Air Quality in Ontario
2008 Report

Protecting our environment.

Ontario

Minister's Message

My ministry works hard to ensure the air we breathe in Ontario is safe and clean. We have created and strengthened our standards and regulations to reduce air pollution and toxic emissions. I am pleased to release this *Air Quality Report*, which marks 38 years of annual monitoring and reporting, and concludes that air quality in Ontario is improving.

The Honourable John Gerretsen, Minister of the Environment.

The phase-out of coal-fired generating stations, with Lakeview Thermal Generating Station shut down in 2005, will continue to improve local air quality. In addition, we introduced 59 new or updated standards for over 50 harmful air pollutants - this is the biggest improvement in reducing air toxics in over 30 years. Our government also made the largest ever investment in public transportation with MoveOntario 2020, a $17.5 billion rapid transit plan with 52 projects, and has created additional carpooling and High Occupancy Vehicle lanes.

Ontario government initiatives that have helped improve air quality include the Drive Clean program which ensures vehicles on the road pass strict emission controls. Ontario's emissions trading regulations for sulphur dioxide and nitrogen oxides have also significantly reduced these air contaminants.

Even with all of these protective measures in Ontario, more than 50 per cent of our smog originates in the United States. Winds coming from the southwest pick up contaminants in the United States and carry them into Ontario. We will continue to encourage American states to reduce their air pollution. Ontario continues to participate in American processes in support of stricter control measures and standards that will positively impact air quality in Ontario.

Ontario's air quality has been improving over the last several years. However, more work needs to be done as Ontario's population grows. We at the ministry look forward to continuing our work to protect the air we all breathe.

Sincerely,

John Gerretsen
Minister

2008 Report Highlights

- The 2008 air quality report marks 38 years of 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 in Ontario has improved significantly over the past 38 years, especially for nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2) - important pollutants emitted by vehicles and industry.

- Air quality has improved significantly over the 10-year period from 1999 to 2008: Provincial average levels of NO_2 have decreased by 35 per cent; CO levels by 66 per cent; and, SO_2 by 46 per cent. Since 2003, fine particulate matter ($PM_{2.5}$) concentrations have decreased by 20 per cent across the province - a major improvement in $PM_{2.5}$ levels over the six-year period.

- Major reductions in province-wide emissions of key pollutants over the 1998 to 2007 period have occurred. Emissions of nitrogen oxides (NO_x) were lowered by 30 per cent, CO emissions by 29 per cent, SO_2 emissions by 35 per cent and $PM_{2.5}$ emissions by 30 per cent.

- Ozone peaks have decreased 17 per cent since 1980, whereas ozone averages have increased by 30 per cent during the summer months and 65 per cent during the winter months, over the same time period.

- A comparison of air quality at 54 cities world-wide was conducted for 2008. Overall, the air quailty of three Ontario cities, Windsor, Toronto and Ottawa, was generally better than the other cities used in this analysis based on ozone, $PM_{2.5}$, NO_2, CO and SO_2.

- In 2008, the Ministry issued eight smog advisories covering 17 days. With 17 smog advisory days, 2008 tied the lowest on record (2006) since $PM_{2.5}$ was included in the Smog Alert program in 2002. Analysis of smog events and weather strongly indicates that the U.S. Midwest and Ohio Valley Region of the U.S. continue to be significant contributors to elevated ozone and $PM_{2.5}$ concentrations in southern Ontario.

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Chapter 1:

Overview

Air pollution is of concern to many people who live in Ontario, and although the average levels for many air pollutants in Ontario have decreased over the last several decades, smog remains an important issue, especially in southern Ontario. As depicted in Figure 1.1, air pollution comes from various sources including stationary sources such as factories, power plants and smelters; mobile sources such as vehicles, aircraft, marine vessels and trains; and, natural sources such as forest fires, windblown dust and biogenic emissions from soils and vegetation.

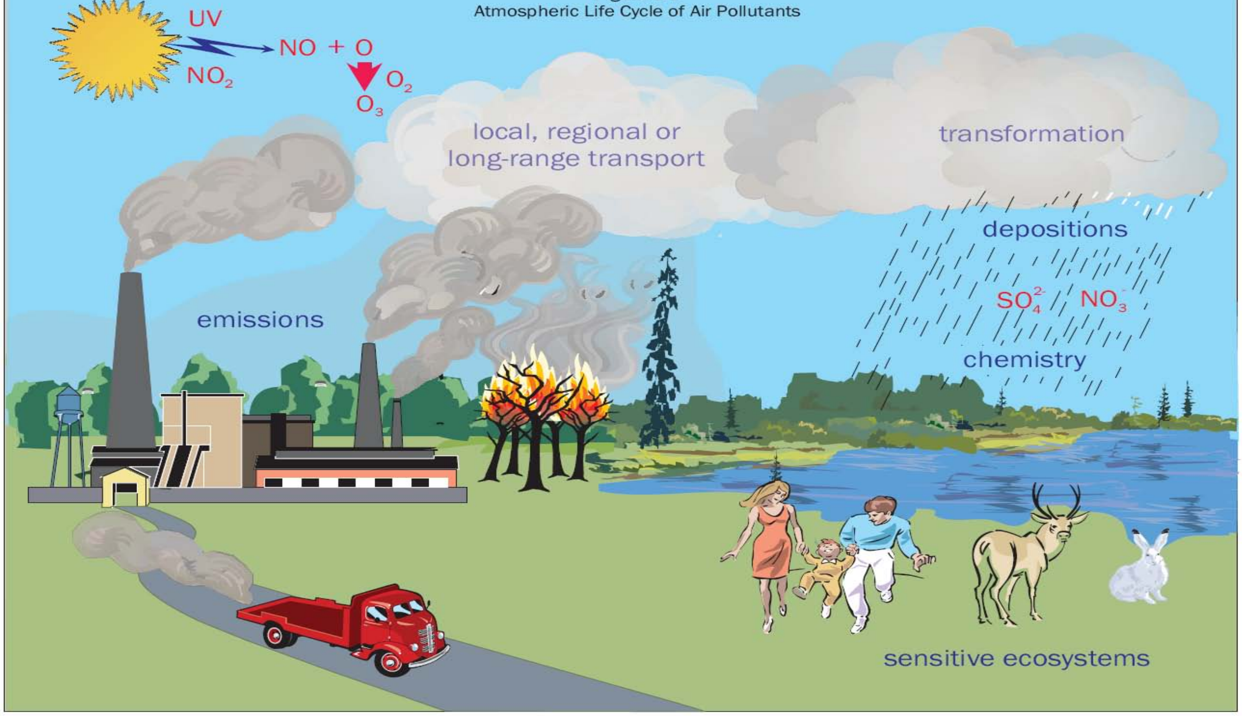
Many pollutants, including those that are associated with smog (ozone and fine particulate matter) remain in the atmosphere for significant periods of time. These air pollutants and their precursors are generated on various geographic scales: locally, regionally, nationally and internationally. They can travel great distances from province to province and country to country, affecting communities far removed from their original sources.

The release of pollutants into the atmosphere and removal of pollutants from the atmosphere are ongoing processes. The resulting air pollutant mixture is affected by the amount of pollutants emitted, distances travelled, and regional and local weather conditions, such as, sunlight, moisture, clouds, winds, precipitation and the geography.

This report focuses on ambient air quality based on measurements of key criteria pollutants in order to assess and summarize the state of air quality in the province of Ontario during 2008 and over the last few decades.

The Ontario Ministry of the Environment operates 40 ambient air monitoring sites across the province. 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).

Figure 1.1
Atmospheric Life Cycle of Air Pollutants



The Ministry of the Environment continues to monitor air quality across Ontario and 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;
- provide quantitative measurements to enable abatement of specific sources;
- determine the contribution from U.S. sources and other provinces 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.

Ambient air monitoring provides information on the concentrations of selected pollutants in communities across Ontario. Table 1.1 shows the relationship between monitored air pollutants and current air issues.

This annual report, the 38th in a series, summarizes the state of ambient air quality in Ontario during 2008 and examines trends over time. 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.

Air pollutant concentrations from selected Ontario cities have been compared to the information available in other cities from around the world (see Figures 2.9, 3.7, 4.4, 4.8, and 4.12). The cities included in this comparative study are depicted in Figure 1.2. City populations, a factor in ambient pollution levels, ranged from approximately 19,000 (Yellowknife, Canada) to 17,600,000 (Mexico City, Mexico). Monitoring methods and siting criteria may vary from country to country; therefore, comparisons among nations 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 ambient air quality criteria (AAQC), the national ambient air quality standards (NAAQS) for the United States, and the guidelines used by the World Health Organization (WHO).

The report also summarizes the results from the Air Quality Index (AQI) and Smog Alert programs, and briefly

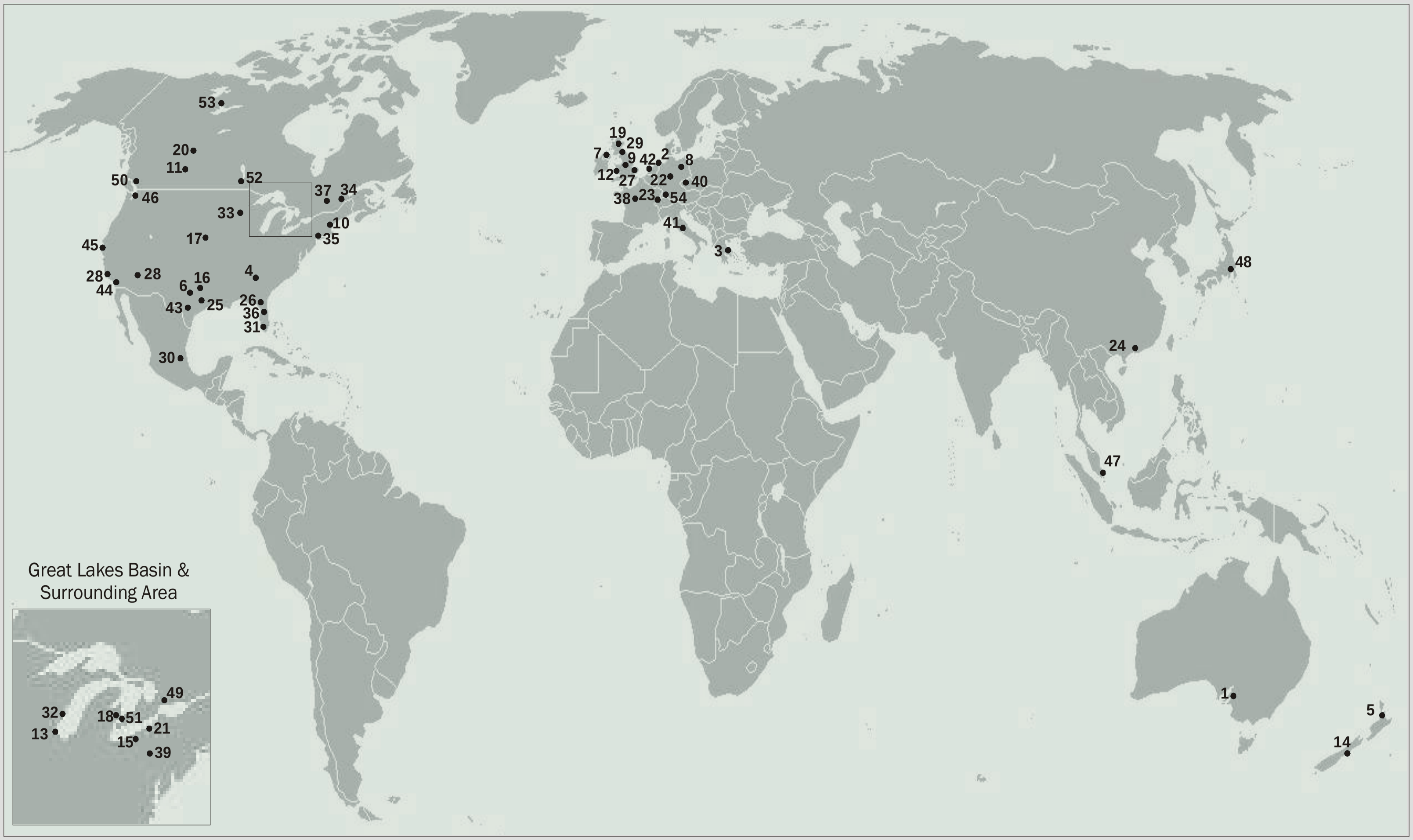
Table 1.1: Linkages between Air Pollutants and Current Air Issues

Pollutant	Smog	Climate Change	Acid Deposition	Odour	Visibility/ Soiling
Ozone	Yes	Yes	Yes	No	No
Sulphur Dioxide	Yes	Yes	Yes	Yes	Yes
Carbon Monoxide	Yes	Yes	No	No	No
Nitrogen Oxides	Yes	Yes	Yes	No	Yes
Volatile Organic Compounds	Yes	Yes	No	Yes	No
Particulate Matter	Yes	Yes	Yes	Yes	Yes
Total Reduced Sulphur Compounds	No	No	No	Yes	No

examines smog episodes, and results of a special air quality study undertaken in Ottawa during 2007 and 2008.

The annual statistics and 10- and 20-year trends of ambient air quality data are presented in the attached appendices. 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 to ensure a high standard of quality.

Figure 1.2
Selected Cities Around the World Used for 2008 Air Quality Comparison



1. Adelaide, AUS; 2. Amsterdam, NED; 3. Athens, GRE; 4. Atlanta, USA; 5. Auckland City, NZL; 6. Austin, USA; 7. Belfast, IRL; 8. Berlin, GER; 9. Birmingham, GBR; 10. Boston, USA; 11. Calgary, CAN; 12. Cardiff, GBR; 13. Chicago, USA; 14. Christchurch, NZL; 15. Cleveland, USA; 16. Dallas, USA; 17. Denver, USA; 18. Detroit, USA; 19. Edinburgh, GBR; 20. Edmonton, CAN; 21. Erie, USA; 22. Frankfurt, GER; 23. Geneva, SUI; 24. Hong Kong, CHN; 25. Houston, USA; 26. Jacksonville, USA; 27. London, GBR; 28. Los Angeles, USA; 29. Manchester, GBR; 30. Mexico City, MEX; 31. Miami, USA; 32. Milwaukee, USA; 33. Minneapolis-St. Paul, USA; 34. Montreal, CAN; 35. New York City, USA; 36. Orlando, USA; 37. Ottawa, CAN; 38. Paris, FRA; 39. Pittsburgh, USA; 40. Prague, CZE; 41. Rome, ITA; 42. Rotterdam, NED; 43. San Antonio, USA; 44. San Diego, USA; 45. San Francisco, USA; 46. Seattle, USA; 47. Singapore, SIN; 48. Tokyo, JPN; 49. Toronto, CAN; 50. Vancouver, CAN; 51. Windsor, CAN; 52. Winnipeg, CAN; 53. Yellowknife, CAN; 54. Zurich, SUI.

Chapter 2:

Ground-Level Ozone

O_3 O_3 O_3 O_3 O_3 O_3 O_3 O_3

CHAPTER HIGHLIGHTS

- The cool, wet and unsettled weather of 2008 resulted in substantially lower numbers of ozone exceedances when compared to 2007. In 2008, Ontario's one-hour AAQC for ozone was exceeded at 31 of the 40 AQI stations on at least one occasion.
- The composite one-hour maximum of 85 ppb recorded in 2008 is the second lowest on record.
- Nineteen of the 20 designated CWS reporting sites recorded 8-hour ozone averages above the CWS of 65 ppb for ozone in 2008. The one exception was Thunder Bay where the CWS calculated value was 55 ppb.

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.

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 and year-to-year. In Ontario, elevated concentrations of ground-level ozone are generally recorded on hot and sunny days from May to September, generally between noon and early evening.

The diurnal variation of ozone and its relationship with NO_x are displayed in Figure 2.1. The increase in NO_x concentrations, measured as the sum of nitric oxide (NO) and nitrogen dioxide (NO_2), during the morning is mainly the result of local vehicular traffic. The ozone concentrations, however, can decrease over the same period due to the scavenging effect of NO. By the late morning, new ozone starts to be produced as a result of chemical reactions of VOCs and NO_x in the presence of sunlight. Ozone concentrations continue to increase and peak later on in the afternoon when the sunlight is still relatively intense. Finally, as the sun goes down, ozone concentrations typically decrease.

Figure 2.2 shows the 2007 estimates of Ontario's VOC emissions from point, area and transportation sources. Transportation sectors accounted for approximately 37 per cent of VOC emissions. General solvent use was the second largest source of VOC emissions, accounting for approximately 24 per cent. Figure 2.3 shows the 2007 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 were the second largest source of NO_x emissions, accounting for approximately 10 per cent.

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

Monitoring results for 2008

During 2008, ozone was monitored at all 40 Ontario Ministry of the Environment AQI monitoring stations. The highest annual mean was 34.3 parts per billion (ppb), measured at Port Stanley, a rural location considered to be a transboundary-influenced site situated on the northern shore of Lake Erie. The lowest annual mean, 20.7 ppb, was measured at Toronto West, a site located near Highway

Figure 2.1
Diurnal Variation of Ozone and Its Relationship with NO_x

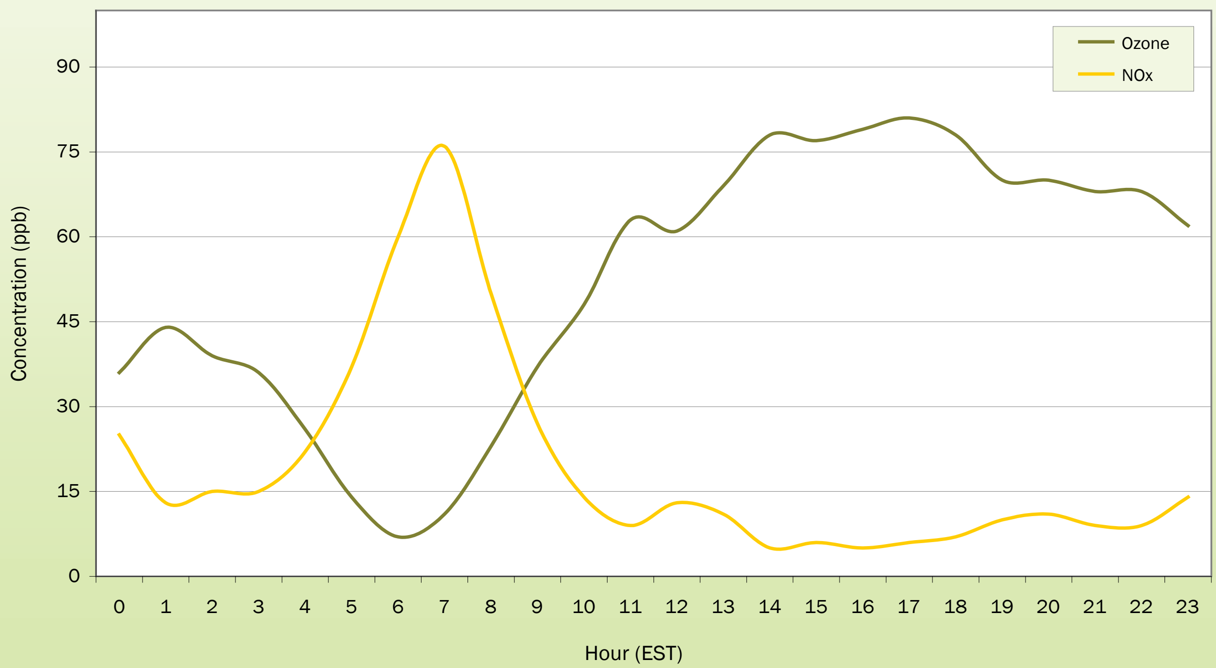
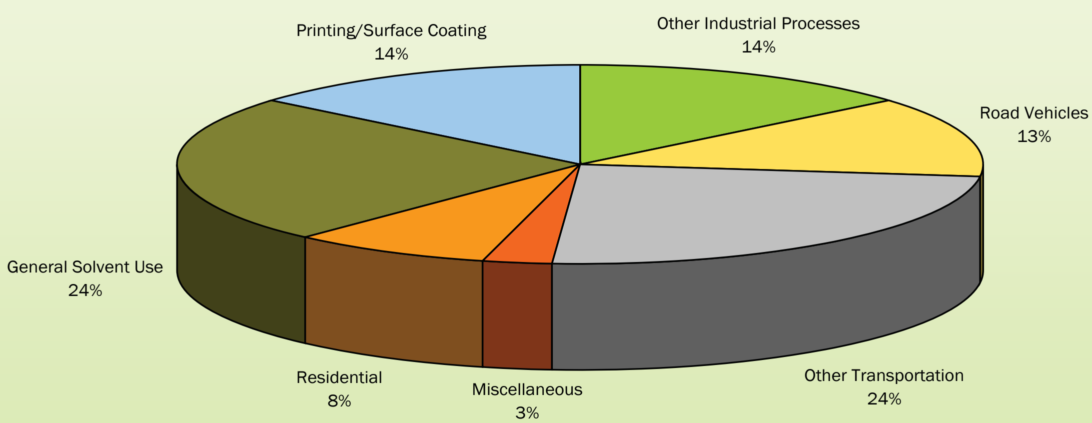
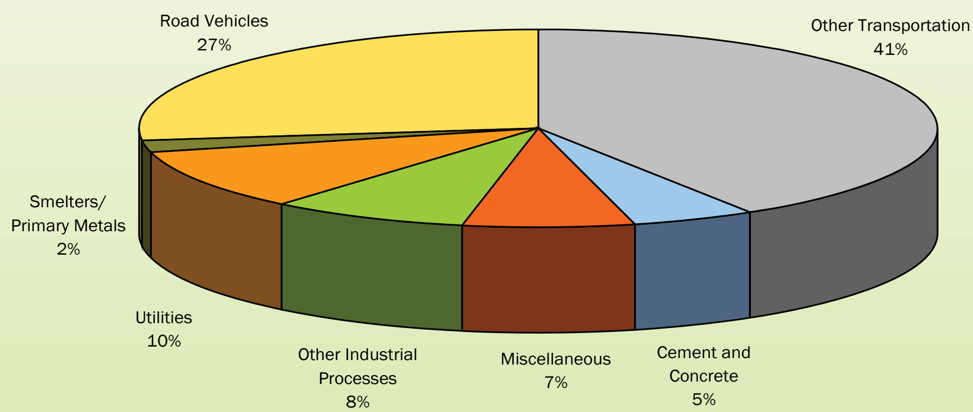


Figure 2.2
Ontario Volatile Organic Compounds Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2007 Estimates)



Note: 2007 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 2.3
Ontario Nitrogen Oxides Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2007 Estimates)



Note: 2007 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

401 and impacted directly by local nitric oxide emissions. Generally, ozone concentrations are lower in urban areas because ozone is reduced by reaction with nitric oxide emitted by vehicles and other local combustion sources.

Ground-level ozone concentrations continued to exceed the provincial one-hour AAQC of 80 ppb across the province. In 2008, Ontario's one-hour AAQC for ozone was exceeded at 31 of the 40 AQI stations on at least one occasion. The maximum one-hour ozone concentrations ranged from 73 ppb recorded in Sudbury to 99 ppb recorded at Grand Bend. Port Stanley, a site impacted significantly by U.S. emissions, recorded the most instances (36) when ozone exceeded Ontario's one-hour AAQC. The nine sites that did not record any hours of ozone above 80 ppb in 2008 include Hamilton Downtown, Hamilton West, Toronto North, Ottawa Downtown, Petawawa, North Bay, Sudbury, Sault Ste. Marie and Thunder Bay.

The geographical distribution of the number of ozone exceedances across Ontario for 2008 compared to 2007 is shown in Figure 2.4. The cool, wet and unsettled weather of 2008 resulted in substantially lower numbers of ozone exceedances when compared to 2007. 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. 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 is then combined with a local build-up of pollutants to potentially impact various areas of the province during a smog episode. Significant variations in ozone levels can also occur in the complex lake breeze regimes over southern Ontario. For example, London reported significantly less exceedances than its surrounding sites in southwestern Ontario. There is evidence that London is affected by lake breezes from both Lake Huron and Lake Erie. The subsequent convergence zone causes the air to rise which leads to the development of clouds and precipitation potentially resulting in lower ozone levels.

Reduce Smog, Reduce the Risk

Whenever we burn fuel, we create the pollutants necessary to form smog. We burn oil and gas to power our cars and to heat our homes. It is important to remember that much of Ontario's electricity is generated by burning fossil fuels, so reducing your energy consumption helps prevent smog.

Figure 2.4
Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario
(2007 and 2008)

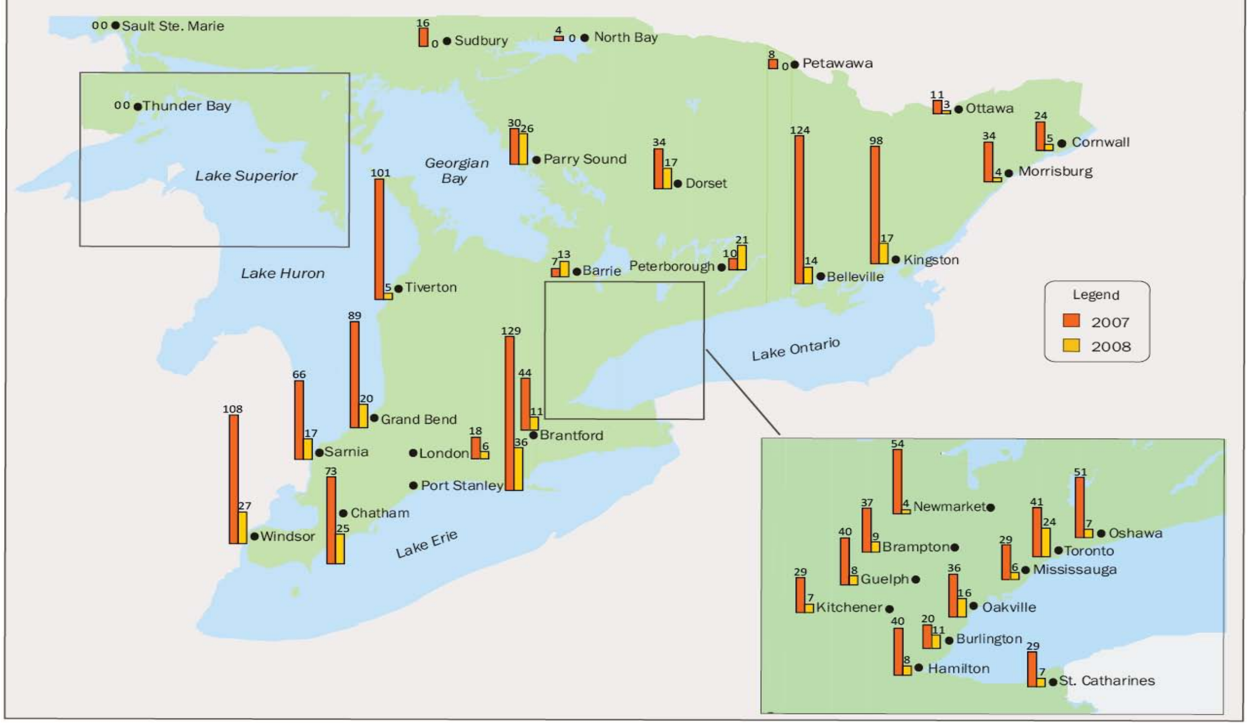
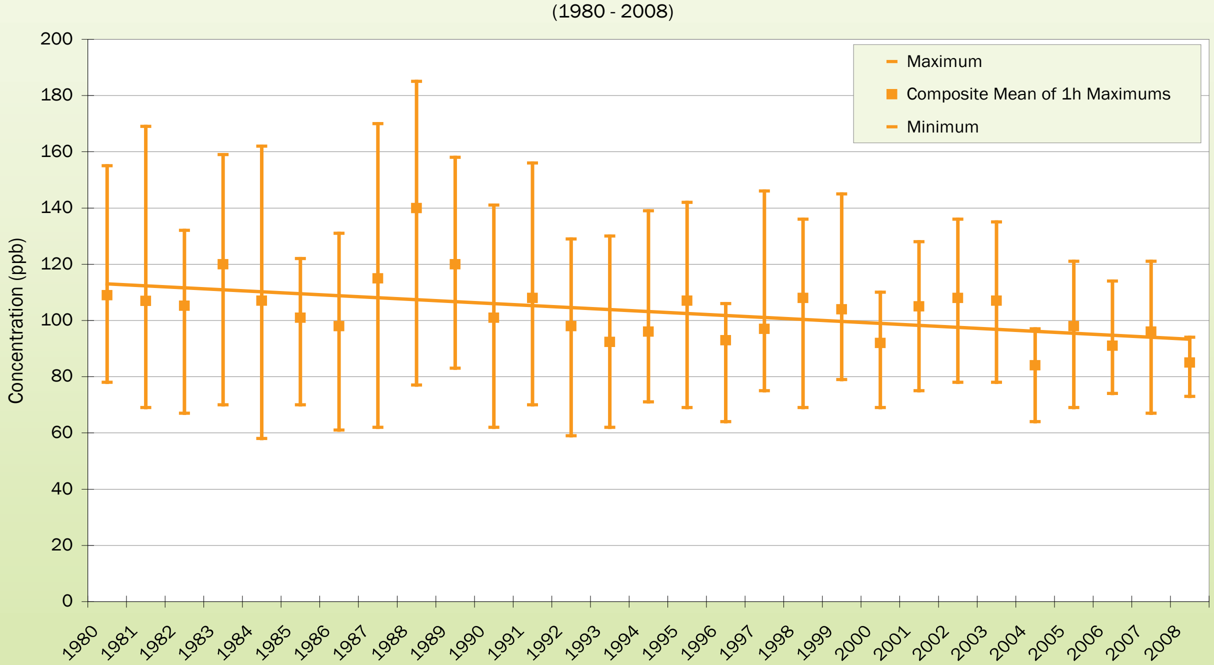


Figure 2.5
Range of Ozone One-Hour Maximum Concentrations in Ontario
(1980 - 2008)



Note: Based on data from 20 ambient ozone sites operated over 29 years.
Ontario 1h AAQC = 80 ppb.

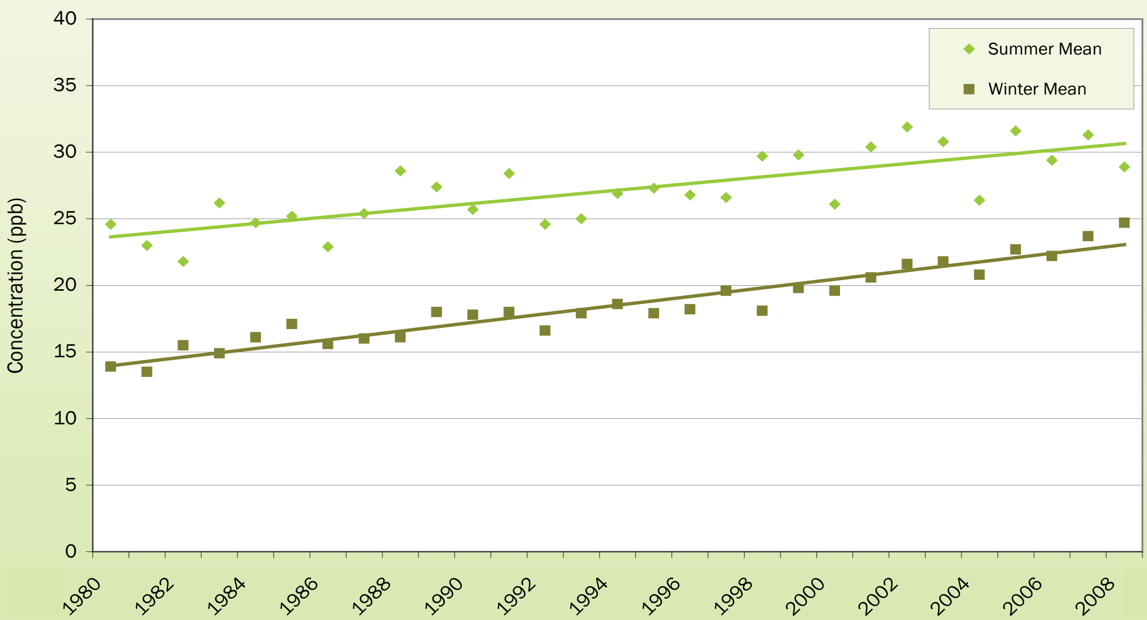
Trends

The range of the annual one-hour maximum ozone concentrations is shown for the 29-year period of 1980 to 2008 in Figure 2.5. For this period, the annual composite mean of the one-hour maximum concentrations ranges from a low of 84 ppb, recorded in 2004, to a high of 140 ppb, recorded in 1988. The composite one-hour maximum of 85 ppb recorded in 2008 is the second lowest on record. The data show random fluctuations year-to-year but an overall decreasing trend (17 per cent) in the annual composite means of the one-hour maximum ozone concentrations from 1980 to 2008 is evident. Over the past 10 years (1999 to 2008), the annual composite means of the one-hour maximum concentrations of ozone have decreased by approximately 14 per cent on average; most of this change has occurred over the last five years. This decrease is partly due to weather conditions less conducive for ozone production, and the 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.

The trend of the ozone seasonal composite means (summer and winter) as recorded at 19 long-term ozone sites for the period 1980 to 2008 is shown in Figure 2.6. It shows that there has been an increasing trend in the ozone seasonal composite means during the 29-year period where the ozone summer composite means have increased by approximately 30 per cent and the winter composite means by approximately 65 per cent. The ozone seasonal composite means differ by 11 ppb in 1980 and only 4 ppb in 2008. For the 10-year period, 1999 to 2008, summer composite means increased by approximately 3 per cent and winter composite means increased by approximately 23 per cent. The increases in summer and winter ozone composite means are mainly related to the reductions in NO_x emissions globally. Potential contributions to the increases in the summer composite means may also be related to meteorological factors and long-range transport of ozone and its precursors from the U.S.

In Figure 2.7, the ozone monthly means are compared for two locations for the period 1993 to 2008. This figure shows the typical behaviour of ozone levels throughout the year in northern and southern Ontario as represented by North Bay and London, respectively. The ozone monthly mean concentrations are higher in North Bay from October through to May. For the month

Figure 2.6
Trend of Ozone Seasonal Means at Sites Across Ontario
(1980 - 2008)



Note: Based on data from 19 ozone sites operated over 29 years.
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).

Figure 2.7
Trend of Ozone Monthly Means in North Bay and London, Ontario
(1993 - 2008)

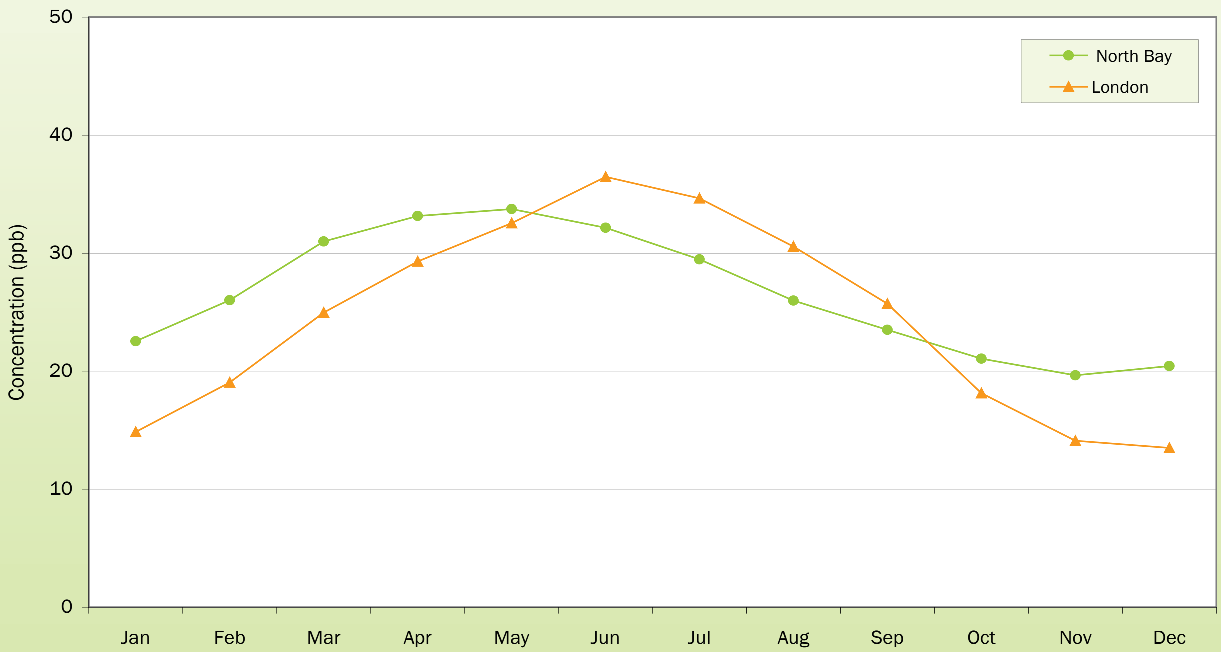
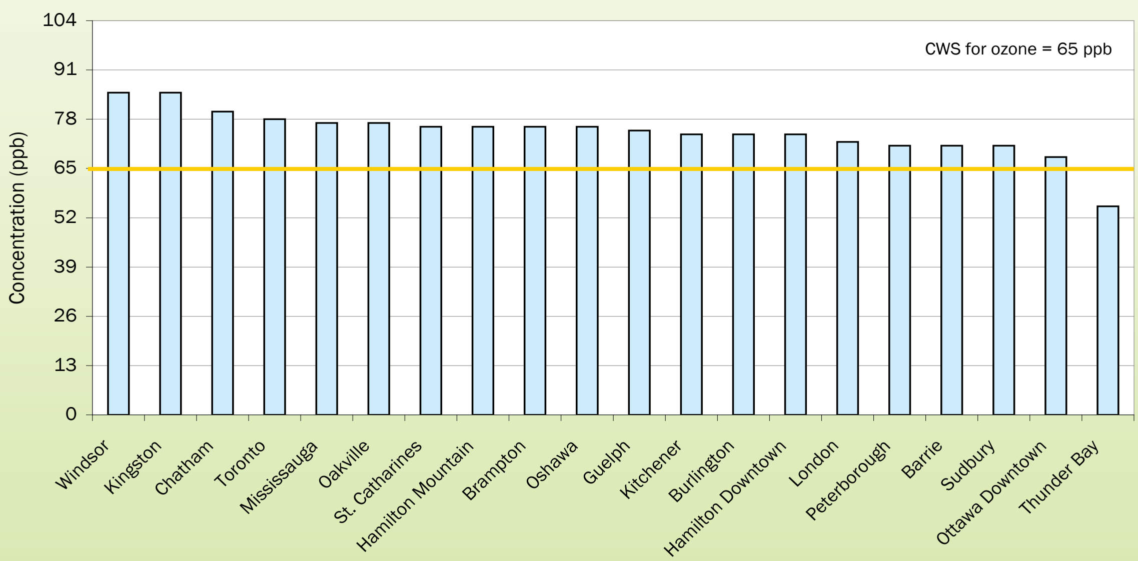


Figure 2.8
Ozone Levels at Designated CWS Sites Across Ontario
Based on the CWS for Ozone
(2006 - 2008)



Note: Displayed sites are based on requirements for Canada-wide Standard (CWS) reporting commencing in 2010.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
The CWS for ozone (65 ppb) is based on the 4th highest 8-hour running average over 3 consecutive years (2006 - 2008).
The value displayed for Mississauga is based on a 2-year average (2006-2007).

of January, the ozone mean concentration in North Bay is approximately 8 ppb greater than that observed in London. Among the possible scientific explanations, local emissions of nitric oxide are generally lower in the north, so there is less removal of ozone than in southern urban areas. Also, during late winter and early spring, there is greater potential for stratospheric ozone to be mixed into the lower troposphere in northern Ontario. During the summer months of June, July and August, the ozone mean concentrations in London are approximately 4 to 5 ppb greater than those reported in North Bay. It is more common for ozone and its precursors to be transported into southern Ontario from the mid-western U.S. during the summer months.

