 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. Jurisdictions are required to meet the CWS by 2010 and commence reporting to the CCME by year 2011. In the interim, comprehensive reporting on progress toward meeting the CWS for $PM_{2.5}$ commenced in 2006.

Table 3.1 displays the calculated CWS $PM_{2.5}$ metric for designated CWS sites across Ontario from 2005 to 2009. The 2009 CWS $PM_{2.5}$ metrics are markedly lower than the metrics reported in 2005. On average there has been an approximate 30 per cent decrease in the $PM_{2.5}$ CWS metrics over the five-year period. The 2009 concentrations, based on the CWS metric for $PM_{2.5}$, ranged from 14 $\mu g/m^3$ in Thunder Bay to 25 $\mu g/m^3$ in Hamilton Downtown. The CWS target of 30 $\mu g/m^3$ was not exceeded at any of the CWS designated sites.

$PM_{2.5}$ is approximately 30 times smaller than the average diameter of a human hair.

Table 3.1
CWS $PM_{2.5}$ Metric for Designated Sites Across Ontario

City	$PM_{2.5}$ CWS Metric 2003 – 2005 ($\mu g/m^3$)	$PM_{2.5}$ CWS Metric 2004 – 2006 ($\mu g/m^3$)	$PM_{2.5}$ CWS Metric 2005 – 2007 ($\mu g/m^3$)	$PM_{2.5}$ CWS Metric 2006 – 2008 ($\mu g/m^3$)	$PM_{2.5}$ CWS Metric 2007 – 2009 ($\mu g/m^3$)
Windsor	31	29	29	25	23
Chatham	n/a	28	28	25	23
London	30	28	26	23	22
Kitchener	34	30	29	25	22
Guelph	34	30	28	24	21
St. Catharines	29	30	31	27	23
Hamilton Downtown	34	32	32	29	25
Hamilton Mountain	32	31	29	26	23
Burlington	30	29	28	25	22
Oakville	34	30	28	24	21
Mississauga	34	32	29	27	19
Brampton	31	29	28	24	22
Toronto	33	31	30	25	22
Oshawa	n/a	29	29	25	21
Barrie	30	29	28	24	21
Peterborough	28	29	28	23	20
Kingston	n/a	n/a	30	28	24
Ottawa Downtown	30	26	25	20	17
Sudbury	n/a	20	21	18	16
Thunder Bay	n/a	n/a	16	15	14

Notes:
The CWS for $PM_{2.5}$ is 30 $\mu g/m^3$, 24-hour running average time, based on the 98^{th} annual ambient measurement averaged over three consecutive years.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
Red font indicates an exceedance of the CWS.

Spare the Air Tip!

Don't use oil-based products such as paints, solvents or cleaners if you can avoid them. They contain volatile organic compounds (VOCs), which contribute to smog.

How can I protect my kids?

- If a smog advisory is issued in your community:
- Reduce outdoor activity levels by choosing less vigorous activities when smog levels are high.
- Avoid or reduce exercising near areas of heavy traffic because motor vehicles are a primary source of air pollution.

4.0 Other Air Pollutants

Characteristics, sources and effects of NO_2, CO and SO_2 are discussed in this chapter, as well as their ambient concentrations during 2009 and, where appropriate, trends, including emissions, over time.

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, utilities and other industrial processes. 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.

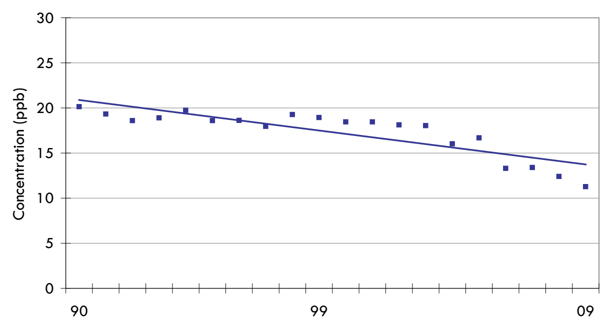
4.1.2 Monitoring results for 2009

The Toronto West site, located in an area of Toronto influenced by significant vehicular traffic, recorded the highest annual mean (19.0 ppb) for NO_2 during 2009, whereas Tiverton, a rural site, recorded the lowest NO_2 annual mean (2.3 ppb). Typically, the highest NO_2 means are recorded in large urbanized areas, such as the Golden Horseshoe area of southern Ontario which includes the GTA. The Toronto North air monitoring station recorded the highest 24-hour average concentration (46 ppb), and the Toronto East site, located within 20 metres of a major roadway, recorded the highest one-hour concentration (79 ppb) in 2009. 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 2009.

4.1.3 Trends

The composite annual means for NO_2 concentrations decreased 42 per cent from 1975 to 2009. As shown in Figure 4.1, average NO_2 concentrations decreased by approximately 34 per cent over the 20-year period of 1990 to 2009, and 40 per cent over the last decade, 2000 to 2009.

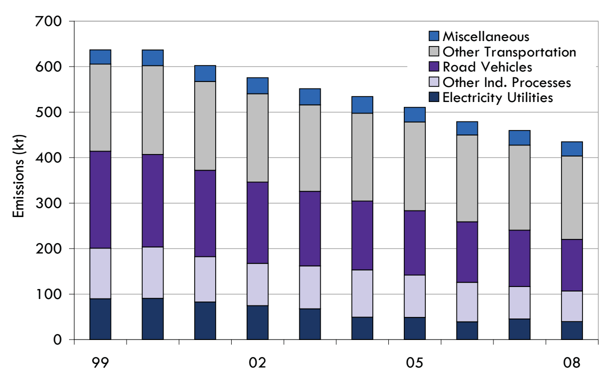
Figure 4.1
Trend of Nitrogen Dioxide Annual Means in Ontario (1990-2009)



Note: Annual composite mean based on 15 ambient sites operated over 20 years.

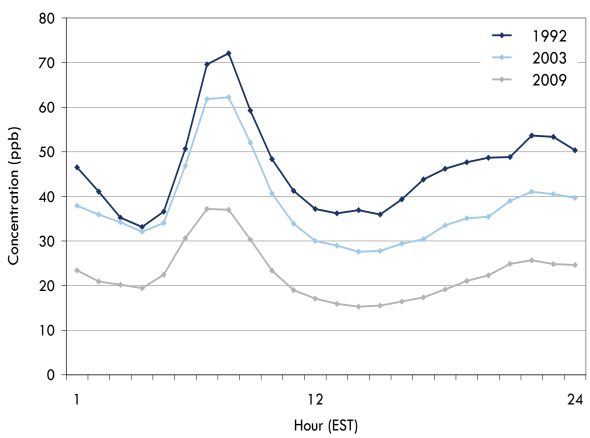
Figure 4.2 displays the NO_x emission trend from 1999 to 2008. Overall, NO_x emissions have decreased approximately 32 per cent from 1999 to 2008. Ontario's emissions trading regulations on sulphur dioxide and nitrogen oxides (O. Reg. 397/01 and O. Reg. 194/05) have contributed to the reduction in nitrogen 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 "Drive Clean" vehicle test program in southern Ontario in 1999 also helped to further reduce the NO_x emissions from light duty gasoline vehicles.

Figure 4.2
Ontario Nitrogen Oxides Emission Trend (1999-2008)



The diurnal air quality trends of NO_x at the Toronto East station are shown for years 1992, 2003 and 2009 in Figure 4.3. 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 10 a.m.) when surface inversions typically occur with light winds which cause less dispersion and local build-up of pollutants. Overall, the diurnal trends show a considerable decrease in NO_x concentrations measured in 2009 when compared to previous years. The reduction in NO_x emissions over time are due to a cleaner vehicle fleet, and in part to Ontario's Drive Clean program. A decrease of 35 ppb has occurred at the 8 a.m. NO_x concentration between 1992 and 2009.

Figure 4.3
Diurnal Trend of NO_x at Toronto East (1992, 2003, 2009)

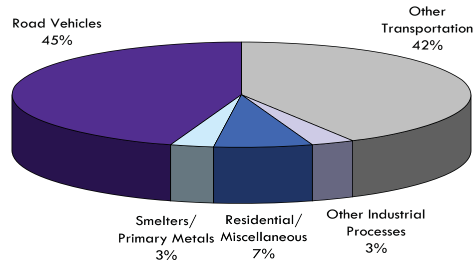


4.2 CARBON MONOXIDE

4.2.1 Characteristics, sources and effects

Carbon monoxide is colourless, odourless, tasteless, and at high concentrations, a 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.

Figure 4.4
Ontario Carbon Monoxide Emissions by Sector (Emissions from Point/Area/Transportation Sources, 2008 Estimates)



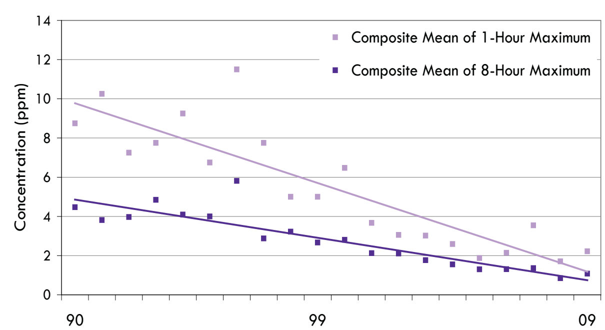
4.2.2 Monitoring results for 2009

In 2009, the highest one-hour maximum CO value, 5.02 parts per million (ppm) and the highest eight-hour maximum CO value, 1.79 ppm, were both measured at the Hamilton 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) ambient air quality criteria for CO have not been exceeded at any of the monitoring sites in Ontario since 1991.

4.2.3 Trends

The trends in provincial composite mean of one-hour and eight-hour maximum CO concentrations have decreased 93 per cent and 99 per cent, respectively, from 1971 to 2009. Ambient CO concentrations, as measured by the composite mean of the one-hour and eight-hour maximums, decreased by approximately 89 per cent and 85 per cent, respectively, over the 20-year period of 1990 to 2009, as shown in Figure 4.5. Over the last decade, there has been a decrease in

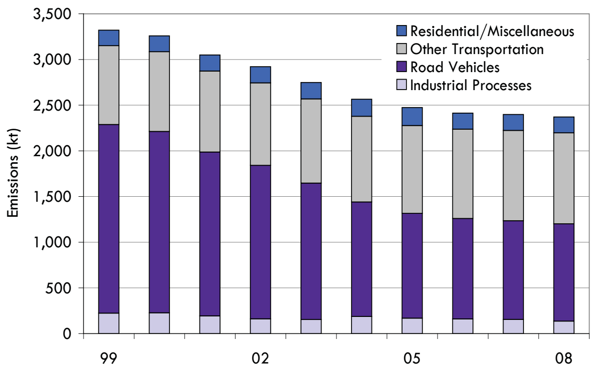
Figure 4.5
Trends of Carbon Monoxide One-Hour and Eight-Hour Maximums in Ontario (1990-2009)



Note: Data are based on four ambient CO sites operated over 20 years.
Ontario's 1-hour AAQC = 30 ppm.
Ontario's 8-hour AAQC = 13 ppm.

the composite mean of the one-hour and eight-hour maximums of approximately 64 per cent and 67 per cent, respectively, while CO emissions, as shown in Figure 4.6, have been reduced by approximately 29 per cent from 1999 to 2008.

Figure 4.6
Ontario Carbon Monoxide Emission Trend (1999-2008)



4.3 SULPHUR DIOXIDE

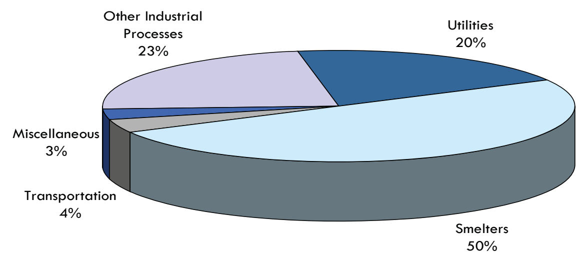
4.3.1 Characteristics, sources and effects

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

Electric utilities and smelters are the major contributors to SO_2 emissions in Ontario accounting for approximately 70 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 23 per cent. The transportation sector and miscellaneous sources accounted for the remaining 7 per cent of all SO_2 emissions.

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 also 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 microscopic particles, which have serious health implications and contribute to climate change.

Figure 4.7
Ontario Sulphur Dioxide Emissions by Sector (Emissions from Point/Area/Transportation Sources, 2008 Estimates)



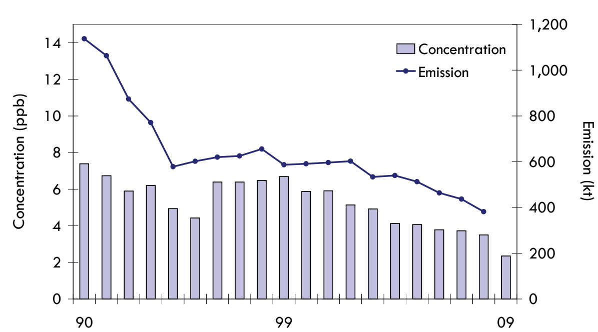
4.3.2 Monitoring results for 2009

Sarnia recorded the highest annual mean (4.5 ppb), one-hour maximum concentration (189 ppb) and 24-hour maximum concentration (39 ppb) of SO_2 during 2009. 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 AQI sites in 2009. Overall, the SO_2 concentrations measured in 2009 were markedly lower when compared to SO_2 concentrations recorded in 2008.

4.3.3 Trends

Since 1971, the composite annual mean for SO_2 in 2009 has decreased by 93 per cent and correspondingly, the provincial SO_2 emissions in 2008 have been reduced by approximately 89 per cent. Figure 4.8 shows the measured composite annual means for ambient SO_2 concentrations from 1990 to 2009 and the SO_2 emissions from 1990 to 2008.

Figure 4.8
Ontario Sulphur Dioxide Annual Mean Concentrations and Emissions Trend (1990-2009)



Note: Emission inventories for 2009 are not available at this time.
Annual composite mean based on 8 ambient sites operated over 20 years.

Sulphur dioxide concentrations have decreased by approximately 50 per cent over the 20-year period, while SO_2 emissions have been reduced by 66 per cent from 1990 to 2008. Over the last decade, 2000 to 2009, there has been a decrease of approximately 54 per cent in SO_2 concentrations, while SO_2 emissions have been reduced by approximately 35 per cent from 1999 to 2008. The reduction of SO_2 emissions over the years is the result of various initiatives which include but are not limited to,

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

Saving Energy at Home: Did you know...?

- A 15-watt energy-saving compact fluorescent light bulb produces about the same amount of light as a 60-watt incandescent bulb.
- An average 15-year old refrigerator consumes more than twice as much energy (1067 kWh) as a modern Energy Star certified model (426 kWh) each year.
- An average Energy Star qualified front-loading washing machine consumes less than a third the energy (275 kWh per year) of an average top-loading washing machine (876 kWh per year).

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. 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 now issued.