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 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.

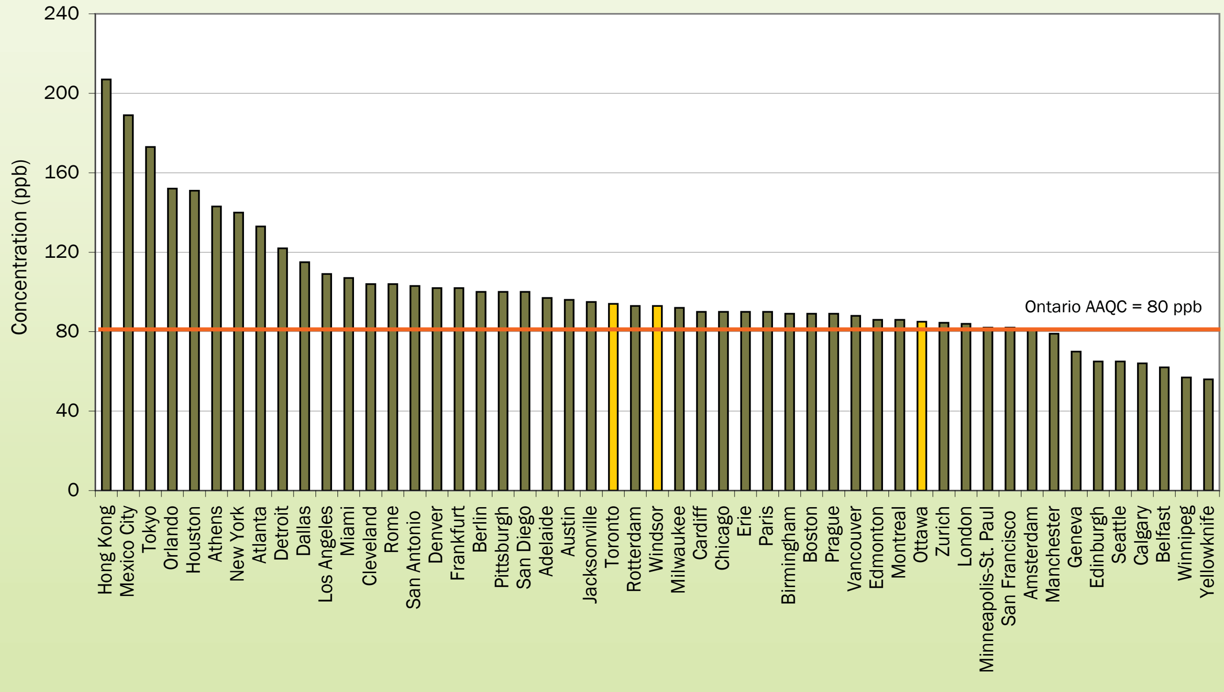
Figure 2.8 displays the 2008 concentrations for ozone based on the 4th highest ozone eight-hour daily maximum for designated CWS sites across Ontario. (The 2008 ozone concentrations in Figure 2.8 consist of an average over a three-year period, 2006 to 2008). All of the sites exceeded the CWS of 65 ppb for ozone, with the exception of Thunder Bay where its 2008 ozone concentration, based on the CWS metric, was 55 ppb. Table 2.1 displays the calculated CWS ozone metric for designated sites across Ontario from 2005 to 2008. The 2008 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)
Windsor	82	81	89	85
Chatham	n/a	86	86	80
London	74	70	73	72
Kitchener	79	74	77	74
Guelph	79	77	79	75
St. Catharines	81	75	81	76
Hamilton Downtown	77	72	76	74
Hamilton Mountain	82	76	80	76
Burlington	75	72	76	74
Oakville	81	74	80	77
Mississauga	80	75	80	77
Brampton	80	75	79	76
Toronto	81	75	80	78
Oshawa	n/a	77	80	76
Barrie	72	69	72	71
Peterborough	81	72	73	71
Kingston	77	77	89	85
Ottawa Downtown	69	67	71	68
Sudbury	76	74	77	71
Thunder Bay	58	57	57	55

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.

Figure 2.9
Ozone One-Hour Maximum Concentrations for Selected Cities World-wide
(2008)



How do Ontario cities compare world-wide?

Figure 2.9 displays the ozone one-hour maximum concentrations in 2008 for 51 cities around the world (see Figure 1.2 for city locations). Hong Kong recorded the highest ozone one-hour maximum reaching 207 ppb, followed by Mexico City and Tokyo at 189 ppb and 173 ppb, respectively. Yellowknife, in Canada, reported the lowest ozone one-hour maximum at 56 ppb. Forty-three cities world-wide exceeded Ontario's one-hour AAQC of 80 ppb, including Toronto, Windsor and Ottawa which reported ozone one-hour maximums of 94 ppb, 93 ppb and 85 ppb, respectively.

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

- If the average household cut its energy consumption by just six per cent, it would reduce annual greenhouse gas emissions by just over one tonne.
- A standard clothes dryer consumes 900 kilowatt-hours of energy per year, creating up to 840 kg of air pollution and greenhouse gases.

Chapter 3:

Fine Particulate Matter

PM$_{2.5}$ PM$_{2.5}$ PM$_{2.5}$ PM$_{2.5}$ PM$_{2.5}$ PM$_{2.5}$ PM$_{2.5}$

CHAPTER HIGHLIGHTS

- Overall concentrations of PM$_{2.5}$ in 2008, were 20 per cent lower than those in 2003.
- Provincial emissions of PM$_{2.5}$ in 2008 were 30 per cent lower than those in 1999.
- In 2008, all of the 20 designated CWS reporting sites for PM$_{2.5}$ were below the CWS of 30 $\mu g/m^3$.

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 (or respirable particles), denoted as PM$_{2.5}$, refers to particles that are 2.5 microns in diameter and less that may 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 from 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 ambient monitoring results from Ontario's PM$_{2.5}$ monitoring network.

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 through fuel combustion such as 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 2007 estimates of Ontario's primary PM$_{2.5}$ emissions from point, area and transportation sources. The residential and transportation sectors accounted for 37 per cent and 23 per cent of PM$_{2.5}$ emissions, respectively, whereas industrial processes accounted for 34 per cent.

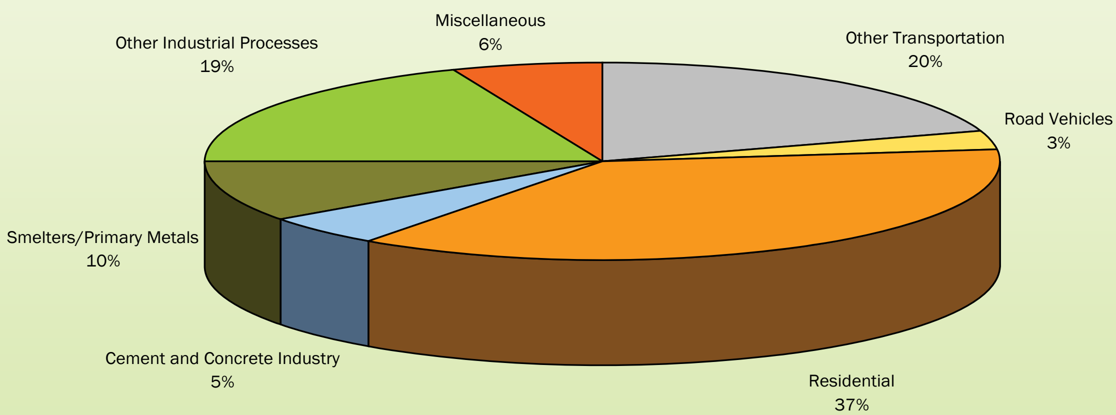
Significant amounts of PM$_{2.5}$ measured in southern Ontario are of secondary formation and of transboundary origin. During periods of elevated concentrations of PM$_{2.5}$ in Ontario, it is estimated that there are significant contributions from the U.S., specifically to border communities, such as 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.

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.

Monitoring results in 2008

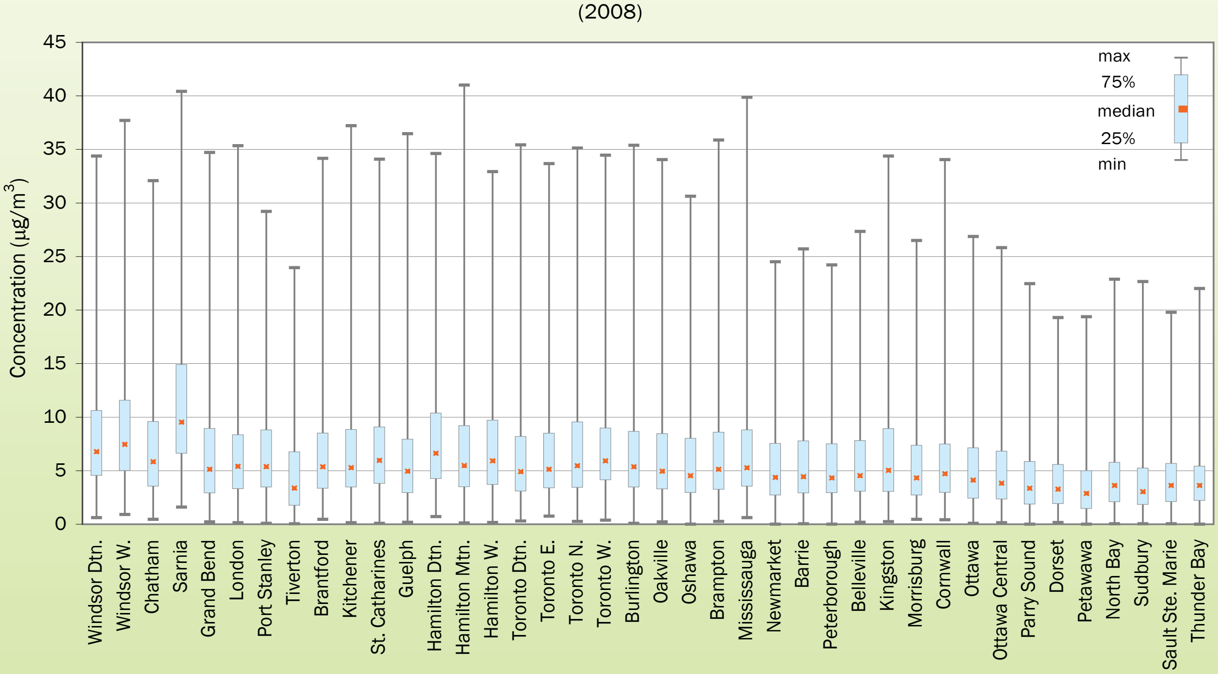
In 2008, each of Ontario's 40 ambient air monitoring sites operated a Tapered Element Oscillating Microbalance (TEOM) instrument with a Sample Equilibration System (SES) set at 30°C to measure the PM$_{2.5}$ concentrations on an hourly basis. The 2008 annual summary statistics for 24-hour PM$_{2.5}$ for sites across Ontario are shown in

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2007 Estimates)



Note: 2007 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 3.2
Annual Statistics for 24-Hour Average $PM_{2.5}$ Across Ontario
(2008)



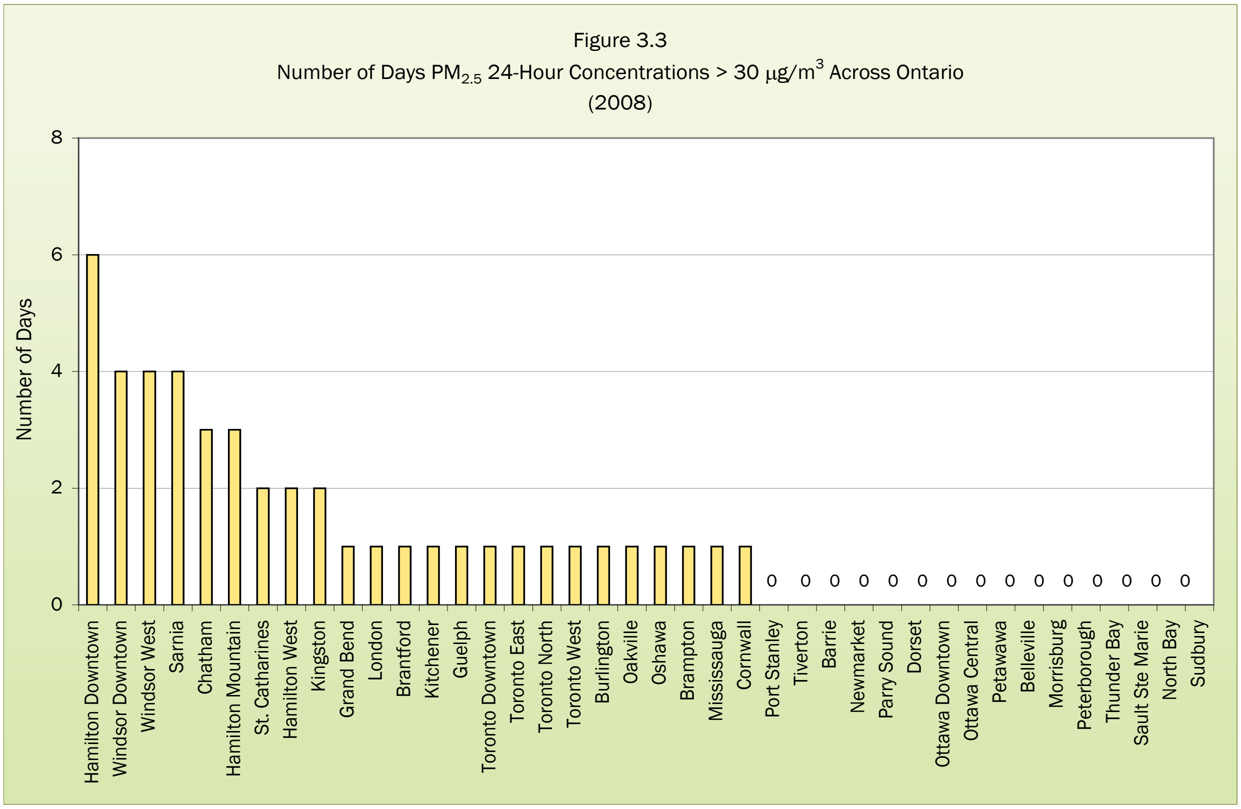


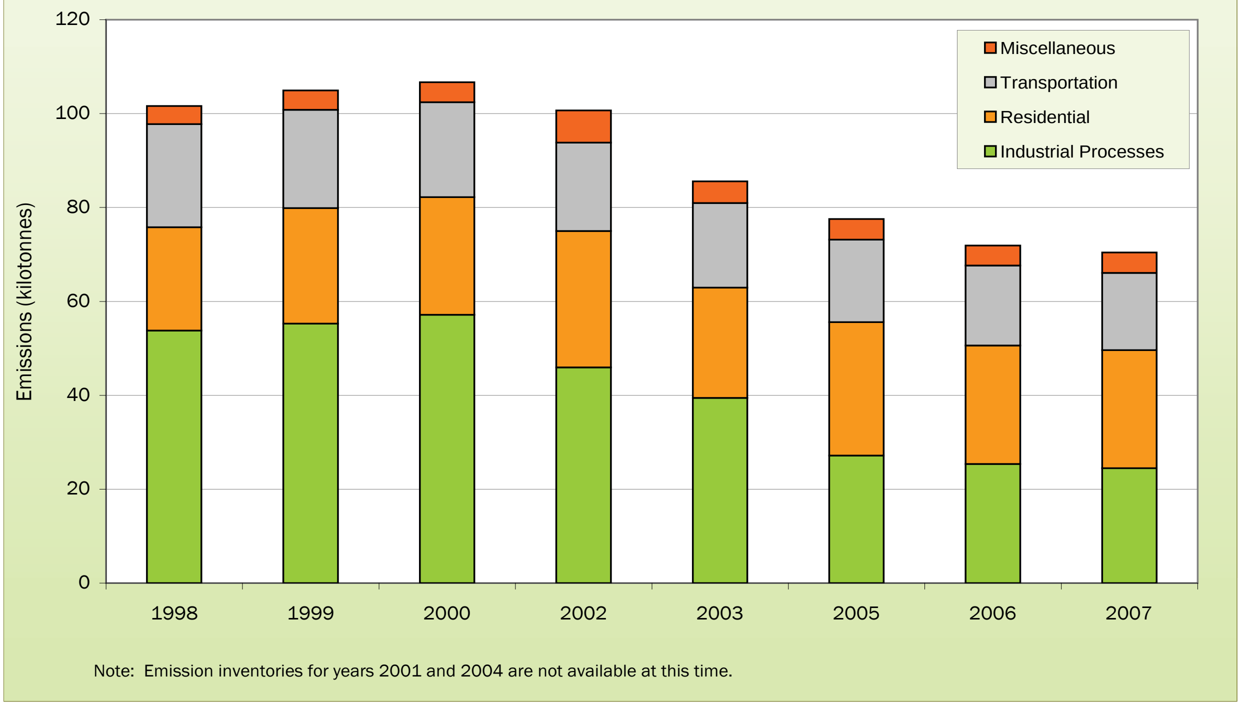
Figure 3.2. The annual mean concentrations ranged from 3.9 micrograms per cubic metre (µg/m³) in Petawawa to 11.4 µg/m³ in Sarnia. The 24-hour $PM_{2.5}$ maximum concentrations measured at urban sites ranged from 20 µg/m³ in Sault Ste. Marie to 41 µg/m³ at Hamilton Mountain; and at rural sites ranged from 19 µg/m³ at both Dorset and Petawawa to 35 µg/m³ in Grand Bend.

Figure 3.3 shows the number of days when $PM_{2.5}$ 24-hour concentrations were greater than 30 µg/m³ across Ontario. The $PM_{2.5}$ reference level of 30 µg/m³ for a 24-hour period was exceeded at 24 of the 40 sites in 2008. Downtown Hamilton recorded six days, the highest number of days in Ontario with 24-hour $PM_{2.5}$ concentrations greater than 30 µg/m³. The provincial annual composite mean for $PM_{2.5}$ during 2008 was 6.4 µg/m³ which is a decrease of approximately 1 µg/m³ when compared to 2007. There has been an overall 20 per cent decrease since 2003 as shown in Figure 3.4. The slight increase in the 2005 provincial 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.

Right: The TEOM at the Belleville air monitoring site.

Figure 3.4
Provincial Annual Composite Mean $PM_{2.5}$ Concentrations
(2003 - 2008)

Figure 3.5
Ontario $PM_{2.5}$ Emission Trend
(1998 - 2007)



Overall, provincial $PM_{2.5}$ emissions have decreased approximately 30 per cent from 1998 to 2007, as shown in Figure 3.5. Fine particlulate emissions from industrial processes have been reduced by over 50 per cent over the 10-year period from 1998 to 2007. Emissions from the transportation sector show a gradual decrease with the phase-in of new vehicles/engines with more stringent emission standards over the same period.

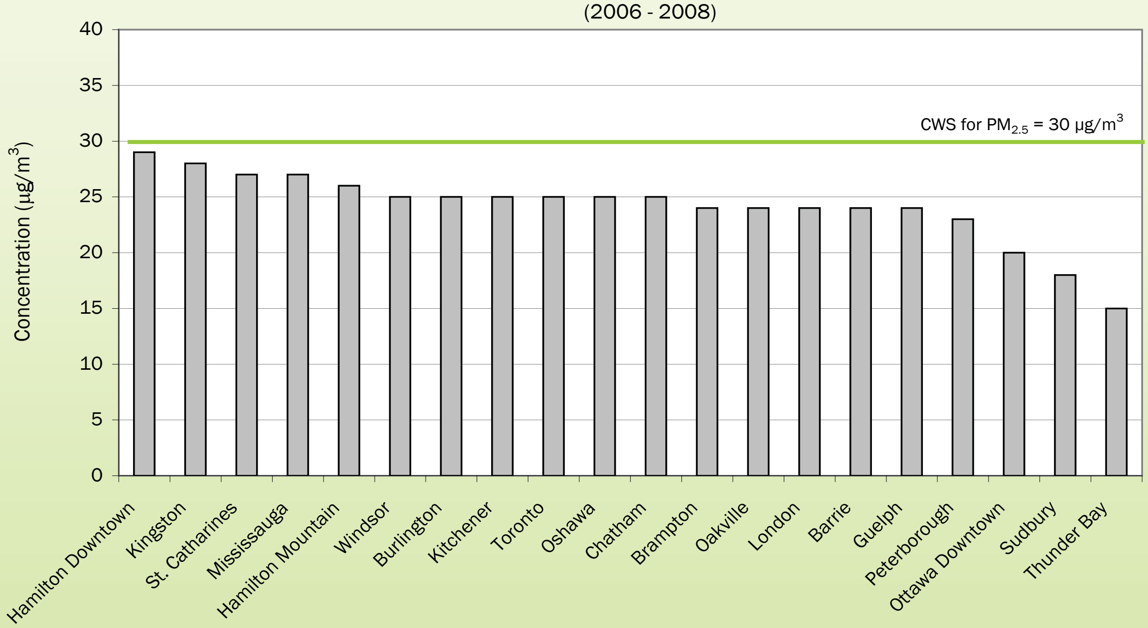
Smog-causing pollutants come from many sources including fossil fuels to run our vehicles and produce energy. The easiest ways to reduce our contribution to smog are to reduce our use of gas-powered vehicles and conserve our energy use.

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

In 2000, the Canadian Council of Ministers of the Environment 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 98^{th} percentile annual ambient measurement averaged over three consecutive years. Jurisdictions are required to meet the CWS by 2010 and commence reporting by year 2011. In the interim, comprehensive reporting on progress toward meeting the CWS for $PM_{2.5}$ commenced in 2006.

Figure 3.6 displays the 2008 concentrations for $PM_{2.5}$ based on the 98th percentile of the daily average for 20 designated CWS sites across Ontario. (The 2008 $PM_{2.5}$ concentrations in Figure 3.6 consist of an average over a three-year period, 2006 to 2008). The concentrations, based on the CWS metric for $PM_{2.5}$, ranged from 29 $\mu g/m^3$ in Hamilton Downtown to 15 $\mu g/m^3$ in Thunder Bay. The CWS target of 30 $\mu g/m^3$ was not exceeded at any of the CWS designated sites. Table 3.1 displays the calculated CWS $PM_{2.5}$ metric for designated CWS sites across Ontario from 2005 to 2008. The 2008 CWS $PM_{2.5}$ metrics are consistently lower than the metrics reported in 2005.

Figure 3.6
$PM_{2.5}$ Levels at Designated CWS Sites Across Ontario
Based on the CWS for $PM_{2.5}$
(2006 - 2008)



Note: Displayed sites are based on requirements for Canada-wide Standard (CWS) reporting commencing in 2010.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
The CWS for $PM_{2.5}$ (30 $\mu g/m^3$) is based on the 24-hour, 98th percentile, annual ambient measurement averaged over 3 years (2006 -

On the Road: Did you know...?

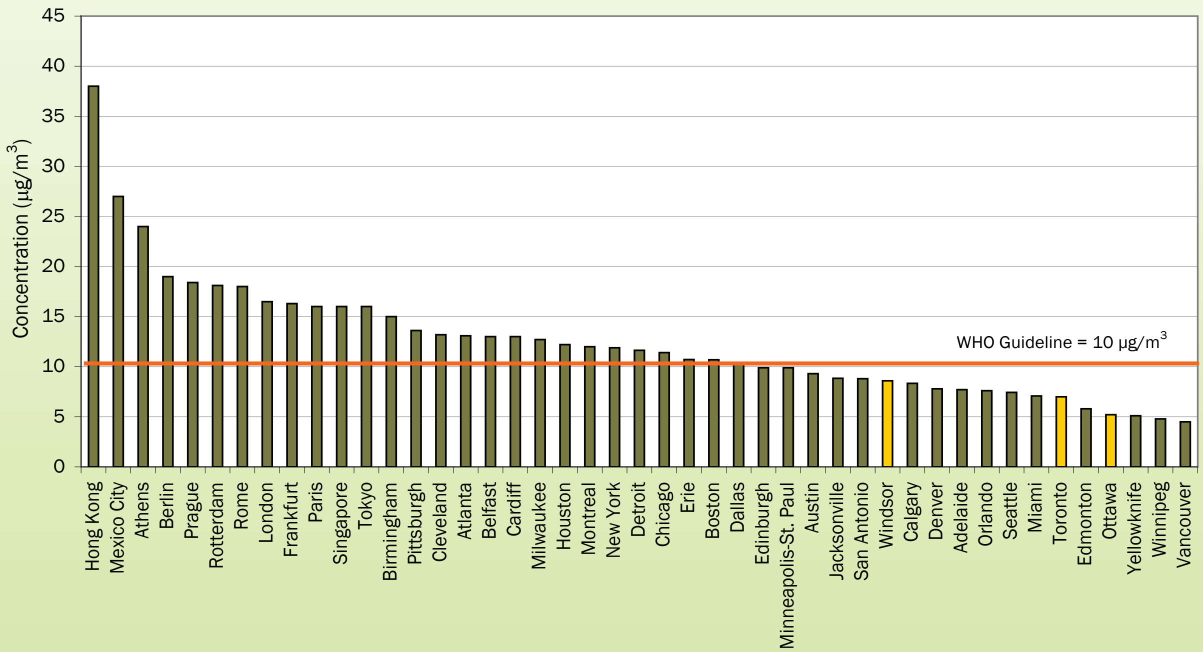
- One poorly tuned vehicle can emit as much pollution as 20 properly tuned cars.
- The average total cost of driving one kilometre in Canada is 46 cents per person. On public transit, this cost drops to 12 cents.
- A well-maintained car runs better and pollutes less. Shut the engine off, even for short 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 at 100 km/h.

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 ($\mu g/m^3$)
Windsor	31	29	29	25
Chatham	n/a	28	28	25
London	34	32	28	24
Kitchener	34	30	29	25
Guelph	34	30	28	24
St. Catharines	29	30	31	27
Hamilton Downtown	34	32	32	29
Hamilton Mountain	32	31	29	26
Burlington	30	29	28	25
Oakville	34	30	28	24
Mississauga	34	32	29	27
Brampton	31	29	28	24
Toronto	33	31	30	25
Oshawa	n/a	29	29	25
Barrie	30	29	28	24
Peterborough	28	29	28	23
Kingston	n/a	n/a	30	28
Ottawa Downtown	30	26	25	20
Sudbury	n/a	20	21	18
Thunder Bay	n/a	n/a	16	15

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.

Figure 3.7
$PM_{2.5}$ Annual Means for Selected Cities World-wide
(2008)



How do Ontario cities compare world-wide?

Figure 3.7 displays the $PM_{2.5}$ annual means in 2008 for 45 cities from around the world (see Figure 1.2 for city locations). The $PM_{2.5}$ annual means are based on both continuous and non-continuous measurements. Monitoring methods and instrument operations may vary between cities; therefore, comparisons among cities are not intended to be used as a comprehensive ranking. Hong Kong reported the highest annual mean $PM_{2.5}$ concentration (38 $\mu g/m^3$) for 2008 and Vancouver recorded the lowest annual mean $PM_{2.5}$ concentration (4.5 $\mu g/m^3$). Of the 45 selected cities world-wide, 27 exceeded the WHO guideline of 10 $\mu g/m^3$. The Ontario cities, Windsor, Toronto, Ottawa, all recorded annual means below the WHO guideline.

What can I do to help?

- Consider joining a citizens' committee to advocate for cleaner air in your community.
- Spend time talking with your children about the importance of a sustainable lifestyle.

Chapter 4:

Other Air Pollutants

CHAPTER HIGHLIGHTS

- Nitrogen dioxide levels in Ontario have decreased by 35 per cent over the last decade and correspondingly, provincial emissions have decreased by 30 per cent over the 1998 to 2007 period.
- Typically, higher CO concentrations are measured in major urban centres as a result of vehicle emissions; as such, the transportation sector accounted for 87 per cent of all CO emissions based on 2007 estimates.
- Since 1971, provincial SO_2 annual means have decreased by 89 per cent and similarly, provincial SO_2 emissions have been reduced by 87 per cent.

Characteristics, sources and effects of nitrogen dioxide, carbon monoxide and sulphur dioxide are discussed in this chapter, as well as their ambient concentrations during 2008 and, where appropriate, trends, including emissions, over time. A comparison of pollutant concentrations from an international perspective is also presented.

NITROGEN DIOXIDE

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 nitrogen oxides, of which NO_2 is a component. Major sources of NO_x emissions include the transportation sector, utilities and other industrial processes. Ontario's nitrogen oxides emission estimates by sector are displayed in Figure 2.3 of Chapter 2.

Nitrogen dioxide can irritate the lungs and lower the 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.

Monitoring results for 2008

Nitrogen dioxide annual means across Ontario are displayed in Figure 4.1. The Toronto West site, located in an area of Toronto influenced by significant vehicular traffic, recorded the highest annual mean (20.8 ppb) for NO_2 during 2008, whereas Tiverton, a rural site, recorded the lowest NO_2 annual mean (3 ppb). Typically, the highest NO_2 means are recorded in large urbanized areas, such as the Golden Horseshoe area of southern Ontario including the GTA. The Toronto West air monitoring station also recorded the highest 24-hour average concentration (49 ppb), and the Barrie site recorded the highest one-hour concentration (86 ppb) in 2008. 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 2008.

Figure 4.1
Nitrogen Dioxide Annual Means Across Ontario
(2008)

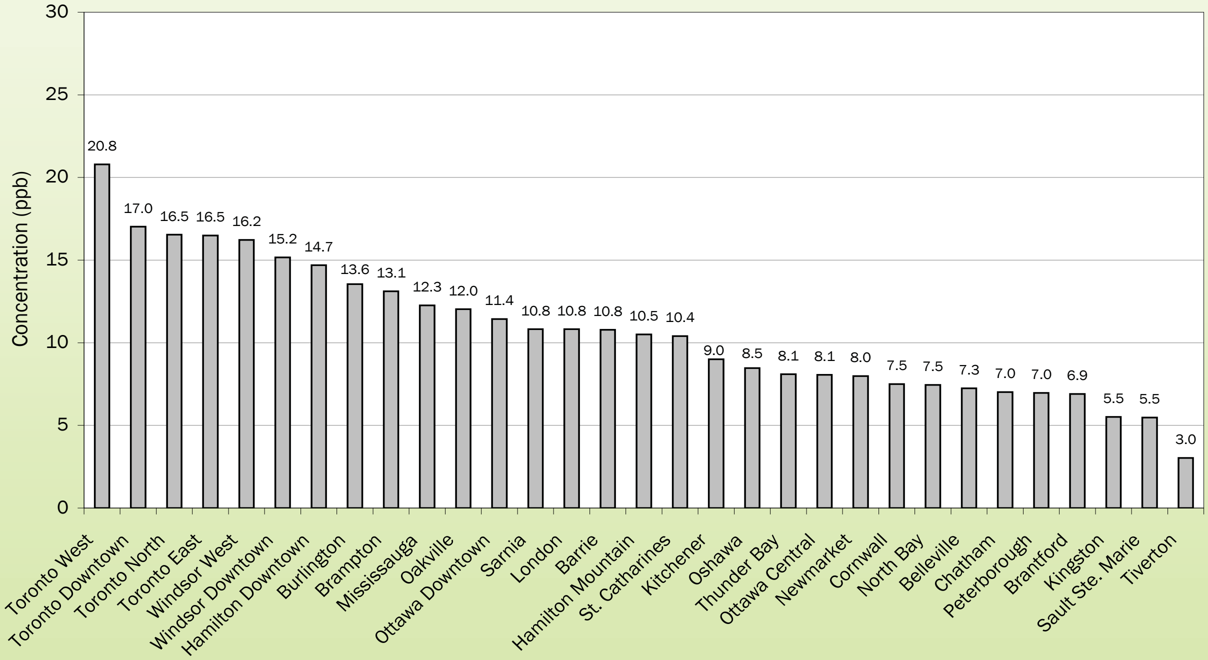
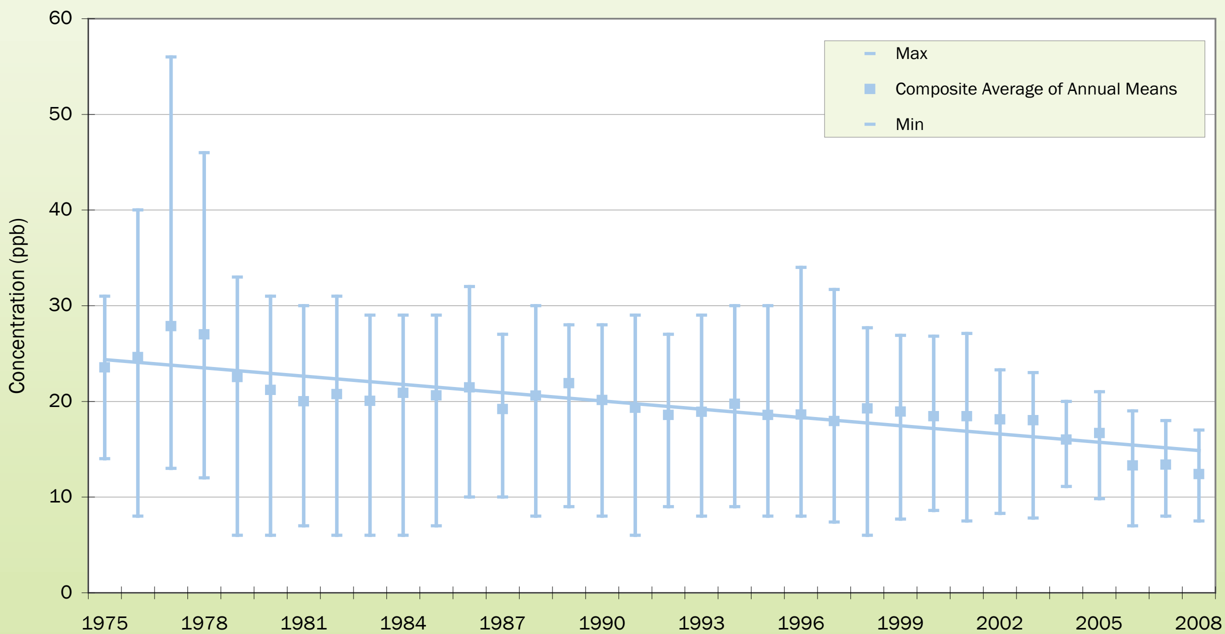
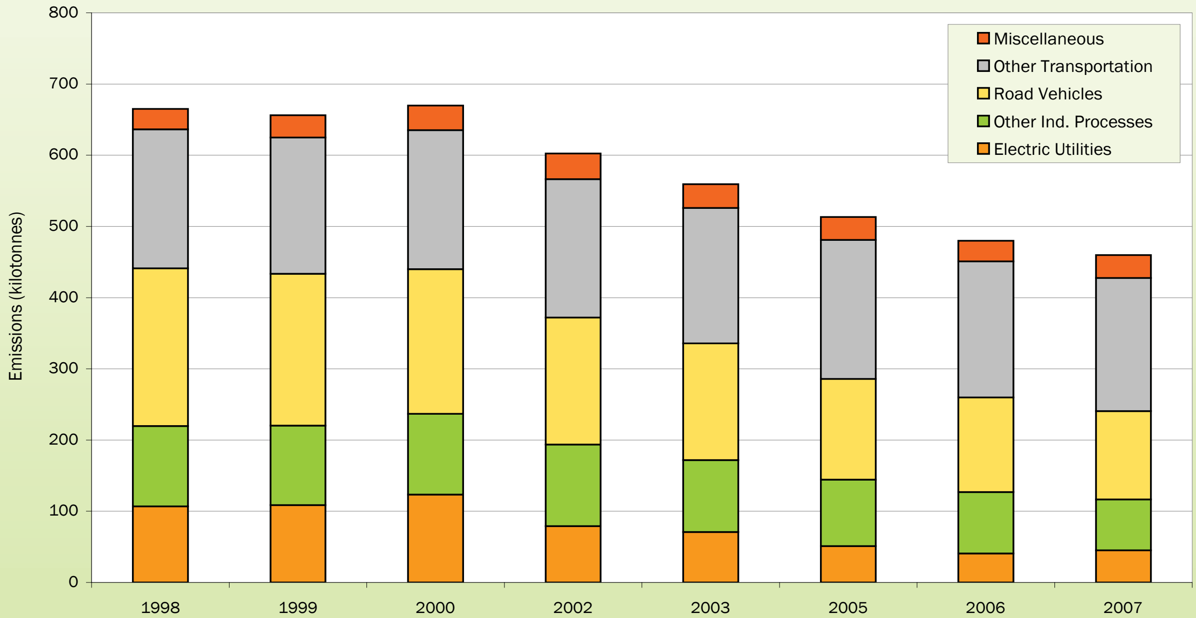


Figure 4.2
Range of Nitrogen Dioxide Annual Means in Ontario
(1975 - 2008)



Note: Annual composite mean based on 15 ambient sites operated over 34 years.