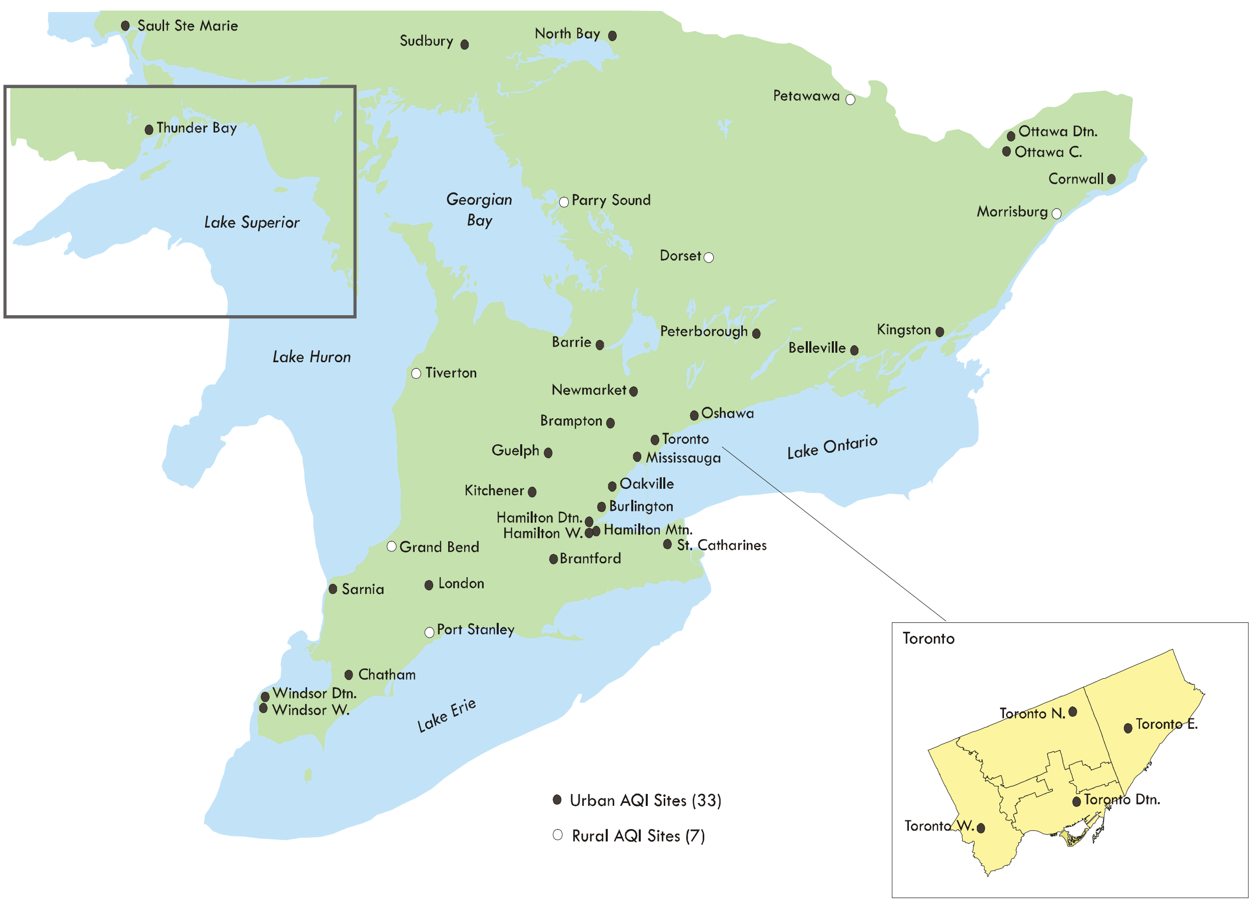
5.1 Air Quality Indices

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2009, 40 of these sites formed the basis of the AQI network. The Air Quality Office of the Environmental Monitoring and Reporting Branch continuously obtains data for criteria air pollutants from these 40 sites.

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. The pollutants are ozone, fine particulate matter, nitrogen dioxide, carbon monoxide, sulphur dioxide, and total reduced sulphur 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

Figure 5.1
Air Quality Index (AQI) Monitoring Sites in Ontario (2009)



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. The public can access the index values by calling the ministry's air quality information Integrated Voice Response (IVR). (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.) The AQI values can also be obtained from the ministry's website at www.airqualityontario.com. Air quality forecasts, based on regional meteorological conditions and current pollution levels in Ontario and bordering U.S. states, are also provided daily on this website.

Table 5.2 shows the percentage distribution of hourly AQI readings for the 40 monitoring sites by the AQI descriptive category and the number of days with at least one hour AQI value greater than 49. Air quality in the very good and good categories ranged from approximately 86 per cent at Sarnia to 99 per cent at Thunder Bay. On average, the AQI sites in 2009 reported air quality in the very good and good categories approximately 96 per cent of the time and moderate to poor categories about 4 per cent of the time. The year 2009 was a relatively clean year when compared to the two previous years. On average, the percentage of time when air quality indices were in the good and very good categories in 2007 and 2008 was 90 and 92 per cent, respectively. The number of days that Sarnia recorded at least one hour of air quality in the poor category was only two; however there were 28 and 15 days in 2007 and 2008, respectively. This improvement was due in part to the wetter/cooler weather experienced during 2009, and also to reduced air emissions in Ontario and the neighbouring U.S.

Spare the Air Tips!

- Look for alternatives to gas-powered machines and vehicles. Try a rowboat or sailboat instead of a motorboat or a push-type lawnmower instead of one that runs on gasoline.
- Consider fuel efficiency when you buy a vehicle. Keep all vehicles well maintained and tires properly inflated.
- Reduce energy use in your home. Learn more about alternative energy resources.
- Do not burn leaves, branches or other yard wastes.

Table 5.1
Air Quality Index Pollutants and Their Impacts*

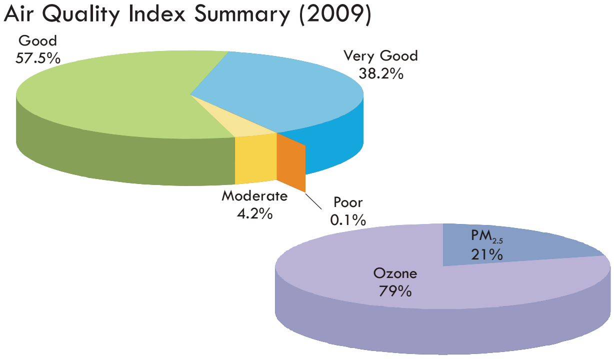
Index	Category	Ozone (O_3)	Fine Particulate Matter ($PM_{2.5}$)	Nitrogen Dioxide (NO_2)	Carbon Monoxide (CO)	Sulphur Dioxide (SO_2)	Total Reduced Sulphur (TRS) Compounds
0-15	Very Good	No health effects are expected in healthy people	Sensitive populations may want to exercise caution	No health effects 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

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

City/Town	Valid Hours	Percentage of Valid Hours AQI in Range					No. of Days at Least 1h > 49
		Very Good 0-15	Good 16-31	Moderate 32-49	Poor 50-99	Very Poor 100+	
Windsor Downtown	8758	40.2	53.1	6.5	0.1	0	3
Windsor West	8748	37.4	55.7	6.8	0.1	0	2
Chatham	8735	31.7	61.5	6.7	<0.1	0	1
Port Stanley	8725	26.4	66.7	6.7	0.2	0	4
London	8757	41.4	54.6	4.0	<0.1	0	2
Sarnia	8683	25.5	67.2	7.3	<0.1	0	2
Grand Bend	8687	27.8	66.7	5.4	0.2	0	2
Tiverton	8697	23.6	71.5	4.9	0.1	0	2
Brantford	8747	37.1	57.4	5.5	<0.1	0	2
Kitchener	8716	35.6	58.9	5.4	<0.1	0	1
Guelph	8753	34.2	60.6	5.2	0.1	0	1
St. Catharines	8745	38.1	57.9	3.9	0	0	0
Hamilton Mountain	8754	34.5	59.6	5.9	0.1	0	2
Hamilton West	8683	48.2	48.9	3.0	0	0	0
Hamilton Downtown	8745	41.0	54.4	4.6	<0.1	0	1
Burlington	8755	41.8	54.6	3.6	<0.1	0	1
Oakville	8754	40.5	55.0	4.4	0.1	0	2
Mississauga	8746	41.3	55.2	3.4	0.1	0	2
Brampton	8759	38.9	56.7	4.3	0.1	0	2
Toronto West	8731	55.2	41.5	3.2	0.1	0	2
Toronto Downtown	8745	43.9	52.5	3.5	<0.1	0	1
Toronto North	8753	47.4	50.2	2.3	0.1	0	2
Toronto East	8748	49.2	47.5	3.3	<0.1	0	3
Oshawa	8741	42.2	55.2	2.5	<0.1	0	2
Newmarket	8737	32.2	62.5	5.2	0.1	0	3
Barrie	8754	41.7	55.4	2.9	<0.1	0	1
Peterborough	8750	34.3	62.1	3.5	0.1	0	1
Belleville	8750	34.6	60.9	4.5	<0.1	0	1
Kingston	8543	27.0	67.2	5.7	0.1	0	2
Morrisburg	8728	38.9	57.9	3.2	<0.1	0	1
Cornwall	8748	38.1	57.7	4.1	0.1	0	2
Ottawa Central	8657	43.0	54.6	2.3	0.1	0	1
Ottawa Downtown	8752	47.4	50.6	2.0	0.1	0	1
Petawawa	8746	37.7	59.0	3.4	0	0	0
Dorset	8750	36.8	59.1	4.0	<0.1	0	1
Parry Sound	8758	29.4	65.9	4.5	0.2	0	2
North Bay	8747	41.0	55.3	3.7	<0.1	0	1
Sudbury	8751	40.9	56.4	2.6	0.1	0	1
Sault Ste. Marie	8740	36.3	59.8	3.9	<0.1	0	1
Thunder Bay	8690	44.7	54.0	1.3	0	0	0

Figure 5.2

Air Quality Index Summary (2009)



Note: *Very Poor* air quality was not reported at any of the AQI sites in 2009.

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 2009. 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 79 per cent of the poor AQI values were due to ozone, and the remaining 21 per cent were due to fine particulate matter.

5.2 Smog Advisories

Smog advisories are issued to the public, under the Smog Alert program, when AQI values are forecast 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 without warning and weather conditions conducive to elevated smog levels are expected to continue for several hours, a smog advisory is issued, effective immediately.

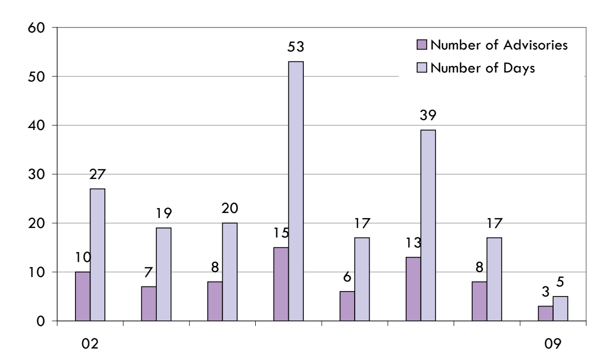
Smog advisories are available to the public and media via www.airqualityontario.com, direct e-mails of smog alerts to everyone who subscribes to the ministry's Smog Alert network at the above website. Updated air quality information can also be obtained by dialing 1-800-387-7768 for English and 1-800-221-8852 for French.

5.2.1 2009 Smog Advisories

For 2009, Ontarians experienced only 3 smog advisories covering just 5 days, all of which occurred during the traditional smog season (May 1 to September 30 inclusive).

In fact, the year 2009 had the lowest number of smog advisories and smog advisory days on record since $PM_{2.5}$ was included in the Smog Alert program in 2002. This is in marked contrast to the high number of smog advisories and smog advisory days in 2005 (15 smog advisories covering 53 days) and 2007 (13 smog advisories covering 39 days). A history of smog advisories and smog advisory days since 2002 is shown in Figure 5.3.

Figure 5.3
Summary of Smog Advisories Issued (2002-2009)



www.airqualityontario.com

5.2.2 Co-operative activities with Lake Michigan Air Director's Consortium (LADCO) and Quebec

Since 2000, from May to September, the traditional smog season, air quality and meteorological discussions between Michigan and Ontario meteorologists are held at least twice per week. Although ozone action days in Michigan and smog advisories in Ontario are not linked to the same air quality standards, the weather conditions conducive to high levels of smog are often common to both airsheds, particularly in the Detroit-Windsor area. This arrangement was expanded in 2004 to also include year round discussions under LADCO on the issuance and harmonizing of smog advisories and ozone action days during the summer, as well as year-round PM2.5 forecasting for the Great Lakes transboundary area.

The issuance of smog advisories in Ontario under the Smog Alert program and in Quebec under their Info-Smog program is also harmonized through discussions when required between Ontario meteorologists and the Meteorological Services of Canada, Quebec Region meteorologists for border regions such as Ottawa, Ontario and Gatineau, Quebec in the National Capital Region.

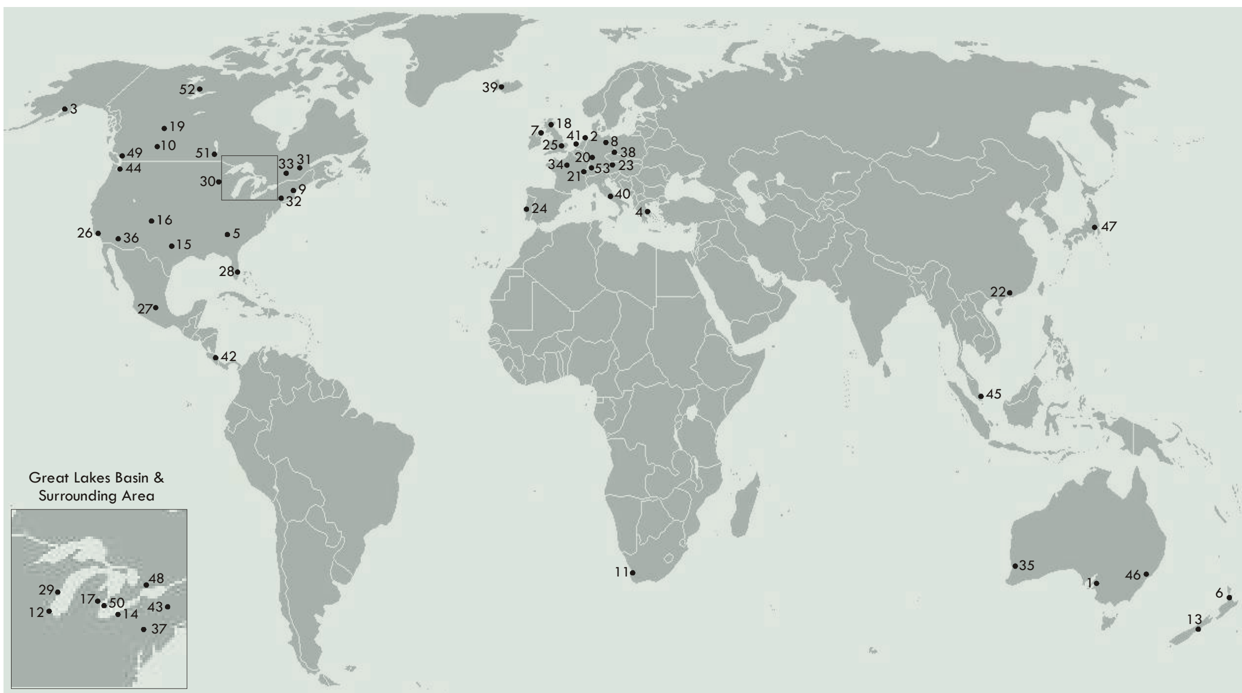

A clean day in Toronto


A smoggy day in Toronto

6.0 International Perspective

Air pollutant concentrations from selected Ontario cities have been compared to the information available in other cities around the world. The cities included in this comparative study are depicted in Figure 6.1. City populations, a factor in ambient pollution levels, ranged from approximately 19,000 (Yellowknife, Canada) to 18,200,000 (Mexico City, Mexico). Monitoring methods and siting criteria may vary from country to country; therefore, comparisons among cities are not intended to be used as a comprehensive ranking. Furthermore, air quality standards for the chosen criteria pollutants may vary from country to country. Pollutant concentrations are referenced to Ontario's AAQC, the national ambient air quality standards (NAAQS) for the United States, and the guidelines used by the World Health Organization (WHO).

Figure 6.1
Selected Cities Around the World Used for 2009 Air Quality Comparison



1. Adelaide, AUS; 2. Amsterdam, NED; 3. Anchorage, USA; 4. Athens, GRE; 5. Atlanta, USA; 6. Auckland, NZL; 7. Belfast, IRL; 8. Berlin, GER; 9. Boston, USA; 10. Calgary, CAN; 11. Cape Town, ZAF; 12. Chicago, USA; 13. Christchurch, NZL; 14. Cleveland, USA; 15. Dallas, USA; 16. Denver, USA; 17. Detroit, USA; 18. Edinburgh, GBR; 19. Edmonton, CAN; 20. Frankfurt, GER; 21. Geneva, SUI; 22. Hong Kong, CHN; 23. Linz, AUT; 24. Lisbon, PRT; 25. London, GBR; 26. Los Angeles, USA; 27. Mexico City, MEX; 28. Miami, USA; 29. Milwaukee, USA; 30. Minneapolis-St. Paul, USA; 31. Montreal, CAN; 32. New York, USA; 33. Ottawa, CAN; 34. Paris, FRA; 35. Perth, AUS; 36. Phoenix, USA; 37. Pittsburgh, USA; 38. Prague, CZE; 39. Reykjavik, ISL; 40. Rome, ITA; 41. Rotterdam, NED; 42. San José; CRI; 43. Scranton, USA; 44. Seattle, USA; 45. Singapore, SIN; 46. Sydney, AUS; 47. Tokyo, JPN; 48. Toronto, CAN; 49. Vancouver, CAN; 50. Windsor, CAN; 51. Winnipeg, CAN; 52. Yellowknife, CAN; 53. Zurich, SUI.

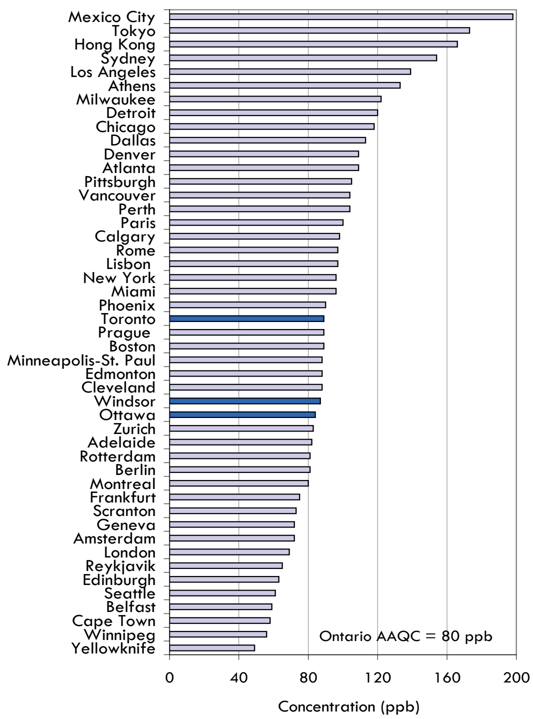
On the Road: Did you know...?

- One poorly tuned vehicle can emit as much pollution as 20 properly tuned cars.
- The average total cost of driving one kilometre in Canada is 46 cents per person. On public transit, this cost drops to 12 cents.
- A well-maintained car runs better and pollutes less. Shut the engine off, even for short stops. One minute of idling uses more fuel than restarting your engine.
- Speeding is not only illegal, it also increases your car's fuel consumption. At 120 km/h, your fuel consumption could be as much as 20 per cent higher than 100 km/h.

6.1 Ozone

Figure 6.2 displays the ozone one-hour maximum concentrations in 2009 for 47 cities around the world. Mexico City recorded the highest ozone one-hour maximum of 198 ppb, followed by Tokyo and Hong Kong of 173 ppb and 166 ppb, respectively. Yellowknife, in Canada, reported the lowest ozone one-hour maximum at 49 ppb. Most cities, 34 in all, exceeded Ontario's one-hour AAQC of 80 ppb, including Toronto, Windsor and Ottawa which reported ozone one-hour maximums of 89 ppb, 87 ppb and 84 ppb, respectively.

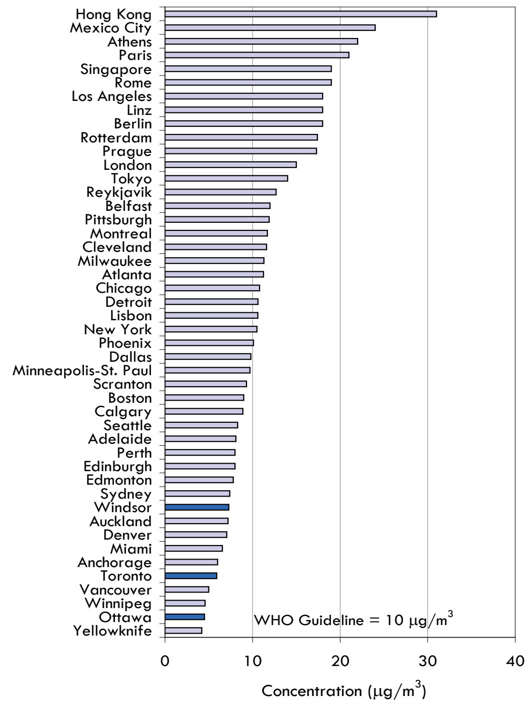
Figure 6.2
Ozone One-Hour Maximum Concentrations for Selected Cities World-wide (2009)



6.2 $PM_{2.5}$

Figure 6.3 displays the $PM_{2.5}$ annual means in 2009 for 46 cities around the world. The $PM_{2.5}$ annual means are based on both continuous and non-continuous measurements. Hong Kong reported the highest annual mean $PM_{2.5}$ concentration (31 $\mu g/m^3$) for 2009 and Yellowknife recorded the lowest annual mean $PM_{2.5}$ concentration of 4.2 $\mu g/m^3$. Of the 46 selected cities world-wide, 25 exceeded the WHO guideline of 10 $\mu g/m^3$. The Ontario cities, Windsor, Toronto, Ottawa, all recorded annual means below the WHO guideline.

Figure 6.3
$PM_{2.5}$ Annual Means for Selected Cities World-wide (2009)



6.3 NO_2

Figure 6.4 displays the NO_2 annual mean concentrations in 2009 for 51 cities world-wide. Mexico City reported the highest NO_2 annual mean of 30 ppb. Seven sites, including Mexico City, exceeded the WHO guideline of 21 ppb. Toronto, Windsor and Ottawa reported NO_2 annual means of 17 ppb, 14 ppb and 8 ppb, respectively. Yellowknife recorded the lowest NO_2 annual mean of 2 ppb. Large urban centres typically experience higher NO_2 levels due to increased energy-related and motor vehicle emissions.

6.4 CO

Figure 6.5 displays the one-hour maximum CO concentrations in 2009 for 44 cities world-wide. Cleveland reported the highest CO one-hour maximum of 19 ppm. Adelaide recorded the lowest CO maximum at 1 ppm. Toronto, Windsor and Ottawa all reported one-hour maximum CO values below 2 ppm. There were no exceedances of the one-hour Ontario AAQC or the U.S. NAAQS at any of the cities examined in 2009.

Figure 6.4
Nitrogen Dioxide Annual Means for Selected Cities World-wide (2009)

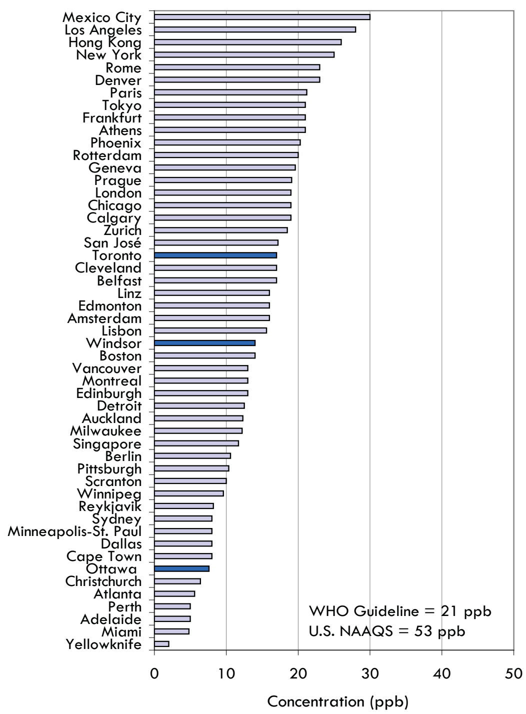
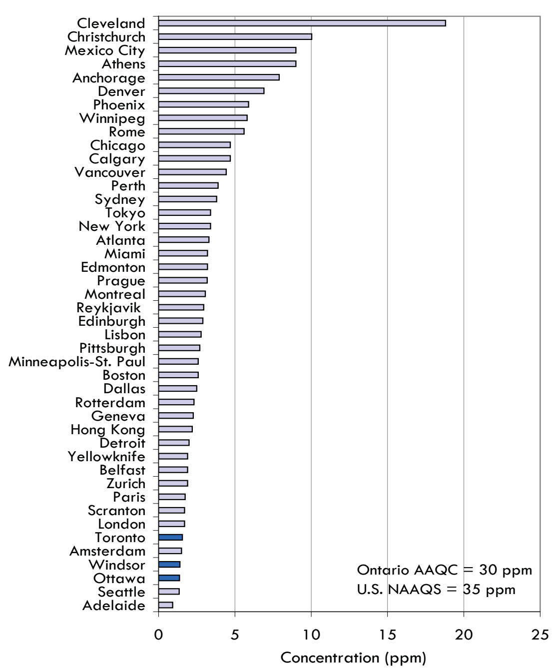


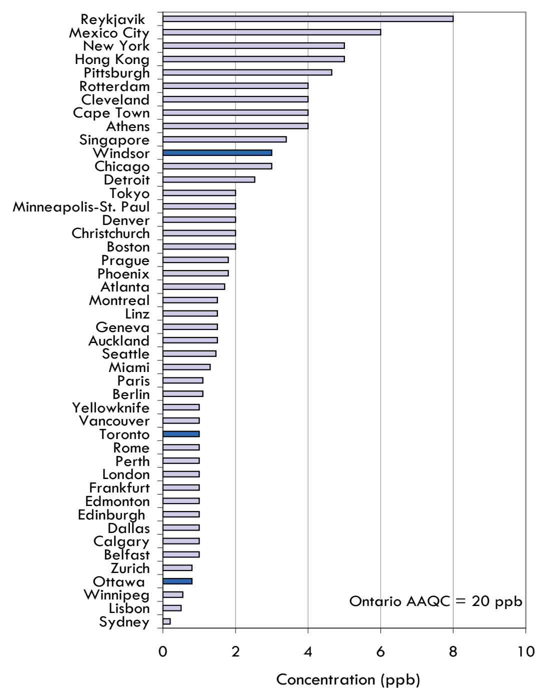
Figure 6.5
Carbon Monoxide One-Hour Maximum Concentrations for Selected Cities World-wide (2009)



6.5 SO_2

Figure 6.6 displays the SO_2 annual mean concentrations in 2009 for 46 cities world-wide. Reykjavik reported the highest annual mean (8 ppb) whereas Sydney recorded the lowest SO_2 annual mean (0.2 ppb). The Ontario cities included here, Windsor, Toronto and Ottawa, reported annual mean levels of 3 ppb, 1ppb and 0.8 ppb, respectively. All reported cities were below the Ontario annual AAQC of 20 ppb.

Figure 6.6
Sulphur Dioxide Annual Means for Selected Cities World-wide (2009)




Port Stanley AQI site

Glossary

acidic deposition - wet and dry deposition of a variety of airborne acidic pollutants (acids or acid-forming substances such as sulphates and nitrates) on biota or land or in waters of the Earth's surface.

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.

airshed - a geographical region of influence or spatial extent of the air pollution burden.

ambient air - outdoor or open air.

carbon monoxide - a colourless, odourless, tasteless and at high concentrations, a 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).

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 reactive hydrocarbons 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.

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.

photochemical reaction - chemical reaction influenced or initiated by light, particularly ultraviolet light.

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, 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.

smog episode day - a day with widespread and persistent ozone levels greater than the Ontario one-hour AAQC of 80 ppb and/or a day with widespread and persistent $PM_{2.5}$ levels greater than the three-hour average of 45 $\mu g/m^3$.

stratosphere - atmosphere 10 to 40 kilometres above the Earth's surface.

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.

toxic deposition - deposition of an airborne toxic pollutant at ground, vegetative or surface levels.

toxic pollutant - substance that can cause cancer, genetic mutations, organ damage, changes to the nervous system, or even physiological harm as a result of prolonged exposure, even to relatively small amounts.

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
COPD	- Chronic obstructive pulmonary disease
CWS	- Canada-wide Standard
GTA	- Greater Toronto Area
IVR	- Integrated Voice Response
LADCO	- Lake Michigan Air Director's Consortium
MOE	- Ministry of the Environment
NAAQS	- National Ambient Air Quality Standard (U.S.)
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
WHO	- World Health Organization
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

References

1. Brook, J.R., Dann, T. and R.T. Burnett. 1997: *The Relationship among TSP, PM_{10}, $PM_{2.5}$ and Inorganic Constituents of Atmospheric Particulate Matter at Multiple Canadian Locations*. Journal of Air and Waste Management Association, Vol 46, pp. 2-18.
2. Burnett, R.T., Dales, R.E., Krewski, D., Vincent, R., Dann, T., and J.R. Brook. 1995: *Associations between Ambient Particulate Sulphate and Admissions to Ontario Hospitals for Cardiac and Respiratory Diseases*. American Journal of Epidemiology, Vol 142, pp. 15-22.
3. Canadian Council of Ministers of the Environment, 2002. *Guidance Document on Achievement Determination: Canada-Wide Standards for Particulate Matter and Ozone*.
4. Environment Ontario. 2010. *Air Quality in Ontario 2008 - A Concise Report on the State of Air Quality in the Province of Ontario*.
5. Fraser, D., Yap, D., Fudge, D., Misra, P.K. and P. Kiely. 1995. *A Preliminary Analysis of Recent Trends in Ground-Level Ozone Concentrations in Southern Ontario*. Presented at the 88th Air and Waste Management Association Annual Conference, San Antonio, Texas, June 1995.
6. Fraser, D., Yap, D., Kiely, P. and D. Mignacca. 1991. *Analysis of Persistent Ozone Episodes in Southern Ontario 1980-1991*. Technology Transfer Conference, Toronto, 1991. Proceedings AP14, pp. 222-227.
7. Lin, C.C.-Y., Jacob, D.J., Munger, J.W., and A.M. Fiore. 2000. *Increasing Background Ozone in Surface Air Over the United States*. Geophysical Research Letters, Vol. 27 (21), pp. 3465-3468.
8. Lioy, P. et al., 1991. *Assessing Human Exposure to Airborne Pollutants*. Environmental Science and Technology, Vol. 25, pp. 1360.
9. Lipfert, F.W. and T. Hammerstrom. 1992. *Temporal Patterns in Air Pollution and Hospital Admissions*. Environmental Research, Vol. 59, pp. 374-399.
10. Lippmann, M. 1991. *Health Effects of Tropospheric Ozone. Environmental Science and Technology*, Vol. 25, No. 12, pp. 1954-1962.
11. Pengelly, L.D., Silverman, F. and C.H. Goldsmith. 1992. *Health Effects of Air Pollution Assessed Using Ontario Health Survey Data*. Urban Air Group, McMaster University.
12. *Rethinking the Ozone Problem in Urban and Regional Air Pollution*. National Academy Press, Washington, D.C., 1991.
13. United States Environmental Protection Agency. 2003. *Latest Findings on National Air Quality, 2002 Status and Trends*.
14. United States Environmental Protection Agency. 2003. *National Air Quality and Emission Trends, 2003 Special Studies Edition*.
15. United States Environmental Protection Agency. 2004. *Particle Pollution Report, Current Understanding of Air Quality and Emissions through 2003*.
16. Wolff, G.T., Kelley, N.A. and M.A. Ferman. 1982. *Source Regions of Summertime Ozone and Haze Episodes in the Eastern U.S. Water, Air and Soil Pollution*, 18: pp. 65-81.
17. Written communication with Dr. A. Adamopoulos, Ministry for the Environment, Athens, Greece, 2010.
18. Written communication with J. Aldredge, Department of Natural Resources, Atlanta, United States of America, 2010.
19. Written communication D. Ambrose, Ohio Environmental Protection Agency, Cleveland, United States of America, 2010.
20. Written communication with J. Almonte, Manitoba Conservation, Winnipeg, Canada, 2010.
21. Written communication with K. Aguilar, Environmental Quality Management Direction, San José, Costa Rica, 2010.
22. Written communication with A. Bolignano, Regional Centre of Air Quality, Rome, Italy, 2010.
23. Written communication with D. Boulet, City of Montréal, Montréal, Canada, 2010.
24. Written communication with C. F. Chow, Environmental Protection Department, Hong Kong, China, 2010.
25. Written communication with D. Dinsmore, Department of Natural Resources, Milwaukee, United States of America, 2010.
26. Written communication with C. Ebube, Florida Department of Environmental Protection, Florida, Miami, United States of America, 2010.
27. Written communication with R. Finnbjörnsdóttir, The Environment Agency of Iceland, Reykjavík, Iceland, 2010.
28. Written communication with I. Gildenhuys, City of Cape Town, Cape Town, South Africa, 2010.
29. Written communication with A. Grieco, Department of Environment and Conservation, Perth, Australia, 2010.
30. Written communication with W. Hager, Municipality of Linz, Linz, Austria, 2010.