Figure 4.3
Ontario Nitrogen Oxides Emission Trend
(1998 - 2007)



Note: Emission inventories for years 2001 and 2004 are not available at this time.

Trends

The trend of the composite annual means for ambient NO_2 concentrations shows a decreasing trend from 1975 to 2008 as displayed in Figure 4.2. Average concentrations decreased by approximately 39 per cent over the 34-year period and 35 per cent over the last decade, 1999 to 2008.

Figure 4.3 displays the NO_x emission trend from 1998 to 2007. Overall, NO_x emissions have decreased approximately 30 per cent from 1998 to 2007. 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 NO_x 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.

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.

How do Ontario cities compare world-wide?

Figure 4.4 displays the NO_2 annual mean concentrations in 2008 for 53 cities world-wide (see Figure 1.2 for city locations). Mexico City reported the highest NO_2 annual mean of 31.0 ppb. Nine sites, including Mexico City, exceeded the WHO guideline of 21 ppb. Toronto, Windsor and Ottawa reported NO_2 annual means of 17.7 ppb, 15.7 ppb and 9.8 ppb, respectively. Yellowknife recorded the lowest NO_2 annual mean of 2.0 ppb. Large urban centres typically experience higher NO_2 levels due to increased energy use and motor vehicle emissions.

CARBON MONOXIDE

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 4.5, the transportation sector accounted for 87 per cent of all CO emissions.

Monitoring results for 2008

In 2008, the highest one-hour maximum CO value, 3.33 ppm, was measured at the Hamilton Downtown site and the highest eight-hour maximum CO value, 1.16 ppm, was measured at the Toronto West site, which is located near a main highway. 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.

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.

Figure 4.4
Nitrogen Dioxide Annual Means for Selected Cities World-wide
(2008)

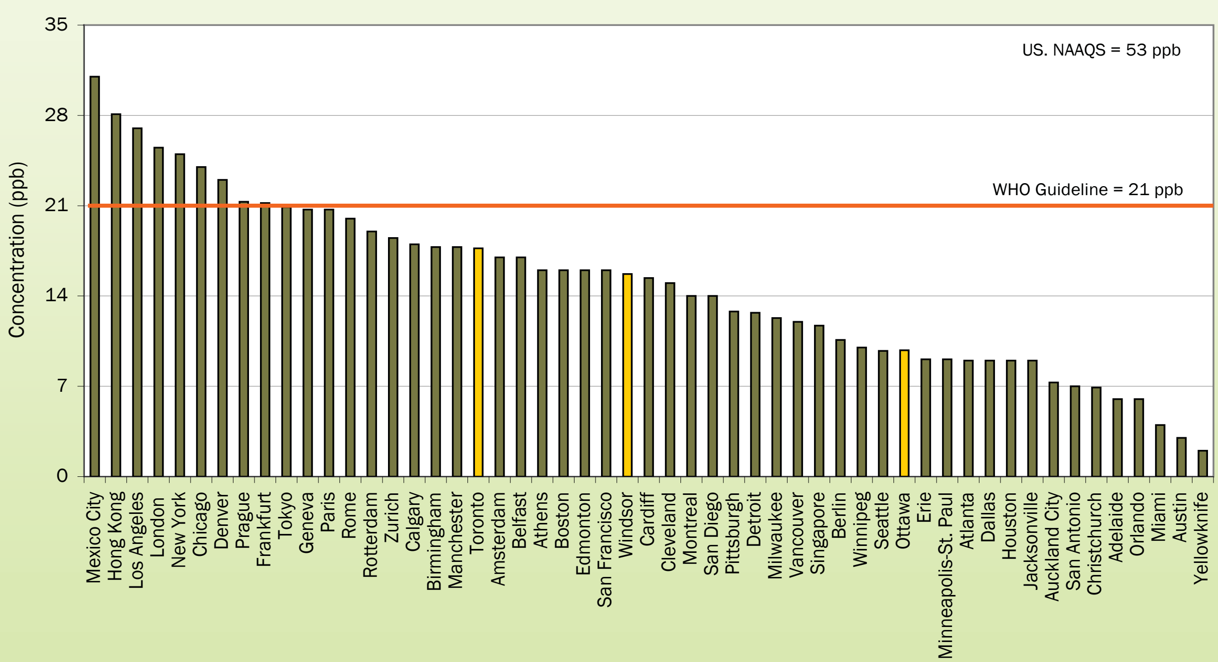
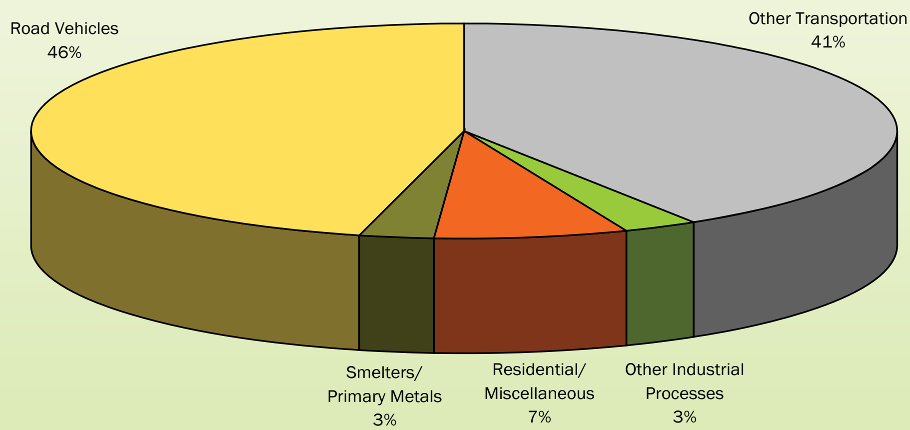
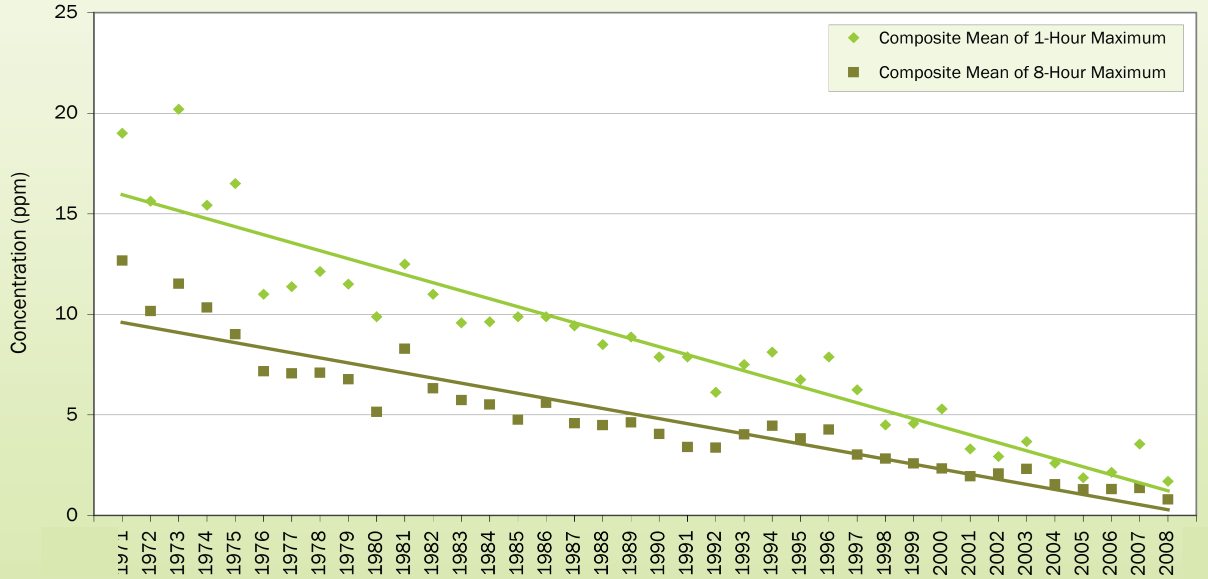


Figure 4.5
Ontario Carbon Monoxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2007 Estimates)



Note: 2007 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 4.6
Trends of Carbon Monoxide One-Hour and Eight-Hour Maximums in Ontario
(1971 - 2008)



Note: Data are based on eight ambient CO sites operated over 38 years.
Ontario's 1-hour AAQC = 30 ppm.
Ontario's 8-hour AAQC = 13 ppm.

Trends

The trends in provincial composite mean of one-hour and eight-hour maximum CO concentrations from 1971 to 2008 are shown in Figure 4.6. Ambient CO concentrations, as measured by the composite mean of the one-hour and eight-hour maximums, decreased by approximately 93 per cent and 97 per cent, respectively, over this 38-year period. Over the last decade, there has been a decrease in the composite mean of the one-hour and eight-hour maximums of approximately 66 per cent and 68 per cent, respectively, while CO emissions, as shown in Figure 4.7, have been reduced by approximately 29 per cent from 1998 to 2007.

How do Ontario cities compare world-wide?

Figure 4.8 displays the one-hour maximum CO concentrations in 2008 for 45 cities world-wide (see Figure 1.2 for city locations). Mexico City and Jacksonville reported the two highest CO one-hour maximums at 9.8 ppm and 8.7 ppm, respectively. Christchurch recorded the lowest CO maximum <1 ppm. Toronto, Ottawa and Windsor reported one-hour maximum CO values of 1.7 ppm, 1.6 ppm and 1.3 ppm, respectively. There were no exceedances of the one-hour Ontario AAQC or the U.S. NAAQS at any of the cities examined in 2008.

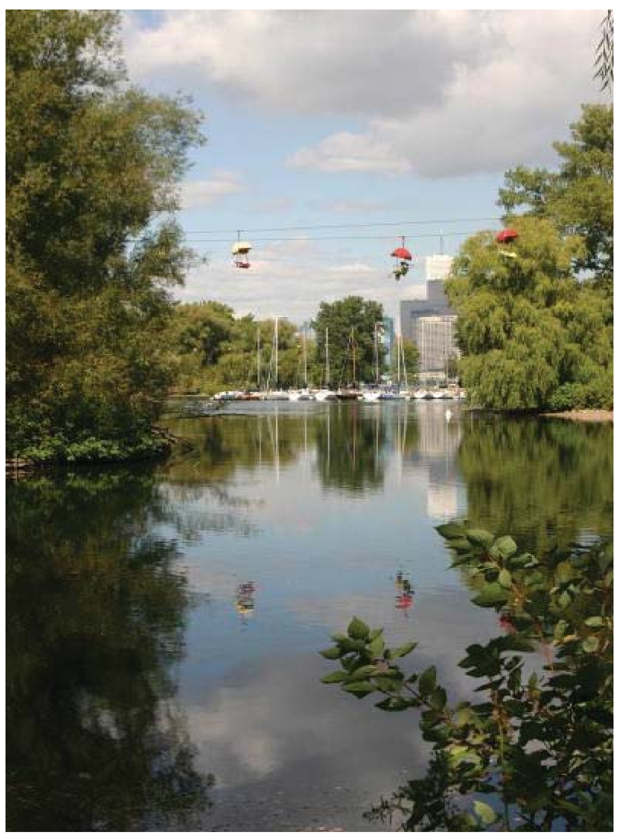
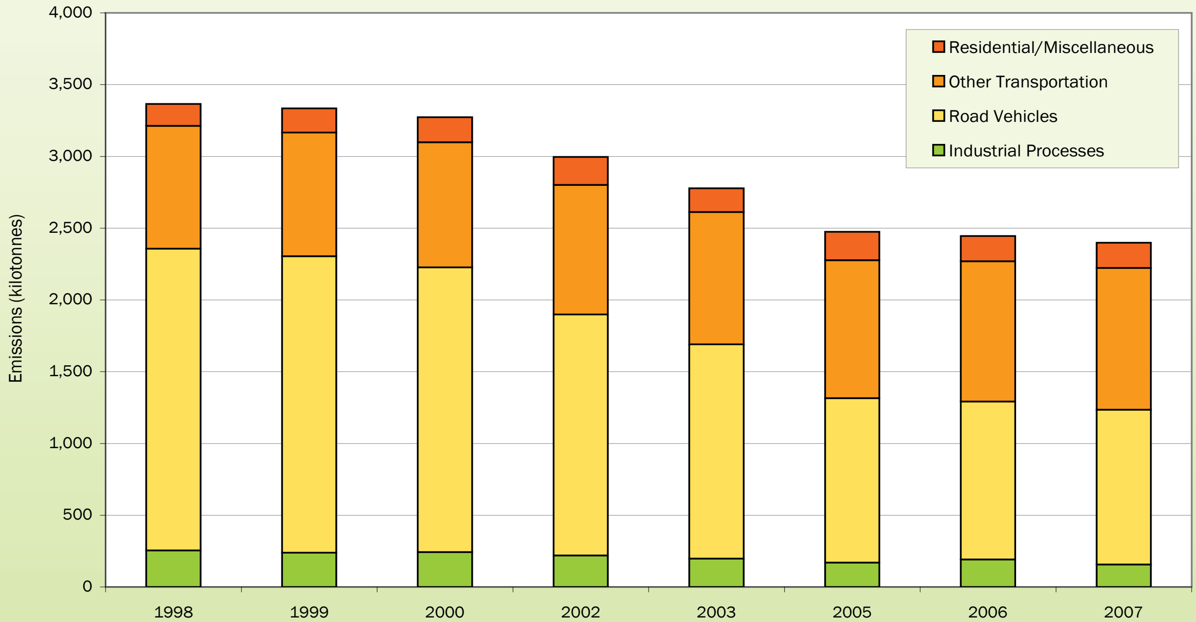
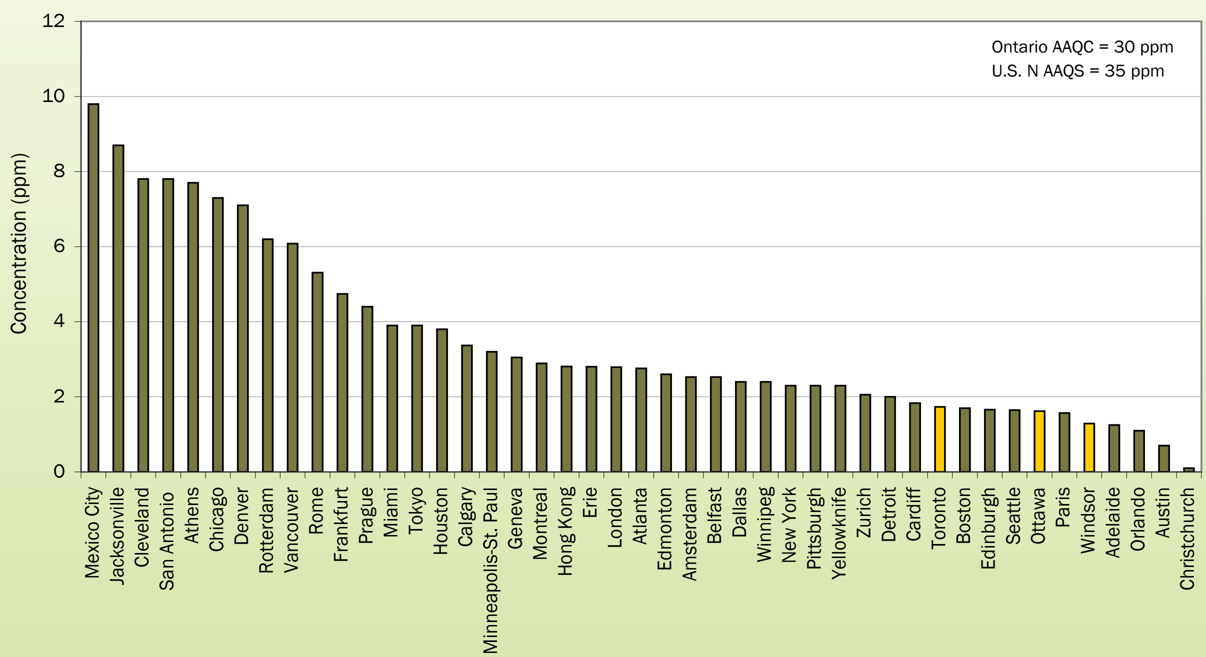


Figure 4.7
Ontario Carbon Monoxide Emission Trend
(1998 - 2007)



Note: Emission inventories for years 2001 and 2004 are not available at this time.

Figure 4.8
Carbon Monoxide One-Hour Maximum Concentrations for Selected Cities World-wide
(2008)



SULPHUR DIOXIDE

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 accounting for approximately 69 per cent of the provincial SO_2 emissions as shown in Figure 4.9. Downstream petroleum industry, cement and concrete, and other industrial processes accounted for an additional 24 per cent. The transportation sector and miscellaneous sources accounted for the remaining 7 per cent of all SO_2 emissions.

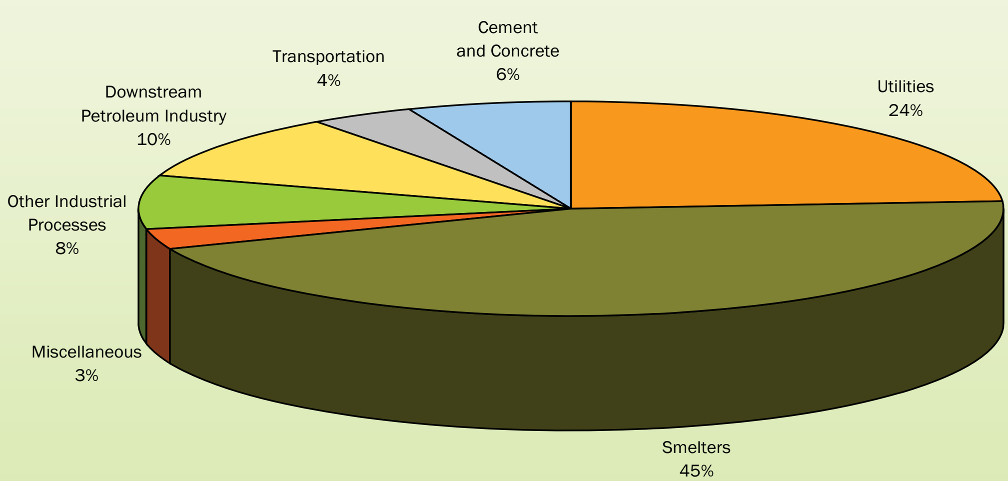
Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, and the exacerbation of respiratory and cardiovascular disease. People with asthma, chronic lung disease or heart disease are the most sensitive to SO_2. Sulphur dioxide also damages trees and crops. 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.

Monitoring results for 2008

Sarnia recorded the highest annual mean (7.7 ppb), one-hour maximum concentration (450 ppb) and 24-hour maximum concentration (194 ppb) of SO_2 during 2008. 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 criterion (250 ppb) for SO_2 was exceeded for five hours, and the 24-hour criterion (100 ppb) for SO_2 was exceeded on two occasions at the Sarnia site in 2008.

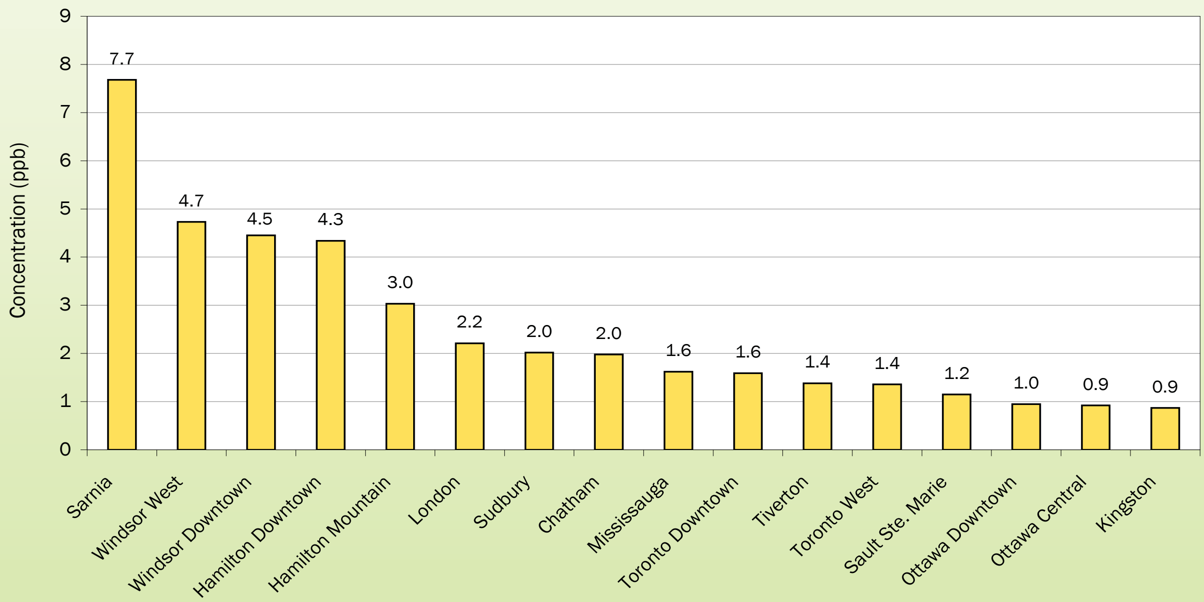
The SO_2 annual means at ambient AQI sites across Ontario are displayed in Figure 4.10. As mentioned previously, Sarnia recorded the highest annual mean in 2008. The annual mean levels across the province ranged from 0.9 ppb at the Kingston and Ottawa Central sites to 7.7 ppb in Sarnia. The annual mean criterion of 20 ppb for SO_2 was not exceeded at any site in Ontario during 2008.

Figure 4.9
Ontario Sulphur Dioxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2007 Estimates)



Note: 2007 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 4.10
Sulphur Dioxide Annual Means Across Ontario
(2008)



Note: Data collected from ambient sites.
Ontario's annual AAQC = 20 ppb.

Trends

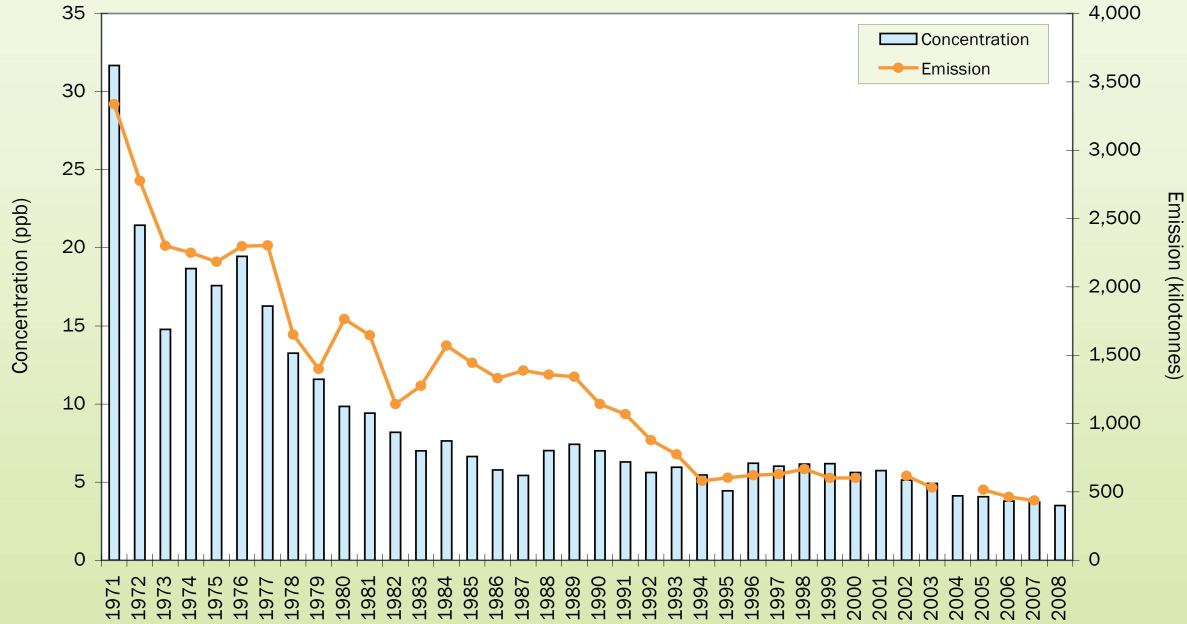
Figure 4.11 shows the measured composite annual means for ambient SO_2 concentrations from 1971 to 2008 and the SO_2 emissions from 1971 to 2007. Since 1971, the composite annual mean for SO_2 in 2008 has decreased by 89 per cent and correspondingly, the provincial SO_2 emissions have been reduced by approximately 87 per cent. Over the last decade, there has been a decrease of approximately 46 per cent in SO_2 concentrations, while SO_2 emissions have been reduced by approximately 35 per cent from 1998 to 2007. The reduction of SO_2 emissions over the years is the result of various initiatives which include but are not limited to,

- control orders for Ontario smelters;
- Countdown Acid Rain program;
- Ontario's emissions trading regulations on sulphur dioxide and nitrogen oxides (O. Reg. 397/01 and O. Reg. 194/05);
- phase-out of coal-fired generating stations, with Lakeview Thermal Generating Station shut down in 2005; and
- low sulphur content in transportation fuels.

How do Ontario cities compare world-wide?

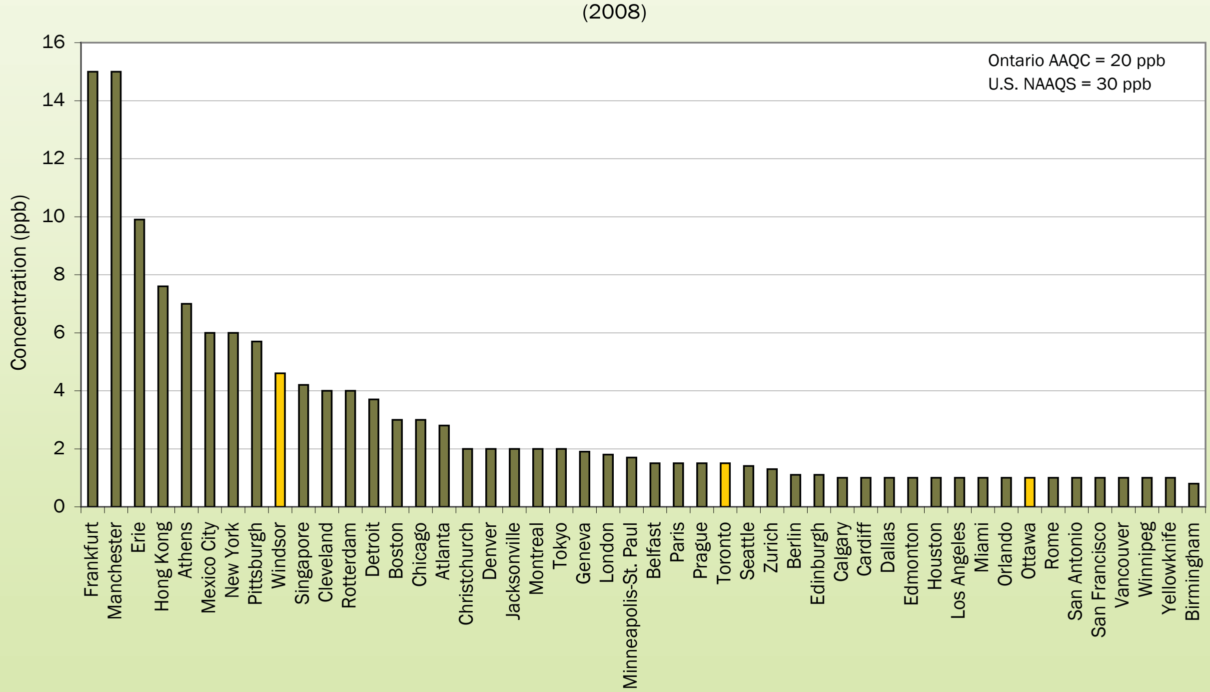
Figure 4.12 displays the SO_2 annual mean concentrations in 2008 for 48 cities world-wide (see Figure 1.2 for city locations). Frankfurt and Manchester reported the highest annual mean (15.0 ppb) whereas Birmingham recorded the lowest SO_2 annual mean (less than 1 ppb) in 2008. The Ontario cities included here, Windsor, Toronto and Ottawa, reported annual mean levels of 4.6 ppb, 1.5 ppb and 1.0 ppb, respectively. All reported cities were below the Ontario annual AAQC of 20 ppb and the U.S. annual NAAQS of 30 ppb.

Figure 4.11
Ontario Sulphur Dioxide Annual Mean Concentrations and Emission Trend
(1971 - 2008)



Note: Emission inventories for years 2001, 2004 and 2008 are not available at this time.
Annual composite mean based on 10 ambient sites operated over 38 years.

Figure 4.12
Sulphur Dioxide Annual Means for Selected Cities World-wide
(2008)



Chapter 5:

Air Quality Index, Smog Advisories and Smog Episodes

CHAPTER HIGHLIGHTS

- Overall, AQI readings were reported in the ***very good*** and ***good*** categories 92 per cent of the time in 2008.
- The year 2008 tied the record for the lowest number of smog advisories at 17 days.
- In 2008, Ontario experienced significantly less transboundary and regionally polluted air because of the cool, wet, unsettled weather conditions inhibiting smog formation.

This chapter focuses on the Air Quality Index (AQI), smog advisories and briefly examines smog episodes in 2008. The ministry's AQI program was established in 1988, and originally included ozone, NO_2, SO_2, CO, suspended particles (SP), and total reduced sulphur (TRS) compounds. On August 23, 2002, the ministry replaced SP with $PM_{2.5}$ in the AQI, 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 issued today.

Air Quality Indices

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2008, 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 site, the highest sub-index for any given hour becomes the AQI reading for that hour. The index is a relative scale, in that, the lower the index, the better the air quality. The index values, corresponding categories, and potential health and environmental effects, are shown in Table 5.1.

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

Computed hourly AQI values in near real-time and air quality forecasts are released to the public and news media at set times each day. 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.

www.airqualityontario.com

Figure 5.1
Air Quality Index (AQI) Monitoring Sites in Ontario
(2008)

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.

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 2008 reported air quality in the very good and good categories approximately 92 per cent of the time and moderate to poor categories about 8 per cent of the time. The highest percentage of hours in the moderate to poor categories was reported in southwestern Ontario. Sarnia recorded approximately 14 per cent of the reported hours in the moderate to poor categories. There were 15 poor air quality days (days with at least one hour in the poor category) in Sarnia, which was the highest number of days recorded in the province during 2008. The London site recorded approximately 8 per cent of air quality in the moderate to poor categories and five poor days. In central Ontario, including Toronto, the highest number of poor days (five), was recorded at three sites, Brampton, Toronto West and Toronto Downtown. In eastern Ontario, Ottawa Downtown did not record air quality readings above the moderate category. The Ottawa Central site recorded poor air quality on one day and Kingston recorded six

Table 5.2: Air Quality Index Summary (2008)

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	8719	36.8	51.6	11.2	0.3	0	8
Windsor West	8779	36.6	51.6	11.5	0.3	0	7
Chatham	8782	29.9	58.3	11.5	0.3	0	9
Port Stanley	8776	22.7	63.0	13.9	0.4	0	7
London	8778	38.0	54.0	7.9	0.1	0	5
Sarnia	8782	20.7	65.1	13.6	0.5	0	15
Grand Bend	8763	25.2	65.5	9.0	0.3	0	7
Tiverton	8723	22.2	70.5	7.2	0.1	0	3
Brantford	8758	32.3	57.7	9.9	0.1	0	3
Kitchener	8760	32.5	58.2	9.2	0.1	0	2
Guelph	8775	34.3	57.3	8.4	0.1	0	2
St. Catharines	8773	33.8	57.5	8.6	0.1	0	3
Hamilton Mountain	8776	31.8	57.6	10.4	0.3	0	4
Hamilton West	8770	41.6	51.0	7.3	0.1	0	3
Hamilton Downtown	8775	39.0	51.4	9.4	0.2	0	4
Burlington	8772	41.5	51.2	7.2	0.1	0	2
Oakville	8561	36.4	55.8	7.7	0.2	0	2
Mississauga	8468	39.4	53.3	7.2	0.1	0	2
Brampton	8760	35.9	55.0	8.9	0.1	0	5
Toronto West	8784	52.5	39.9	7.3	0.2	0	5
Toronto Downtown	8784	42.8	78.2	8.7	0.3	0	5
Toronto North	8733	44.6	49.1	6.3	<0.1	0	1
Toronto East	8780	51.9	42.5	5.6	0.1	0	4
Oshawa	8765	42.3	51.5	6.1	0.1	0	2
Newmarket	8782	27.9	64.6	7.4	<0.1	0	2
Barrie	8782	37.8	55.3	6.7	0.1	0	4
Peterborough	8739	34.6	57.7	7.4	0.2	0	7
Belleville	8768	30.5	60.4	8.9	0.2	0	3
Kingston	8740	22.8	64.9	12.0	0.3	0	6
Morrisburg	8758	33.5	60.5	5.9	<0.1	0	1
Cornwall	8775	35.2	59.2	5.6	0.1	0	1
Ottawa Central	8768	34.6	60.1	5.3	<0.1	0	1
Ottawa Downtown	8782	46.9	49.9	3.2	0	0	0
Petawawa	8761	36.0	60.1	3.8	0	0	0
Dorset	8610	32.5	60.0	7.3	0.2	0	4
Parry Sound	8781	24.8	65.4	9.5	0.3	0	5
North Bay	8776	36.3	57.2	6.5	<0.1	0	1
Sudbury	8759	36.1	59.3	4.6	0	0	0
Sault Ste. Marie	8779	32.6	62.7	4.7	0	0	0
Thunder Bay	8775	47.6	51.1	1.3	<0.1	0	1

Figure 5.2
Air Quality Index Summary
(2008)

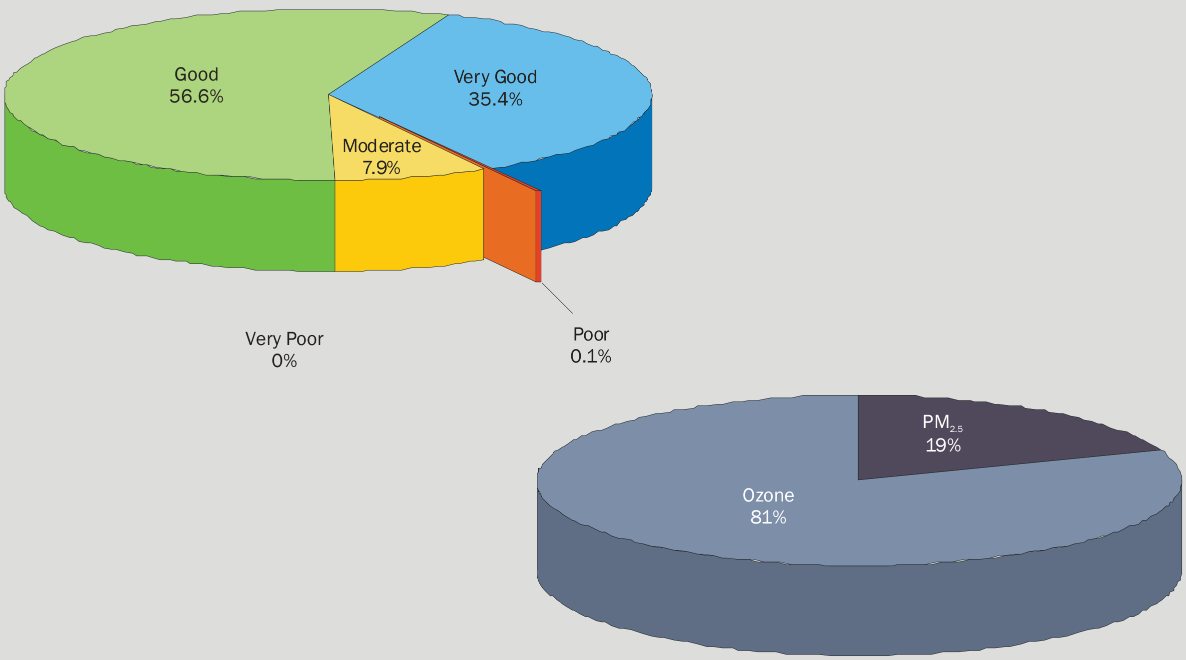
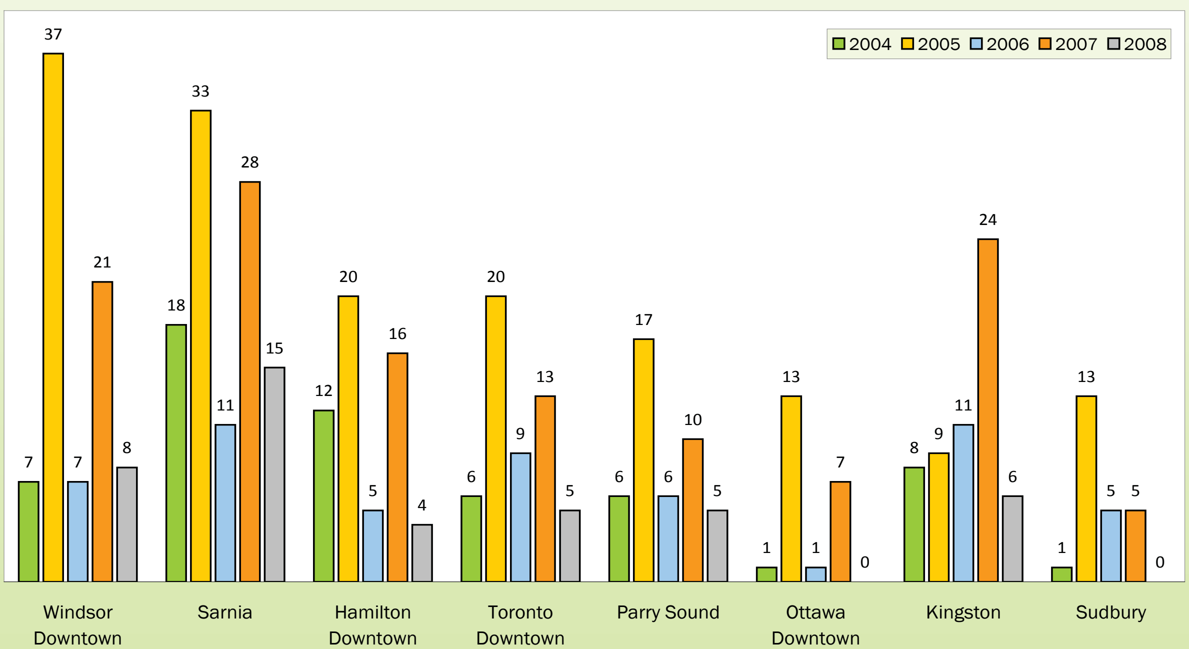


Figure 5.3
Number of Days with at Least One Hour AQI > 49
(2004 - 2008)



days of poor air quality. In northern Ontario, Sudbury and Sault Ste. Marie did not record any hours of air quality in the poor category. There were no hours of very poor air quality reported at any site in Ontario during 2008.