31. Written communication with M. Heindorf, Department of Natural Resources and Environment, Detroit, United States of America, 2010.
32. Written communication with A. Holmes, Department of Environment, Climate and Waste Division, Belfast, Ireland, 2010.
33. Written communication with T. Imai, Environmental Protection Division, Tokyo, Japan, 2010.
34. Written communication with A. Kettschau, Senate Department for Urban Development, Berlin, Germany, 2010.
35. Written communication with B. Kotasek, Colorado Department of Public Health and Environment, Denver, United States of America, 2010.
36. Written communication with B. Lambet, Texas Commission on Environmental Quality, Dallas, United States of America, 2010.
37. Written communication with Dr. B. Lazzarotto, Geneva Atmospheric Pollution Observatory Network, Geneva, Switzerland, 2010.
38. Written communication with A. Loader, AEA, Oxfordshire, Great Britain, 2010.
39. Written communication with J. Maranche, Allegheny County Health Department, Pittsburgh, United States of America, 2010.
40. Written communication with M. McAuliffe, Pennsylvania Department of Environmental Protection, Scranton, United States of America, 2010.
41. Written communication with J. McKay, Government of the Northwest Territories, Yellowknife, Canada, 2010.
42. Written communication with J. McMillen, Washington Department of Ecology, Seattle, United States of America, 2010.
43. Written communication with C. Michel, City of Frankfurt am Main, Frankfurt, Germany, 2010.
44. Written communication with R. Mitchell, Environment Protection Authority, Adelaide, Australia, 2010.
45. Written communication with C. Mojica, Mexico City Ministry of the Environment, Mexico City, Mexico, 2010.
46. Written communication with S. Morris, Anchorage Department of Health and Human Services, Anchorage, United States of America, 2010.
47. Written communication with R. Mulawin, Ministry for the Environment, Auckland City, New Zealand, 2010.
48. Written communication with V. Novak, Czech Hydrometeorological Institute, Prague, Czech Republic, 2010.
49. Written communication with B. Paris, Arizona Department of Environmental Quality, Arizona, United States of America, 2010.
50. Written communication with C. Price, Illinois Environmental Protection Agency, Chicago, United States of America, 2010.
51. Written communication with N. Rederlechner, City of Zurich, Zurich, Switzerland, 2010.
52. Written communication with C. Renaudot, Air Parif, Paris, France, 2010.
53. Written communication with K. Rivett, Department of Environment, Climate Change and Water, Sydney, Australia, 2010.
54. Written communication with J. Ross, Alberta Environment, Edmonton, Canada, 2010.
55. Written communication with T.L. San, National Environment Agency, Singapore City, Singapore, 2010.
56. Written communication with P. Sanborn, Massachusetts Department of Environmental Protection, Boston, United States of America, 2010.
57. Written communication with J. Saxton, Metro Vancouver, Vancouver, Canada, 2010.
58. Written communication with A. Snijder, DCMR Environmental Protection Agency, Rotterdam, Netherlands, 2010.
59. Written communication with R. Spoor, National Institute of Public Health and the Environment, Amsterdam, Netherlands, 2010.
60. Written communication with R. Strassman, Minnesota Pollution Control Agency, Minneapolis-St. Paul, United States of America, 2010.
61. Written communication with R. Twaddell, New York State Department of Environmental Conservation, New York City, United States of America, 2010.
62. Written communication with L. Varandas, Portuguese Environment Agency, Lisbon, Portugal, 2010.
63. Yap, D., Reid, N., De Brou, G. and R. Bloxam. 2005. *Transboundary Air Pollution in Ontario*. Ontario Ministry of the Environment.
64. Yap, D., Fraser, D., Kiely, P., De Brou, G. and W Dong. 1997. *The Role of Trans-boundary Flow on 1995 Ozone Levels in Ontario*. Presented at the 90th Air and Waste Management Association Annual Conference, Toronto, Ontario, June 1997.
65. Yap, D., Ning, D.T. and W. Dong. 1988. *An Assessment of Source Contribution to the Ozone Concentrations in Southern Ontario*. Atmospheric Environment, Vol. 22, No. 6, pp. 1161-1168.

Appendices

The Appendices are intended for use in conjunction with the 2009 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 2009, the AQI network was comprised of 138 continuous monitoring instruments at 40 sites. These instruments have the capability of recording minute data (approximately 72.5 million data points per year) that are used to scan and validate the continuous hourly data. During 2009, the Environmental Monitoring and Reporting Branch (EMRB) operated all of the ambient air monitoring sites. Monitoring site locations for the AQI network are illustrated in Map 1.

Quality Assurance and Quality Control

Day-to-day air monitoring and maintenance of the instruments is administered by staff of the EMRB. 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.

Map 1
Locations of AQI Stations in Ontario (2009)

The air monitoring station operators routinely inspect and maintain monitoring equipment and stations with mandatory monthly on-site visits where secondary transfer standards are used to calibrate instrumentation. Station activity is recorded using FieldWorker Inc. an electronic documentation solution; this information is transferred directly to the Ministry's database. The instrumentation used throughout the provincial air 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
- Carbon Monoxide – TE48C
- Fine Particulate Matter – TEOM 1400AB/SES
- Sulphur Dioxide – TE43C
- Nitrogen Oxides – TE42C
- Total Reduced Sulphur – TE43C/CDN101

The Environmental Monitoring and Reporting Branch operates a laboratory with gas reference standards that adhere to those of the U.S. National Institute of Standards and Technology (NIST) and the Pollution Measurement 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 Thermo Electron Corporation 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 staff of the Environmental Monitoring and Reporting Branch. 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 2009 ambient air quality monitoring network had greater than 98 per cent valid data from over 3 million data points.

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, 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.

NETWORK DESCRIPTIVE TABLE, ANNUAL STATISTICS AND TRENDS

The AQI network for 2009 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.

The 2009 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 2000-2009.

The 20-year trends for ozone, NO_2, CO and SO_2 are provided in Appendices C-F. 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 1990-2009.

Table 1
2009 Ontario Air Quality Index Network

ID	CITY/TOWN	STATION LOCATION	YEAR	LATITUDE (D:M:S)	LONGITUDE (D:M:S)	AIR INTAKE (AGL)	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	CO	SO_2	TRS
12008	WINDSOR DOWNTOWN	467 UNIVERSITY AVE.	1969	42°18`56.8``	-83°02`37.2``	8	A/C/N	U	T	T	T	T	T	.
12016	WINDSOR WEST	COLLEGE/SOUTH ST.	1975	42°17`34.4``	-83°04`23.3``	4	A/N	U	T	T	T	.	T	T
13001	CHATHAM	435 GRAND AVE. W.	2005	42°24`13.3``	-82°12`29.9``	15	A/C/N	U	T	T	T	.	T	.
14064	SARNIA	FRONT ST./CN TRACKS/CENTENNIAL PARK	1976	42°58`56.2``	-82°24`18.3``	3	A/N	U	T	T	T	.	T	T
15020	GRAND BEND	POINT BLAKE CONSERVATION AREA	1991	43°19`59.1``	-81°44`34.4``	10	A/N	R	T	T	.	.	.	.
15025	LONDON	900 HIGHBURY AVE. N.	1995	43°00`24.2``	-81°12`23.1``	4	A/C/N	U	T	T	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	R	T	T	.	.	.	.
18007	TIVERTON	4TH CONCESSION RD./BRUCE RD. 23	1979	44°18`52.1``	-81°32`59.0``	4	A/N	R	T	T	T	.	T	.
21005	BRANTFORD	324 GRAND RIVER AVE.	2004	43°08`19.0``	-80°17`33.5``	5	A/N	U	T	T	T	.	.	.
26060	KITCHENER	WEST AVE./HOMEWOOD	1990	43°26`37.8``	-80°30`13.7``	5	A/C/N	U	T	T	T	.	.	.
27067	ST. CATHARINES	ARGYLE CRES., PUMP STN.	1987	43°09`36.2``	-79°14`05.1``	4	A/C/N	U	T	T	T	.	.	.
28028	GUELPH	EXHIBITION ST./CLARK ST. W.	2000	43°33`05.8``	-80°15`51.0``	4	A/C/N	U	T	T	.	.	.	.
29000	HAMILTON DOWNTOWN	ELGIN ST./KELLY ST.	1987	43°15`28.0``	-79°51`42.0``	4	A/C/N	U	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	U	T	T	T	.	T	.
29118	HAMILTON WEST	MAIN ST. W./ HWY 403	1985	43°15`26.8``	-79°54`27.9``	3	A	U	T	T	.	.	.	.
31103	TORONTO DOWNTOWN	BAY/WELLESLEY ST. W.	2000	43°39`46.7``	-79°23`17.2``	10	A/C/N	U	T	T	T	T	T	.
33003	TORONTO EAST	KENNEDY RD./LAWRENCE AVE. E.	1970	43°44`52.5``	-79°16`26.6``	4	A/C/N	U	T	T	T	.	.	.
34020	TORONTO NORTH	HENDON/YONGE ST.	1988	43°46`53.8``	-79°25`03.8``	5	A/C/N	U	T	T	T	.	.	.
35125	TORONTO WEST	125 RESOURCES RD.	2003	43°42`34.0``	-79°32`36.6``	8	A/C/N	U	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	U	T	T	T	.	.	.
44017	OAKVILLE	EIGHTH LINE/GLENASHTON DR., HALTON RESERVOIR	2003	43°29`12.9``	-79°42`08.2``	12	A/C/N	U	T	T	T	.	.	.
45026	OSHAWA	2000 SIMCOE ST. N., DURHAM COLLEGE	2005	43°56`45.4``	-78°53`41.7``	7	A/C/N	U	T	T	T	.	.	.
46089	BRAMPTON	525 MAIN ST. N., PEEL MANOR	2000	43°41`55.5``	-79°46`51.3``	5	A/C/N	U	T	T	T	.	.	.
46108	MISSISSAUGA	3359 MISSISSAUGA RD. N., U OF T CAMPUS	2007	43°32`49.1``	-79°39`31.3``	5	A/C/N	U	T	T	T	T	T	.
47045	BARRIE	83 PERRY ST.	2001	44°22`56.5``	-79°42`08.3``	5	A/C/N	U	T	T	T	.	.	.
48006	NEWMARKET	EAGLE ST. W./McCAFFREY RD.	2001	44°02`39.5``	-79°28`59.7``	5	A/N	U	T	T	T	.	.	.
49005	PARRY SOUND	7 BAY ST.	2001	45°20`16.3``	-80°02`17.4``	5	A/N	R	T	T	.	.	.	.
49010	DORSET	DISTRICT RD. 117/PAINT LAKE RD.	1981	45°13`27.4``	-78°55`58.6``	3	A/N	R	T	T	.	.	.	.
51001	OTTAWA DOWNTOWN	RIDEAU ST./WURTEMBURG ST.	1971	45°26`03.6``	-75°40`33.6``	4	A/C/N	U	T	T	T	T	T	.
51002	OTTAWA CENTRAL	960 CARLING AVE.	2007	45°22`57.1``	-75°42`51.1``	5	A/N	U	T	T	T	.	.	.
51010	PETAWAWA	PETAWAWA RESEARCH FOREST FACILITY	2007	45°59`48.2``	-77°26`28.3``	6	A/N	R	T	T	.	.	.	.
52022	KINGSTON	752 KING ST. W.	2006	44°12`58.5``	-76°31`41.9``	13	A/C/N	U	T	T	T	T	T	.
54012	BELLEVILLE	2 SIDNEY ST., WATER TREATMENT PLANT	2002	44°09`01.9``	-77°23`43.8``	10	A/N	U	T	T	T	.	.	.
56010	MORRISBURG	COUNTY RD. 2, MORRISBURG WATER TOWER	2005	44°53`59.1``	-75°11`23.8``	5	A/N	R	T	T	.	.	.	.
56051	CORNWALL	BEDFORD ST./3RD ST. W.	1970	45°01`04.7``	-74°44`06.8``	4	A/N	U	T	T	T	.	.	.
59006	PETERBOROUGH	10 HOSPITAL DR.	1998	44°18`06.9``	-78°20`46.4``	10	A/C/N	U	T	T	T	.	.	.
63203	THUNDER BAY	421 JAMES ST. S.	2004	48°22`45.8``	-89°17`24.6``	15	A/C/N	U	T	T	T	.	.	.
71078	SAULT STE. MARIE	SAULT COLLEGE	2004	46°31`59.5``	-84°18`35.7``	8	A/N	U	T	T	T	.	T	T
75010	NORTH BAY	540 CHIPPEWA ST. N., DEPT. NATIONAL DEFENCE	1979	46°19`23.5``	-79°26`57.4``	4	A/N	U	T	T	T	.	.	.
77219	SUDBURY	1222 RAMSEY LAKE RD.	2004	46°28`32.5``	-80°57`46.6``	3	A/C/N	U	T	T	.	.	T	.

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, C = CWS, N = NAPS
AQI	- Air Quality Index site: U = urban, R = Rural
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

Appendix A Annual Statistics

Table A1

2009 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.	8711	6	16	24	31	44	64	24.8	87	50	4
12016	Windsor West	College Ave./South St.	8670	6	16	24	32	44	63	24.9	78	51	0
13001	Chatham	435 Grand Ave. W.	8725	13	21	28	34	46	65	28.8	88	56	2
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8671	10	19	26	33	43	58	26.6	85	54	2
15020	Grand Bend	Point Blake Conservation Area	8681	14	23	29	35	45	62	29.6	98	66	11
15025	London	900 Highbury Ave. N.	8745	9	18	24	31	42	58	25.1	76	56	0
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8662	16	24	30	36	47	66	30.9	90	70	14
18007	Tiverton	4th Concession/Bruce Rd. 23	8673	17	25	31	37	45	62	31.4	83	65	7
21005	Brantford	324 Grand River Ave.	8741	8	19	26	34	45	61	26.5	83	62	1
26060	Kitchener	West Ave./Homewood Ave.	8712	10	20	27	34	44	60	27.0	84	62	3
27067	St. Catharines	Argyle Cres., Pump Stn.	8738	6	19	26	33	43	58	25.6	79	63	0
28028	Guelph	Exhibition St./Clark St. W.	8751	10	20	27	34	44	60	27.3	88	64	5
29000	Hamilton Downtown	Elgin St./Kelly St.	8733	7	17	24	31	42	59	24.3	83	65	2
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8746	10	20	27	34	45	61	27.2	82	67	5
29118	Hamilton West	Main St. W./ Hwy 403	8677	3	14	22	29	40	55	21.8	79	60	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8735	8	17	24	31	42	58	24.6	89	61	2
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8728	4	14	21	29	40	57	22.1	82	54	2
34020	Toronto North	Hendon Ave./Yonge St.	8748	4	14	22	29	38	55	22.1	83	57	6
35125	Toronto West	125 Resources Rd.	8718	2	10	18	26	39	58	19.5	85	53	8
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8750	5	16	24	31	42	58	24.1	85	56	4
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8750	7	18	25	32	43	60	25.5	89	66	5
45026	Oshawa	2000 Simcoe St. N., Durham College	8411	9	18	25	32	41	55	25.5	88	50	2
46089	Brampton	525 Main St. N., Peel Manor	8735	5	17	26	33	43	60	25.2	90	65	7
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8706	4	16	25	32	42	58	24.0	89	62	5
47045	Barrie	83 Perry St.	8746	5	17	25	31	41	57	24.3	86	64	3
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	8723	11	22	29	36	45	61	28.6	88	70	10
49005	Parry Sound	7 Bay St.	8753	13	23	30	36	45	61	29.7	88	73	14
49010	Dorset	District Rd. 117 / Paint Lake Rd.	8739	10	21	28	34	43	59	27.7	85	70	4
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8649	8	16	23	29	39	52	23.4	84	66	5
51002	Ottawa Central	960 Carling Ave.	8616	7	18	25	32	41	54	24.7	84	67	6
51010	Petawawa	Petawawa Research Forest Facility	8739	11	21	27	34	43	57	27.3	80	68	0
52022	Kingston	752 King St. W.	8526	15	24	30	36	46	60	30.3	84	68	2
54012	Belleville	2 Sidney St., Water Treatment Plant	8437	12	22	29	35	44	61	28.5	83	68	3
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8724	9	19	26	33	41	56	26.1	81	66	1
56051	Cornwall	Bedford St./3rd St. W.	8741	8	19	26	32	42	57	25.5	82	69	2
59006	Peterborough	10 Hospital Dr.	8745	12	21	28	34	43	59	27.7	88	68	5
63203	Thunder Bay	421 James St. S.	8681	7	17	24	31	40	51	24.2	59	48	0
71078	Sault Ste. Marie	Sault College	8465	12	21	27	33	44	58	27.8	85	57	1
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8740	8	19	26	33	43	58	26.1	81	66	1
77219	Sudbury	1222 Ramsey Lake Rd.	8738	12	20	26	31	39	57	25.9	88	64	6