Figure 5.2 shows the provincial average for the percentages of time the AQI was in the very good, good, moderate and poor air quality categories as recorded by all sites across the province in 2008. The pie diagram at the top left shows the category percentages. The pie diagram at the bottom right breaks down the poor air quality into percentages of pollutants associated with the AQI above 49. Approximately 81 per cent of the poor AQI values were due to ozone, and the remaining 19 per cent were due to fine particulate matter.

Figure 5.3 displays the number of poor days recorded at selected locations in Ontario during the five-year period 2004 to 2008. The figure shows a large yearly variability in poor days at most sites. This year-to-year variability in the number of poor air quality days is due primarily to variations in the meteorological conditions. During the relatively hot, humid conditions of 2005 and 2007, there was a large number of poor air quality days, whereas during the relatively cooler and cloudier summers of 2004, 2006 and 2008, poor air quality days were less frequent.

On some days, both ozone and fine particulate matter caused the AQI to exceed the poor threshold of 49 simultaneously. Table 5.3 shows the number of days when ozone, fine particulate matter and both pollutants resulted in poor air quality for at least one hour during 2008 at selected cities throughout the province.

Table 5.3: Number of Days that Ozone, $PM_{2.5}$, and Both Pollutants Resulted in at Least One Hour AQI > 49 (2008)

City	No. of days at least 1hour AQI > 49 due to Ozone only	No. of days at least 1hour AQI > 49 due to $PM_{2.5}$ only	No. of days at least 1hour AQI > 49 due to Ozone and $PM_{2.5}$	Total no. of days AQI > 49
Windsor Dtn.	7	0	1	8
Sarnia	6	7	1	14
Hamilton Dtn.	0	4	0	4
Toronto Dtn.	5	0	0	5
Parry Sound	5	0	0	5
Kingston	4	2	0	6

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.

Figures 5.4a-e display the maximum AQI values at Windsor Downtown, Sarnia, Hamilton Downtown, Toronto Downtown, and Ottawa Downtown for 2008. Ozone was the determining pollutant at Windsor Downtown, Toronto Downtown, and Ottawa Downtown, accounting for 81 per cent, 86 per cent, and 85 per cent of the daily maximums, respectively. This was especially apparent during the summer months (May to September), where 90 per cent of daily maximums at Windsor Downtown were due to ozone, 93 per cent at Toronto Downtown, and 94 per cent at Ottawa Downtown. Although ozone was also the determining pollutant at Sarnia and Hamilton Downtown, there were significantly more daily maximums due to $PM_{2.5}$. Sarnia reported only 63 per cent of daily maximums due to ozone, and Hamilton Downtown reported 71 per cent. Sarnia was the only station to report a daily maximum due to a pollutant other than ozone or $PM_{2.5}$. Sarnia reported five days in January, and one day in December with daily maximums due to SO_2.

The figures also show that poor air quality days were recorded at Windsor Downtown, Sarnia, Hamilton Downtown, and Toronto Downtown. All of the poor days were contained within the period of April to September, with the exception of Sarnia, which reported a daily maximum AQI value of 56 due to SO_2 on January 6, 2008, and Hamilton, with a daily maximum AQI value of 57 due to $PM_{2.5}$ on November 7, 2008. All Windsor Downtown and Toronto Downtown poor days were due to ozone, whereas all poor days at Hamilton Downtown were due to $PM_{2.5}$. Sarnia reported the most poor days (15), six of which were due to ozone, eight due to $PM_{2.5}$, and one due to SO_2.

Figure 5.4a
Daily Maximum AQI Values in Windsor Downtown
(2008)

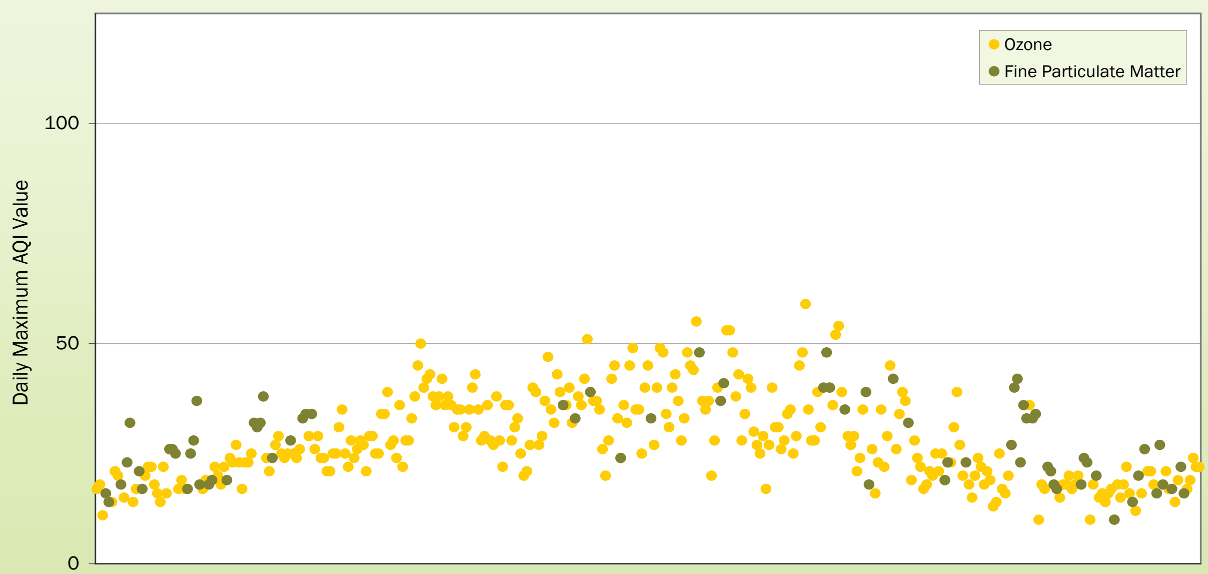


Figure 5.4b
Daily Maximum AQI Values in Sarnia
(2008)

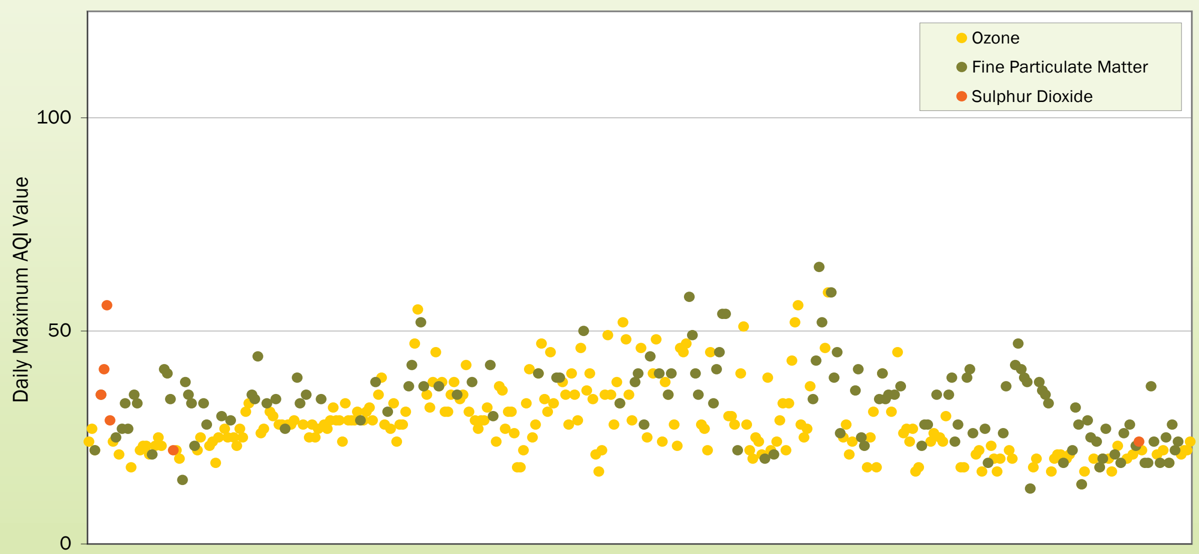


Figure 5.4c
Daily Maximum AQI Values in Hamilton Downtown
(2008)

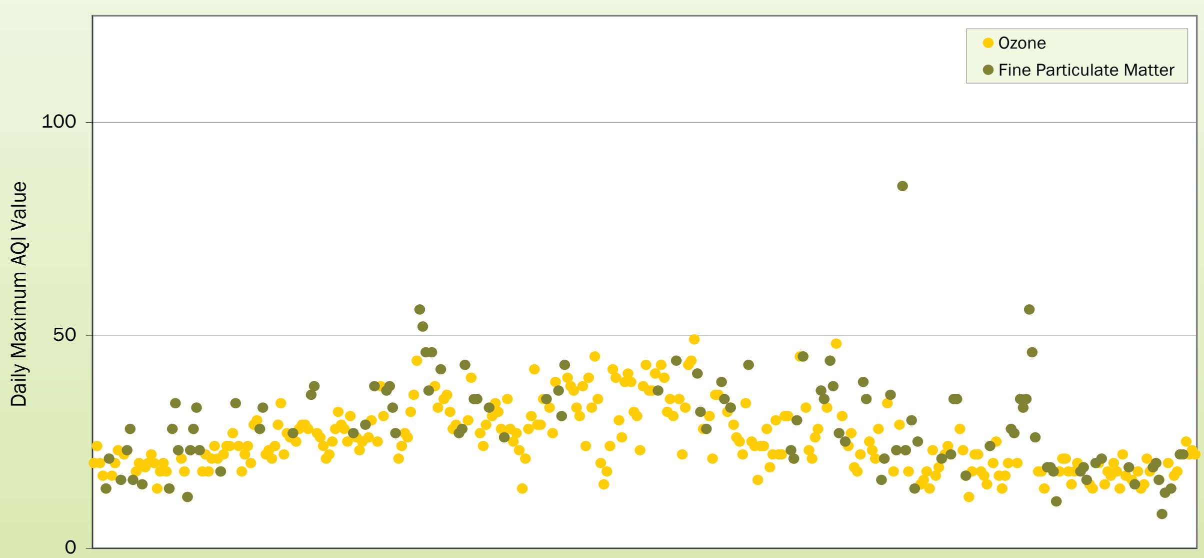


Figure 5.4d
Daily Maximum AQI Values in Toronto Downtown
(2008)

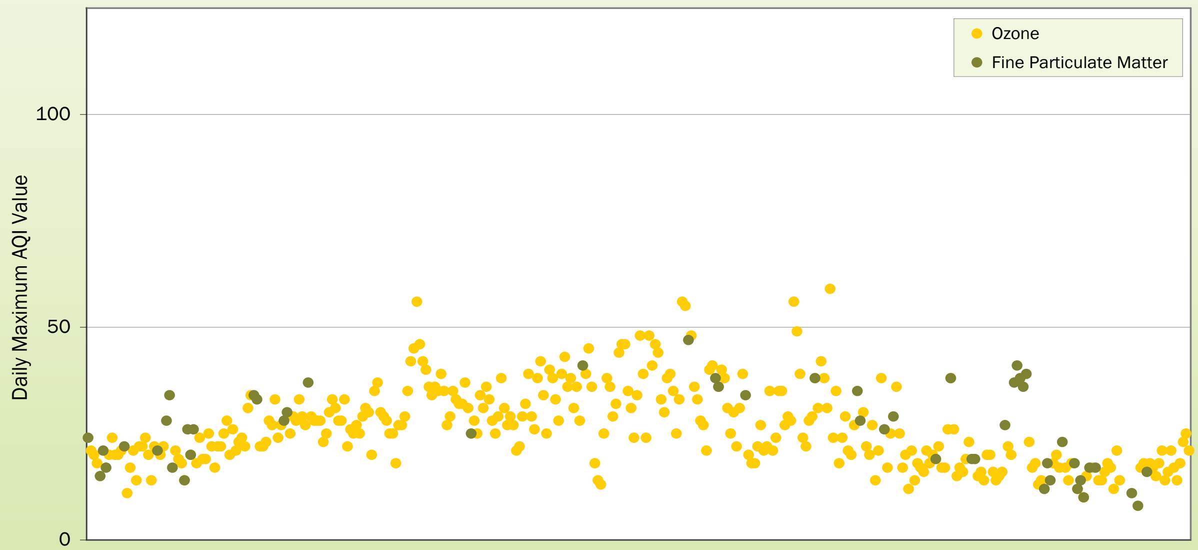
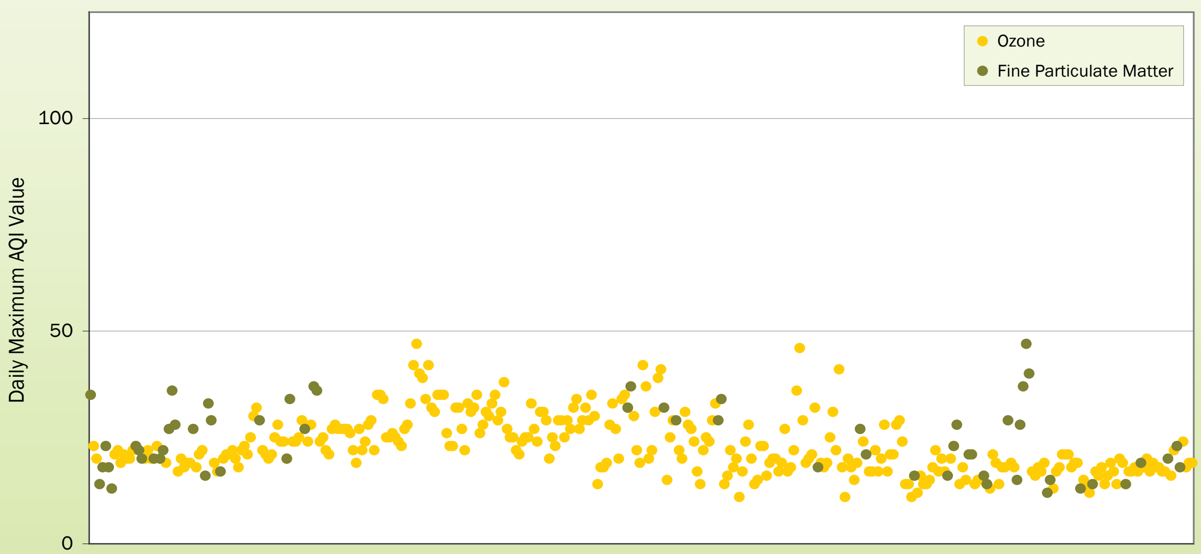


Figure 5.4e
Daily Maximum AQI Values in Ottawa Downtown
(2008)



Smog Advisories

Smog advisories are issued to the public, under the Smog Alert program, when widespread, elevated (AQI values greater than 49) and persistent smog (O_3 and/or $PM_{2.5}$) levels are forecast to occur within the next 24 hours, or if elevated smog conditions occur without warning and weather conditions conducive to elevated smog levels are forecast to continue for several hours. Smog advisories are issued for southern, eastern and central Ontario where pollutant concentrations are most likely to exceed the one-hour AAQC of 80 ppb for ozone and/or the Ontario three-hour benchmark of 45 µg/m^3 for $PM_{2.5}$.

The Smog Alert program provides Ontarians with improved reporting through comprehensive and timely air quality readings and forecasts, and includes the following:

- An air quality forecast that provides a three-day outlook;
- A Smog Advisory when there is a strong likelihood that elevated smog levels are forecast within the next 24 hours;
- An immediate Smog Advisory if widespread, elevated smog levels occur without warning and weather conditions conducive to the persistence of such levels are forecast to continue for several hours;
- A public website, www.airqualityontario.com, where current AQI readings, smog forecasts and other air quality information are available;
- Direct e-mails of smog alerts to everyone who subscribes to the ministry's Smog Alert network at the above website;
- Toll-free numbers by which anyone at anytime can get updated information on air quality (1-800-387-7768 in English and 1-800-221-8852 in French).

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

Since May 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 $PM_{2.5}$ 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.

2008 smog advisories

For 2008, Ontarians experienced 8 smog advisories covering 17 days, of which seven smog advisories covering 14 days occurred during the traditional smog season (May 1 to September 30 inclusive). The remaining smog advisory covering three days was issued in April 2008, reflecting for the first time an earlier start to the traditional summer smog season. The details of these smog advisories are shown in Table 5.4.

The year 2008 tied the lowest on record (17 smog advisory days in 2006) since fine particulate matter 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). The number of smog advisory days issued in April 2008 was notable for that month, a total of three days.

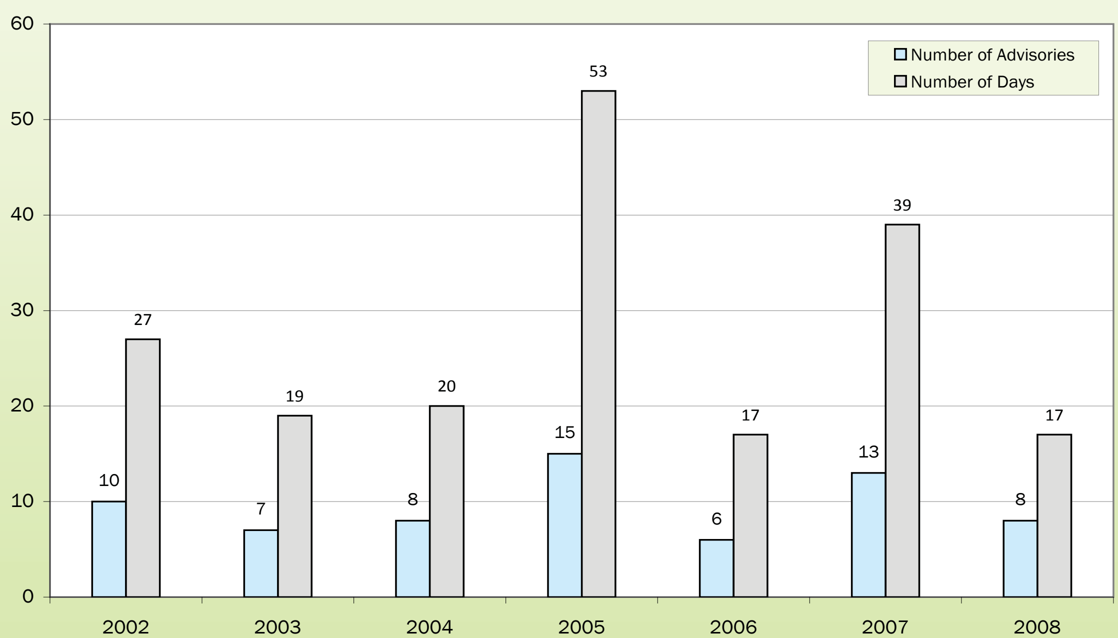
Above: The North Bay AQI site.

Table 5.4: Smog Advisory Statistics for Ontario (2008)

Advisory	Advisory Period	Duration of Advisory
1	April 18-20	3 days
2	June 13	1 day
3	July 7-8	2 days
4	July 16-19	4 days
5	July 28-29	2 days
6	August 22-23	2 days
7	September 2-3	2 days
8	September 25	1 day

The early arrival of smog warnings was then followed by only one smog advisory covering one day in the following two months, May and June. In comparison, the number of smog advisory days in May and June ranged from five to 26 during the previous six years. A history of smog advisories and smog advisory days since 2002 is shown in Figure 5.5.

Figure 5.5
Summary of Smog Advisories Issued
(2002 - 2008)



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.

2008 smog episodes

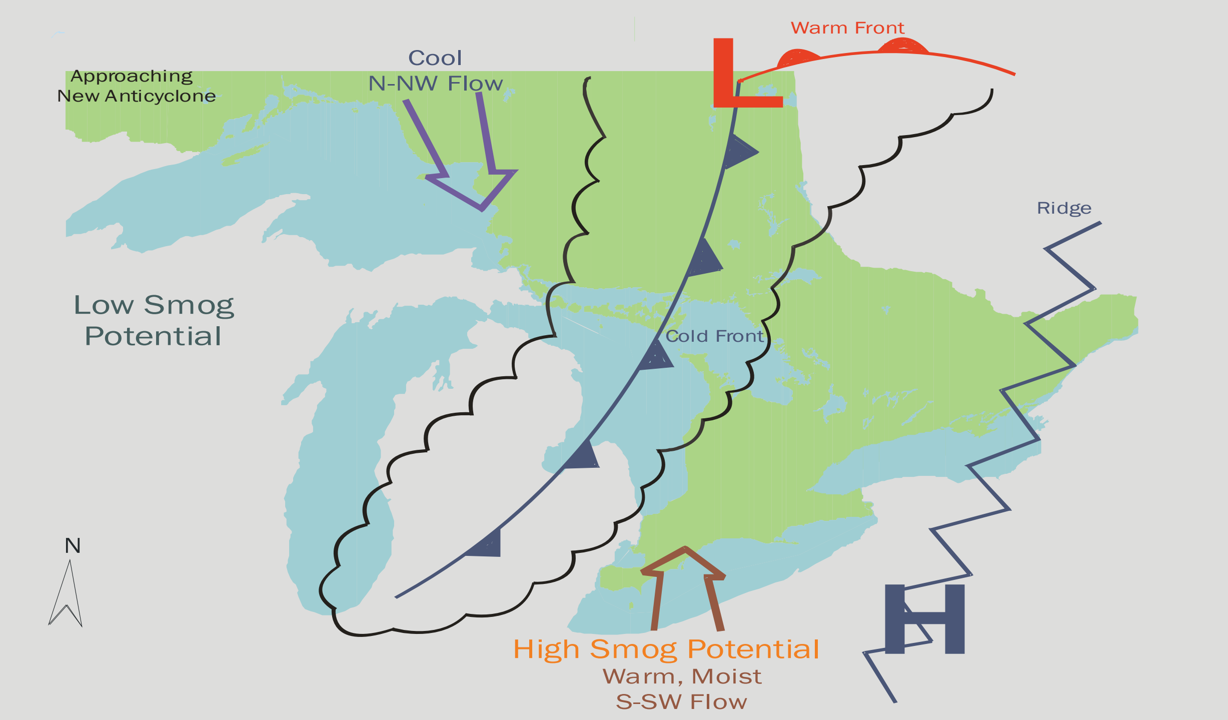
Summer smog episodes in Ontario are often a part of a regional weather condition that prevails over much of northeastern North America. Elevated levels of ozone and $PM_{2.5}$ are typically due to weather patterns that affect the lower Great Lakes region. Such weather patterns are invariably associated with slow-moving high pressure cells across the region and result in the long-range transport of smog pollutants from neighbouring U.S. industrial and urbanized states during warm south to southwesterly air flow conditions. Figure 5.6 is an illustration depicting these typical summer smog episode conditions. The blue "H" just southeast of Lake Erie represents a high pressure system which results in sunny skies and a light south to southwesterly flow of warm moist air across the lower Great Lakes region. The red "L" over northeastern Ontario represents a low pressure system, and has a cold front stretching southward across Lake Huron, which results in cloudiness and precipitation. It is the passage of this cold front that typically ends a smog episode. Behind the cold front, another high pressure system approaches from the northwest, causing a north to northwesterly flow of cooler, drier, and cleaner air.

Smog episodes in Ontario are less prevalent in the winter and are due primarily to fine particulate matter. They are typically associated with relatively stagnant conditions, the development of strong temperature inversion conditions overnight, and the trapping of air pollutants near the ground.

In 2008, Ontario experienced significantly less transboundary and regionally polluted air as meteorological conditions of cool, wet, and unsettled weather often inhibited smog formation. Temperature conditions were also less conducive in 2008, compared to that of 2007, for the development of elevated smog levels across most of southern Ontario. For example, in 2008 Toronto recorded 10 hot days (days on which the maximum temperature was greater than 30°C) and was in marked contrast to the 26 hot days in 2007. These contrasting weather conditions between 2008 and 2007 resulted in significantly less smog incidences in 2008 compared to those in 2007.

Smog episodes in 2008 were typically of one or two-day durations, and these events were dominated by ozone. Fine particulate matter was not significant. There were only four episodes noted in 2008, two of two-day

Figure 5.6
Generalized Synoptic Weather Pattern Over Southern Ontario Conducive to Elevated Pollutant Levels

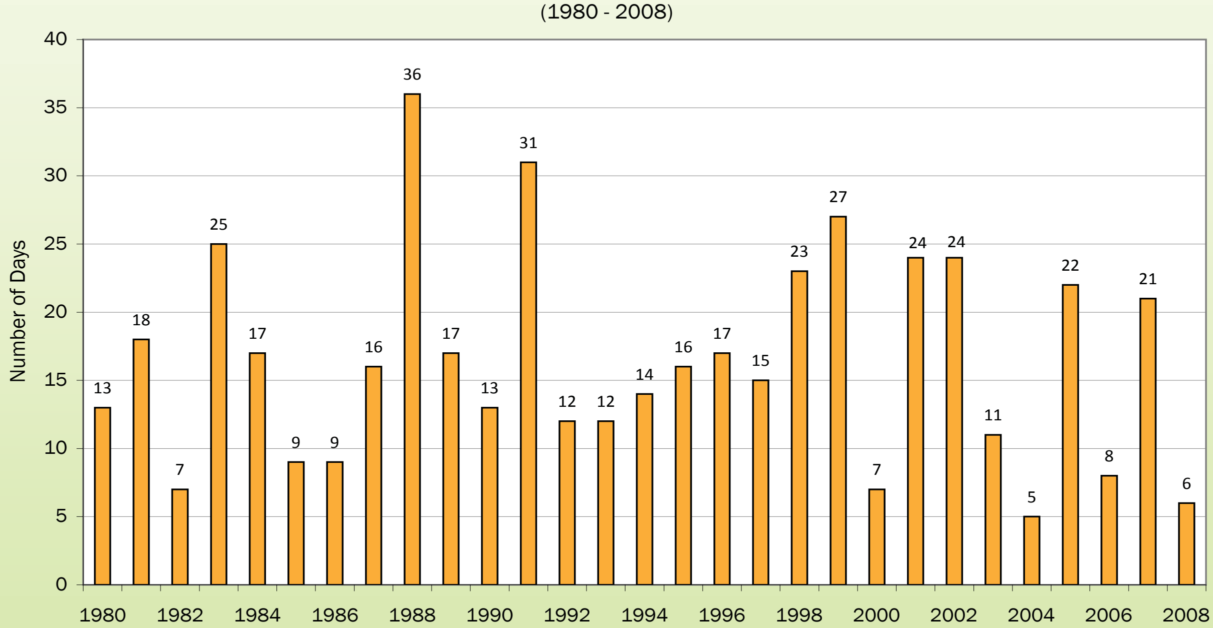


durations (April 18-19, 2008 and August 22-23, 2008) and 2 one-day episodes (July 18, 2008 and September 3, 2008). In general, smog conditions during episodes in 2008 were not as widespread, persistent and elevated as in 2007. For example, the most persistent and widespread episode in 2008 was a two-day event and impacted only 22 sites on April 19. In contrast, 38 sites were impacted on May 24, 2007 during a three-day smog episode. Also, there was one four-day smog episode in 2007. Maximum one-hour ozone levels ranged between 90 and 97 ppb during the four 2008 smog episodes whereas levels ranged typically between 90 and 125 ppb during 2007 smog episodes including 13 days with levels in excess of 100 ppb. A detailed description of the April 2008 event is provided below.

The most significant and extensive smog event of the season occurred early in the year, during the period April 18 and April 19, 2008. Warm, sunny conditions, combined with a southerly flow of polluted air from the U.S. and a local build-up of pollutants resulted in elevated smog levels across southern and central and parts of eastern Ontario. Poor air quality due to ground-level ozone occurred at 20 sites, and the maximum one-hour level of 90 ppb occurred at Dorset, a rural site in the Muskoka area of Ontario's cottage country. On April 19, 22 AQI sites across Ontario recorded poor air quality due to ground-level ozone, with the maximum one-hour level of 91 ppb at Port Stanley, a rural site on the northern shores of Lake Erie and at Grand Bend, a rural site on the eastern shores of Lake Huron. Poor air quality due to fine particulate matter was reported at three urban sites on April 18 with the maximum three-hour average concentration of 52 μg/m^3 recorded at Hamilton West. On April 19, five sites reported poor air quality due to fine particulate matter with the maximum three-hour average concentration of 61 μg/m^3 recorded at Hamilton Mountain. On April 20, 2008, slightly cooler temperatures, partly cloudy skies and southeasterly winds resulted in cleaner air across southern Ontario.

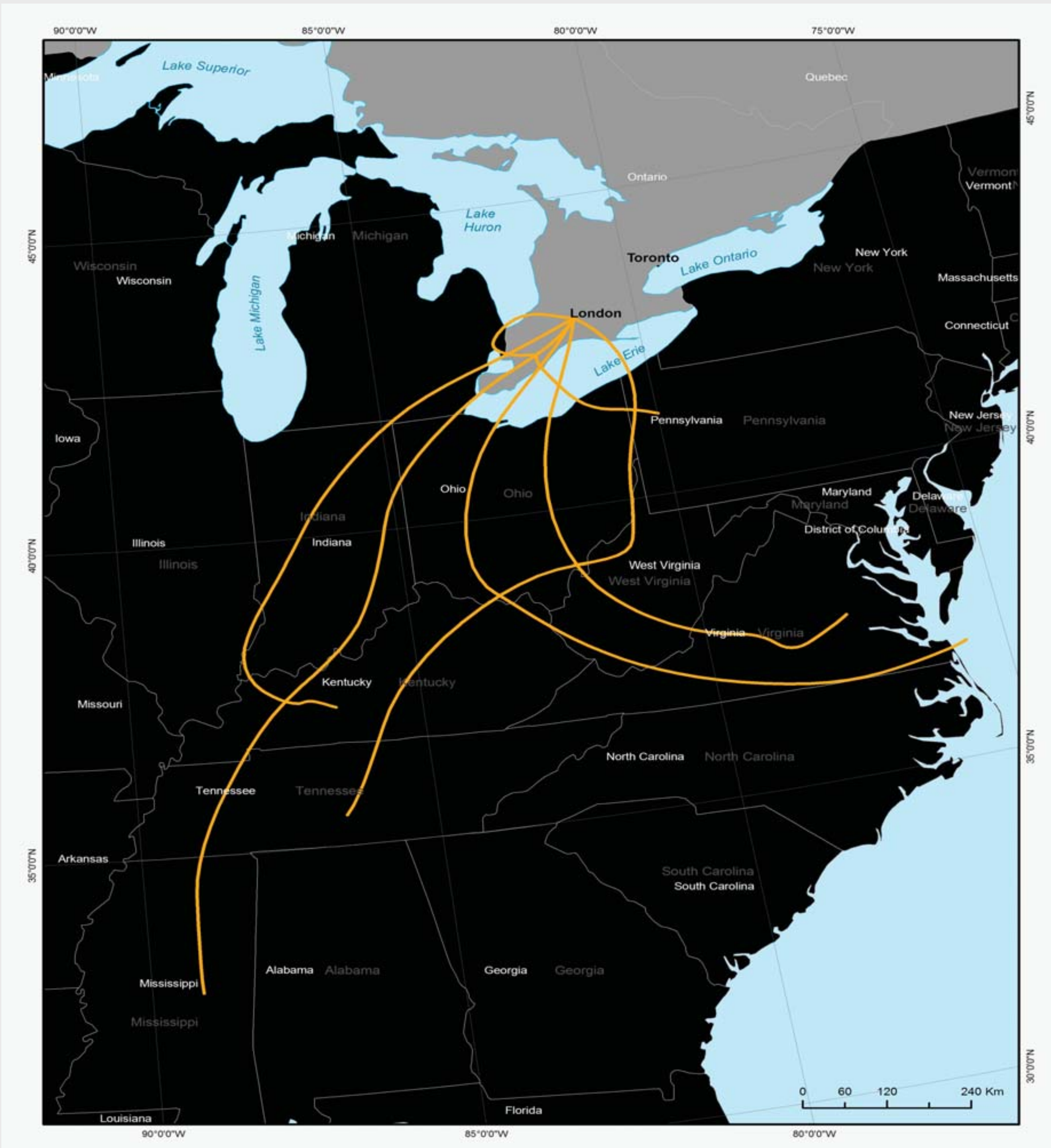
Occurrences of elevated ozone and fine particulate matter are highly dependent upon weather conditions which vary from year to year. To depict the trend in Ontario, the number of ozone episode days, characterized by days with widespread one-hour average ozone levels greater than 80 ppb, for the period 1980 to 2008 is depicted in Figure 5.7. This shows that the number of ozone episode days in 2008 was relatively low, a total of six, and was in marked contrast to the total of 21 such days in 2007. The year 2008 also had the second lowest number of ozone

Figure 5.7
Number of Ozone Episode Days in Ontario
(1980 - 2008)



episode days since 1980. In terms of fine particulate matter episodes, there were no cases recorded in 2008; this is in stark contrast to nine reported in 2007, five in 2006, 17 in 2005, 13 in 2004 and seven in 2003. The air flow into Ontario, as shown with 48-hour back trajectories on smog episode days during 2008, is depicted in Figure 5.8. This qualitatively confirms that ozone and $PM_{2.5}$ episode days in Ontario are typically associated with south to southwesterly flows from the heavily industrialized and urbanized regions of the U.S.

Figure 5.8
48-Hour Back Trajectories at 500 m Arriving at London, Ontario at 1300 EDT on Smog Episode Days in 2008



A clean day (*top*) and a smoggy day (*bottom*) in Toronto.

CHAPTER 6:

City of Ottawa Special Air Study

CHAPTER HIGHLIGHTS

- In 2008, the Ministry continued its support to the City of Ottawa in an air quality study designed to look at criteria pollutants across the municipality and VOCs at King Edward Avenue.
- Results from two permanent stations and several temporary monitoring sites indicated that air pollutant levels were similar across the municipality with the exception at King Edward Avenue, a traffic-influenced site, where higher levels of NO_2 were measured and lower levels of ozone.

This chapter analyses the Ottawa study which was initiated to support the City of Ottawa in the development of an operational mapping service for the National Capital Region with a focus on the spatial distribution of air pollutants. The results of this study for 2007 and 2008 are summarised below and focus on measurements taken at King Edward Avenue in Ottawa by the Ontario Ministry of the Environment.

National Capital Region integral air quality mapping service

The City of Ottawa study was a 15-month project (September 2007 to December 2008) used to map air quality concentrations across the municipality as a basis for future environmental decisions and public health protection. The project was sponsored by GeoConnections, a program of Natural Resources Canada. The Ontario Ministry of the Environment provided technical support for the project, as did Environment Canada, Transport Canada and the Ottawa Macdonald-Cartier International Airport. The study consisted of data from a satellite monitoring system, two permanent provincial AQI stations (Ottawa Downtown and Ottawa Central), and three mobile monitoring units, including one from the ministry, recording week-long measurements on a rotational basis at selected sites throughout Ottawa.

2007 results from Glen Cairn and Orleans

The ministry collected data from the two AQI sites, Ottawa Downtown and Ottawa Central, in addition to data measured by two mobile air quality units (mobile AQI unit and mobile PM unit) sited in Glen Cairn and Orleans from September 13, 2007 to October 16, 2007, during the first phase of the project. The pollutants measured for the study include ozone, $PM_{2.5}$, NO_2, CO and SO_2.

There were no significant differences between the daily one-hour maximum ozone concentrations. Ambient ozone measurements were relatively similar among the sites. Ottawa Central recorded the highest one-hour ozone maximum concentration (72 ppb) which was below Ontario's one-hour AAQC of 80 ppb.

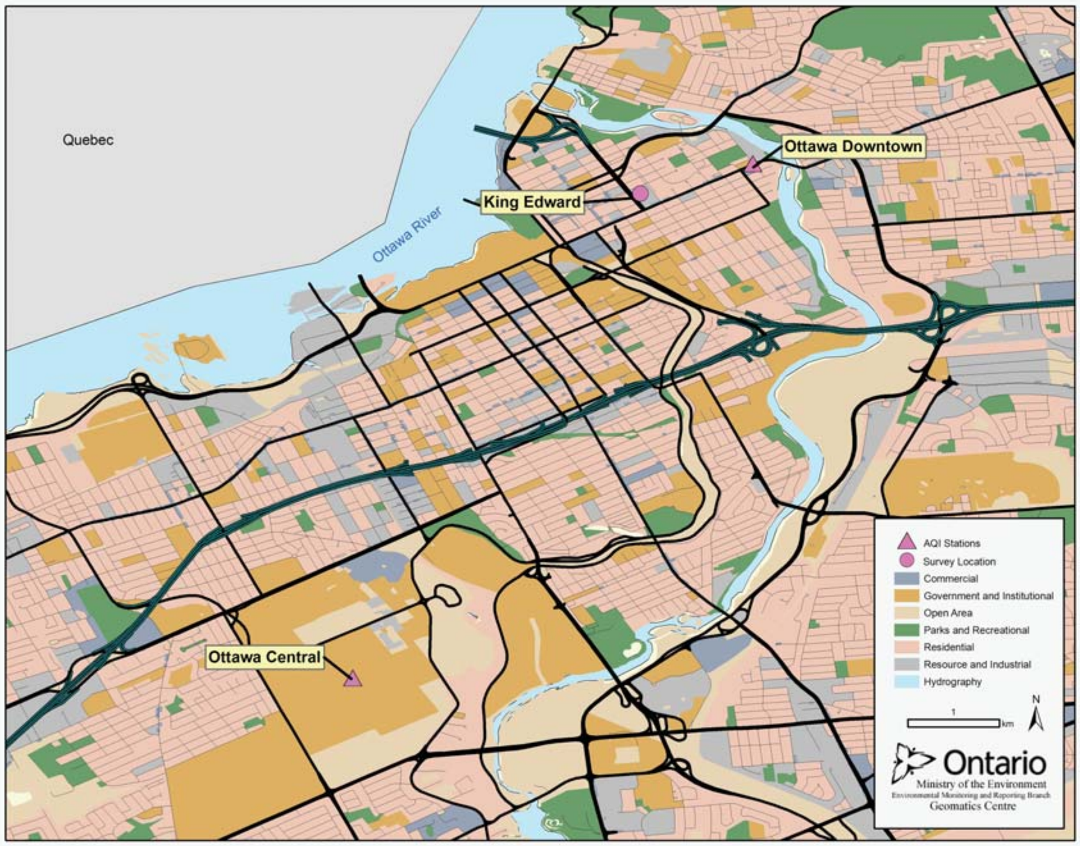
Above: Mobile AQI Unit

There were no significant differences between the $PM_{2.5}$ concentrations measured at the four sites. Ottawa Downtown was the only site to exceed the Ontario three-hour benchmark of 45 μg/m^3 which is the threshold for poor air quality based on $PM_{2.5}$. This site recorded poor air quality for a duration of two consecutive hours.

Similar to the ozone and $PM_{2.5}$ measurements, concentrations of NO_2, CO and SO_2 were comparable and far below their associated provincial criteria. The measurements obtained throughout the study confirm that there is no significant difference between levels observed at various Ottawa locations.

The Ottawa Downtown (*top*) and Ottawa Central (*bottom*) AQI sites.

Figure 6.1
Survey Location at King Edward and Fixed Air Monitoring Sites in Ottawa



For additional information on the Glen Cairn and Orleans analyses, refer to Chapter 6 of the Air Quality in Ontario 2007 Report that can be accessed via the ministry web site (www.ene.gov.on.ca).

2007 results from King Edward Avenue

The study at King Edward was initiated in response to public concern with the increase in vehicular traffic in the vicinity of King Edward Avenue, which forms a junction with the six-lane McDonald-Cartier Bridge at the Gatineau-Ottawa border, and the Queensway, Ottawa's major freeway. Located approximately 1.5 kilometres from the King Edward study site, is the ministry's Ottawa Downtown AQI site, which is influenced by vehicular traffic from roads nearby. In contrast, the Ottawa Central AQI site is located in the centre of an open area, the experimental farm where the nearest major roadway is 500 m away in all directions. The Ottawa study also presented the opportunity to determine if the two existing ministry AQI stations in Ottawa were representative of the air quality on King Edward Avenue, with comparatively higher commuter traffic volume.

The ministry's mobile AQI unit was stationed at 351 King Edward Avenue, a Hydro One Substation Facility, from October 17 to October 30, 2007. Data from King Edward were compared with data from the ministry's Ottawa Downtown and Ottawa Central AQI sites. Figure 6.1 depicts the study location and the surrounding air monitoring stations with which data were compared. The pollutants measured for the study include ozone, $PM_{2.5}$, NO_2, CO and SO_2.

The correlation coefficients (r) of the daily maximum one-hour ozone concentrations at King Edward as compared to those measured at the ministry's fixed AQI sites, Ottawa Downtown and Ottawa Central, are 0.99 and

0.95, respectively. The positive values of the correlation coefficient close to one indicate that the maximum ozone concentrations measured at the two fixed AQI sites in Ottawa are similar to the concentrations measured at King Edward.

The daily maximum one-hour ozone concentrations for the three sites are displayed in Figure 6.2 for the period October 17 to October 30, 2007. There are no significant differences between the daily maximum one-hour ozone concentrations; however Ottawa Central recorded higher ozone maximums throughout the study period. Lower maximum concentrations were due to the scavenging effect of NO from vehicle exhaust at Ottawa Downtown and King Edward showing the effect of local traffic influence. This is also shown when comparing the hourly average ozone concentrations between the three sites in Figure 6.3. The ministry's AAQC for ozone was not exceeded at any of the Ottawa sites during the King Edward study period.

The correlation coefficients (r) of the daily average $PM_{2.5}$ concentrations at King Edward as compared to those measured at the ministry's two AQI sites in Ottawa are 0.99 with both Ottawa Downtown and Ottawa Central. The positive values of the correlation coefficient close to one indicate that the concentrations measured at the two fixed AQI sites in Ottawa are similar to the concentrations measured at King Edward.

The hourly average $PM_{2.5}$ concentrations measured on October 18, 2007 are displayed in Figure 6.4. The hourly $PM_{2.5}$ concentrations recorded were relatively the same between the three sites. On October 18, 2007, the highest daily average of $PM_{2.5}$ concentrations were recorded at all three sites during the study period: 15.8 $\mu g/m^3$ at Ottawa Downtown, 15.2 $\mu g/m^3$ at Ottawa Central, and 15.7 $\mu g/m^3$ at King Edward.

Ways to reduce smog...

At work:

- **If possible, take public transit, or walk to work.**
- **If you use a car, don't travel alone, encourage and facilitate carpooling.**
- **Consider teleconferencing instead of travelling to meetings.**

Figure 6.2
Daily Maximum One-Hour Ozone Concentrations at Ottawa
October 17 - 30, 2007

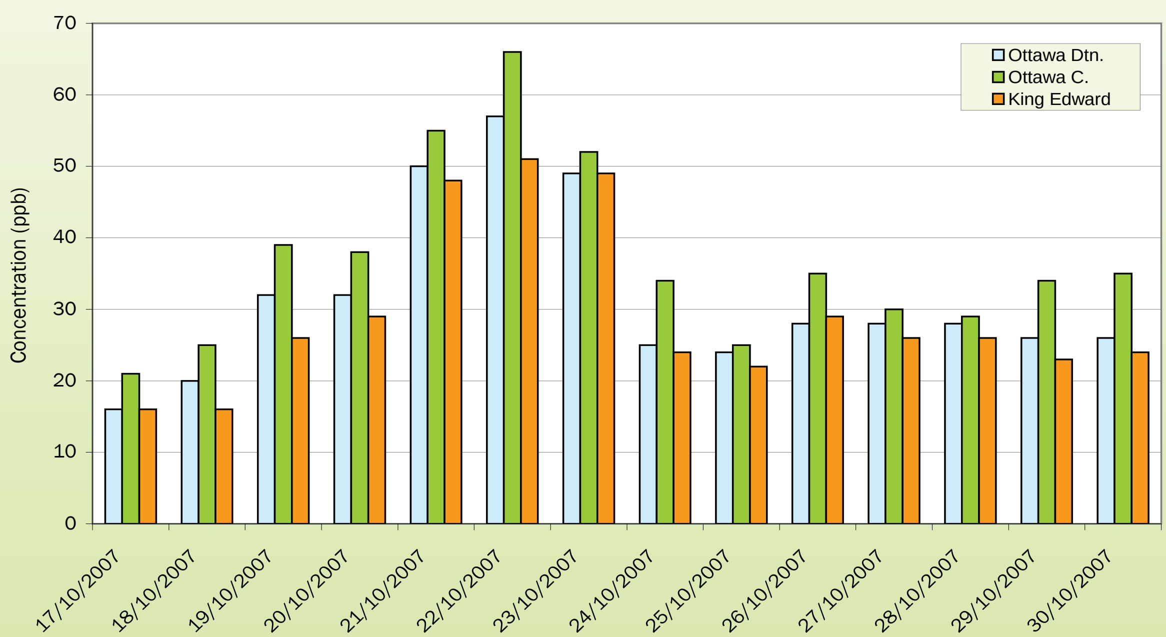


Figure 6.3
Hourly Average Ozone Concentrations at Ottawa
October 17 - 30, 2007

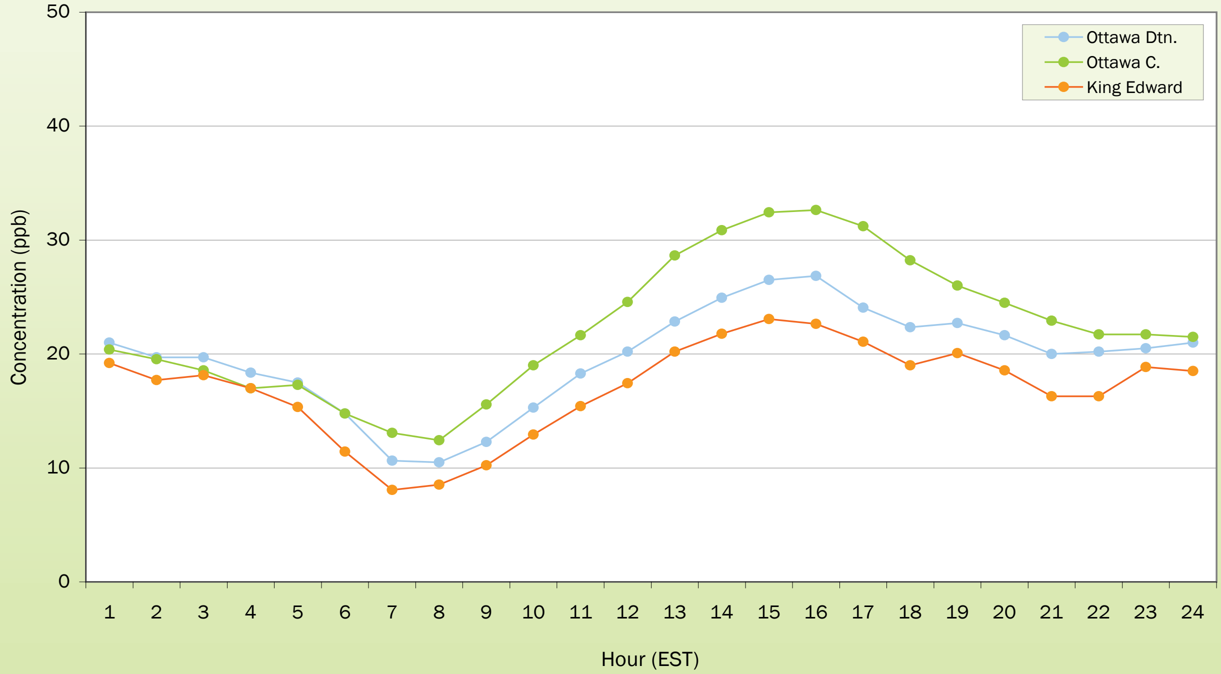
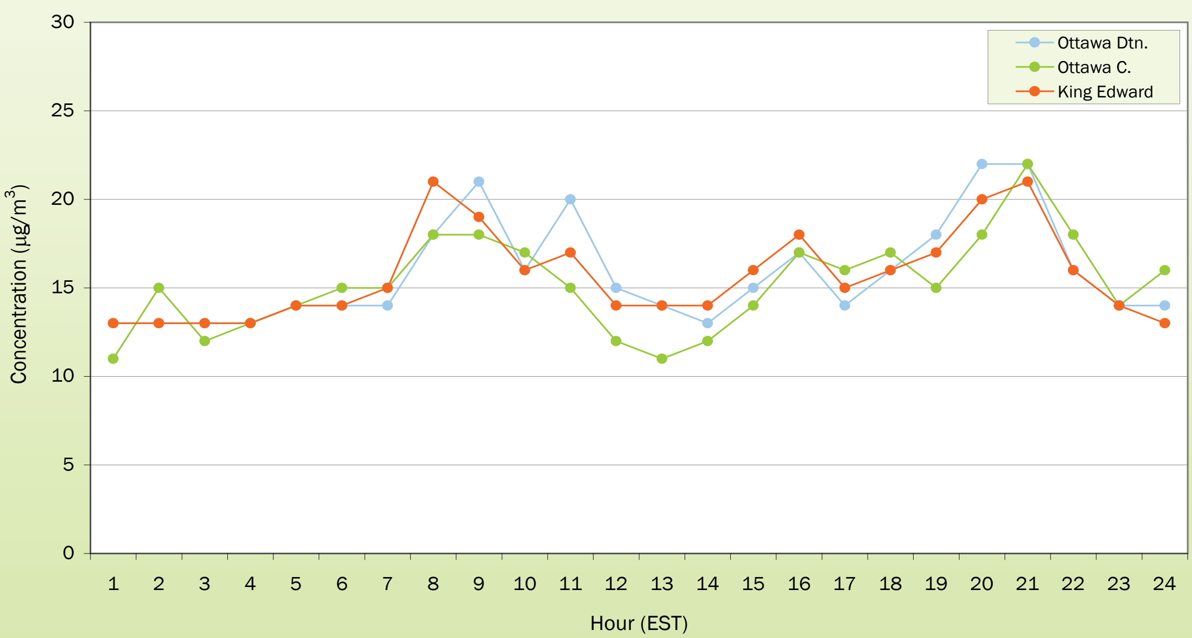


Figure 6.4
Hourly Average $PM_{2.5}$ Concentrations at Ottawa
October 18, 2007



Note: Measurements taken at Ottawa Downtown from 1 a.m. to 6 a.m. are identical to those measured at King Edward.

Figure 6.5
Daily Maximum One-Hour NO_2 Concentrations at Ottawa
October 17 - 30, 2007

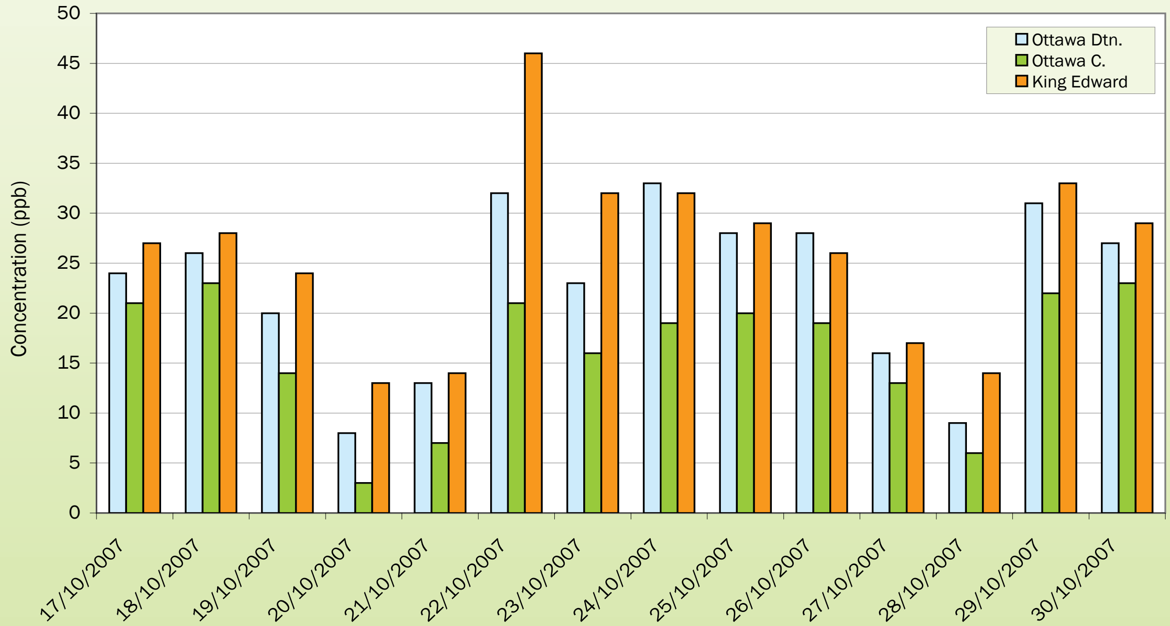
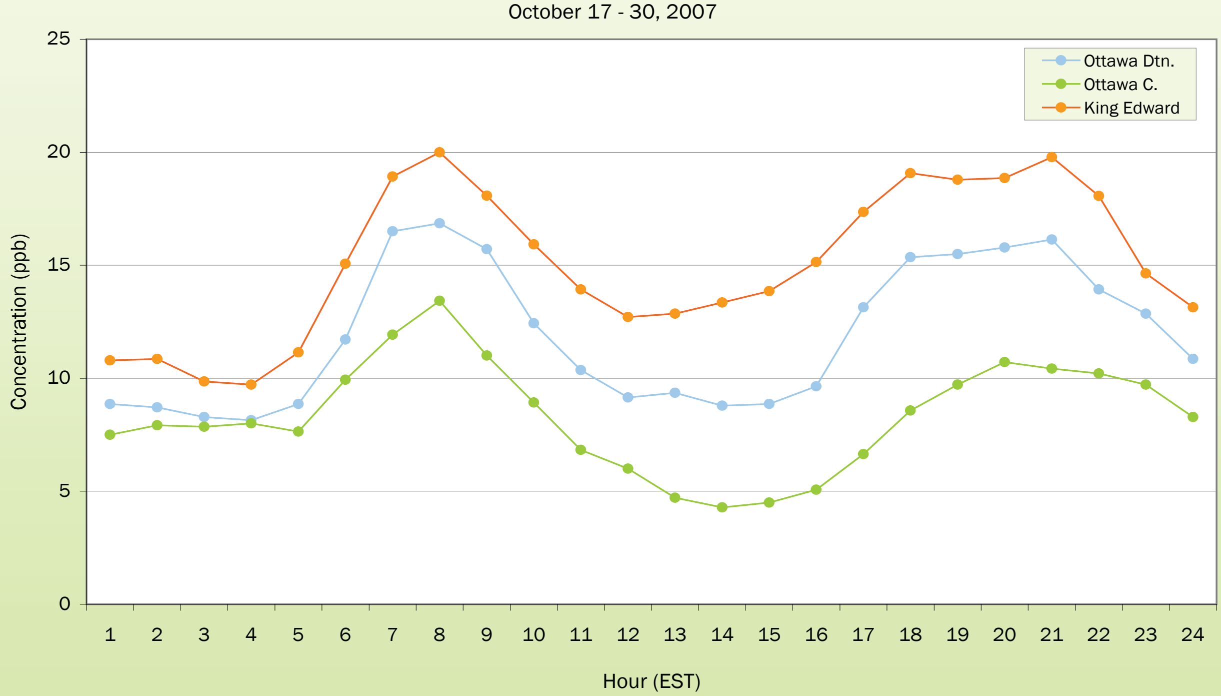


Figure 6.6
Hourly Average NO_2 Concentrations at Ottawa
October 17 - 30, 2007



The daily maximum one-hour NO_2 concentrations are shown for the three Ottawa sites in Figure 6.5 for the study period. Ottawa Downtown and King Edward measured similar NO_2 concentrations and were consistently greater than those measured at Ottawa Central due to the influence of vehicle emissions from heavy commuter traffic in those two areas. The maximum one-hour NO_2 concentration (46 ppb) was recorded at King Edward on October 22, 2007; however, it was well below the ministry's one-hour AAQC of 200 ppb.

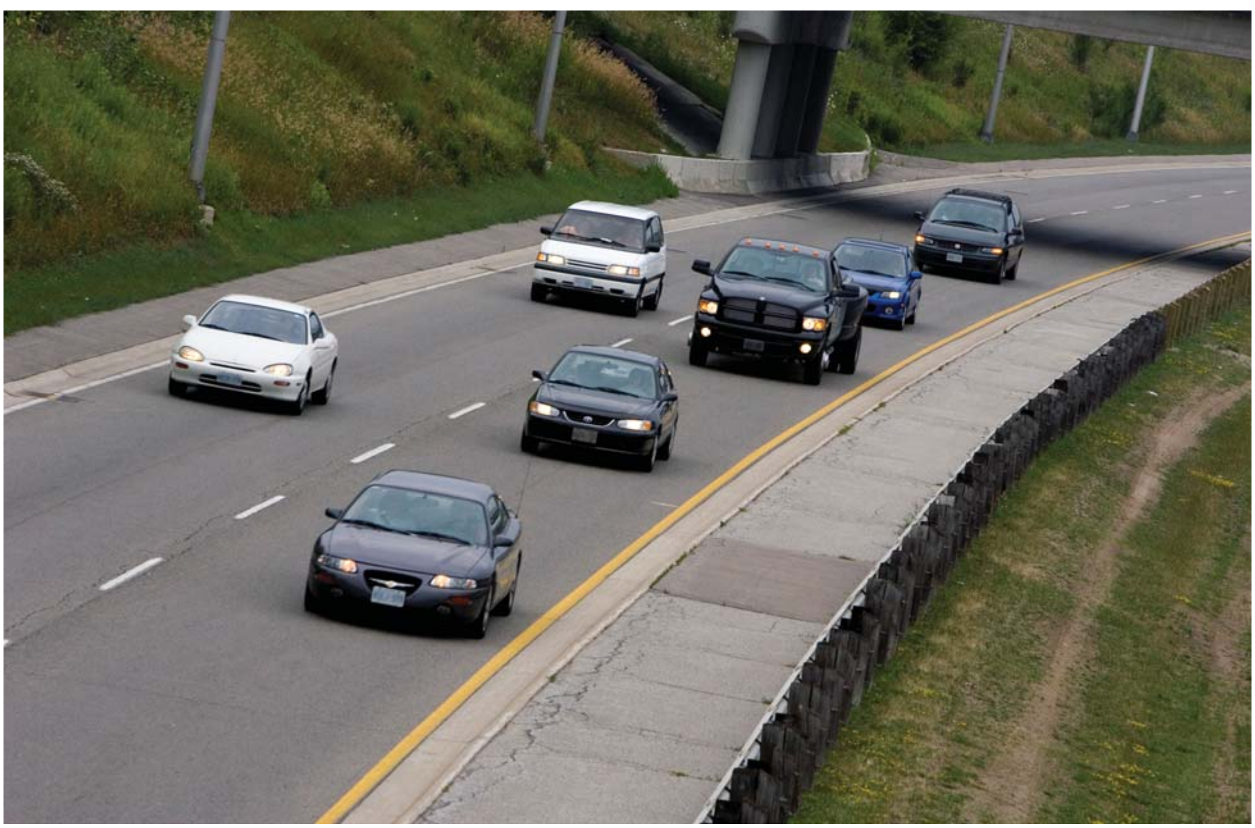
The hourly average NO_2 concentrations between the three sites are shown in Figure 6.6. They generally follow the same pattern with NO_2 increasing during the morning and evening rush-hour periods, once again, indicating the influence of vehicular traffic. King Edward consistently measured higher NO_2 concentrations than the fixed Ottawa AQI sites.

Similar to the ozone, $PM_{2.5}$ and NO_2 measurements, concentrations of CO and SO_2 were comparable and far below their associated provincial criteria. The maximum one-hour CO measurement was 0.82 ppm recorded at King Edward. The maximum one-hour SO_2 concentration was 6 ppb recorded at both Ottawa Downtown and King Edward; whereas the highest 24-hour average for SO_2 was 4.0 ppb recorded at King Edward. The measurements obtained throughout the study confirm that there is no statistical significant difference between observed levels at the three sites; however, Ottawa Downtown and King Edward do show an influence of traffic-related pollutants.

VOCs – 2007 and 2008 results from King Edward Avenue

In September and October 2007 and in July 2008, the ministry conducted an air quality survey to measure ambient levels of selected VOCs in the vicinity of King Edward Avenue and Rideau Street in Ottawa. The survey was conducted using VOC cartridge sampling and the Trace Atmospheric Gas Analyzer (TAGA) mass spectrometry analysis method. The ministry acquired 32 one-hour air samples in 2007 and 34 in 2008 at three sites near 350 King Edward Avenue.

Sixteen individual VOCs were detected during the survey. In 2007, the total concentrations ranged from 4 $\mu g/m^3$ to 76 $\mu g/m^3$ with an overall average of 32 $\mu g/m^3$, and



concentrations ranged from 4 $\mu g/m^3$ to 38 $\mu g/m^3$ with an overall average of 13 $\mu g/m^3$ in 2008. Figures 6.7a-b show the average one-hour concentrations recorded in 2007 and 2008. Toluene was the most abundant VOC measured in 2007 and 2008, accounting for approximately 45 per cent of the total concentration of the 16 VOCs. Toluene also recorded the highest one-hour maximum of 45 $\mu g/m^3$ in 2007 and 20 $\mu g/m^3$ in 2008, as shown in Figures 6.8a-b. On average, the sum of benzene, toluene, ethylbenzene, and xylenes (BTEX) was 75 per cent of the total VOC concentration.

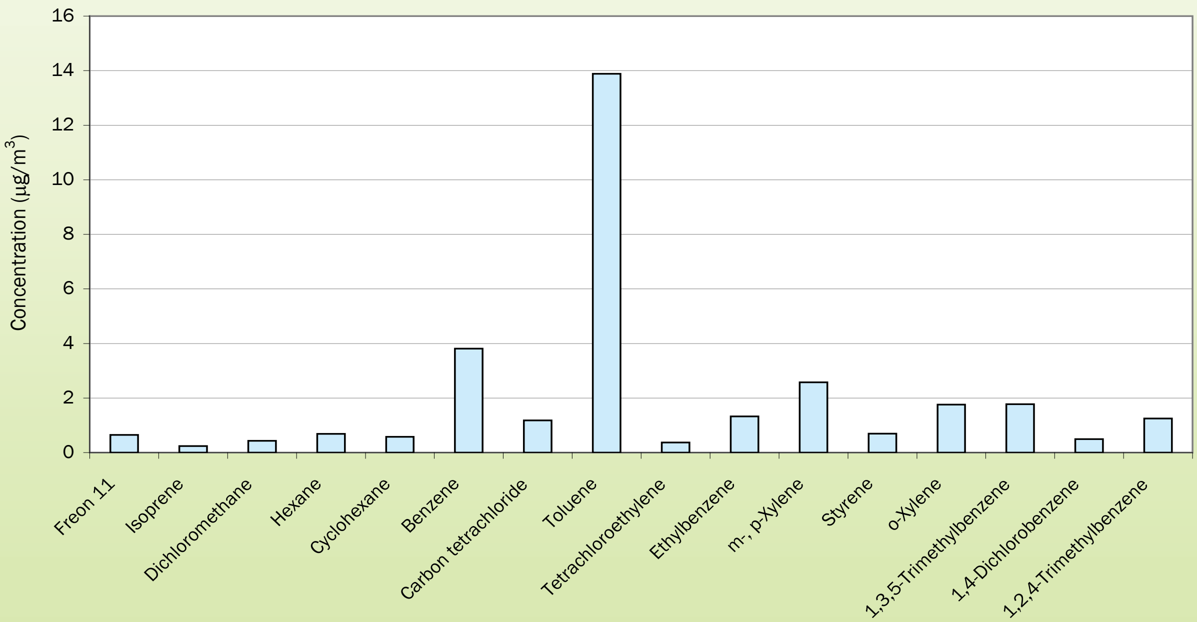
Conclusion

These data collected by the ministry during the 2007 and 2008 study periods will assist the City of Ottawa with the mapping of air quality concentrations over an extensive area. Details on the spatial and temporal distribution of air pollution and the ability to forecast such levels over an urban area are becoming of increasing importance in the characterization of urban air quality. Such information is essential for the impacts of sources and in the development of appropriate control strategies.

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

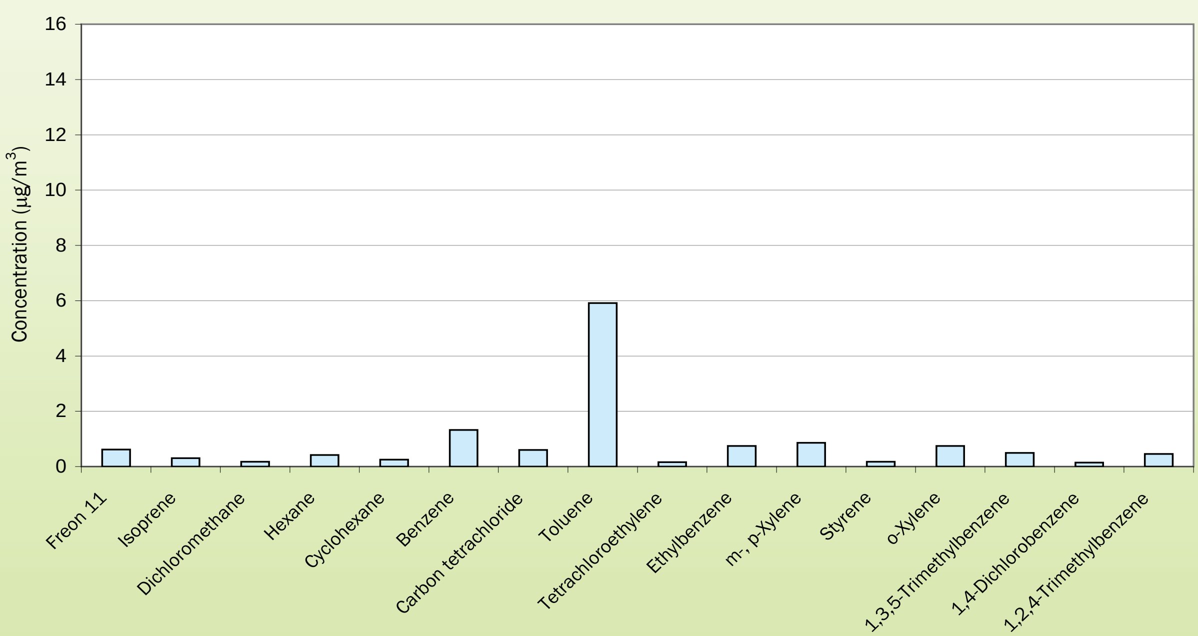
- A 15-watt energy-saving compact fluorescent light bulb produces about the same amount of light as a 60-watt incandescent bulb.
- An average 15-year-old refrigerator consumes more than twice as much energy (1067 kWh) as a modern Energy Star certified model (426 kWh) each year.
- An average Energy Star 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).

Figure 6.7a
Average One-Hour VOC Concentrations at King Edward
(September - October 2007)



Note: Average of 32 one-hour air samples.

Figure 6.7b
Average One-Hour VOC Concentrations at King Edward
(July 2008)



Note: Average of 34 one-hour air samples.

Figure 6.8a
Maximum One-Hour VOC Concentrations at King Edward
(September - October 2007)

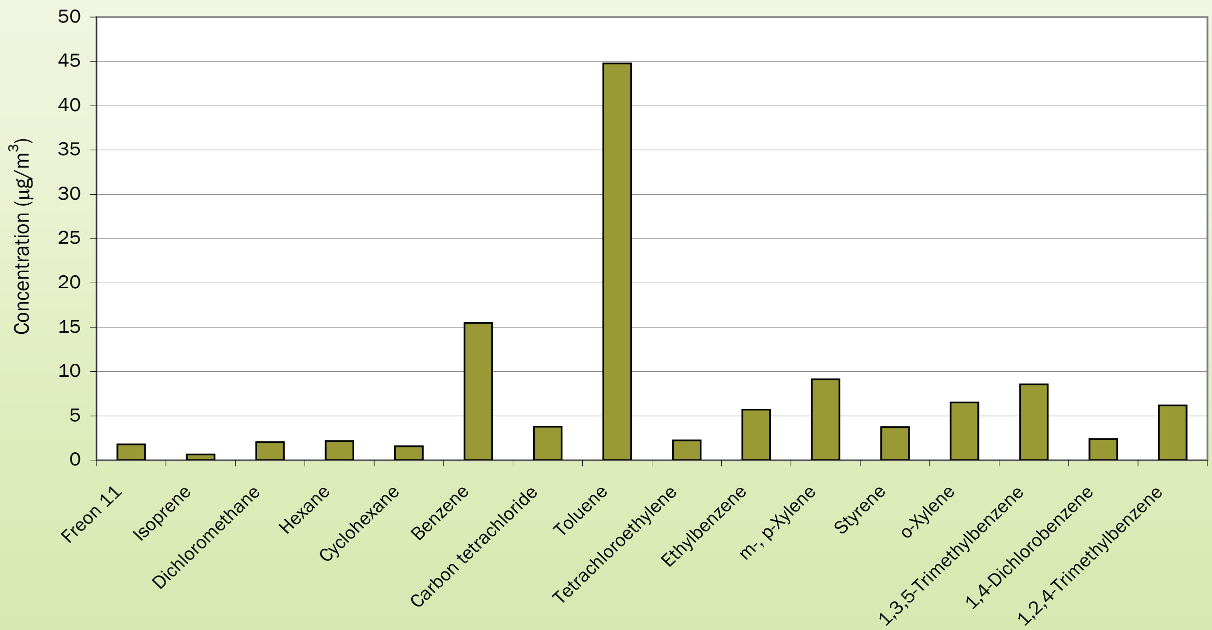
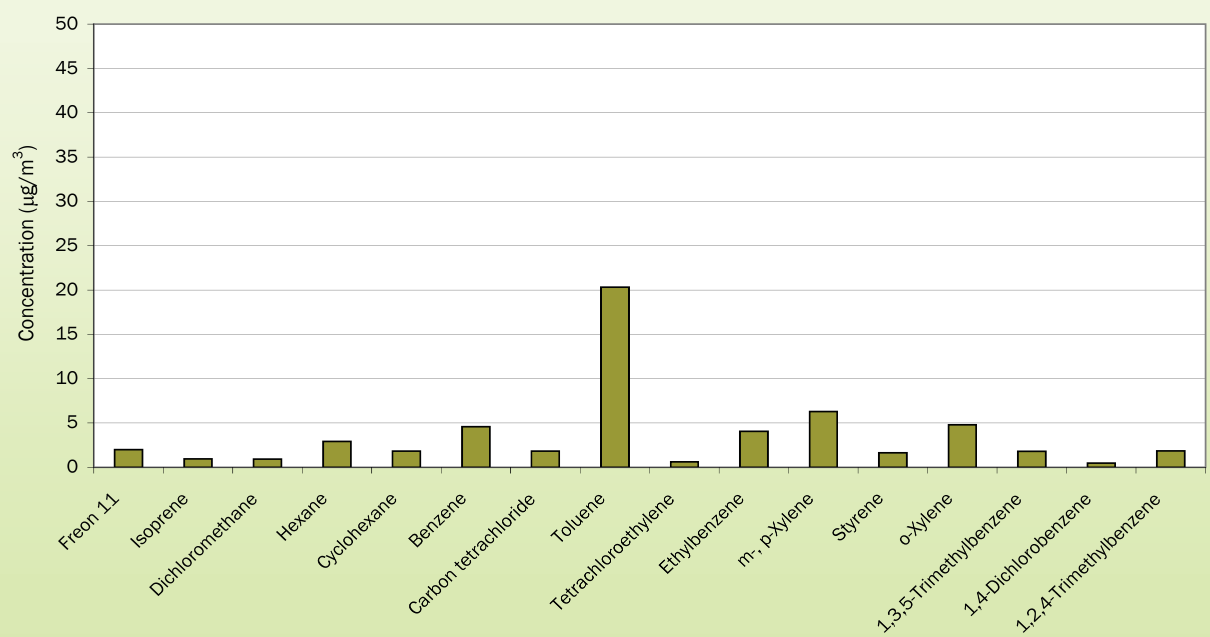


Figure 6.8b
Maximum One-Hour VOC Concentrations at King Edward
(July 2008)



Acidic deposition	–	refers to 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).
Continuous station	–	where pollutants are measured on a real-time basis and data determined hourly (for example ozone, sulphur dioxide).
Criterion	–	maximum concentration or level (based on potential effects) of pollutant that is desirable or considered acceptable in ambient air.
Diurnal	–	recurring every day; actions that are completed in 24 hours and repeated every 24 hours.
Exceedance	–	violation of the air pollutant concentration levels established by environmental protection criteria or other environmental standards.
Fine Particulate Matter	–	particles smaller than 2.5 microns in aerodynamic diameter, which arise mainly from fuel combustion, condensation of hot vapours and chemically-driven gas-to-particle conversion processes; also referred to as $PM_{2.5}$ or respirable particles. These are fine enough to penetrate deep into the lungs.
Fossil fuels	–	natural gas, petroleum, coal and any form of solid, liquid or gaseous fuel derived from organic materials for the purpose of generating heat.
Global warming	–	long-term rise in the average temperature of the earth's atmosphere; principally due to an increase in the build-up of carbon dioxide and other gases.
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.
Ozone episode day	–	a day on which widespread (hundreds of kilometres) elevated ozone levels (greater than 80 ppb maximum hourly concentration) occur simultaneously.
Particulate matter	–	refers to all airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 44 microns.
Percentile value	–	percentage of the data set that lies below the stated value; if the 70 percentile value is 0.10 ppm, then 70 per cent of the data are equal to or below 0.10 ppm.
Photochemical oxidation	–	a complex mixture of chemicals produced in the atmosphere; these air pollutants are formed by the action of sunlight on oxides of nitrogen and VOCs.

Photochemical smog	–	see smog.
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.