Table A2

2009 Fine Particulate Matter ($PM_{2.5}$) Statistics

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

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.	8620	1	4	6	9	15	27	7.2	71	27	0
12016	Windsor West	College Ave./South St.	8658	1	4	6	9	15	27	7.4	82	27	0
13001	Chatham	435 Grand Ave. W.	8647	1	3	5	8	13	24	6.3	39	28	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8611	3	6	8	12	18	31	9.8	59	27	0
15020	Grand Bend	Point Blake Conservation Area	8520	0	2	4	7	13	26	5.8	93	43	1
15025	London	900 Highbury Ave. N.	8633	0	2	4	7	13	24	5.7	56	29	0
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8643	1	3	4	7	12	22	5.6	36	30	1
18007	Tiverton	4th Concession/Bruce Rd. 23	8651	0	1	3	5	9	20	4.0	33	25	0
21005	Brantford	324 Grand River Ave.	8677	1	3	5	7	12	24	5.8	64	30	0
26060	Kitchener	West Ave./Homewood Ave.	8622	0	2	4	7	13	25	5.8	50	33	1
27067	St. Catharines	Argyle Cres., Pump Stn.	8654	1	3	5	8	13	22	6.0	38	31	1
28028	Guelph	Exhibition St./Clark St. W.	8633	0	2	4	7	12	23	5.6	42	32	1
29000	Hamilton Downtown	Elgin St./Kelly St.	8570	1	3	5	8	14	26	6.8	43	31	1
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8702	1	3	5	8	13	25	6.3	62	31	1
29118	Hamilton West	Main St. W./ Hwy 403	8638	1	3	5	8	13	24	6.1	43	31	1
31103	Toronto Downtown	Bay St./Wellesley St. W.	8709	1	2	4	7	12	23	5.6	44	35	1
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8683	1	3	4	7	12	24	5.9	55	36	1
34020	Toronto North	Hendon Ave./Yonge St.	7490	1	3	4	7	13	23	5.9	43	36	1
35125	Toronto West	125 Resources Rd.	8682	1	3	5	7	13	23	6.1	45	34	1
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8653	1	3	5	7	12	24	5.9	46	35	1
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8662	0	2	4	7	11	22	5.3	44	33	1
45026	Oshawa	2000 Simcoe St. N., Durham College	8663	1	2	4	6	11	22	5.2	40	33	1
46089	Brampton	525 Main St. N., Peel Manor	8618	1	2	4	7	12	23	5.6	37	32	1
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8538	1	3	5	7	12	23	5.8	41	33	1
47045	Barrie	83 Perry St.	8692	0	2	4	6	12	22	5.2	44	32	1
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	7957	0	2	4	6	11	22	5.1	41	34	1
49005	Parry Sound	7 Bay St.	8659	0	2	3	5	9	16	3.9	29	15	0
49010	Dorset	District Rd. 117 / Paint Lake Rd.	8609	0	1	2	4	8	18	3.6	42	27	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8582	0	2	3	6	11	21	4.6	79	26	0
51002	Ottawa Central	960 Carling Ave.	8621	0	2	3	5	10	20	4.4	43	26	0
51010	Petawawa	Petawawa Research Forest Facility	8733	0	1	2	4	7	15	3.1	33	26	0
52022	Kingston	752 King St. W.	8445	1	3	5	8	13	27	6.4	49	40	2
54012	Belleville	2 Sidney St., Water Treatment Plant	8654	1	2	4	6	11	21	4.9	36	31	1
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8614	1	2	4	6	11	19	5.0	40	25	0
56051	Cornwall	Bedford St./3rd St. W.	8666	1	2	4	7	11	25	5.4	49	37	2
59006	Peterborough	10 Hospital Dr.	8646	0	2	4	6	11	20	4.9	31	15	0
63203	Thunder Bay	421 James St. S.	8652	0	1	3	5	9	17	3.8	30	18	0
71078	Sault Ste. Marie	Sault College	8639	0	1	3	5	9	20	4.0	59	25	0
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8711	0	1	3	5	9	16	3.8	30	25	0
77219	Sudbury	1222 Ramsey Lake Rd.	8598	0	1	2	4	8	15	3.4	27	13	0

Notes:

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

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

Table A3

2009 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.	8443	0	1	2	5	13	58	5.6	194	40
12016	Windsor West	College Ave./South St.	8113	0	1	2	4	9	69	5.4	278	51
13001	Chatham	435 Grand Ave. W.	8682	1	2	3	3	6	20	3.5	123	20
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8652	1	1	2	2	5	22	2.8	122	14
15025	London	900 Highbury Ave. N.	8673	0	1	1	2	5	32	2.8	158	24
18007	Tiverton	4th Concession/Bruce Rd. 23	8581	0	0	0	0	1	4	0.4	45	4
21005	Brantford	324 Grand River Ave.	8741	0	0	0	1	4	22	1.7	130	14
26060	Kitchener	West Ave./Homewood Ave.	8712	0	0	1	1	4	33	2.1	218	41
27067	St. Catharines	Argyle Cres., Pump Stn.	8739	0	1	1	2	7	53	3.7	174	41
29000	Hamilton Downtown	Elgin St./Kelly St.	8650	0	1	2	4	14	64	5.8	179	46
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8552	0	0	1	1	6	37	2.5	115	23
31103	Toronto Downtown	Bay St./Wellesley St. W.	8739	1	2	3	4	10	40	5.1	138	46
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8727	0	1	3	7	17	79	7.8	263	76
34020	Toronto North	Hendon Ave./Yonge St.	8748	1	2	3	6	18	56	7.1	219	55
35125	Toronto West	125 Resources Rd.	8708	1	2	5	12	34	116	13.5	377	89
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8717	0	1	2	4	13	66	5.9	216	42
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8515	0	1	1	2	7	42	3.5	147	44
45026	Oshawa	2000 Simcoe St. N., Durham College	8402	0	1	2	3	6	27	3.0	66	18
46089	Brampton	525 Main St. N., Peel Manor	8633	0	1	2	4	16	72	6.5	201	60
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8703	0	1	1	2	11	69	5.1	184	67
47045	Barrie	83 Perry St.	8706	0	1	1	2	14	62	5.1	209	38
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	7848	1	1	1	2	5	35	3.2	133	21
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8735	0	0	1	2	5	27	2.4	121	33
51002	Ottawa Central	960 Carling Ave.	8637	0	0	0	0	3	39	1.8	120	39
52022	Kingston	752 King St. W.	8249	0	0	0	1	1	6	0.6	32	4
54012	Belleville	2 Sidney St., Water Treatment Plant	8743	0	0	1	1	4	21	1.9	103	11
56051	Cornwall	Bedford St./3rd St. W.	8736	0	0	1	1	4	61	3.2	265	74
59006	Peterborough	10 Hospital Dr.	8745	0	1	1	1	3	21	1.9	121	16
63203	Thunder Bay	421 James St. S.	8683	0	1	2	4	15	50	5.7	225	44
71078	Sault Ste. Marie	Sault College	8208	0	1	1	1	4	17	1.8	113	14
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8722	1	1	2	3	8	50	4.2	205	52

Table A4

2009 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	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8443	5	8	12	17	28	43	14.4	61	36	0	0
12016	Windsor West	College Ave./South St.	8113	5	8	11	15	25	42	13.2	67	36	0	0
13001	Chatham	435 Grand Ave. W.	8682	2	4	6	8	15	29	7.5	51	25	0	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8652	2	4	6	10	18	30	8.2	48	25	0	0
15025	London	900 Highbury Ave. N.	8673	3	5	7	10	19	36	9.0	52	27	0	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8581	0	1	1	3	6	13	2.3	38	13	0	0
21005	Brantford	324 Grand River Ave.	8741	2	4	6	8	15	29	7.3	57	25	0	0
26060	Kitchener	West Ave./Homewood Ave.	8712	3	4	6	10	18	37	8.6	54	32	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8739	3	5	8	12	20	34	9.9	50	24	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8650	4	8	11	17	26	42	13.6	57	36	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8552	3	5	8	12	20	37	9.9	52	30	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8739	7	10	14	20	29	44	16.5	67	40	0	0
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8727	5	8	12	18	29	49	14.9	79	39	0	0
34020	Toronto North	Hendon Ave./Yonge St.	8748	4	8	14	20	31	47	15.8	71	46	0	0
35125	Toronto West	125 Resources Rd.	8708	7	12	17	23	34	50	19.0	68	42	0	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8717	3	6	10	15	25	43	12.5	59	35	0	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8515	3	5	8	13	24	41	11.1	62	36	0	0
45026	Oshawa	2000 Simcoe St. N., Durham College	8402	2	4	5	9	16	29	7.4	43	26	0	0
46089	Brampton	525 Main St. N., Peel Manor	8633	3	6	10	16	29	45	13.3	57	38	0	0
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8703	3	6	10	15	25	42	12.2	56	35	0	0
47045	Barrie	83 Perry St.	8706	3	5	7	11	22	39	9.9	55	39	0	0
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	7848	2	3	5	9	17	35	7.8	56	29	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8735	2	4	6	10	19	35	8.6	51	32	0	0
51002	Ottawa Central	960 Carling Ave.	8637	1	2	4	7	16	37	6.6	48	32	0	0
52022	Kingston	752 King St. W.	8249	2	2	3	5	10	24	5.0	39	18	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8743	2	3	4	6	13	29	6.0	44	19	0	0
56051	Cornwall	Bedford St./3rd St. W.	8736	2	3	5	8	17	37	7.3	62	34	0	0
59006	Peterborough	10 Hospital Dr.	8745	1	2	4	6	12	31	5.6	50	23	0	0
63203	Thunder Bay	421 James St. S.	8683	2	4	6	10	18	37	8.4	55	32	0	0
71078	Sault Ste. Marie	Sault College	8208	2	2	4	5	11	26	5.1	48	24	0	0
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8722	2	3	5	8	20	43	8.2	62	39	0	0

Table A5

2009 Nitrogen Oxides (NO_x) Statistics

Unit: parts per billion (ppb)

ID	City/Town	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	24h
12008	Windsor Downtown	467 University Ave. W.	8443	6	10	15	22	39	94	20.0	236	64
12016	Windsor West	College Ave./South St.	8113	6	10	13	19	33	102	18.6	329	83
13001	Chatham	435 Grand Ave. W.	8682	5	6	8	12	20	47	10.9	152	37
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8652	3	5	8	13	23	47	11.0	168	33
15025	London	900 Highbury Ave. N.	8673	4	6	8	13	23	61	11.9	208	49
18007	Tiverton	4th Concession/Bruce Rd. 23	8581	0	1	2	3	6	14	2.7	83	14
21005	Brantford	324 Grand River Ave.	8741	2	4	6	9	18	48	9.1	186	37
26060	Kitchener	West Ave./Homewood Ave.	8712	3	5	7	11	22	65	10.8	269	73
27067	St. Catharines	Argyle Cres., Pump Stn.	8739	4	6	9	14	27	78	13.7	197	65
29000	Hamilton Downtown	Elgin St./Kelly St.	8650	5	9	14	21	40	100	19.5	231	80
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8552	3	5	8	13	25	66	12.4	165	52
31103	Toronto Downtown	Bay St./Wellesley St. W.	8739	9	13	18	24	39	78	21.6	198	86
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8727	5	10	16	25	45	120	22.7	323	113
34020	Toronto North	Hendon Ave./Yonge St.	8748	5	10	17	26	47	97	22.8	289	99
35125	Toronto West	125 Resources Rd.	8708	9	15	24	36	65	161	32.5	445	121
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8717	4	8	12	19	38	103	18.4	252	72
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8515	4	6	10	15	31	78	14.6	186	75
45026	Oshawa	2000 Simcoe St. N., Durham College	8402	3	5	7	11	22	50	10.4	95	44
46089	Brampton	525 Main St. N., Peel Manor	8633	4	8	12	20	44	111	19.9	248	97
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8703	4	7	11	18	36	104	17.3	221	92
47045	Barrie	83 Perry St.	8706	3	6	8	14	34	95	15.1	242	76
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	7848	3	5	7	11	23	63	11.0	175	48
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8735	3	5	7	11	24	59	11.0	155	60
51002	Ottawa Central	960 Carling Ave.	8637	1	2	4	8	19	71	8.4	157	63
52022	Kingston	752 King St. W.	8249	2	3	4	6	11	28	5.7	52	21
54012	Belleville	2 Sidney St., Water Treatment Plant	8743	2	3	5	8	16	46	7.9	142	30
56051	Cornwall	Bedford St./3rd St. W.	8736	2	4	6	9	22	90	10.6	327	98
59006	Peterborough	10 Hospital Dr.	8745	2	3	5	8	15	47	7.5	168	36
63203	Thunder Bay	421 James St. S.	8683	3	5	8	15	32	81	14.1	276	68
71078	Sault Ste. Marie	Sault College	8208	2	3	4	7	14	40	6.9	148	39
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8722	3	5	7	11	28	89	12.4	262	91

Table A6

2009 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 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	8h	No. of Times Above Criteria 1h	8h
12008	Windsor Downtown	467 University Ave. W.	8547	0.04	0.14	0.20	0.26	0.36	0.64	0.21	1.40	0.78	0	0
15025	London	900 Highbury Ave. N.	8747	0.03	0.08	0.13	0.20	0.28	0.49	0.15	1.41	0.91	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8713	0.01	0.10	0.17	0.23	0.39	0.80	0.19	5.02	1.79	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8586	0.04	0.11	0.16	0.21	0.30	0.49	0.17	1.10	0.93	0	0
35125	Toronto West	125 Resources Rd.	8588	0.08	0.15	0.20	0.25	0.36	0.76	0.22	1.56	1.08	0	0
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8730	0.08	0.15	0.18	0.22	0.30	0.61	0.20	2.53	1.25	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8681	0.17	0.22	0.26	0.31	0.39	0.62	0.27	1.37	0.82	0	0
52022	Kingston	752 King St. W.	8511	0.12	0.15	0.17	0.20	0.24	0.33	0.18	0.59	0.39	0	0

Table A7

2009 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.	8744	0	1	2	3	10	26	3.5	55	15	0	0	0
12016	Windsor West	College Ave./South St.	8698	0	1	1	3	10	27	3.6	59	28	0	0	0
13001	Chatham	435 Grand Ave. W.	8712	0	0	1	2	4	12	1.6	49	11	0	0	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8667	0	1	1	3	10	55	4.5	189	39	0	0	0
15025	London	900 Highbury Ave. N.	8747	0	0	1	1	3	7	1.0	19	6	0	0	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8689	0	0	1	1	2	8	0.9	29	7	0	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8734	0	1	1	3	8	31	3.3	136	24	0	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8749	0	1	1	3	8	22	3.0	68	18	0	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8740	0	0	1	1	2	7	0.9	23	7	0	0	0
35125	Toronto West	125 Resources Rd.	8721	0	0	1	1	3	8	1.2	18	8	0	0	0
46108	Mississauga	3359 Mississauga Rd. N., U of T	8731	0	0	1	1	3	9	1.1	42	10	0	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8740	0	0	1	1	1	4	0.9	71	10	0	0	0
52022	Kingston	752 King St. W.	8518	0	0	1	1	2	5	0.8	18	7	0	0	0
71078	Sault Ste. Marie	Sault College	8724	0	0	0	0	1	16	0.6	47	12	0	0	0
77219	Sudbury	1222 Ramsey Lake Rd.	8738	0	0	0	0	2	22	1.1	131	22	0	0	0

Table A8

2009 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.	8100	0	0	0	1	1	4	0.52	17	7
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8655	0	0	0	0	0	1	0.08	5	1
29000	Hamilton Downtown	Elgin St./Kelly St.	8733	0	0	1	1	1	3	0.73	20	3
71078	Sault Ste. Marie	Sault College	8678	0	0	0	0	1	1	0.11	2	1

Appendix B

10y Trends (2000-2009)

Table B1

10-Year Trend for O_3

Annual Mean (ppb)

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	18.6	20.5	21.9	22.9	20.2	26.0	24.6	27.0	26.9	24.8
12016	Windsor West	17.0	19.0	20.2	22.8	22.6	25.6	24.3	25.3	25.9	24.9
14064	Sarnia	24.3	25.6	26.5	24.7	23.8	27.4	26.7	28.6	28.7	26.6
15020	Grand Bend	32.6	31.6	29.8	30.7	25.8	32.5	29.7	31.7	31.3	29.6
15025	London	21.1	24.2	25.3	26.9	23.6	26.1	25.1	27.2	27.0	25.1
18007	Tiverton	32.3	34.7	34.7	33.2	28.1	31.8	28.9	34.3	32.6	31.4
26060	Kitchener	23.0	25.7	27.3	28.1	24.8	28.0	26.6	28.6	28.1	27.0
27067	St. Catharines	18.9	21.2	24.1	25.3	23.6	26.3	26.2	28.1	27.5	25.6
29000	Hamilton Downtown	17.0	18.8	20.4	21.7	20.1	23.2	23.2	24.8	25.1	24.3
29114	Hamilton Mountain	22.6	24.2	27.7	28.4	24.6	28.2	27.5	29.2	29.0	27.2
29118	Hamilton West	16.9	18.6	20.5	22.0	19.2	21.2	20.9	23.0	23.3	21.8
31103	Toronto Downtown	19.7	22.0	24.0	23.6	22.8	24.5	22.6	25.7	26.0	24.6
33003	Toronto East	19.6	21.7	21.0	21.8	19.9	22.4	22.0	23.2	21.6	22.1
34020	Toronto North	20.6	23.4	25.1	23.6	22.5	24.5	23.3	24.5	22.7	22.1
44008	Burlington	23.4	24.6	26.3	22.8	21.0	23.9	23.4	24.6	24.9	24.1
44017	Oakville	21.0	22.9	25.1	INS	24.6	27.7	26.1	27.5	27.0	25.5
45026	Oshawa	21.2	23.4	23.2	24.1	23.3	28.6	25.1	28.0	27.0	25.5
46109	Mississauga	19.9	22.4	23.1	24.8	20.7	23.1	22.4	23.3	24.6	24.0
49010	Dorset	29.3	31.0	32.4	30.1	28.8	32.3	28.9	29.9	29.3	27.7
51001	Ottawa Downtown	19.9	25.0	24.9	24.7	21.7	23.3	23.6	24.7	23.3	23.4
56051	Cornwall	24.0	29.0	24.8	25.9	23.8	27.7	27.5	28.3	26.6	25.5
59006	Peterborough	28.1	30.7	30.5	29.7	27.1	31.2	24.9	27.6	28.2	27.7
63203	Thunder Bay	22.6	24.4	23.4	26.1	22.0	22.3	23.5	24.2	23.0	24.2
71078	Sault Ste. Marie	24.8	25.2	24.2	26.8	27.0	30.2	29.1	29.7	28.9	27.8
75010	North Bay	22.1	26.6	26.8	27.0	25.2	28.0	26.7	27.1	27.7	26.1
77219	Sudbury	26.1	29.1	29.2	28.5	27.7	31.0	28.4	28.1	27.9	25.9

Notes:
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 $PM_{2.5}$

Annual Mean (µg/m^3)

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	-	-	-	8.5	8.6	10.4	8.2	9.5	8.3	7.2
12016	Windsor West	-	-	-	9.6	9.5	10.5	9.2	9.8	8.9	7.4
13001	Chatham	-	-	-	n/a	INS	9.1	7.4	7.9	7.3	6.3
14064	Sarnia	-	-	-	11.9	12.2	12.9	11.3	12.2	11.4	9.8
15020	Grand Bend	-	-	-	INS	7.0	7.4	6.5	6.7	6.8	5.8
15025	London	-	-	-	7.9	7.8	8.8	6.9	6.5	6.8	5.7
16015	Port Stanley	-	-	-	8.0	7.5	8.6	7.3	7.2	6.7	5.6
18007	Tiverton	-	-	-	6.5	5.8	6.6	5.6	5.6	5.0	4.0
21005	Brantford	-	-	-	INS	7.5	8.9	7.6	7.7	6.8	5.8
26060	Kitchener	-	-	-	8.1	8.1	9.5	7.7	8.0	7.1	5.8
27067	St. Catharines	-	-	-	7.8	7.3	8.6	7.9	8.2	7.4	6.0
28028	Guelph	-	-	-	7.3	7.8	8.8	7.0	7.5	6.5	5.6
29000	Hamilton Downtown	-	-	-	10.6	8.9	10.0	9.1	8.9	8.3	6.8
29114	Hamilton Mountain	-	-	-	9.6	9.3	9.8	8.1	7.8	7.3	6.3
29118	Hamilton West	-	-	-	INS	8.4	9.6	8.2	8.3	7.6	6.1
31103	Toronto Downtown	-	-	-	8.4	7.1	8.5	7.3	7.3	6.6	5.6
33003	Toronto East	-	-	-	8.8	7.4	8.4	7.6	7.8	6.7	5.9
34020	Toronto North	-	-	-	8.3	7.7	9.4	7.6	7.8	7.3	5.9
35125	Toronto West	-	-	-	9.8	9.8	10.0	8.2	8.4	7.5	6.1
44008	Burlington	-	-	-	8.6	7.9	9.1	7.6	7.3	6.9	5.9
44017	Oakville	-	-	-	INS	8.1	8.9	7.4	7.6	6.7	5.3
45026	Oshawa	-	-	-	INS	INS	8.1	6.8	6.8	6.3	5.2
46089	Brampton	-	-	-	8.2	7.7	8.9	7.2	7.4	6.8	5.6
47045	Barrie	-	-	-	7.5	6.9	8.1	6.7	6.9	6.1	5.2
48006	Newmarket	-	-	-	7.3	6.4	7.7	6.4	6.6	6.0	5.1
49005	Parry Sound	-	-	-	INS	5.3	6.1	5.3	5.5	4.7	3.9
49010	Dorset	-	-	-	5.9	4.7	5.8	4.5	5.0	4.5	3.6
51001	Ottawa Downtown	-	-	-	7.2	6.5	7.7	6.1	6.0	5.3	4.6
54012	Belleville	-	-	-	6.9	6.4	7.0	6.2	6.2	6.1	4.9
56010	Morrisburg	-	-	-	INS	6.2	7.0	6.8	6.2	5.7	5.0
56051	Cornwall	-	-	-	INS	6.8	7.6	6.5	6.4	6.1	5.4
59006	Peterborough	-	-	-	6.7	5.9	7.5	6.3	6.4	6.0	4.9
63203	Thunder Bay	-	-	-	n/a	4.2	4.4	4.8	4.4	4.2	3.8
71078	Sault Ste Marie	-	-	-	INS	4.5	5.4	5.2	5.3	4.4	4.0
75010	North Bay	-	-	-	5.5	4.5	5.6	4.9	5.0	4.6	3.8
77219	Sudbury	-	-	-	n/a	INS	5.1	4.6	4.9	4.1	3.4

Notes:

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

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.

Table B3
10-Year Trend for NO

Annual Mean (ppb)

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	13.9	11.0	10.9	INS	10.5	7.8	7.2	6.4	5.9	5.6
14064	Sarnia	8.9	6.7	7.1	5.0	3.7	3.8	3.7	3.2	3.2	2.8
15025	London	8.0	6.6	INS	INS	6.0	5.5	4.4	3.6	3.1	2.8
26060	Kitchener	7.4	5.7	3.8	INS	4.9	4.4	3.5	2.7	2.5	2.1
29000	Hamilton Downtown	14.7	11.5	10.4	11.7	9.6	9.9	8.0	7.7	6.5	5.8
31103	Toronto Downtown	14.4	10.0	8.2	8.7	7.6	7.2	6.9	5.9	5.0	5.1
33003	Toronto East	23.0	17.9	16.1	17.0	16.0	14.4	12.5	10.8	9.2	7.8
34020	Toronto North	16.8	14.3	12.4	12.4	INS	10.8	10.0	8.3	7.7	7.1
44008	Burlington	21.8	13.2	11.8	15.5	11.1	12.3	9.8	8.8	6.5	5.9
44017	Oakville	16.2	11.9	INS	INS	5.3	5.2	4.3	3.9	4.0	3.5
45026	Oshawa	14.2	13.7	10.0	9.3	8.2	INS	3.8	3.2	3.2	3.0
51001	Ottawa Downtown	11.0	7.3	INS	5.8	3.2	3.3	3.0	3.4	2.7	2.4

Table B4
10-Year Trend for NO_2

Annual Mean (ppb)

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	21.6	19.4	19.1	INS	18.3	16.9	17.2	17.2	15.2	14.4
14064	Sarnia	16.3	16.8	17.5	13.0	11.7	12.7	11.0	11.3	10.8	8.2
15025	London	17.4	17.3	INS	INS	13.7	14.1	12.3	11.7	10.8	9.0
26060	Kitchener	14.7	14.1	11.9	INS	13.1	12.9	10.8	9.7	9.0	8.6
29000	Hamilton Downtown	21.8	22.5	20.9	21.3	16.8	19.3	17.0	17.0	14.7	13.6
31103	Toronto Downtown	26.8	27.1	23.3	23.2	20.0	20.7	19.1	18.2	17.0	16.5
33003	Toronto East	23.7	22.9	22.0	21.3	19.8	20.1	17.4	17.2	16.5	14.9
34020	Toronto North	22.7	22.0	21.0	20.4	INS	19.2	17.4	16.7	16.5	15.8
44008	Burlington	20.3	16.5	17.9	17.3	15.3	17.2	16.2	16.0	13.6	12.5
44017	Oakville	17.2	16.2	INS	INS	13.5	14.5	12.4	13.0	12.0	11.1
45026	Oshawa	19.7	19	17.2	16.2	14.15	INS	8.9	8.1	8.5	7.4
51001	Ottawa Downtown	13.8	14.3	INS	13.7	11.1	9.8	8.6	8.7	11.4	8.6

Notes:
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 B5
10-Year Trend for NO_x

Annual Mean (ppb)

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	36.0	30.5	29.2	INS	29.3	24.9	24.4	23.6	21.1	20.0
14064	Sarnia	25.0	23.6	24.6	18.1	15.7	16.8	14.7	14.5	13.9	11.0
15025	London	24.7	23.1	INS	INS	19.4	19.4	16.7	15.3	13.9	11.9
26060	Kitchener	21.9	19.5	15.5	INS	18.2	17.4	14.3	12.4	11.5	10.8
29000	Hamilton Downtown	37.0	34.4	31.4	33.3	27.7	30.0	24.9	24.7	21.2	19.5
31103	Toronto Downtown	40.4	36.6	31.5	32.1	28.1	28.2	26.1	24.2	22.1	21.6
33003	Toronto East	46.3	40.3	37.7	37.9	36.3	34.7	29.9	28.0	25.7	22.7
34020	Toronto North	39.3	36.2	33.4	33.0	28.3	30.4	27.5	25.0	24.3	22.8
44008	Burlington	42.2	29.0	28.4	32.5	26.1	29.3	26.0	24.8	20.0	18.4
44017	Oakville	33.0	27.8	INS	INS	18.3	19.5	16.7	16.9	16.1	14.6
45026	Oshawa	33.6	32.6	27.2	25.5	22.5	INS	12.7	11.3	11.7	10.4
51001	Ottawa Downtown	24.4	21.0	INS	20.1	14.7	13.7	11.5	12.0	14.0	11.0

Notes:
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 CO

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

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	11.8	4.9	4.3	4.3	2.3	1.3	2.9	5.0	1.3	1.4
15025	London	2.5	3.5	2.3	2.4	2.3	2.4	1.8	1.2	1.0	1.4
29000	Hamilton Downtown	7.3	3.7	2.3	3.1	4.0	2.6	2.8	6.0	3.3	5.0
31103	Toronto Downtown	3.6	3.2	2.9	2.4	1.9	1.6	1.5	1.7	0.9	1.1
51001	Ottawa Downtown	3.2	2.9	2.8	2.2	2.2	2.0	1.4	1.5	1.3	1.4

Table B7
10-Year Trend for SO_2

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

ID	City/Town	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
12008	Windsor Downtown	6.2	6.1	5.7	5.9	4.8	4.9	5.0	5.5	4.5	3.5
12016	Windsor West	8.8	9.3	7.9	6.3	4.6	5.1	4.9	5.2	4.7	3.6
14064	Sarnia	10.4	12.5	10.4	7.1	8.2	7.8	8.3	8.0	7.7	4.5
15025	London	3.5	3.5	2.2	INS	2.2	2.3	1.9	1.9	2.2	1.0
29000	Hamilton Downtown	5.1	6.0	4.9	5.0	4.0	5.3	4.8	4.2	4.3	3.3
29114	Hamilton Mountain	5.8	5.3	4.8	5.3	n/a	n/a	3.3	3.5	3.0	3.0
31103	Toronto Downtown	4.7	5.0	4.0	3.2	2.2	2.8	1.9	1.9	1.6	0.9
51001	Ottawa Downtown	4.1	2.3	2.9	INS	1.0	1.5	1.1	0.9	0.9	0.9
71078	Sault Ste. Marie	2.0	2.0	1.7	2.0	0.9	1.5	1.4	1.8	1.2	0.6
77219	Sudbury	4.2	2.6	3.1	2.0	INS	2.8	2.4	2.3	2.0	1.1

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 20y Ozone Trends (1990-2009)