AAQC	-	Ambient Air Quality Criteria (Ontario)
AQI	-	Air Quality Index
BTEX	-	benzene, toluene, ethylbenzene, xylenes (o-, m-, and p-xylene)
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.)
NAPS	-	National Air Pollution Surveillance (Canada)
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
TAGA	-	Trace Atmospheric Gas Analyzer
TEOM	-	Tapered Element Oscillating Microbalance
TRS	-	total reduced sulphur
VOCs	-	volatile organic compounds
WHO	-	World Health Organization
$\mu g/m^3$	-	micrograms (of contaminant) per cubic metre (of air) – by weight
ppb	-	parts (of contaminant) per billion (parts of air) – by volume
ppm	-	parts (of contaminant) per million (parts of air) – by volume

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AIR QUALITY IN ONTARIO
2008 REPORT

APPENDICES

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.

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Appendix D: 20-Year NO_2 Trends

Appendix E: 20-Year CO Trends

Appendix F: 20-Year SO_2 Trends

INTRODUCTION

The Appendices are intended for use in conjunction with the 2008 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 2008, the AQI network was comprised of 142 continuous monitoring instruments at 40 sites. These instruments have the capability of recording minute data (approximately 74.6 million data points per year) that are used to scan and validate the continuous hourly data. During 2008, 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 QA/QC review is performed on the ambient data set in order to highlight anomalies and administer corrective action in a timely manner.

The air monitoring station operators routinely inspect and maintain monitoring equipment and stations with mandatory 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
- Fine Particulate Matter – TEOM 1400AB/SES
- Nitrogen Oxides – TE42C
- Carbon Monoxide – TE48C
- Sulphur Dioxide – TE43C
- 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 2008 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 2008 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 2008 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 1999-2008.

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 1989-2008.

Map 1: Locations of Air Quality Index (AQI) Stations in Ontario
2008

Table 1: 2008 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	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	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	.	.	.

Table 1: 2008 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
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	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:

A single CWS metric for Toronto is produced using data from four sites (Toronto Downtown, Toronto North, Toronto East and Toronto West) as per the Guidance Document on Achievement Determination.

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

Table A1: 2008 Ozone (O_3) Statistics

Unit: parts per billion (ppb)

O_3 1-hour AAQC is 80 ppb

ID	City	Location	Valid h	PERCENTILES						Mean	Maximum		No. of Times Above Criterion
				10%	30%	50%	70%	90%	99%		1h	24h	1h
12008	Windsor Downtown	467 University Ave. W.	8711	7	17	25	34	49	71	26.9	93	62	27
12016	Windsor West	College Ave./South St.	8767	5	16	24	33	48	69	25.9	93	63	15
13001	Chatham	435 Grand Ave. W.	8773	14	22	29	38	50	71	30.9	94	60	25
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8771	10	21	28	35	46	67	28.7	93	58	17
15020	Grand Bend	Point Blake Conservation Area	8732	15	24	31	37	47	69	31.3	99	67	20
15025	London	900 Highbury Ave. N.	8772	10	19	26	33	45	63	27.0	87	59	6
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8773	17	25	32	41	54	75	34.3	95	74	36
18007	Tiverton	4th Concession/Bruce Rd. 23	8613	18	26	32	38	47	65	32.6	89	60	5
21005	Brantford	324 Grand River Ave.	8751	9	20	27	36	48	68	28.4	91	65	11
26060	Kitchener	West Ave./Homewood Ave.	8671	10	20	27	35	47	64	28.1	87	57	7
27067	St. Catharines	Argyle Cres., Pump Stn.	8766	8	19	27	34	47	66	27.5	87	64	3
28028	Guelph	Exhibition St./Clark St. W.	8766	9	20	27	35	47	64	27.9	86	58	8
29000	Hamilton Downtown	Elgin St./Kelly St.	8696	7	17	24	31	45	64	25.1	80	63	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8753	12	21	27	35	48	67	29.0	86	65	8
29118	Hamilton West	Main St. W./ Hwy 403	8763	4	15	23	30	42	60	23.3	77	58	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8653	8	17	24	33	47	69	26.0	94	66	24
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8772	4	13	20	28	40	63	21.6	85	64	7
34020	Toronto North	Hendon Ave./Yonge St.	8723	4	14	22	30	41	60	22.7	76	56	0
35125	Toronto West	125 Resources Rd.	8765	2	10	18	27	42	67	20.7	87	57	20
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8766	6	16	24	32	44	63	24.9	86	68	11
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8553	9	19	26	34	46	66	27.0	90	66	16
45026	Oshawa	2000 Simcoe St. N., Durham College	7906	9	19	26	34	44	67	27.0	88	66	7
46089	Brampton	525 Main St. N., Peel Manor	8702	6	18	26	34	47	67	26.6	83	60	9
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8621	4	16	24	32	43	64	24.6	84	57	6
47045	Barrie	83 Perry St.	8631	7	19	26	33	45	63	26.5	94	61	13
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	8763	12	23	30	36	46	64	29.5	88	59	4
49005	Parry Sound	7 Bay St.	8776	15	25	31	38	49	69	32.1	97	68	26
49010	Dorset	District Rd. 117 / Paint Lake Rd.	8604	11	22	29	36	48	65	29.3	90	57	17
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8754	7	16	23	29	40	56	23.3	76	53	0
51002	Ottawa Central	960 Carling Ave.	8730	8	20	28	35	45	60	27.4	85	54	3
51010	Petawawa	Petawawa Research Forest Facility	8706	11	20	28	34	43	60	27.6	78	57	0
52022	Kingston	752 King St. W.	8711	17	25	31	38	51	71	32.7	88	68	17
54012	Belleville	2 Sidney St., Water Treatment Plant	8763	13	22	29	36	48	70	29.8	85	60	14
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8749	10	21	28	34	45	60	27.9	82	58	4
56051	Cornwall	Bedford St./3rd St. W.	8746	9	19	26	33	44	60	26.6	86	53	5
59006	Peterborough	10 Hospital Dr.	8593	11	21	27	34	46	70	28.2	91	63	21

Table A1: 2008 Ozone (O_3) Statistics

Unit: parts per billion (ppb)

O_3 1-hour AAQC is 80 ppb

ID	City	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criterion
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
63203	Thunder Bay	421 James St. S.	8745	6	17	24	30	38	49	23.0	74	44	0
71078	Sault Ste. Marie	Sault College	8769	14	22	28	35	44	60	28.9	77	54	0
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8761	8	20	28	35	46	63	27.7	80	65	0
77219	Sudbury	1222 Ramsey Lake Rd.	8746	12	21	28	34	45	58	27.9	73	51	0

Table A2: 2008 Fine Particulate Matter ($PM_{2.5}$) Statistics

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

ID	City	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.	8583	2	4	7	10	17	33	8.3	67	34	4
12016	Windsor West	College Ave./South St.	8668	2	4	7	11	18	34	8.9	71	38	4
13001	Chatham	435 Grand Ave. W.	8699	1	3	6	9	16	32	7.3	47	32	3
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8757	4	6	9	13	23	39	11.4	75	40	4
15020	Grand Bend	Point Blake Conservation Area	8642	0	3	5	8	16	31	6.8	63	35	1
15025	London	900 Highbury Ave. N.	8608	1	3	5	8	15	31	6.8	50	35	1
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8705	1	3	5	8	14	29	6.7	47	29	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8375	0	2	3	6	13	25	5.0	42	24	0
21005	Brantford	324 Grand River Ave.	8658	1	3	5	8	15	30	6.8	46	34	1
26060	Kitchener	West Ave./Homewood Ave.	8653	1	3	5	8	16	33	7.1	54	37	1
27067	St. Catharines	Argyle Cres., Pump Stn.	8687	1	3	6	9	16	30	7.4	57	34	2
28028	Guelph	Exhibition St./Clark St. W.	8699	1	3	5	8	15	30	6.5	47	36	1
29000	Hamilton Downtown	Elgin St./Kelly St.	8729	1	4	6	10	18	36	8.3	102	35	6
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8729	1	3	5	8	16	34	7.3	63	41	3
29118	Hamilton West	Main St. W./ Hwy 403	8696	1	3	6	9	17	33	7.6	65	33	2
31103	Toronto Downtown	Bay St./Wellesley St. W.	8740	1	3	5	8	15	29	6.6	43	35	1
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8687	1	3	5	8	15	28	6.7	51	34	1
34020	Toronto North	Hendon Ave./Yonge St.	8669	1	3	5	9	16	31	7.3	54	35	1
35125	Toronto West	125 Resources Rd.	8719	1	4	6	9	16	30	7.5	45	34	1
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8677	1	3	5	8	16	29	6.9	42	35	1
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8433	1	3	5	8	15	28	6.7	42	34	1
45026	Oshawa	2000 Simcoe St. N., Durham College	8693	1	3	4	7	15	27	6.3	45	31	1
46089	Brampton	525 Main St. N., Peel Manor	8690	1	3	5	8	16	31	6.8	49	36	1
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8449	1	3	5	8	16	30	7.1	48	40	1
47045	Barrie	83 Perry St.	8704	1	2	4	7	14	28	6.1	45	26	0
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	8702	1	2	4	7	14	28	6.0	46	25	0
49005	Parry Sound	7 Bay St.	8598	0	2	3	5	11	24	4.7	40	22	0
49010	Dorset	District Rd. 117 / Paint Lake Rd.	8421	0	2	3	5	10	23	4.5	40	19	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8665	0	2	4	6	12	23	5.3	44	27	0
51002	Ottawa Central	960 Carling Ave.	8701	0	2	4	6	12	22	5.1	40	26	0
51010	Petawawa	Petawawa Research Forest Facility	8710	0	1	3	4	9	19	3.9	27	19	0
52022	Kingston	752 King St. W.	8628	1	3	5	8	16	31	7.0	54	34	2
54012	Belleville	2 Sidney St., Water Treatment Plant	8721	1	3	5	7	14	26	6.1	49	27	0
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8689	0	2	4	7	13	24	5.7	40	27	0
56051	Cornwall	Bedford St./3rd St. W.	8718	1	3	4	7	14	27	6.1	48	34	1
59006	Peterborough	10 Hospital Dr.	8695	1	3	4	7	14	26	6.0	42	24	0

Table A2: 2008 Fine Particulate Matter ($PM_{2.5}$) Statistics

Unit: micrograms per cubic metre (µg/m³)

ID	City	Location	Valid h	PERCENTILES						Mean	Maximum		No. of Times Above Reference Level
				10%	30%	50%	70%	90%	99%		1h	24h	24h
63203	Thunder Bay	421 James St. S.	8724	0	2	3	5	9	21	4.2	72	22	0
71078	Sault Ste. Marie	Sault College	8707	0	2	3	5	10	20	4.4	41	20	0
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8737	0	2	3	5	10	22	4.6	59	23	0
77219	Sudbury	1222 Ramsey Lake Rd.	8561	0	2	3	5	9	21	4.1	42	23	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 µg/m³ for a 24-hour period (based on CWS).

Table A3: 2008 Nitric Oxide (NO) Statistics

Unit: parts per billion (ppb)

ID	City	Location	Valid h	PERCENTILES						Mean	Maximum	
				10%	30%	50%	70%	90%	99%		1h	24h
12008	Windsor Downtown	467 University Ave. W.	8703	0	1	3	5	13	55	5.9	173	50
12016	Windsor West	College Ave./South St.	7947	0	1	2	4	10	63	5.1	195	51
13001	Chatham	435 Grand Ave. W.	8113	1	2	2	3	5	15	3.1	81	15
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8684	0	1	2	3	6	20	3.2	89	17
15025	London	900 Highbury Ave. N.	8542	0	1	2	3	6	28	3.1	107	22
18007	Tiverton	4th Concession/Bruce Rd. 23	8640	0	0	0	0	1	3	0.2	41	4
21005	Brantford	324 Grand River Ave.	8745	0	0	0	1	3	20	1.3	112	16
26060	Kitchener	West Ave./Homewood Ave.	8745	0	0	0	1	4	46	2.5	193	34
27067	St. Catharines	Argyle Cres., Pump Stn.	8764	0	1	1	2	6	51	3.6	177	32
29000	Hamilton Downtown	Elgin St./Kelly St.	8689	1	1	2	5	14	76	6.5	248	84
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8767	0	0	1	2	5	33	2.4	101	30
31103	Toronto Downtown	Bay St./Wellesley St. W.	8775	1	2	2	4	11	44	5.0	122	32
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8767	1	2	4	8	20	89	9.2	213	66
34020	Toronto North	Hendon Ave./Yonge St.	8715	1	1	3	6	19	71	7.7	194	63
35125	Toronto West	125 Resources Rd.	8761	1	3	7	15	39	140	16.2	356	116
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8756	0	1	2	5	14	75	6.5	189	92
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8469	0	1	1	2	8	54	4.0	201	39
45026	Oshawa	2000 Simcoe St. N., Durham College	7715	0	1	2	3	7	31	3.2	91	28
46089	Brampton	525 Main St. N., Peel Manor	8625	0	1	2	3	13	71	5.8	227	55
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8490	0	1	2	3	12	85	6.1	231	59
47045	Barrie	83 Perry St.	8589	0	1	1	3	12	74	5.5	296	79
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	8162	0	0	1	2	5	36	2.6	123	27
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8682	0	0	0	2	7	38	2.7	124	40
51002	Ottawa Central	960 Carling Ave.	8370	0	0	0	1	5	44	2.7	137	41
52022	Kingston	752 King St. W.	8552	0	1	1	1	2	7	1.1	33	8
54012	Belleville	2 Sidney St., Water Treatment Plant	8759	1	1	1	2	6	33	3.0	145	34
56051	Cornwall	Bedford St./3rd St. W.	8761	1	1	1	2	4	61	3.6	232	70
59006	Peterborough	10 Hospital Dr.	7887	0	1	1	2	6	30	3.0	100	29
63203	Thunder Bay	421 James St. S.	8601	0	1	2	3	13	51	5.1	128	41
71078	Sault Ste. Marie	Sault College	8711	0	0	1	1	3	16	1.4	111	10
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8736	0	1	1	3	8	48	3.8	155	39

Table A4: 2008 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	Location	Valid h	PERCENTILES							Maximum		No. of Times Above Criteria	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8703	6	9	13	18	28	45	15.2	64	39	0	0
12016	Windsor West	College Ave./South St.	7947	7	10	14	19	28	45	16.2	66	36	0	0
13001	Chatham	435 Grand Ave. W.	8113	2	4	6	8	14	26	7.0	42	24	0	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8685	3	5	8	14	23	36	10.8	57	29	0	0
15025	London	900 Highbury Ave. N.	8542	4	6	9	13	21	37	10.8	61	31	0	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8640	0	1	2	3	8	16	3.0	34	16	0	0
21005	Brantford	324 Grand River Ave.	8745	2	3	5	8	15	27	6.9	45	22	0	0
26060	Kitchener	West Ave./Homewood Ave.	8745	2	4	7	10	19	37	9.0	70	32	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8764	4	6	8	12	20	36	10.4	58	29	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8689	5	8	12	18	29	46	14.7	74	38	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8767	3	5	8	12	22	40	10.5	64	38	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8775	7	11	15	20	30	47	17.0	68	43	0	0
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8767	6	10	14	20	31	48	16.5	66	44	0	0
34020	Toronto North	Hendon Ave./Yonge St.	8715	4	8	14	21	33	51	16.5	81	48	0	0
35125	Toronto West	125 Resources Rd.	8761	8	14	19	25	36	53	20.8	78	49	0	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8756	4	7	11	16	27	43	13.6	59	39	0	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8469	3	6	9	14	25	45	12.0	70	41	0	0
45026	Oshawa	2000 Simcoe St. N., Durham College	7714	3	4	6	10	18	32	8.5	51	29	0	0
46089	Brampton	525 Main St. N., Peel Manor	8625	3	6	9	16	28	47	13.1	68	43	0	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8490	4	6	10	15	24	43	12.3	64	38	0	0
47045	Barrie	83 Perry St.	8589	3	5	8	13	24	46	10.8	86	44	0	0
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	8162	2	3	5	9	18	39	8.0	53	32	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8681	3	5	8	14	24	42	11.4	69	31	0	0
51002	Ottawa Central	960 Carling Ave.	8370	1	3	5	9	19	40	8.1	56	34	0	0
52022	Kingston	752 King St. W.	8552	2	3	4	6	11	23	5.5	43	20	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8759	2	4	5	8	15	33	7.3	55	22	0	0
56051	Cornwall	Bedford St./3rd St. W.	8761	2	3	5	8	18	38	7.5	65	34	0	0
59006	Peterborough	10 Hospital Dr.	7887	1	3	5	8	15	30	7.0	51	25	0	0
63203	Thunder Bay	421 James St. S.	8601	2	3	5	9	19	36	8.1	48	26	0	0
71078	Sault Ste. Marie	Sault College	8711	1	3	4	6	12	24	5.5	54	17	0	0
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8736	1	3	4	8	18	40	7.5	58	27	0	0

Table A5: 2008 Nitrogen Oxides (NO_x) Statistics

Unit: parts per billion (ppb)

ID	City	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	24h
12008	Windsor Downtown	467 University Ave. W.	8703	7	11	16	24	39	89	21.1	218	79
12016	Windsor West	College Ave./South St.	7947	8	12	16	22	38	101	21.3	259	81
13001	Chatham	435 Grand Ave. W.	8113	4	6	8	11	19	39	10.1	112	38
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8684	4	7	10	17	28	51	13.9	146	46
15025	London	900 Highbury Ave. N.	8542	5	7	11	15	26	62	13.9	146	53
18007	Tiverton	4th Concession/Bruce Rd. 23	8640	0	1	2	4	8	18	3.3	51	18
21005	Brantford	324 Grand River Ave.	8745	2	3	6	9	18	41	8.2	141	35
26060	Kitchener	West Ave./Homewood Ave.	8745	3	5	7	12	23	75	11.5	263	65
27067	St. Catharines	Argyle Cres., Pump Stn.	8764	4	7	10	14	27	77	14.0	208	53
29000	Hamilton Downtown	Elgin St./Kelly St.	8689	6	10	15	22	41	111	21.2	292	117
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8767	3	6	9	14	26	65	12.9	136	64
31103	Toronto Downtown	Bay St./Wellesley St. W.	8775	9	13	18	25	39	83	22.1	167	68
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8767	7	13	19	28	50	128	25.7	269	96
34020	Toronto North	Hendon Ave./Yonge St.	8715	5	10	17	27	51	115	24.3	253	112
35125	Toronto West	125 Resources Rd.	8761	10	18	28	40	72	184	37.0	414	154
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8756	5	9	14	21	40	109	20.0	246	118
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8469	4	7	11	17	32	91	16.1	266	70
45026	Oshawa	2000 Simcoe St. N., Durham College	7714	3	5	8	12	24	58	11.7	140	49
46089	Brampton	525 Main St. N., Peel Manor	8625	4	7	12	20	42	106	18.9	273	92
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8490	5	8	12	18	37	120	18.4	254	97
47045	Barrie	83 Perry St.	8589	3	6	9	16	36	109	16.3	382	124
48006	Newmarket	Eagle St. W./Mc Caffrey Rd.	8162	2	4	6	10	23	70	10.4	172	53
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8682	3	6	9	15	31	76	14.0	174	65
51002	Ottawa Central	960 Carling Ave.	8370	2	3	6	10	25	76	10.8	188	75
52022	Kingston	752 King St. W.	8552	3	4	5	7	12	28	6.5	64	26
54012	Belleville	2 Sidney St., Water Treatment Plant	8759	3	5	7	10	20	60	10.2	184	53
56051	Cornwall	Bedford St./3rd St. W.	8761	2	4	6	10	22	90	11.1	288	96
59006	Peterborough	10 Hospital Dr.	7887	2	4	7	11	21	54	10.0	152	49
63203	Thunder Bay	421 James St. S.	8601	2	4	7	13	32	81	13.2	172	65
71078	Sault Ste. Marie	Sault College	8711	2	3	5	7	14	36	6.9	165	24
75010	North Bay	540 Chippewa St. N., Dept. National Defence	8736	2	4	6	10	26	83	11.3	203	66

Table A6: 2008 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	Location	Valid h	PERCENTILES						Mean	Maximum		No. of Times Above Criteria	
				10%	30%	50%	70%	90%	99%		1h	8h	1h	8h
12008	Windsor Downtown	467 University Ave. W.	8637	0.02	0.11	0.18	0.25	0.35	0.65	0.19	1.29	1.02	0	0
13001	Chatham	435 Grand Ave. W.	8731	0.08	0.13	0.17	0.21	0.27	0.38	0.18	1.52	0.58	0	0
15025	London	900 Highbury Ave. N.	8655	0.03	0.08	0.15	0.20	0.28	0.44	0.15	0.98	0.65	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8674	0.00	0.08	0.17	0.24	0.38	0.79	0.19	3.33	0.99	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8697	0.00	0.03	0.08	0.13	0.20	0.37	0.09	0.93	0.48	0	0
35125	Toronto West	125 Resources Rd.	8690	0.06	0.15	0.21	0.27	0.38	0.77	0.22	1.73	1.16	0	0
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8642	0.11	0.17	0.22	0.26	0.35	0.67	0.23	1.58	1.00	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8772	0.18	0.23	0.28	0.33	0.42	0.66	0.29	1.27	0.90	0	0
51002	Ottawa Central	960 Carling Ave.	8749	0.18	0.22	0.26	0.31	0.39	0.68	0.28	1.62	1.07	0	0
52022	Kingston	752 King St. W.	8716	0.11	0.15	0.18	0.20	0.24	0.33	0.18	0.66	0.46	0	0
71078	Sault Ste. Marie	Sault College	8767	0.09	0.13	0.15	0.19	0.25	0.48	0.17	2.20	0.82	0	0

Table A7: 2008 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	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.	8703	0	1	2	4	11	30	4.5	57	20	0	0	0
12016	Windsor West	College Ave./South St.	8718	0	1	2	5	13	30	4.7	65	20	0	0	0
13001	Chatham	435 Grand Ave. W.	8773	0	0	1	2	5	12	2.0	54	12	0	0	0
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8768	0	1	2	4	17	98	7.7	450	194	5	2	0
15025	London	900 Highbury Ave. N.	8753	1	1	2	2	4	10	2.2	32	10	0	0	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8508	0	0	1	1	4	10	1.4	28	10	0	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8696	0	1	2	3	11	42	4.3	74	32	0	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8730	0	1	1	3	7	29	3.0	72	39	0	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8581	0	1	1	2	4	9	1.6	33	9	0	0	0
35125	Toronto West	125 Resources Rd.	8773	0	0	1	1	4	10	1.4	24	8	0	0	0
46108	Mississauga	3359 Mississauga Rd. N., U of T Campus	8559	0	1	1	2	4	10	1.6	29	7	0	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8743	0	0	1	1	2	5	1.0	25	7	0	0	0
51002	Ottawa Central	960 Carling Ave.	8685	0	1	1	1	2	4	0.9	16	6	0	0	0
52022	Kingston	752 King St. W.	8733	0	0	1	1	2	6	0.9	12	6	0	0	0
71078	Sault Ste. Marie	Sault College	8765	0	0	0	1	3	14	1.2	52	8	0	0	0
77219	Sudbury	1222 Ramsey Lake Rd.	8679	0	0	0	1	3	35	2.0	213	31	0	0	0

Table A8: 2008 Total Reduced Sulphur (TRS) Compounds Statistics

Unit: parts per billion (ppb)

ID	City	Location	Valid h	PERCENTILES							Maximum	
				10%	30%	50%	70%	90%	99%	Mean	1h	24h
12016	Windsor West	College Ave./South St.	7924	0	0	1	1	1	5	0.74	13	4
14064	Sarnia	Front St. N./Cn Tracks, Centennial Park	8761	0	0	0	0	0	2	0.13	19	4
29000	Hamilton Downtown	Elgin St./Kelly St.	8696	0	0	0	0	1	3	0.26	11	3
71078	Sault Ste. Marie	Sault College	8656	0	0	0	0	1	2	0.31	7	3

Table B1: 10-Year Trend for O_3

Annual Mean (ppb)

ID	City	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12008	Windsor Downtown	21.7	18.6	20.5	21.9	22.9	20.2	26.0	24.6	27.0	26.9
12016	Windsor West	18.9	17.0	19.0	20.2	22.8	22.6	25.6	24.3	25.3	25.9
14064	Sarnia	26.5	24.3	25.6	26.5	24.7	23.8	27.4	26.7	28.6	28.7
15020	Grand Bend	32.5	32.6	31.6	29.8	30.7	25.8	32.5	29.7	31.7	31.3
15025	London	25.8	21.1	24.2	25.3	26.9	23.6	26.1	25.1	27.2	27.0
18007	Tiverton	INS	32.3	34.7	34.7	33.2	28.1	31.8	28.9	34.3	32.6
26060	Kitchener	25.2	23.0	25.7	27.3	28.1	24.8	28.0	26.6	28.6	28.1
27067	St. Catharines	21.7	18.9	21.2	24.1	25.3	23.6	26.3	26.2	28.1	27.5
29000	Hamilton Downtown	19.5	17.0	18.8	20.4	21.7	20.1	23.2	23.2	24.8	25.1
29114	Hamilton Mountain	24.1	22.6	24.2	27.7	28.4	24.6	28.2	27.5	29.2	29.0
29118	Hamilton West	20.0	16.9	18.6	20.5	22.0	19.2	21.2	20.9	23.0	23.3
31103	Toronto Downtown	20.2	19.7	22.0	24.0	23.6	22.8	24.5	22.6	25.7	26.0
33003	Toronto East	21.5	19.6	21.7	21.0	21.8	19.9	22.4	22.0	23.2	21.6
34020	Toronto North	22.8	20.6	23.4	25.1	23.6	22.5	24.5	23.3	24.5	22.7
44008	Burlington	26.2	23.4	24.6	26.3	22.8	21.0	23.9	23.4	24.6	24.9
44017	Oakville	22.4	21.0	22.9	25.1	INS	24.6	27.7	26.1	27.5	27.0
45026	Oshawa	25.0	21.2	23.4	23.2	24.1	23.3	28.6	25.1	28.0	27.0
46109	Mississauga	22.2	19.9	22.4	23.1	24.8	20.7	23.1	22.4	23.3	24.6
49010	Dorset	31.0	29.3	31.0	32.4	30.1	28.8	32.3	28.9	29.9	29.3
51001	Ottawa Downtown	21.2	19.9	25.0	24.9	24.7	21.7	23.3	23.6	24.7	23.3
56051	Cornwall	25.8	24.0	29.0	24.8	25.9	23.8	27.7	27.5	28.3	26.6
59006	Peterborough	31.4	28.1	30.7	30.5	29.7	27.1	31.2	24.9	27.6	28.2
63203	Thunder Bay	22.5	22.6	24.4	23.4	26.1	22.0	22.3	23.5	24.2	23.0
71078	Sault Ste. Marie	24.1	24.8	25.2	24.2	26.8	27.0	30.2	29.1	29.7	28.9
75010	North Bay	29.1	22.1	26.6	26.8	27.0	25.2	28.0	26.7	27.1	27.7
77219	Sudbury	30.7	26.1	29.1	29.2	28.5	27.7	31.0	28.4	28.1	27.9

Notes:

n/a indicates pollutant not monitored.

INS indicates there was insufficient data in the 2nd and/or 3rd quarter to calculate a valid annual mean.

Station 44017 replaced station 44015 as the Oakville site in 2003.

Station 45026 replaced station 45025 as the Oshawa site in 2005.

Station 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 NO

Annual mean (ppb)

ID	City	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12008	Windsor Downtown	13.3	13.9	11.0	10.9	INS	10.5	7.8	7.2	6.4	5.9
14064	Sarnia	7.1	8.9	6.7	7.1	5.0	3.7	3.8	3.7	3.2	3.2
15025	London	8.5	8.0	6.6	INS	INS	6.0	5.5	4.4	3.6	3.1
26060	Kitchener	6.6	7.4	5.7	3.8	INS	4.9	4.4	3.5	2.7	2.5
29000	Hamilton Downtown	12.0	14.7	11.5	10.4	11.7	9.6	9.9	8.0	7.7	6.5
31103	Toronto Downtown	15.8	14.4	10.0	8.2	8.7	7.6	7.2	6.9	5.9	5.0
33003	Toronto East	20.7	23.0	17.9	16.1	17.0	16.0	14.4	12.5	10.8	9.2
34020	Toronto North	16.5	16.8	14.3	12.4	12.4	INS	10.8	10.0	8.3	7.7
44008	Burlington	22.6	21.8	13.2	11.8	15.5	11.1	12.3	9.8	8.8	6.5
44017	Oakville	13.0	16.2	11.9	INS	INS	5.3	5.2	4.3	3.9	4.0
45026	Oshawa	15.1	14.2	13.7	10.0	9.3	8.2	INS	3.8	3.2	3.2
51001	Ottawa Downtown	14.8	11.0	7.3	INS	5.8	3.2	3.3	3.0	3.4	2.7

Table B3: 10-Year Trend for NO_2

Annual Mean (ppb)

ID	City	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12008	Windsor Downtown	22.9	21.6	19.4	19.1	INS	18.3	16.9	17.2	17.2	15.2
14064	Sarnia	16.7	16.3	16.8	17.5	13.0	11.7	12.7	11.0	11.3	10.8
15025	London	19.4	17.4	17.3	INS	INS	13.7	14.1	12.3	11.7	10.8
26060	Kitchener	14.0	14.7	14.1	11.9	INS	13.1	12.9	10.8	9.7	9.0
29000	Hamilton Downtown	21.6	21.8	22.5	20.9	21.3	16.8	19.3	17.0	17.0	14.7
31103	Toronto Downtown	26.9	26.8	27.1	23.3	23.2	20.0	20.7	19.1	18.2	17.0
33003	Toronto East	24.6	23.7	22.9	22.0	21.3	19.8	20.1	17.4	17.2	16.5
34020	Toronto North	24.3	22.7	22.0	21.0	20.4	INS	19.2	17.4	16.7	16.5
44008	Burlington	22.9	20.3	16.5	17.9	17.3	15.3	17.2	16.2	16.0	13.6
44017	Oakville	17.2	17.2	16.2	INS	INS	13.5	14.5	12.4	13.0	12.0
45026	Oshawa	21.5	19.7	19	17.2	16.2	14.15	INS	8.9	8.1	8.5
51001	Ottawa Downtown	12.2	13.8	14.3	INS	13.7	11.1	9.8	8.6	8.7	11.4

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 B4: 10-Year Trend for NO_x

Annual Mean (ppb)

ID	City	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12008	Windsor Downtown	37.0	36.0	30.5	29.2	INS	29.3	24.9	24.4	23.6	21.1
14064	Sarnia	23.5	25.0	23.6	24.6	18.1	15.7	16.8	14.7	14.5	13.9
15025	London	25.9	24.7	23.1	INS	INS	19.4	19.4	16.7	15.3	13.9
26060	Kitchener	20.5	21.9	19.5	15.5	INS	18.2	17.4	14.3	12.4	11.5
29000	Hamilton Downtown	34.0	37.0	34.4	31.4	33.3	27.7	30.0	24.9	24.7	21.2
31103	Toronto Downtown	41.9	40.4	36.6	31.5	32.1	28.1	28.2	26.1	24.2	22.1
33003	Toronto East	44.9	46.3	40.3	37.7	37.9	36.3	34.7	29.9	28.0	25.7
34020	Toronto North	40.7	39.3	36.2	33.4	33.0	28.3	30.4	27.5	25.0	24.3
44008	Burlington	45.4	42.2	29.0	28.4	32.5	26.1	29.3	26.0	24.8	20.0
44017	Oakville	29.6	33.0	27.8	INS	INS	18.3	19.5	16.7	16.9	16.1
45026	Oshawa	35.8	33.6	32.6	27.2	25.5	22.5	INS	12.7	11.3	11.7
51001	Ottawa Downtown	27.5	24.4	21.0	INS	20.1	14.7	13.7	11.5	12.0	14.0

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 B5: 10-Year Trend for CO

1h Maximum (ppm)

ID	City	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12008	Windsor Downtown	6.7	11.8	4.9	4.3	4.3	2.3	1.3	2.9	5.0	1.3
15025	London	3.0	2.5	3.5	2.3	2.4	2.3	2.4	1.8	1.2	1.0
29000	Hamilton Downtown	5.5	7.3	3.7	2.3	3.1	4.0	2.6	2.8	6.0	3.3
31103	Toronto Downtown	3.2	3.6	3.2	2.9	2.4	1.9	1.6	1.5	1.7	0.9
51001	Ottawa Downtown	0.8	0.7	0.6	0.7	0.6	0.5	0.4	0.3	1.5	1.3

Table B6: 10-Year Trend for SO_2

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

ID	City	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12008	Windsor Downtown	6.7	6.2	6.1	5.7	5.9	4.8	4.9	5.0	5.5	4.5
12016	Windsor West	9.6	8.8	9.3	7.9	6.3	4.6	5.1	4.9	5.2	4.7
14064	Sarnia	11.8	10.4	12.5	10.4	7.1	8.2	7.8	8.3	8.0	7.7
15025	London	4.9	3.5	3.5	2.2	INS	2.2	2.3	1.9	1.9	2.2
29000	Hamilton Downtown	6.6	5.1	6.0	4.9	5.0	4.0	5.3	4.8	4.2	4.3
29114	Hamilton Mountain	5.5	5.8	5.3	4.8	5.3	n/a	n/a	3.3	3.5	3.0
31103	Toronto Downtown	INS	4.7	5.0	4.0	3.2	2.2	2.8	1.9	1.9	1.6
51001	Ottawa	4.2	4.1	2.3	2.9	INS	1.0	1.5	1.1	0.9	0.9
71078	Sault Ste. Marie	1.9	2.0	2.0	1.7	2.0	0.9	1.5	1.4	1.8	1.2
77219	Sudbury	3.0	4.2	2.6	3.1	2.0	INS	2.8	2.4	2.3	2.0

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.
S tation 77219 replaced station 77203 as the Sudbury site in 2004.

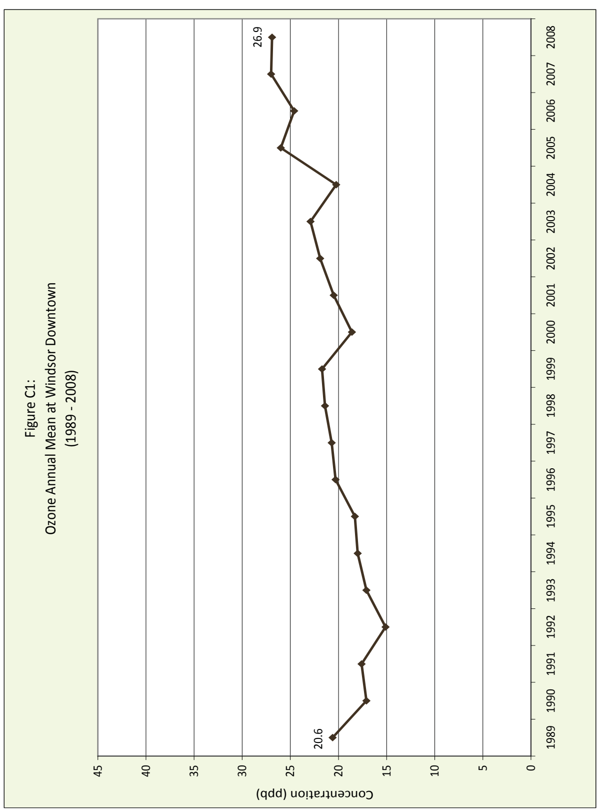


Figure C1:
Ozone Annual Mean at Windsor Downtown
(1989 - 2008)

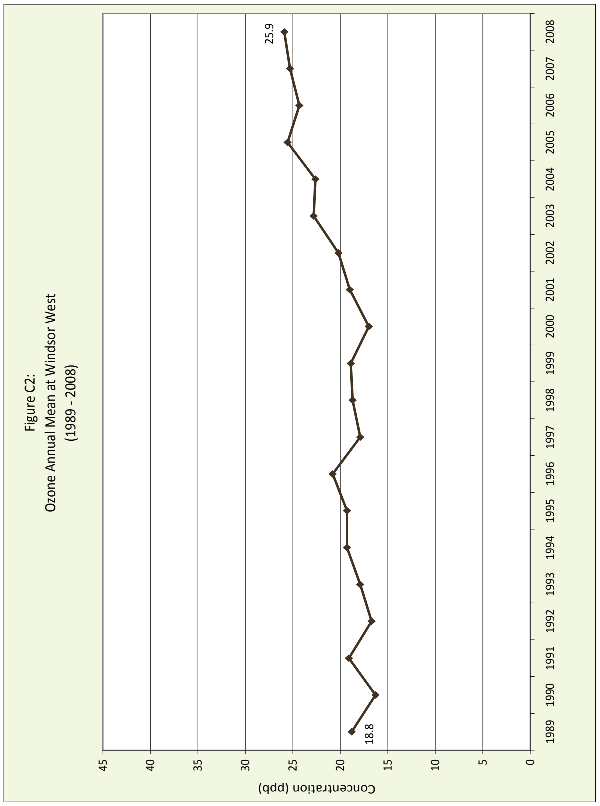


Figure C2:
Ozone Annual Mean at Windsor West
(1989 - 2008)

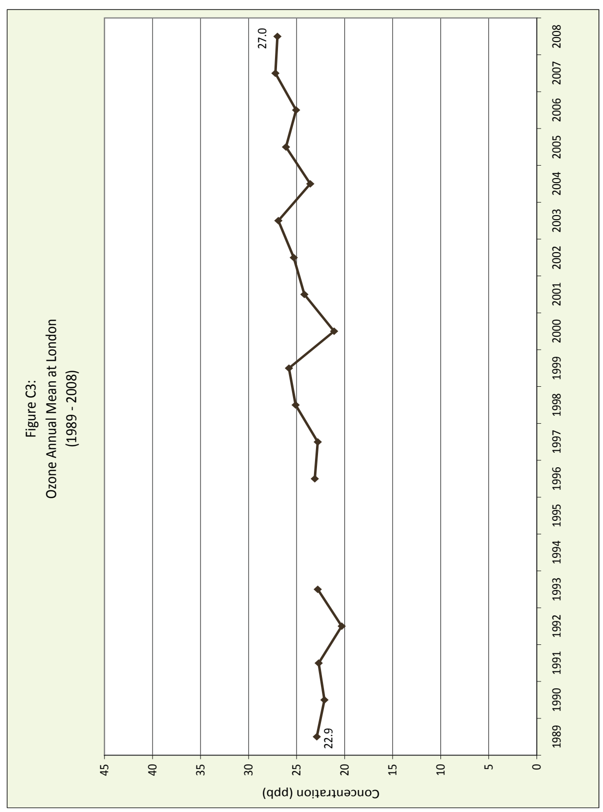


Figure C3:
Ozone Annual Mean at London
(1989 - 2008)

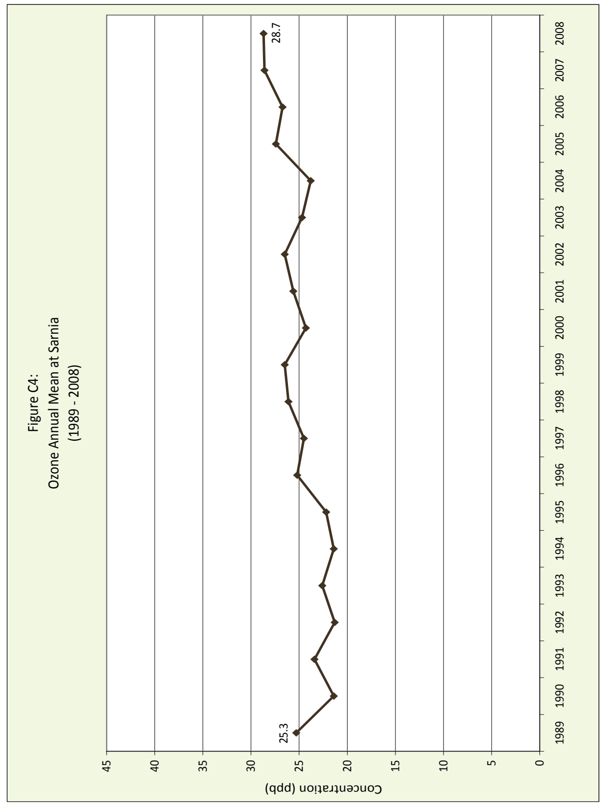


Figure C4:
Ozone Annual Mean at Sarnia
(1989 - 2008)

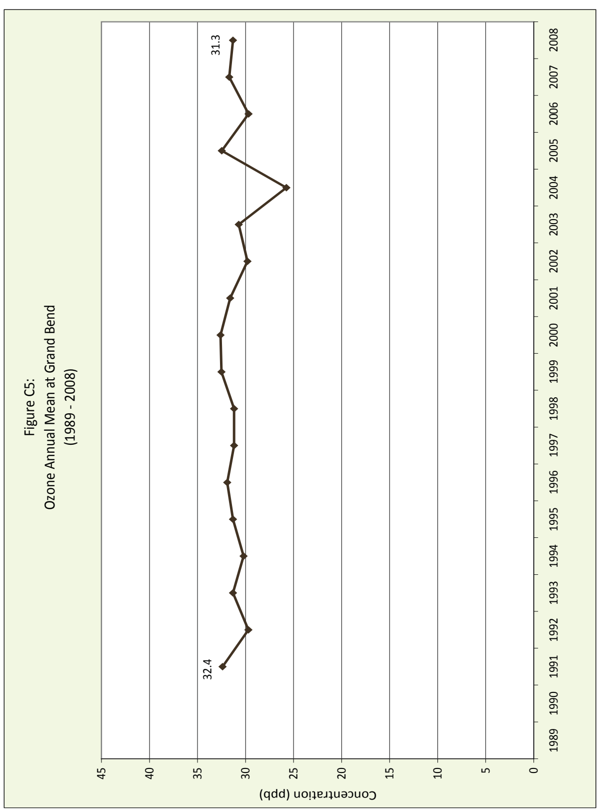


Figure C5:
Ozone Annual Mean at Grand Bend
(1989 - 2008)
Concentration (ppb)
32.4
31.3

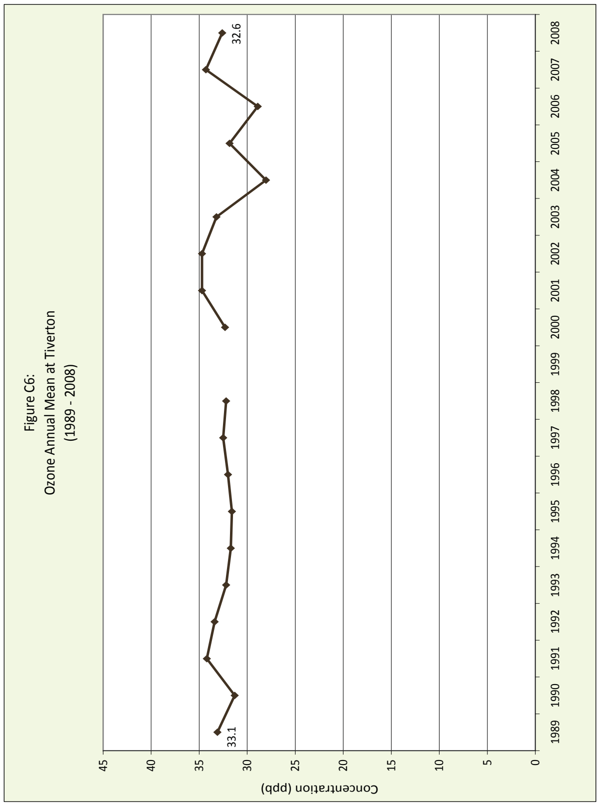


Figure C6:
Ozone Annual Mean at Tiverton
(1989 - 2008)
Concentration (ppb)
33.1
32.6

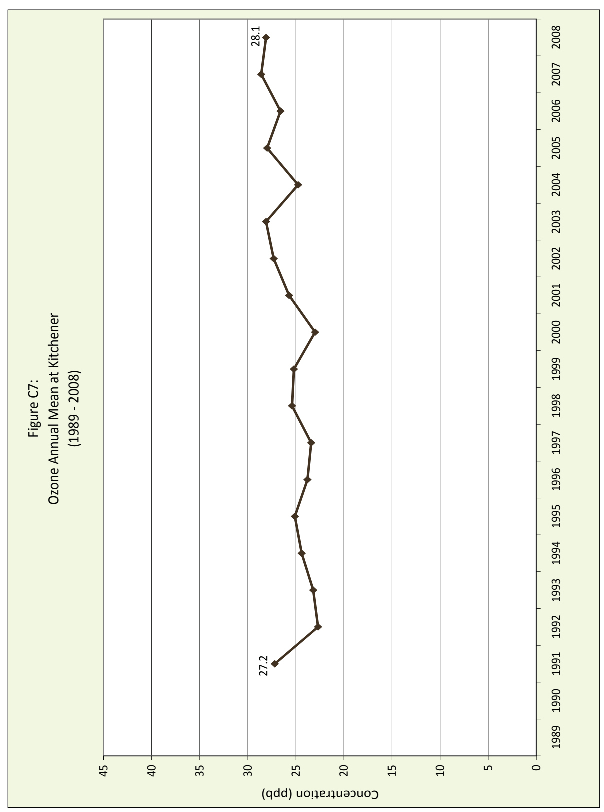


Figure C7:
Ozone Annual Mean at Kitchener
(1989 - 2008)
Concentration (ppb)
27.2
28.1

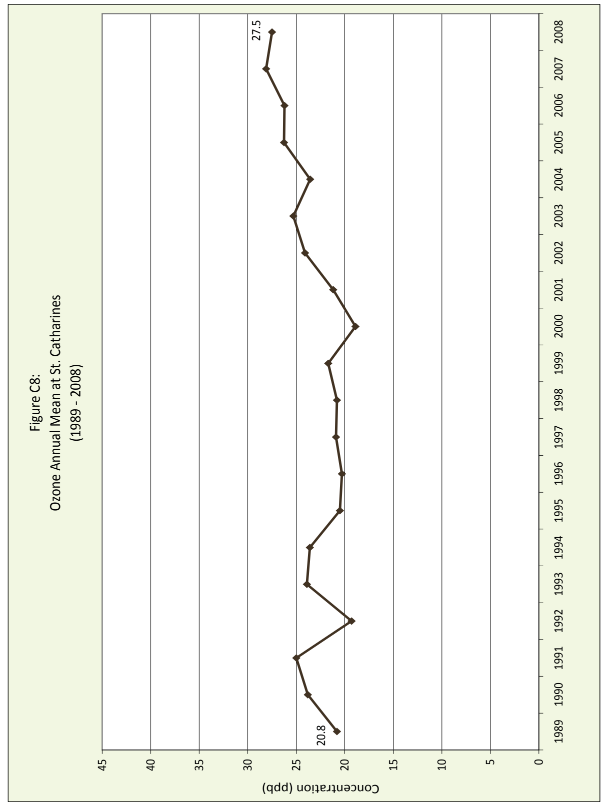


Figure C8:
Ozone Annual Mean at St. Catharines
(1989 - 2008)
Concentration (ppb)
20.8
27.5

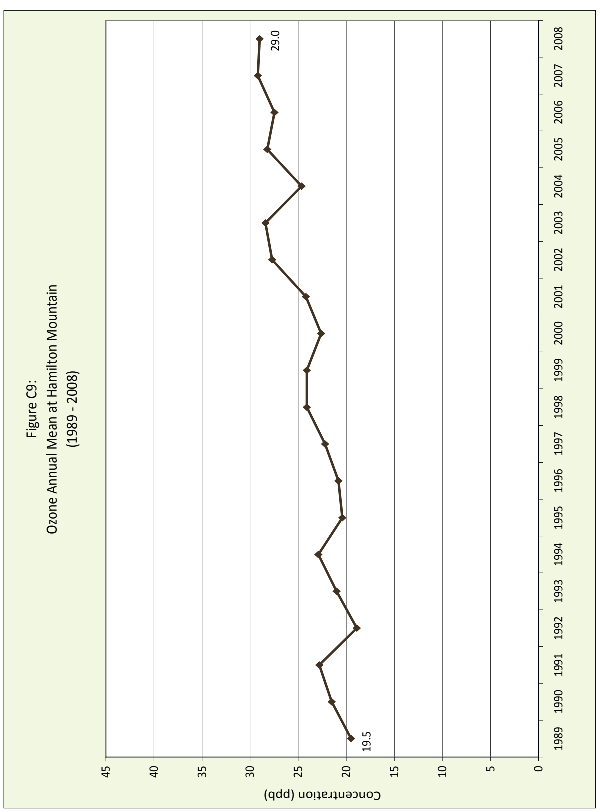


Figure C9:
Ozone Annual Mean at Hamilton Mountain
(1989 - 2008)

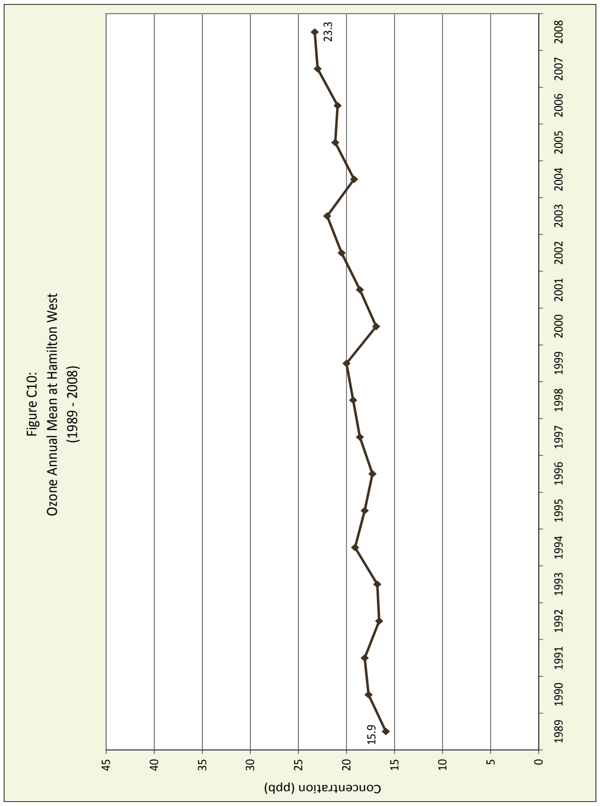


Figure C10:
Ozone Annual Mean at Hamilton West
(1989 - 2008)

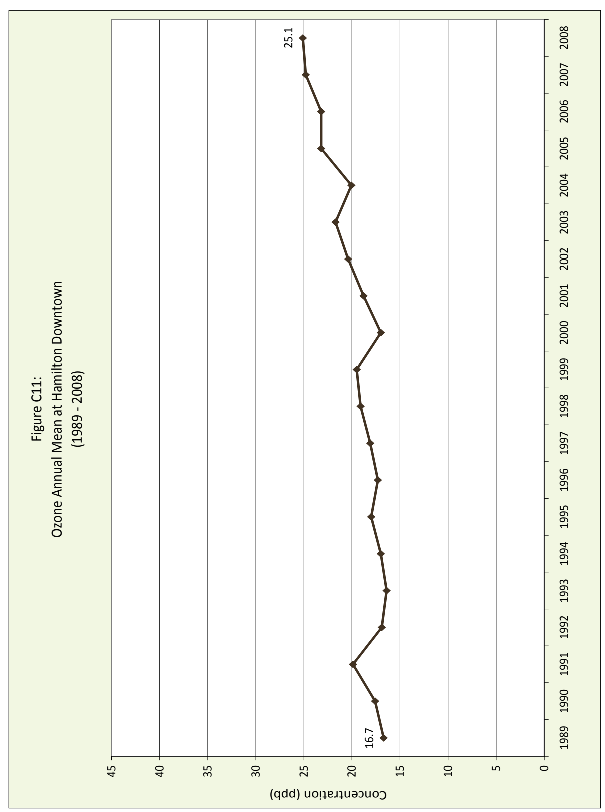


Figure C11:
Ozone Annual Mean at Hamilton Downtown
(1989 - 2008)

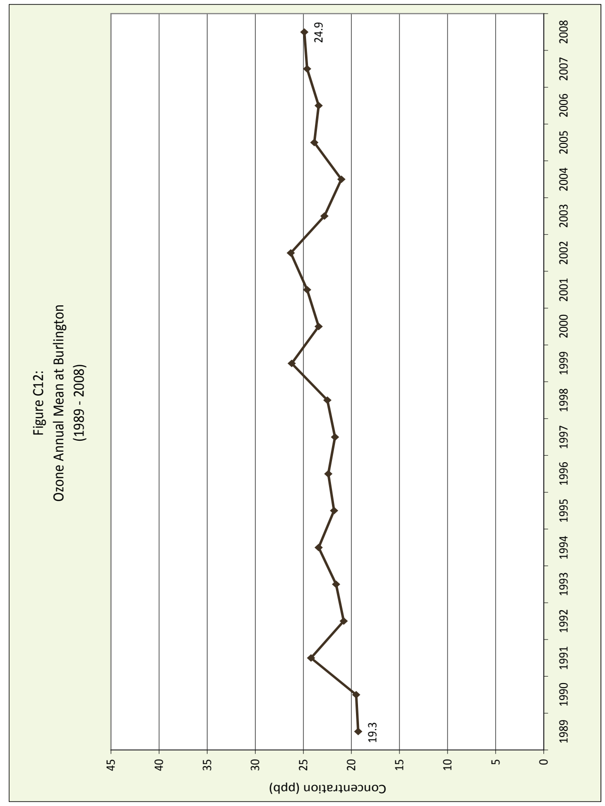


Figure C12:
Ozone Annual Mean at Burlington
(1989 - 2008)

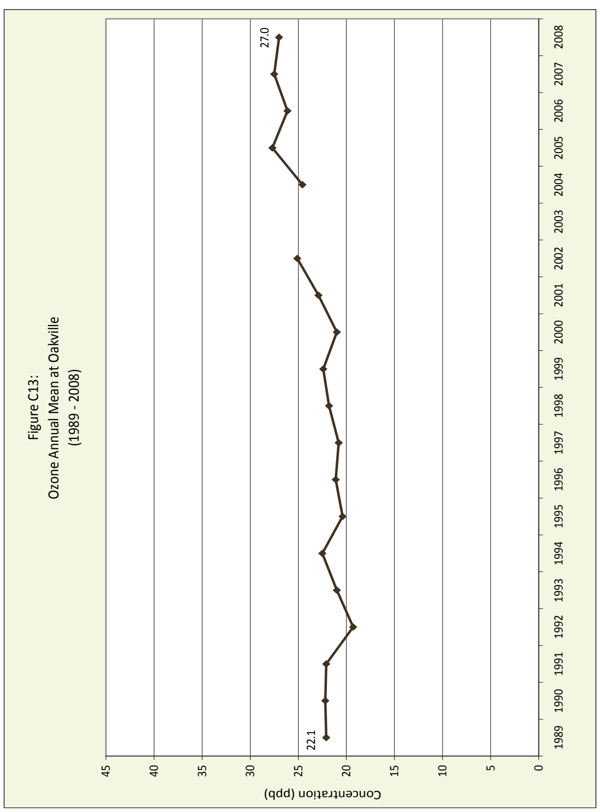


Figure C13:
Ozone Annual Mean at Oakville
(1989 - 2008)

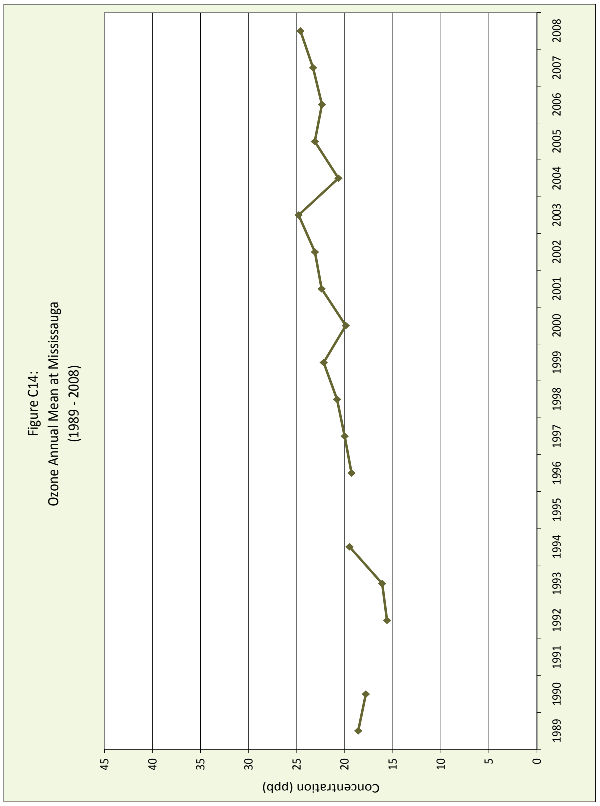


Figure C14:
Ozone Annual Mean at Mississauga
(1989 - 2008)

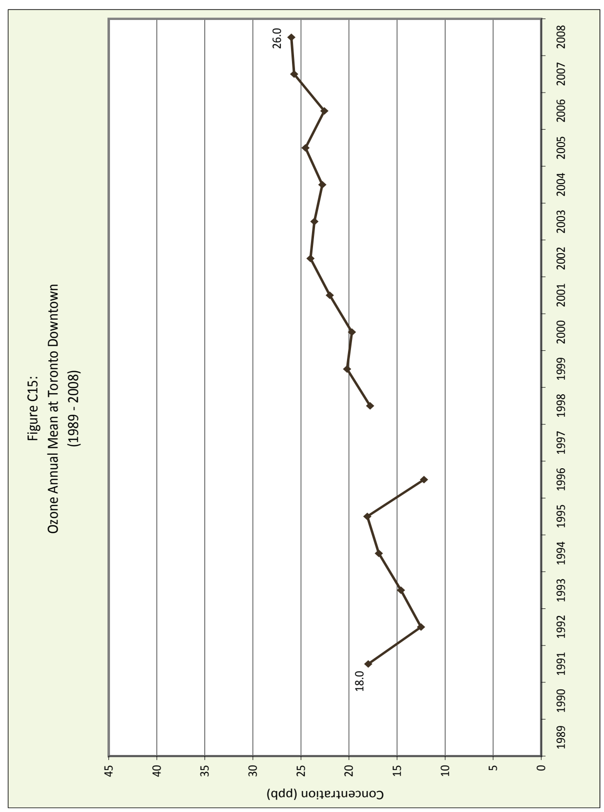


Figure C15:
Ozone Annual Mean at Toronto Downtown
(1989 - 2008)

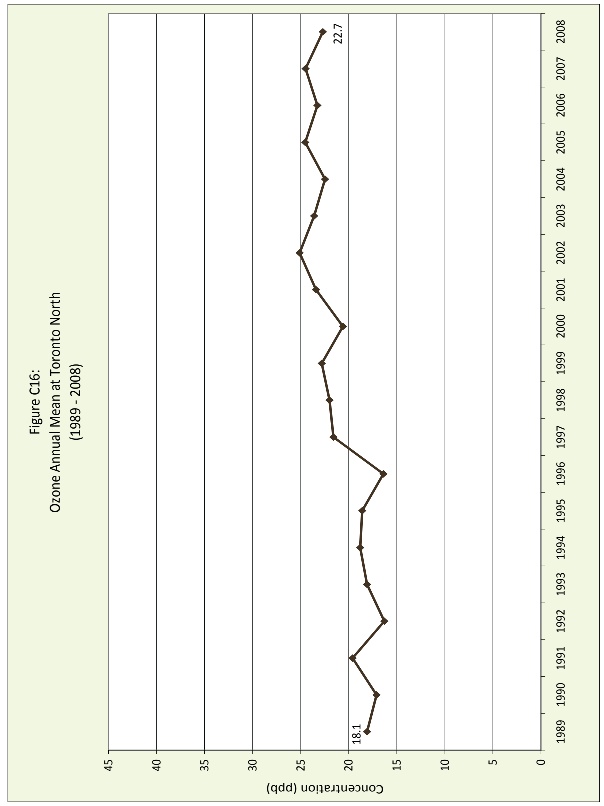


Figure C16:
Ozone Annual Mean at Toronto North
(1989 - 2008)

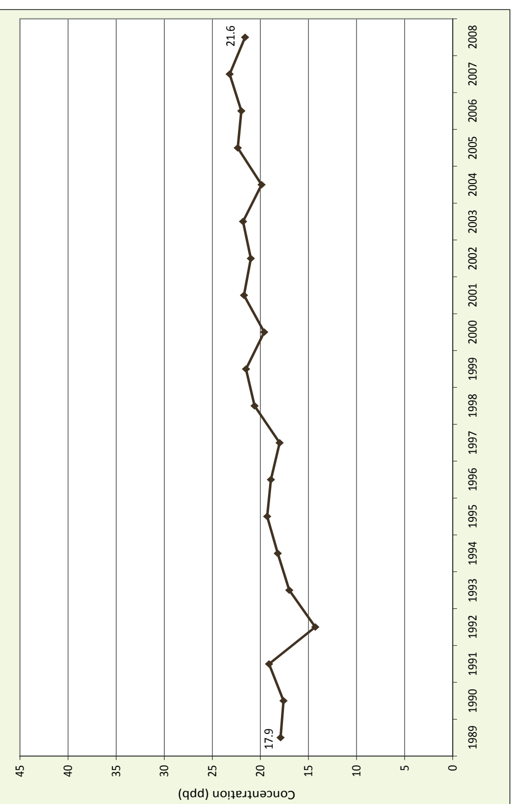


Figure C17:
Ozone Annual Mean at Toronto East
(1989 - 2008)

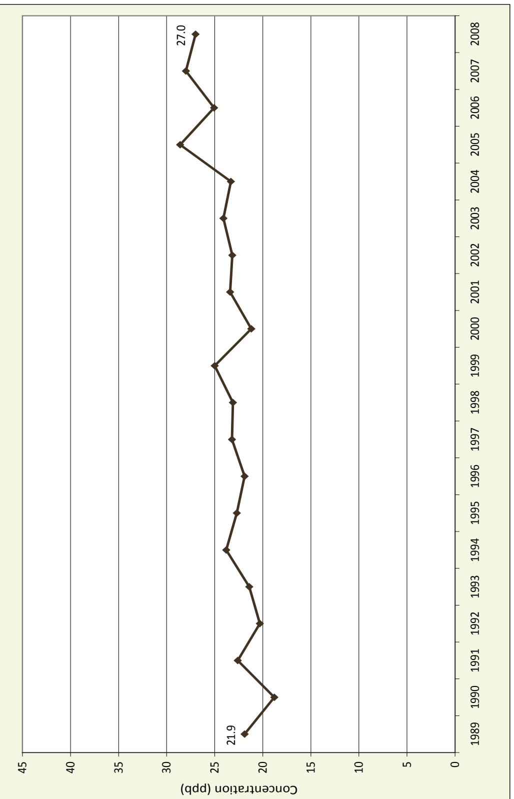


Figure C18:
Ozone Annual Mean at Oshawa
(1989 - 2008)

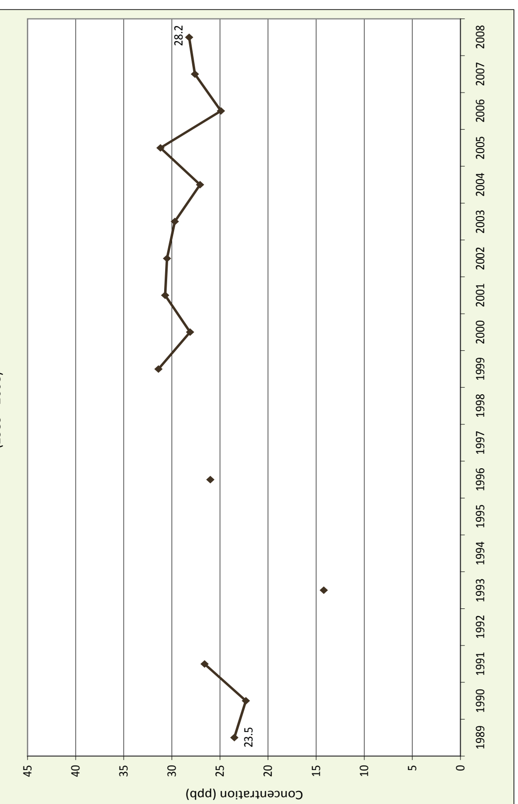


Figure C19:
Ozone Annual Mean at Peterborough
(1989 - 2008)

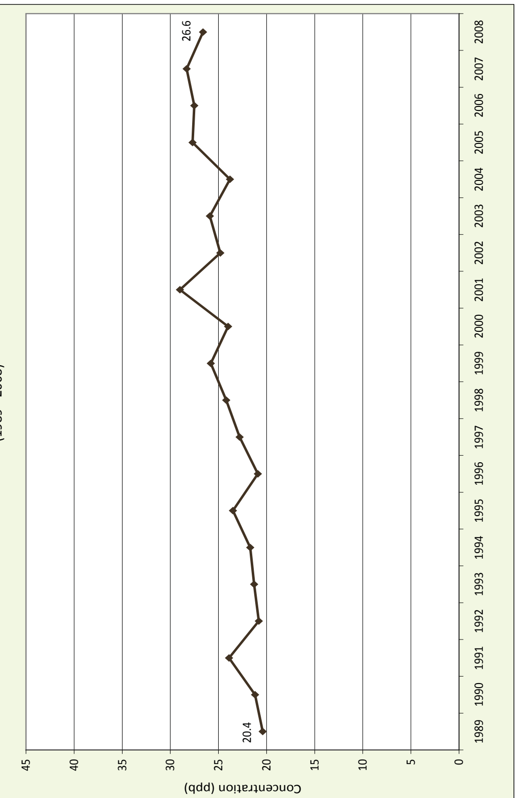


Figure C20:
Ozone Annual Mean at Cornwall
(1989 - 2008)

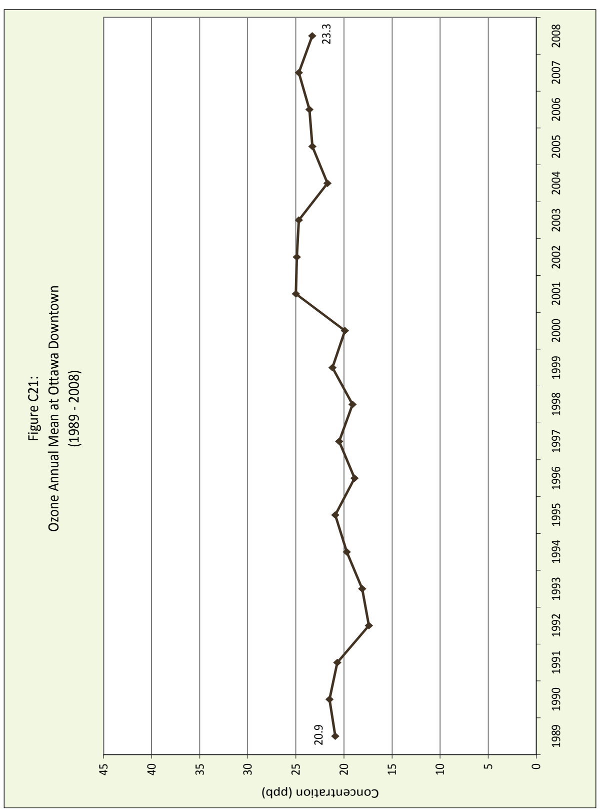


Figure C21:
Ozone Annual Mean at Ottawa Downtown
(1989 - 2008)

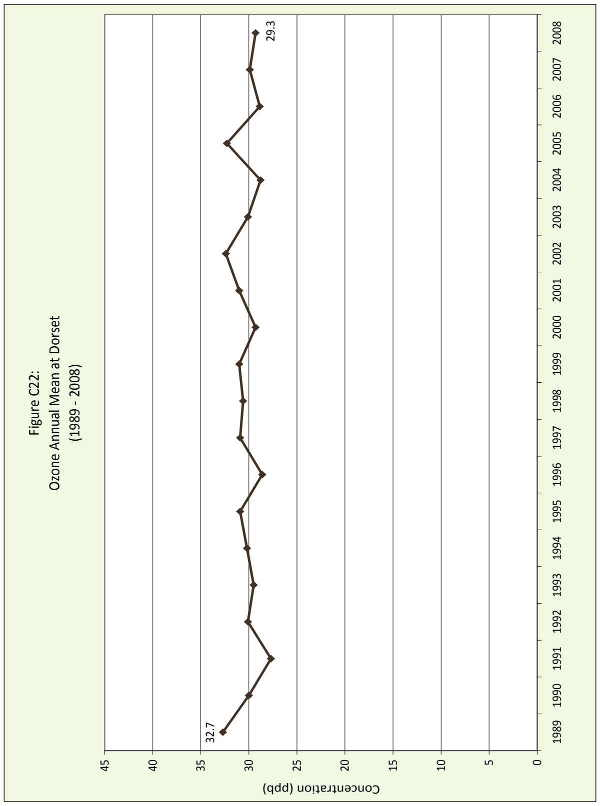


Figure C22:
Ozone Annual Mean at Dorset
(1989 - 2008)

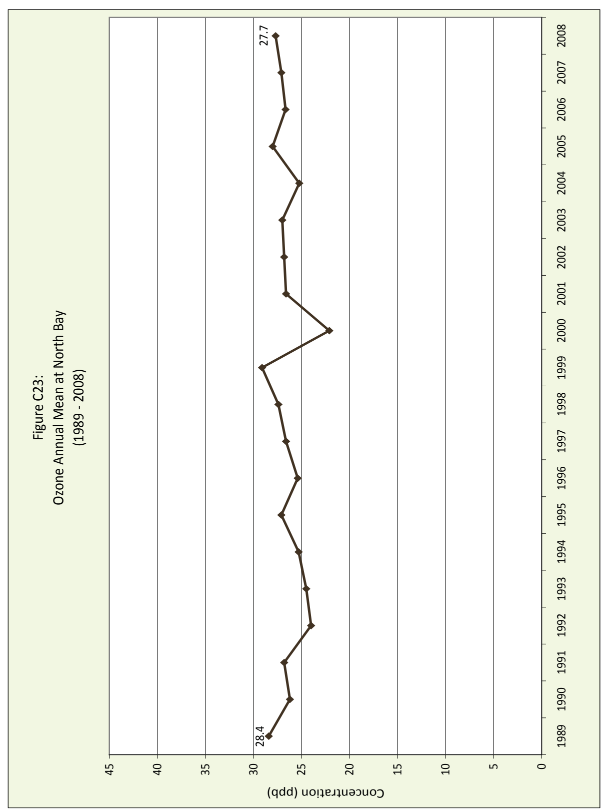


Figure C23:
Ozone Annual Mean at North Bay
(1989 - 2008)

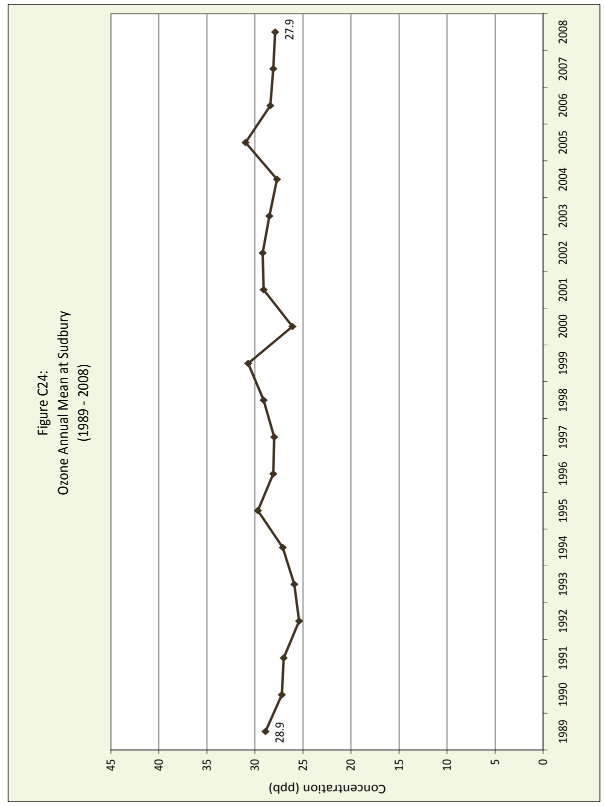


Figure C24:
Ozone Annual Mean at Sudbury
(1989 - 2008)

Figure C25:
Ozone Annual Mean at Sault Ste. Marie
(1989 - 2008)

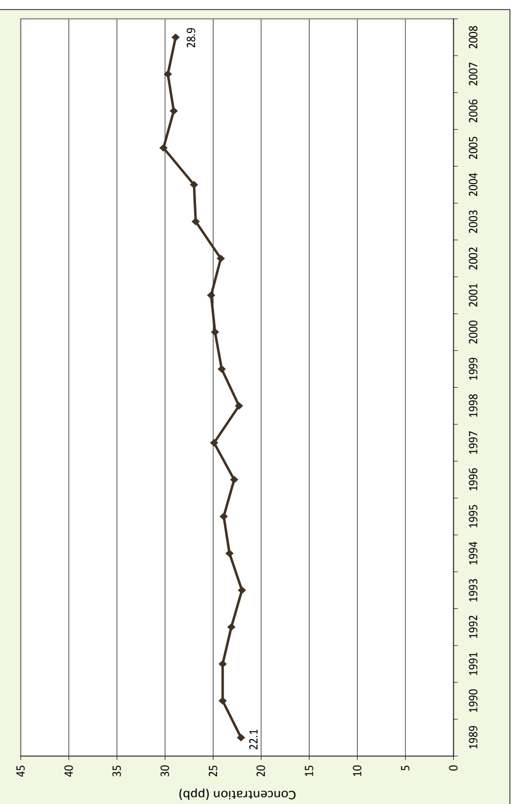
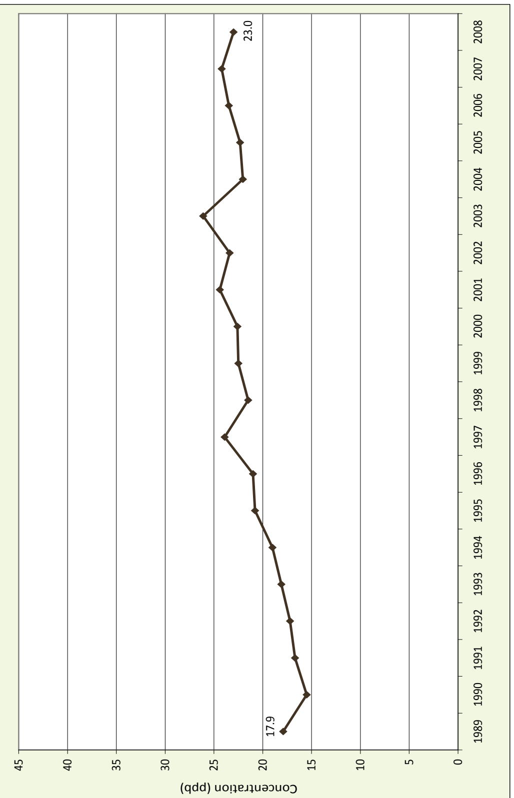


Figure C26:
Ozone Annual Mean at Thunder Bay
(1989 - 2008)