Figure C1
Ozone Annual Mean at Windsor Downtown

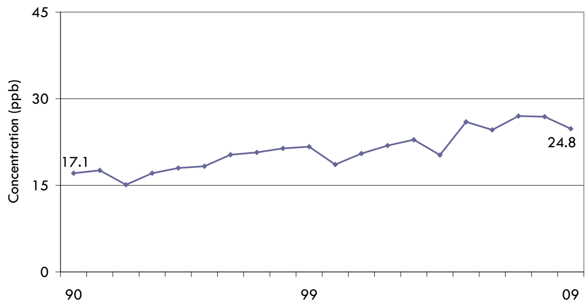


Figure C2
Ozone Annual Mean at Windsor West

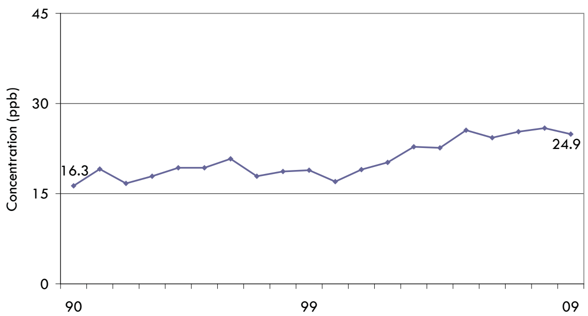


Figure C3
Ozone Annual Mean at London

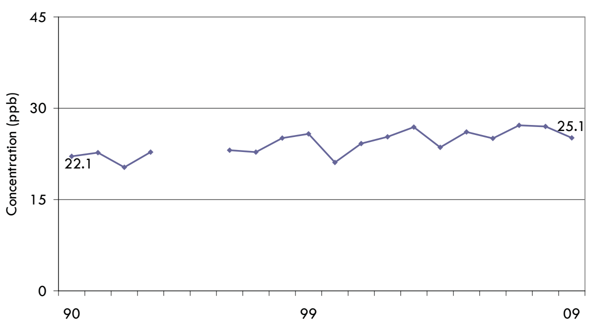


Figure C4
Ozone Annual Mean at Sarnia

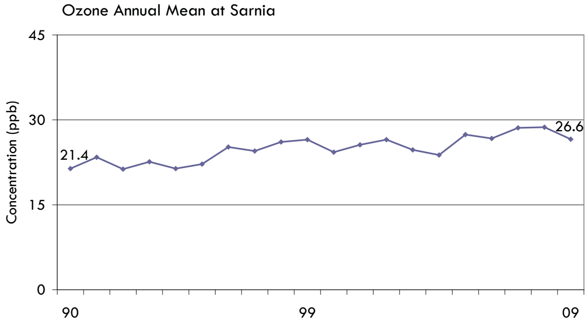


Figure C5
Ozone Annual Mean at Grand Bend

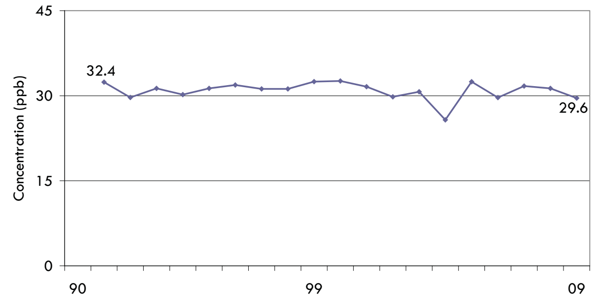


Figure C6
Ozone Annual Mean at Tiverton

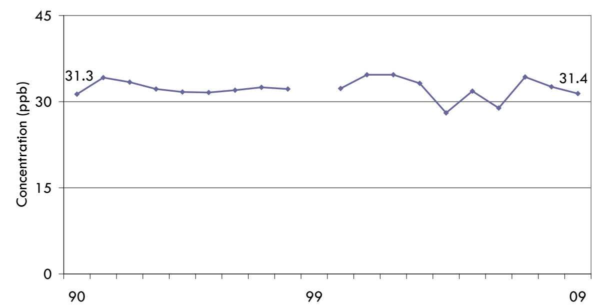


Figure C7
Ozone Annual Mean at Kitchener

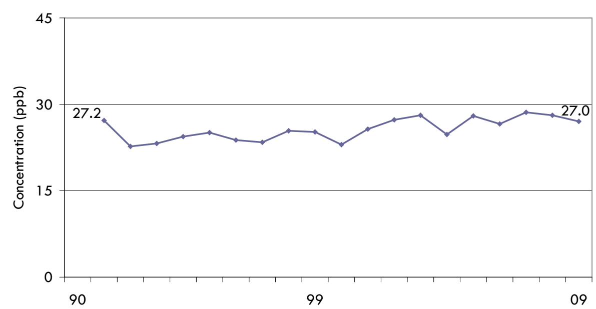


Figure C8
Ozone Annual Mean at St. Catharines

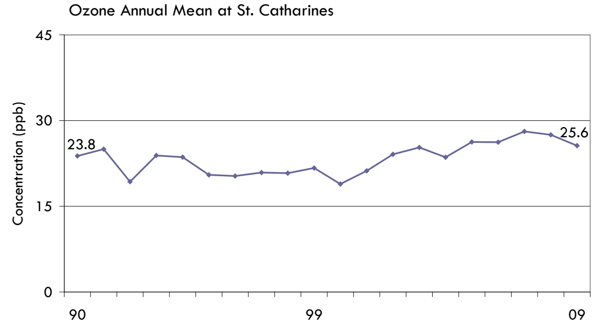


Figure C9
Ozone Annual Mean at Hamilton Mountain

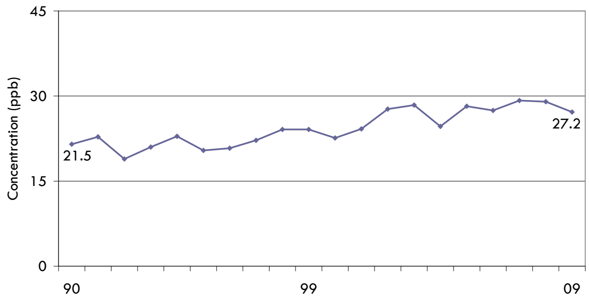


Figure C10
Ozone Annual Mean at Hamilton West

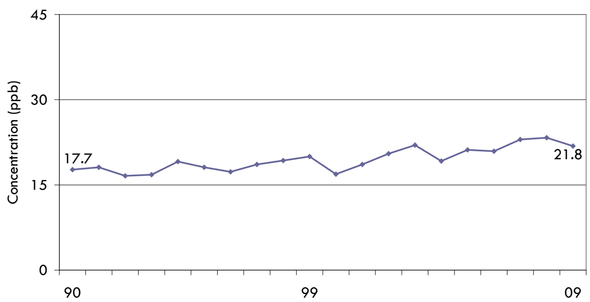


Figure C11
Ozone Annual Mean at Hamilton Downtown

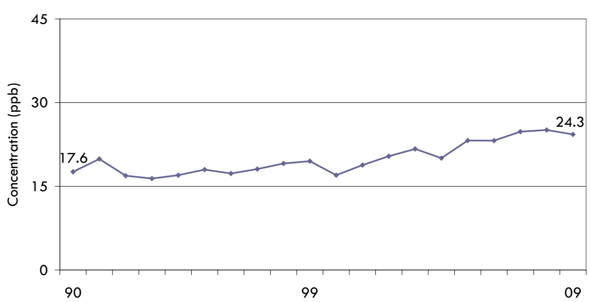


Figure C12
Ozone Annual Mean at Burlington

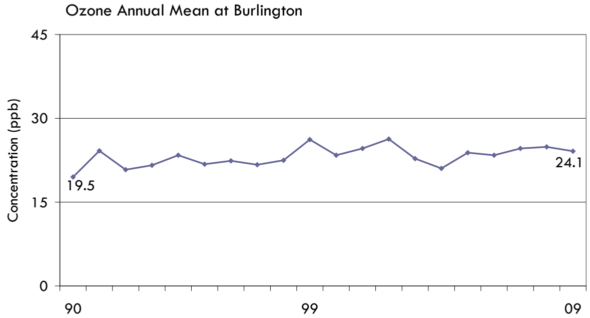


Figure C13
Ozone Annual Mean at Oakville

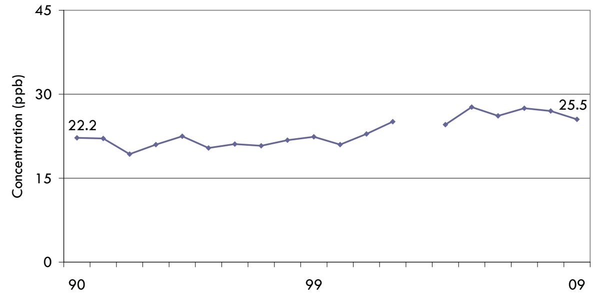


Figure C14
Ozone Annual Mean at Mississauga

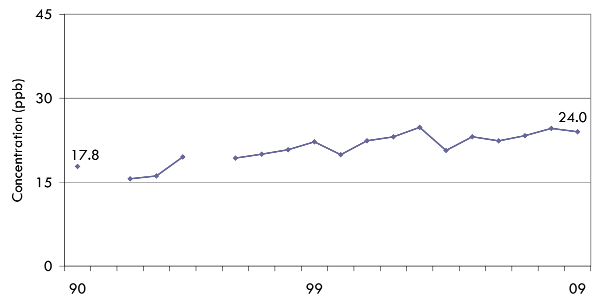


Figure C15
Ozone Annual Mean at Toronto Downtown

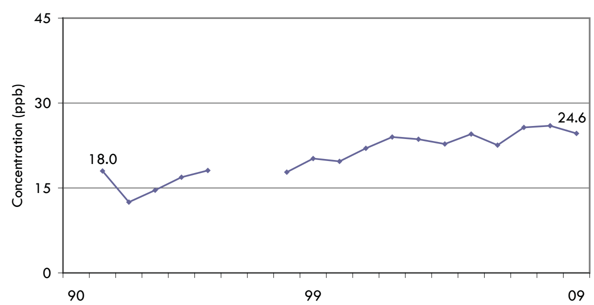


Figure C16
Ozone Annual Mean at Toronto North

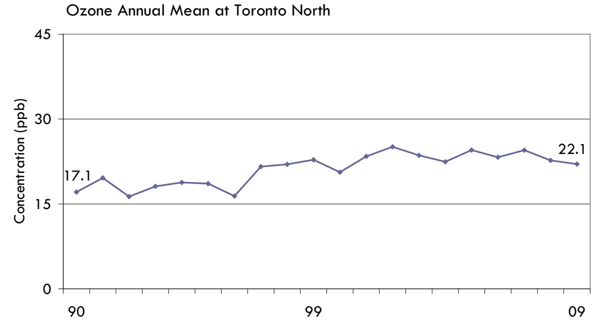


Figure C17
Ozone Annual Mean at Toronto East

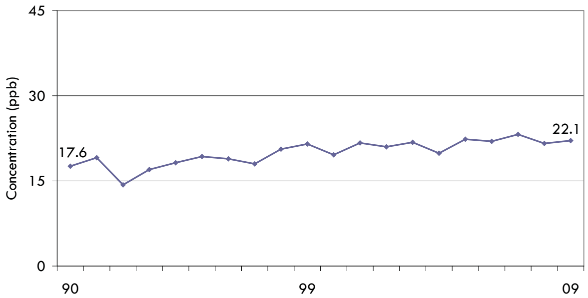


Figure C18
Ozone Annual Mean at Oshawa

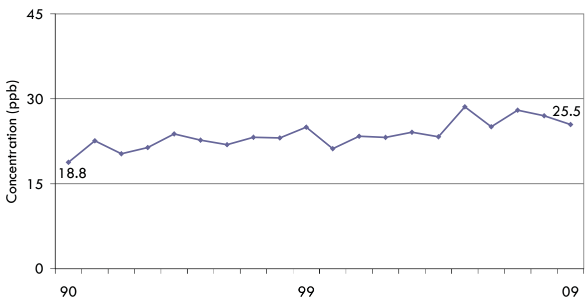


Figure C19
Ozone Annual Mean at Cornwall

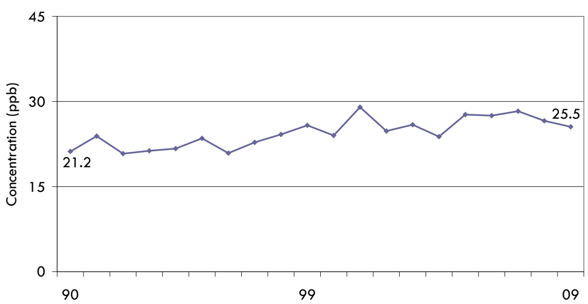


Figure C20
Ozone Annual Mean at Ottawa Downtown

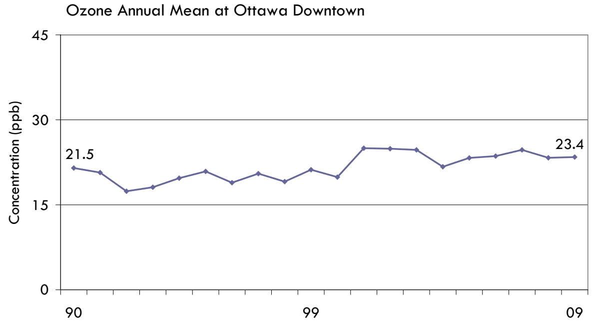


Figure C21
Ozone Annual Mean at Dorset

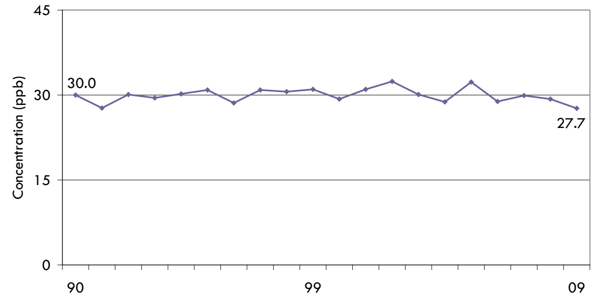


Figure C22
Ozone Annual Mean at Sudbury

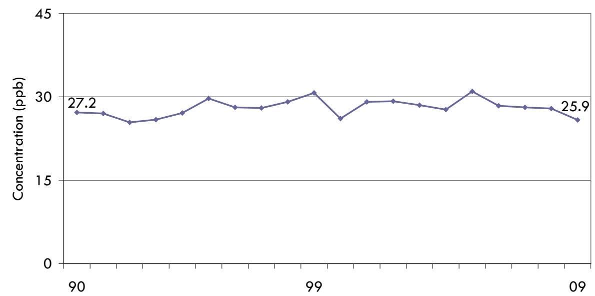


Figure C23
Ozone Annual Mean at Sault Ste. Marie

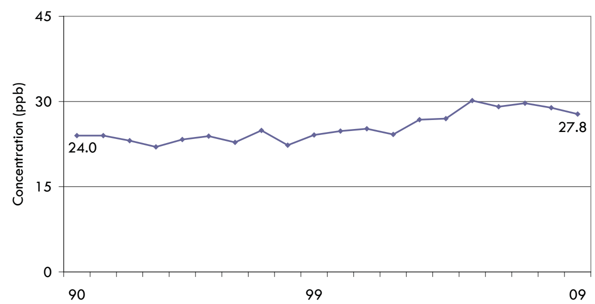
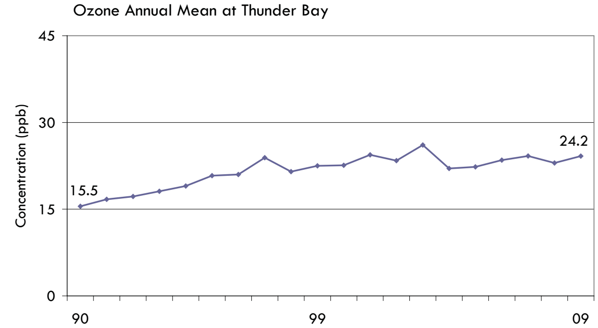


Figure C24
Ozone Annual Mean at Thunder Bay



Appendix D 20y NO_2 Trends (1990-2009)

Figure D1
NO_2 Annual Mean at Windsor Downtown

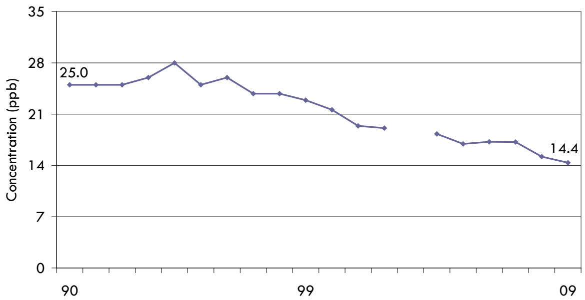


Figure D2
NO_2 Annual Mean at London

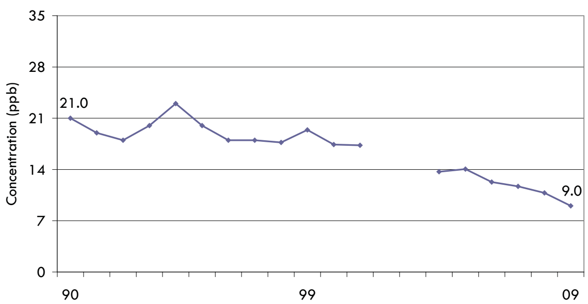


Figure D3
NO_2 Annual Mean at Sarnia

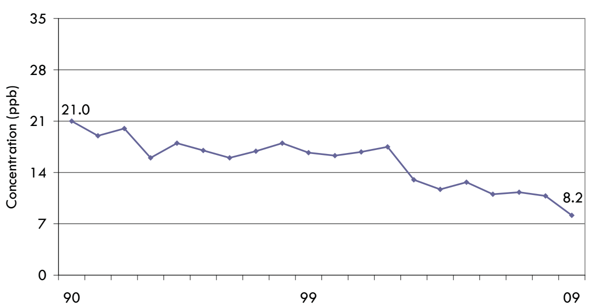


Figure D4
NO_2 Annual Mean at Kitchener

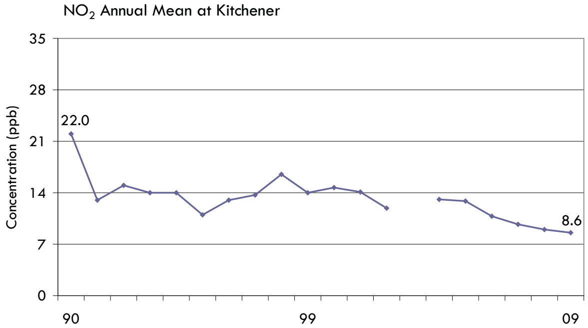


Figure D5
NO_2 Annual Mean at Hamilton Downtown

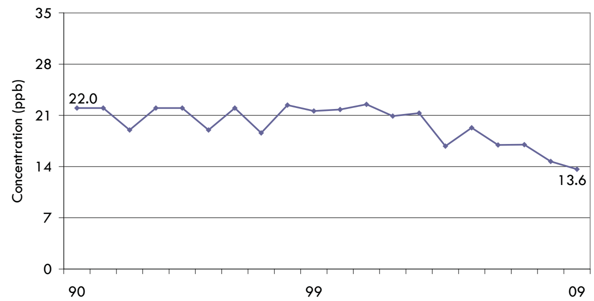


Figure D6
NO_2 Annual Mean at Burlington

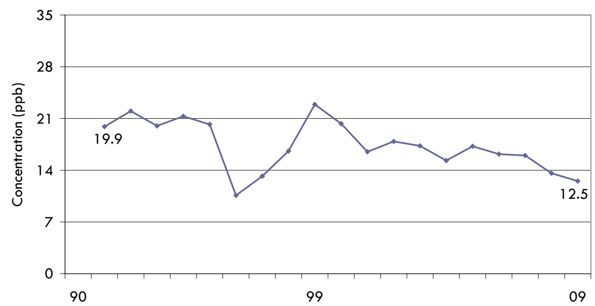


Figure D7
NO_2 Annual Mean at Oakville

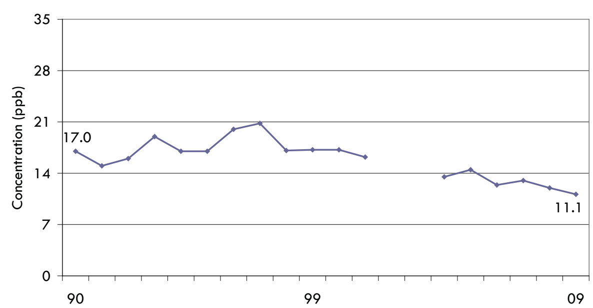


Figure D8
NO_2 Annual Mean at Toronto Downtown

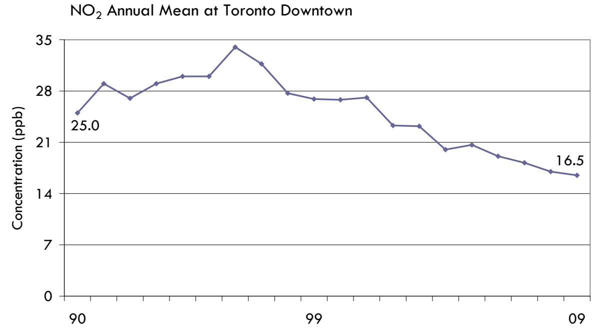


Figure D9
NO_2 Annual Mean at Toronto North

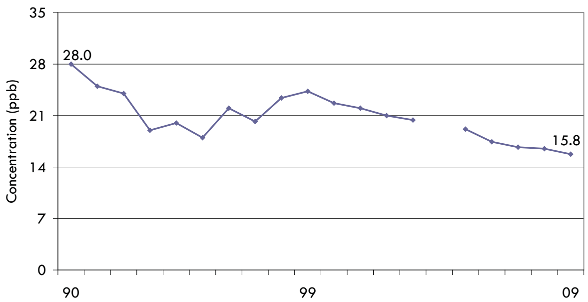


Figure D10
NO_2 Annual Mean at Toronto East

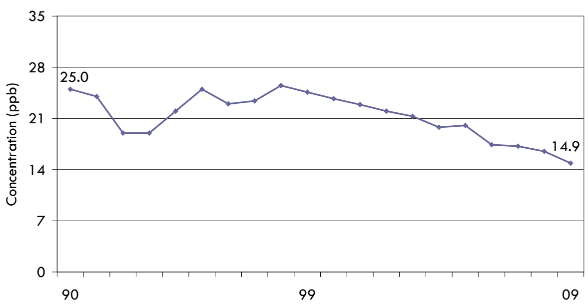


Figure D11
NO_2 Annual Mean at Oshawa

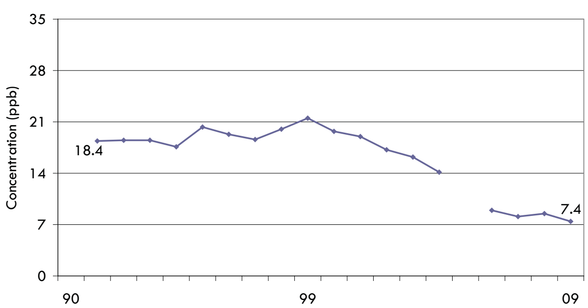
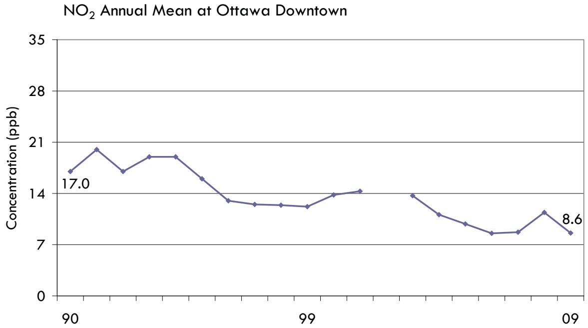


Figure D12
NO_2 Annual Mean at Ottawa Downtown



Appendix E 20y CO Trends (1990-2009)

Figure E1
CO 1h Maximum at Windsor Downtown

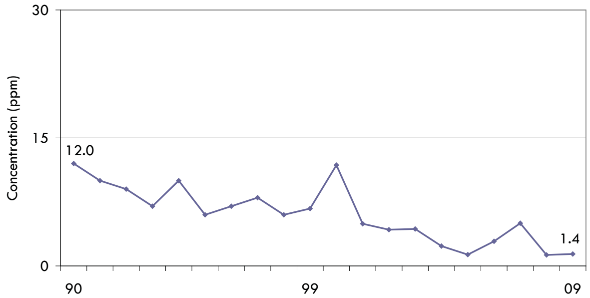


Figure E2
CO 1h Maximum at London

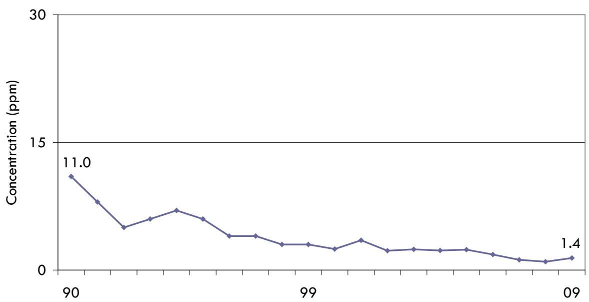


Figure E3
CO 1h Maximum at Hamilton Downtown

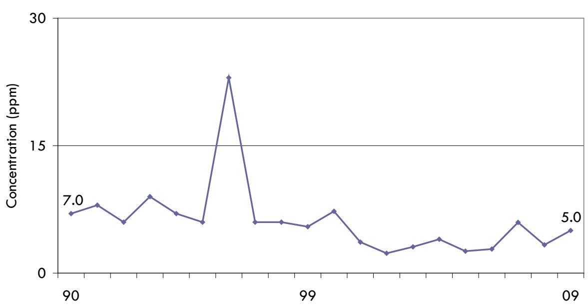


Figure E4
CO 1h Maximum at Toronto Downtown

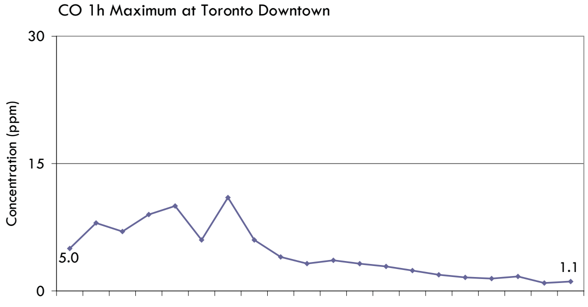
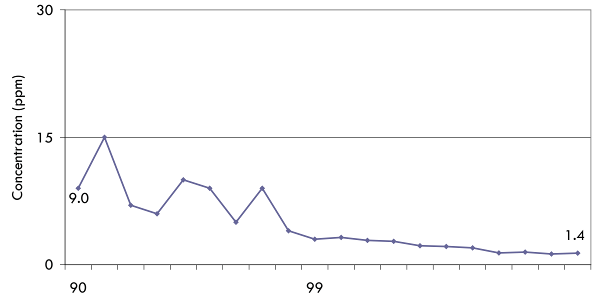


Figure E5
CO 1h Maximum at Ottawa Downtown



Appendix F 20y SO_2 Trends (1990-2009)

Figure F1
SO_2 Annual Mean at Windsor Downtown

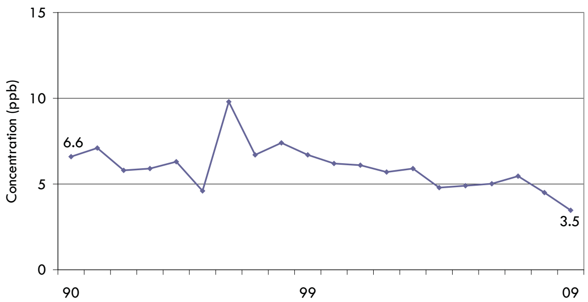


Figure F2
SO_2 Annual Mean at Windsor West

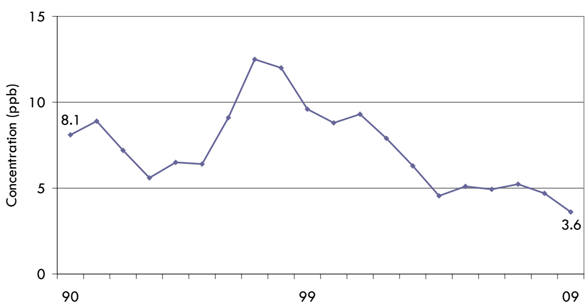


Figure F3
SO_2 Annual Mean at London

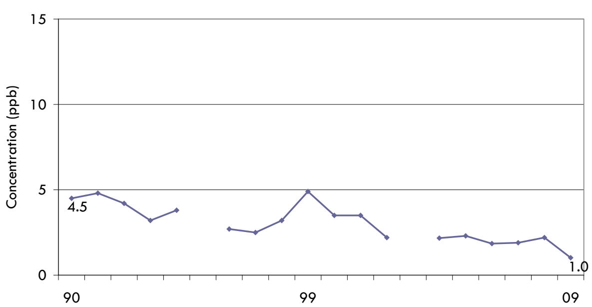


Figure F4
SO_2 Annual Mean at Sarnia

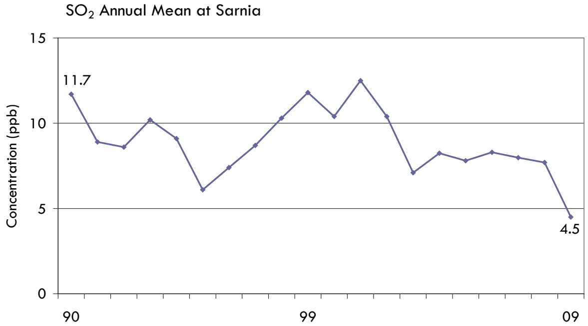


Figure F5
SO_2 Annual Mean at Hamilton Mountain

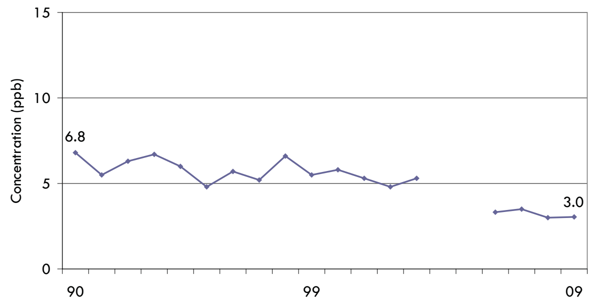


Figure F6
SO_2 Annual Mean at Hamilton Downtown

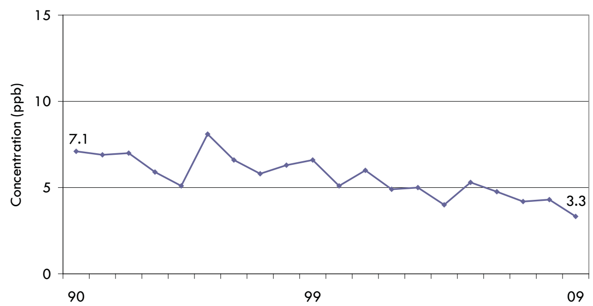


Figure F7
SO_2 Annual Mean at Toronto Downtown

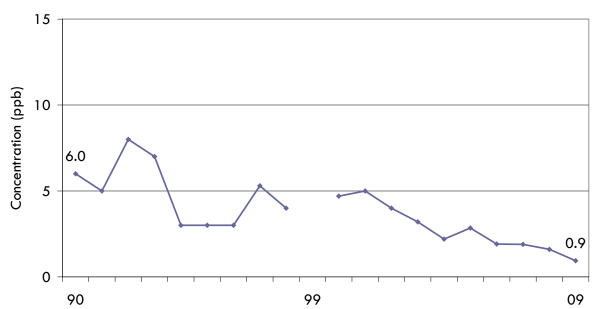


Figure F8
SO_2 Annual Mean at Ottawa Downtown

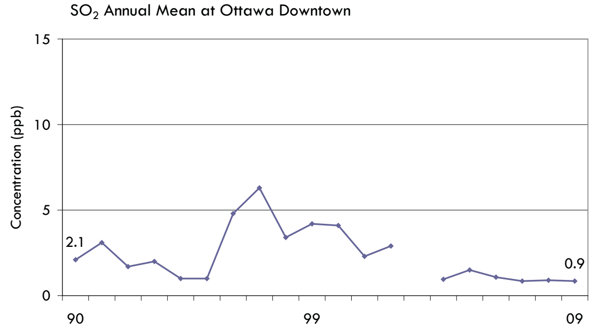


Figure F9
SO_2 Annual Mean at Sudbury

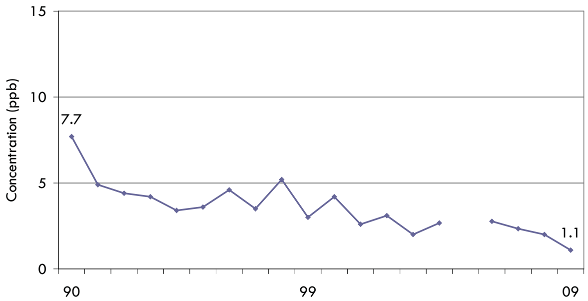


Figure F10
SO_2 Annual Mean at Sault Ste. Marie