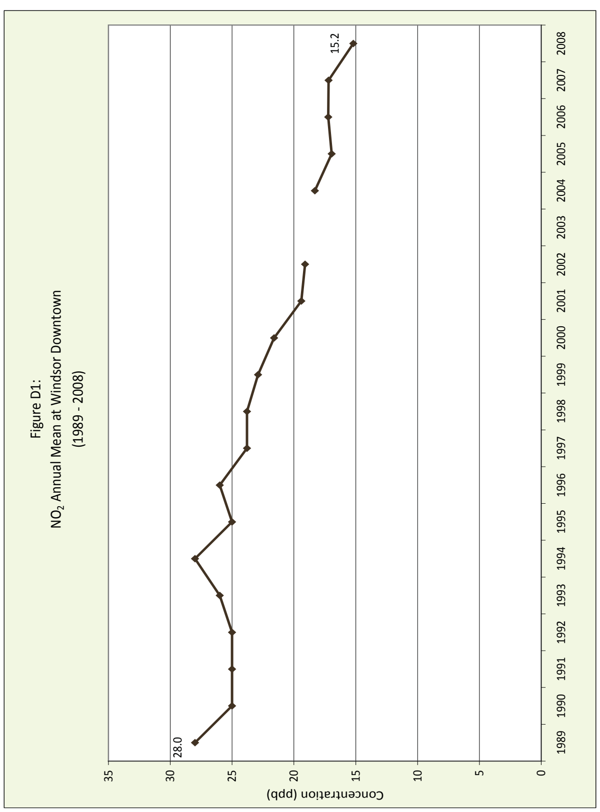


Figure D1:
NO_2 Annual Mean at Windsor Downtown
(1989 - 2008)

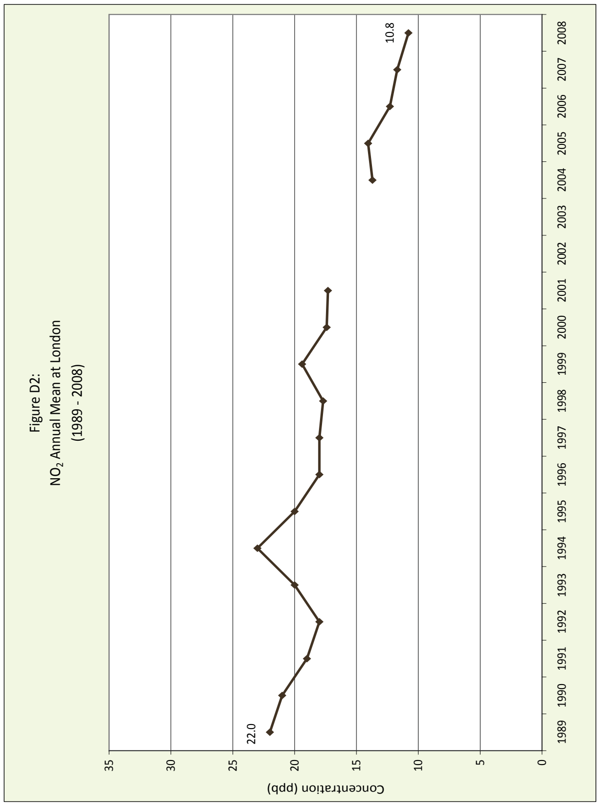


Figure D2:
NO_2 Annual Mean at London
(1989 - 2008)

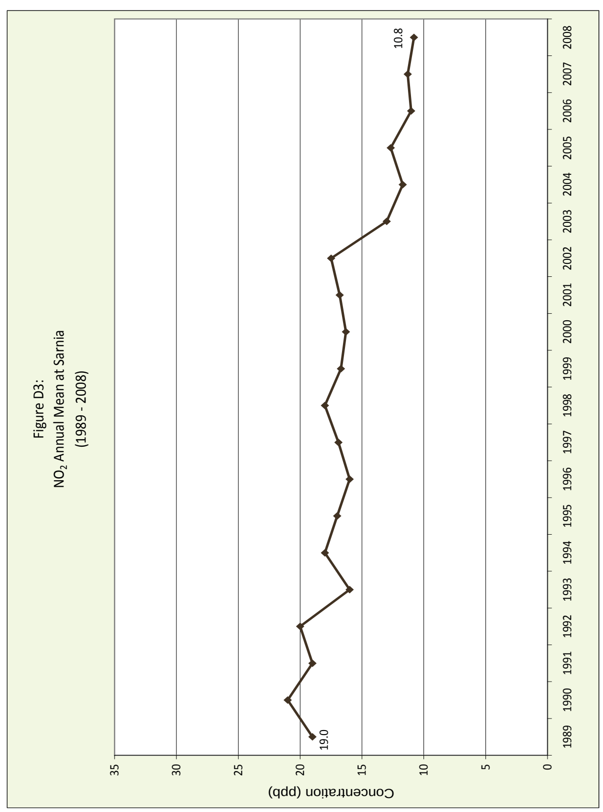


Figure D3:
NO_2 Annual Mean at Sarnia
(1989 - 2008)

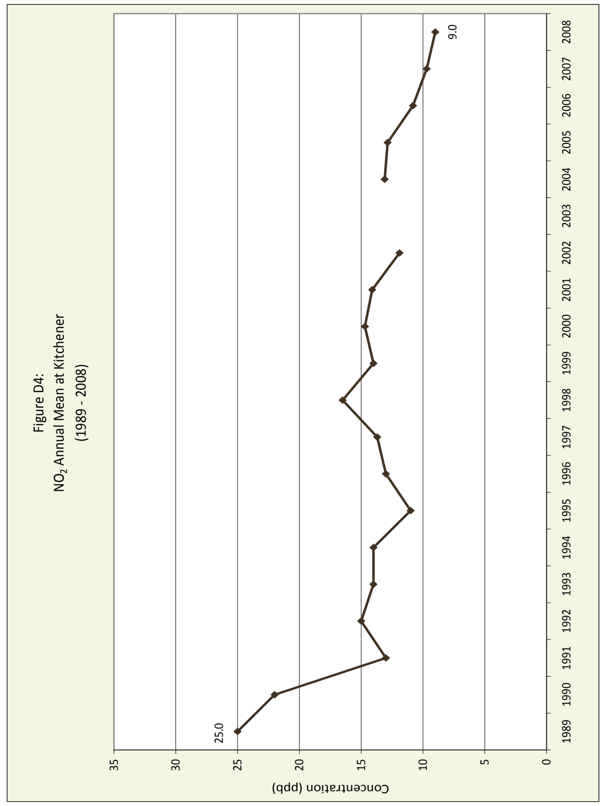


Figure D4:
NO_2 Annual Mean at Kitchener
(1989 - 2008)

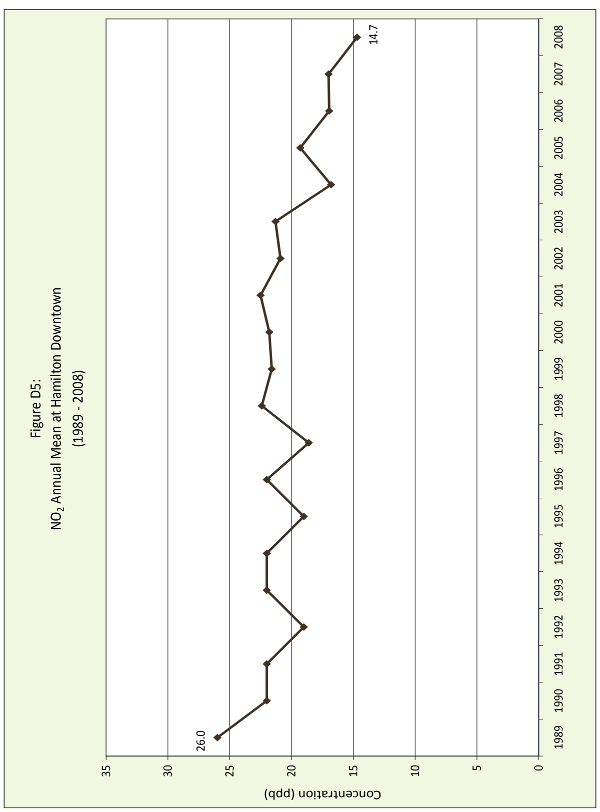


Figure D5:
NO_2 Annual Mean at Hamilton Downtown
(1989 - 2008)

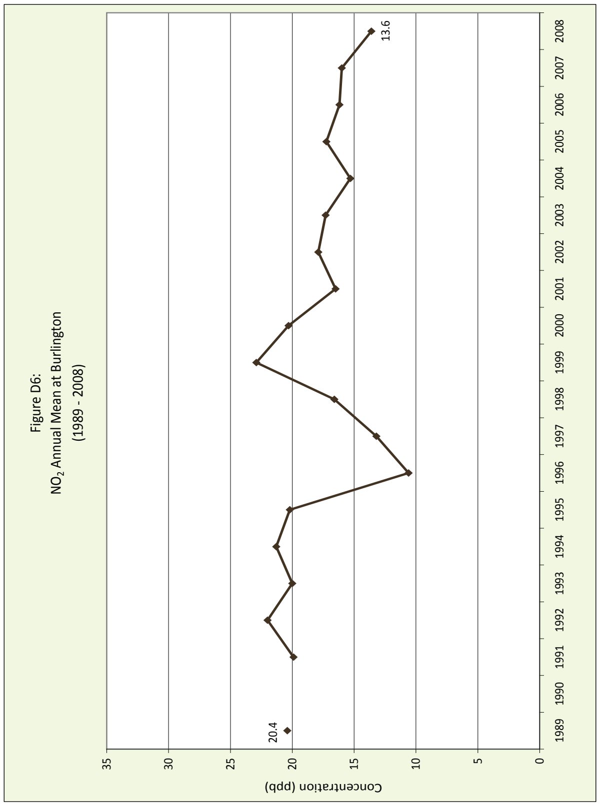


Figure D6:
NO_2 Annual Mean at Burlington
(1989 - 2008)

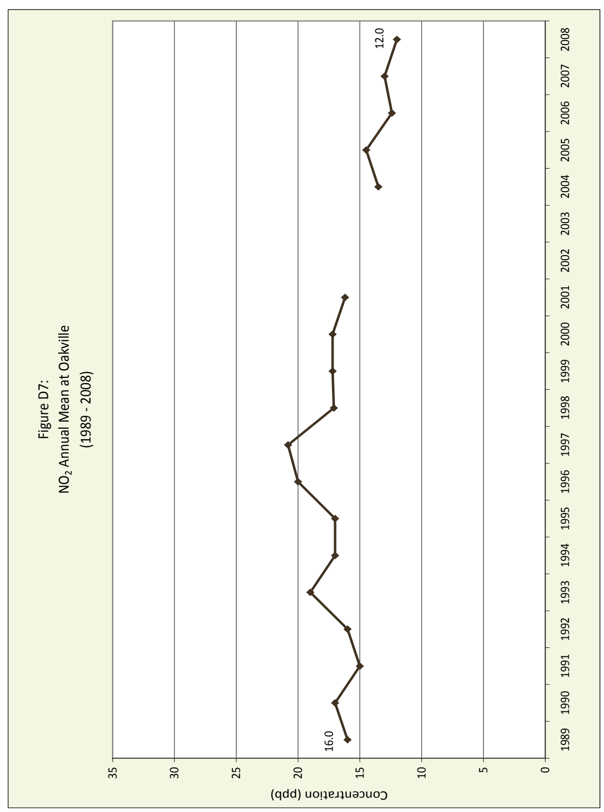


Figure D7:
NO_2 Annual Mean at Oakville
(1989 - 2008)

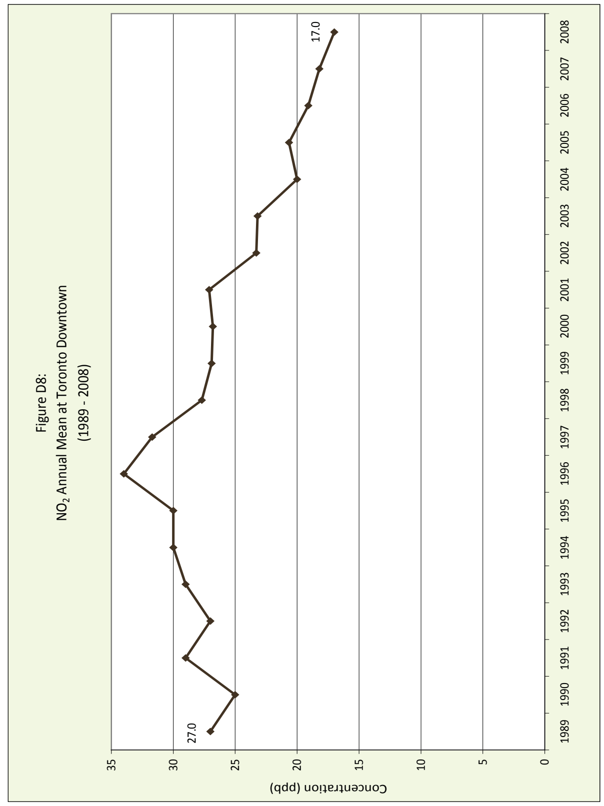


Figure D8:
NO_2 Annual Mean at Toronto Downtown
(1989 - 2008)

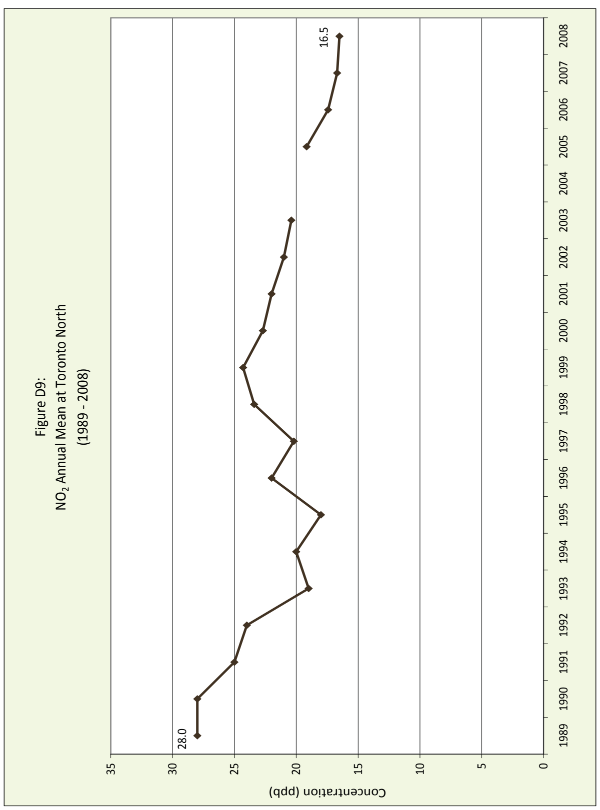


Figure D9:
NO_2 Annual Mean at Toronto North
(1989 - 2008)

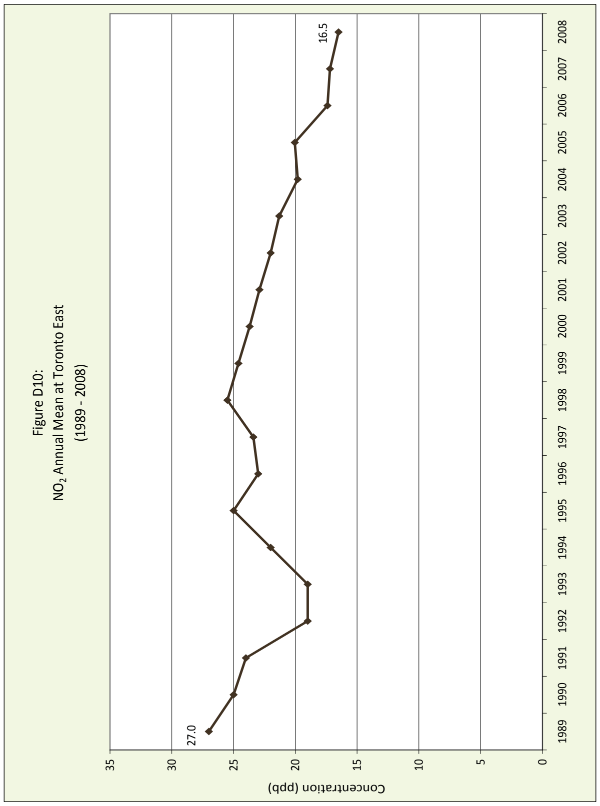


Figure D10:
NO_2 Annual Mean at Toronto East
(1989 - 2008)

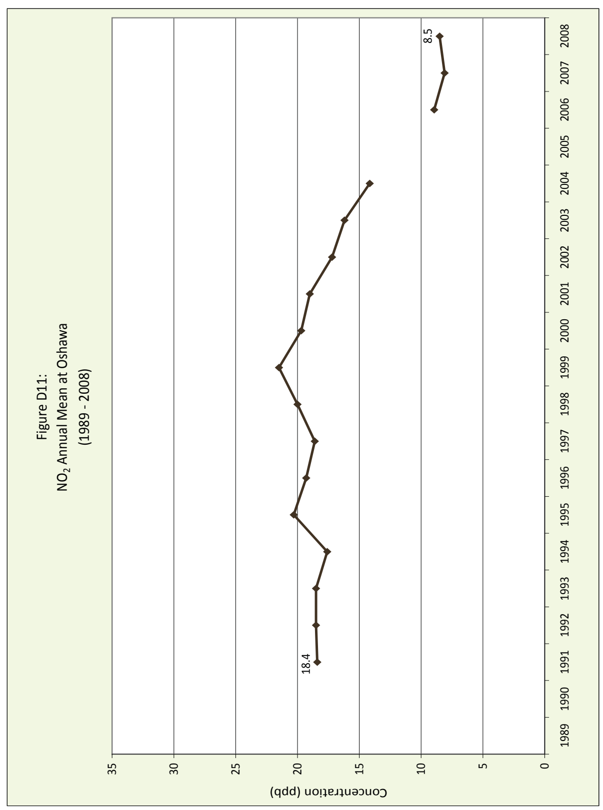


Figure D11:
NO_2 Annual Mean at Oshawa
(1989 - 2008)

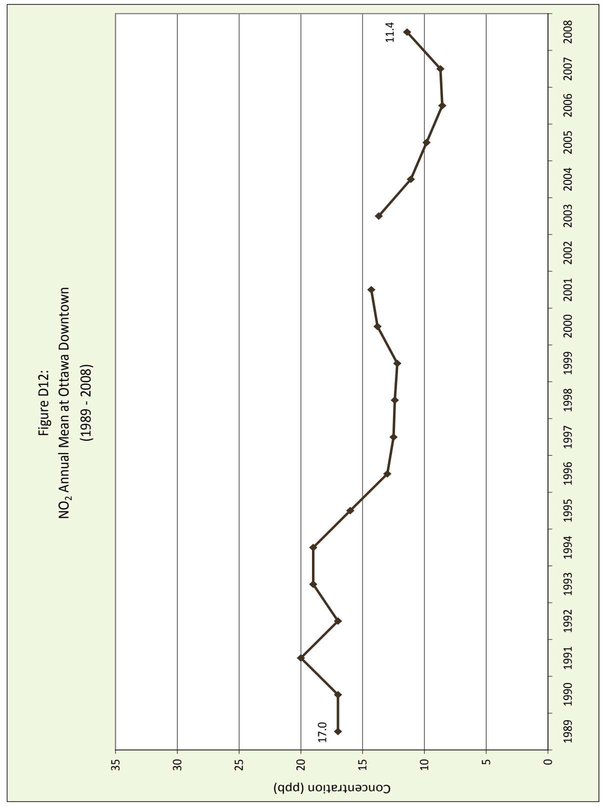


Figure D12:
NO_2 Annual Mean at Ottawa Downtown
(1989 - 2008)

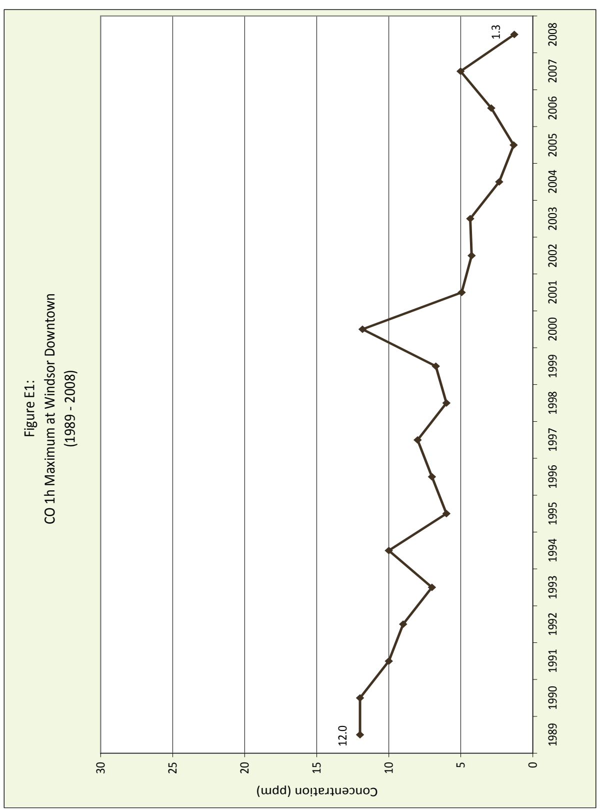


Figure E1:
CO 1h Maximum at Windsor Downtown
(1989 - 2008)

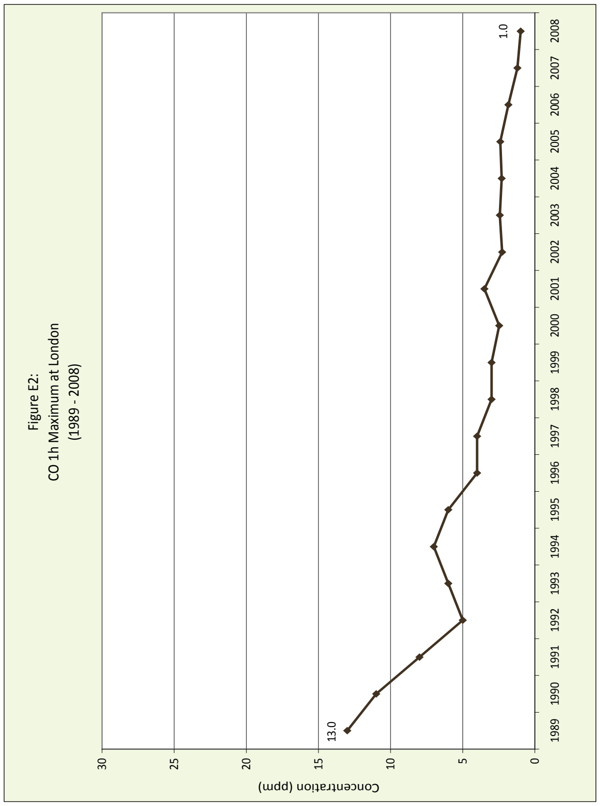


Figure E2:
CO 1h Maximum at London
(1989 - 2008)

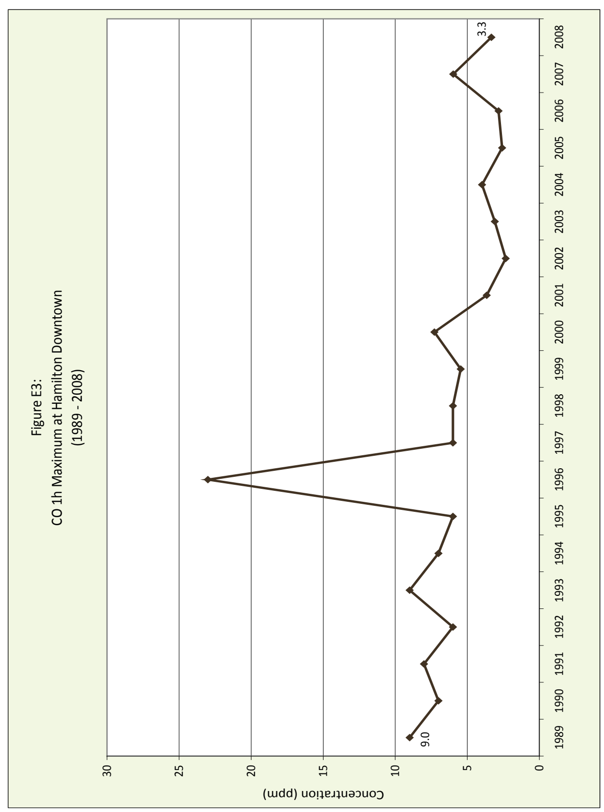


Figure E3:
CO 1h Maximum at Hamilton Downtown
(1989 - 2008)

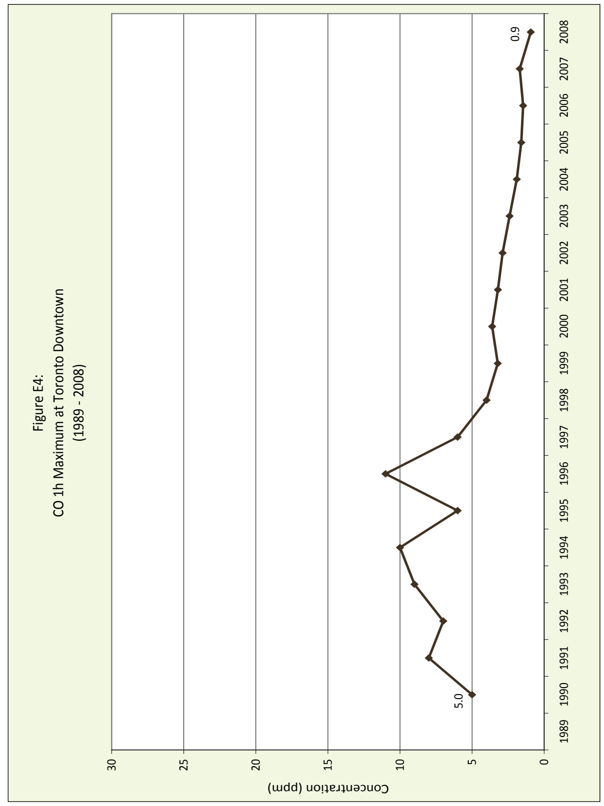


Figure E4:
CO 1h Maximum at Toronto Downtown
(1989 - 2008)

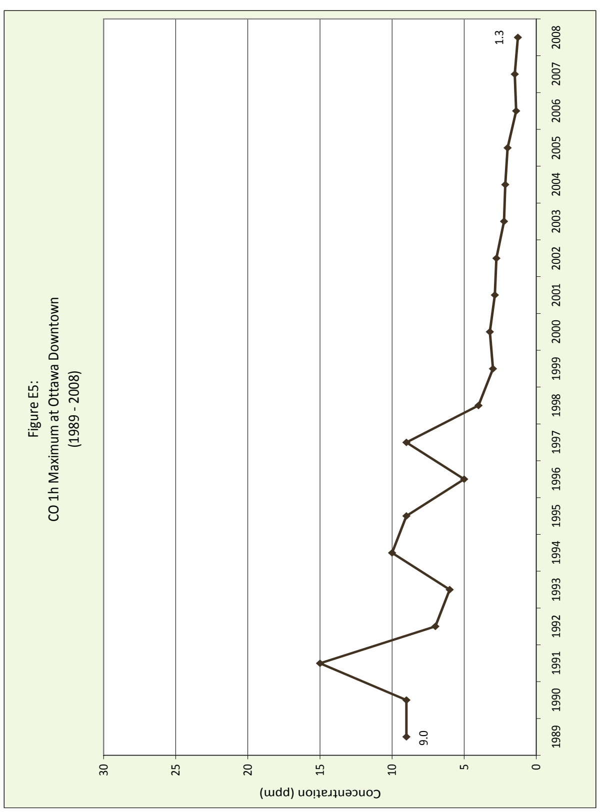


Figure E5:
CO 1h Maximum at Ottawa Downtown
(1989 - 2008)

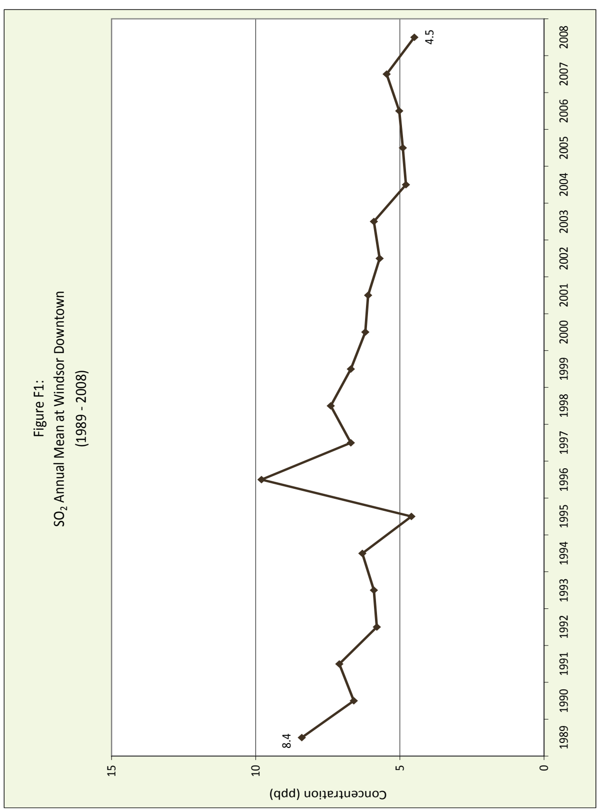


Figure F1:
SO_2 Annual Mean at Windsor Downtown
(1989 - 2008)

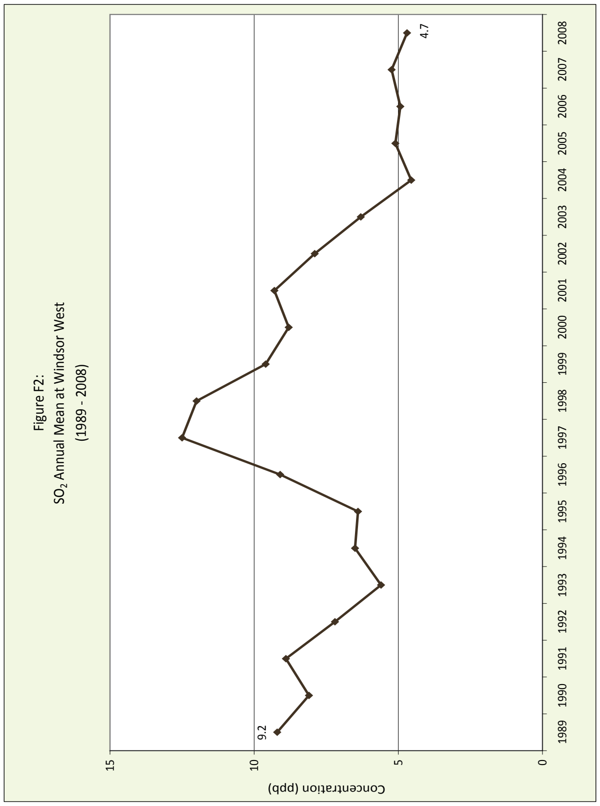


Figure F2:
SO_2 Annual Mean at Windsor West
(1989 - 2008)

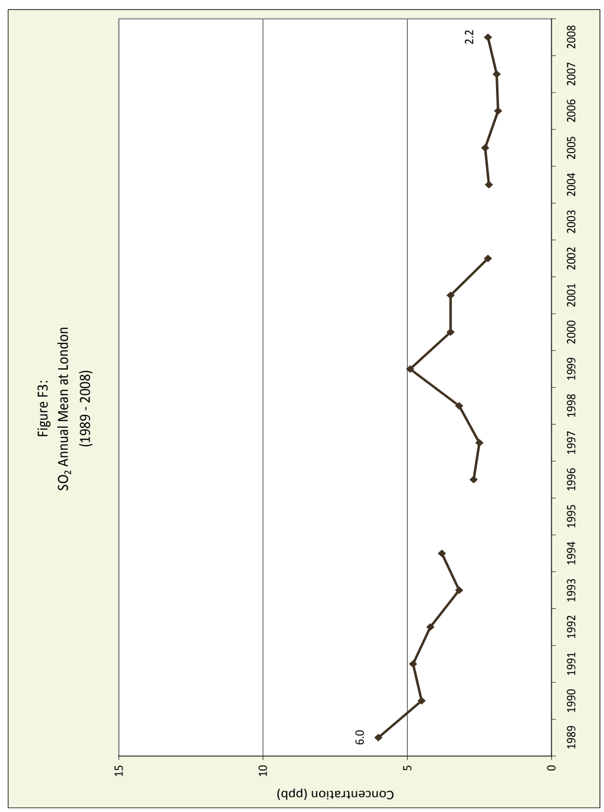


Figure F3:
SO_2 Annual Mean at London
(1989 - 2008)

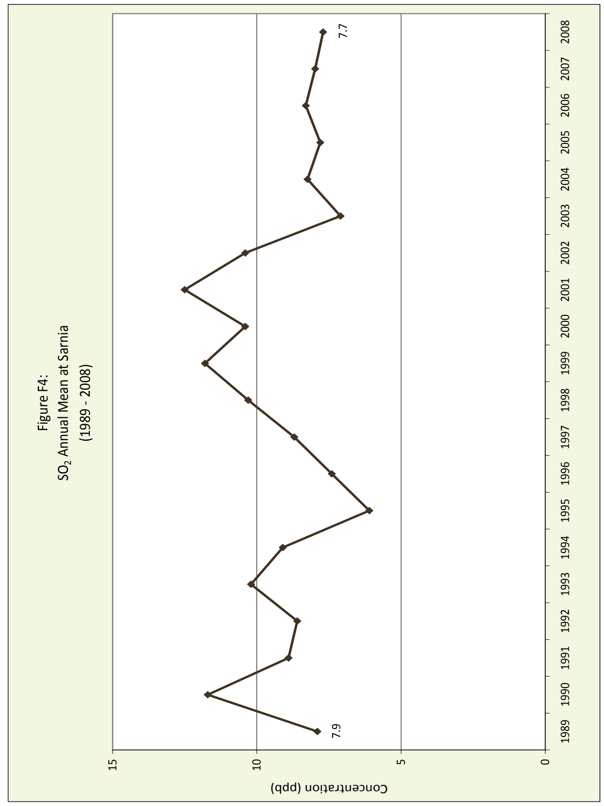


Figure F4:
SO_2 Annual Mean at Sarnia
(1989 - 2008)

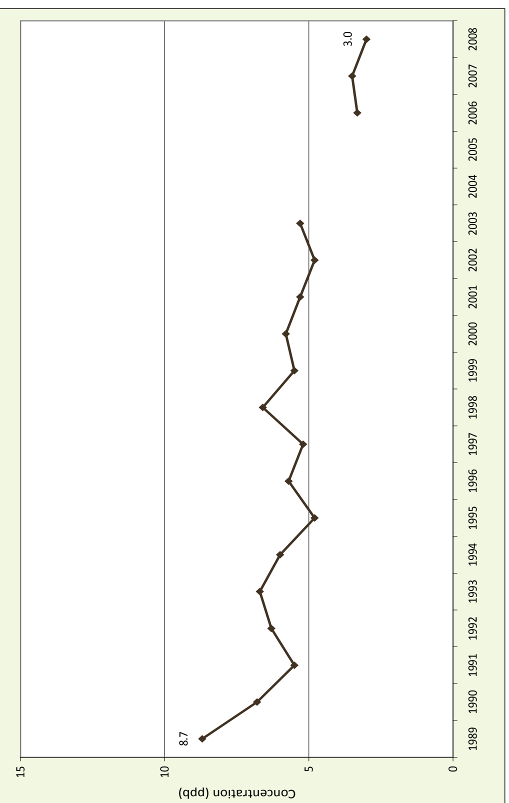


Figure F5:
SO_2 Annual Mean at Hamilton Mountain
(1989 - 2008)

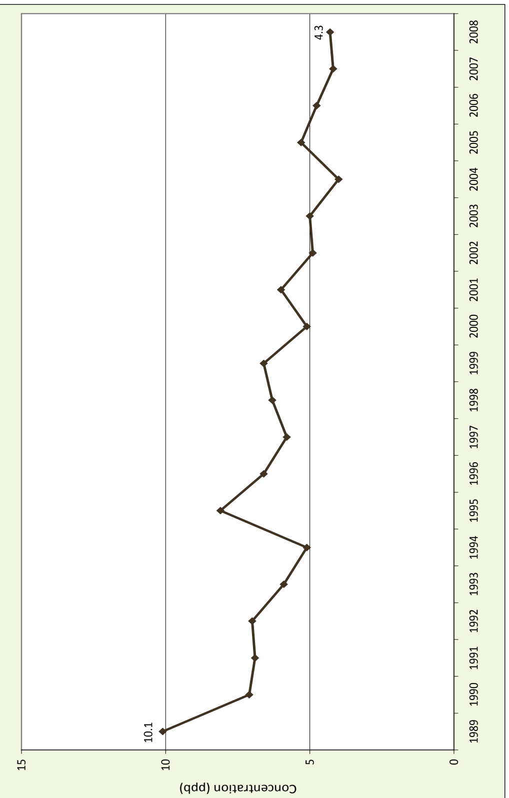


Figure F6:
SO_2 Annual Mean at Hamilton Downtown
(1989 - 2008)

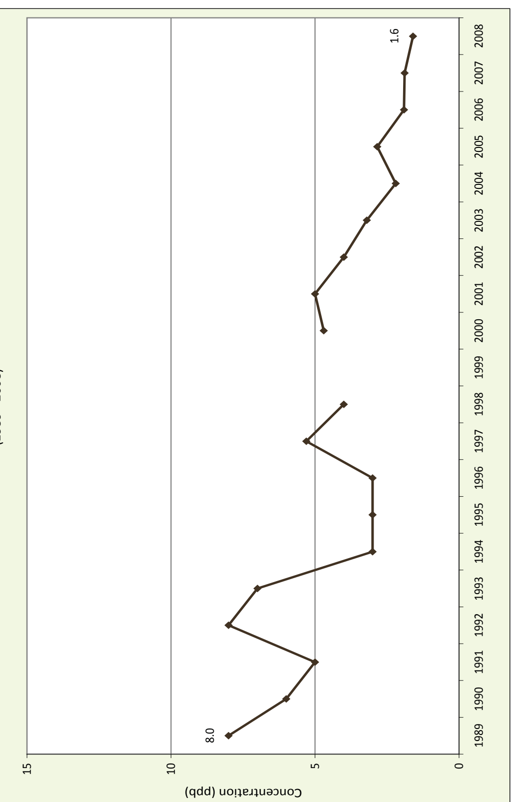


Figure F7:
SO_2 Annual Mean at Toronto Downtown
(1989 - 2008)

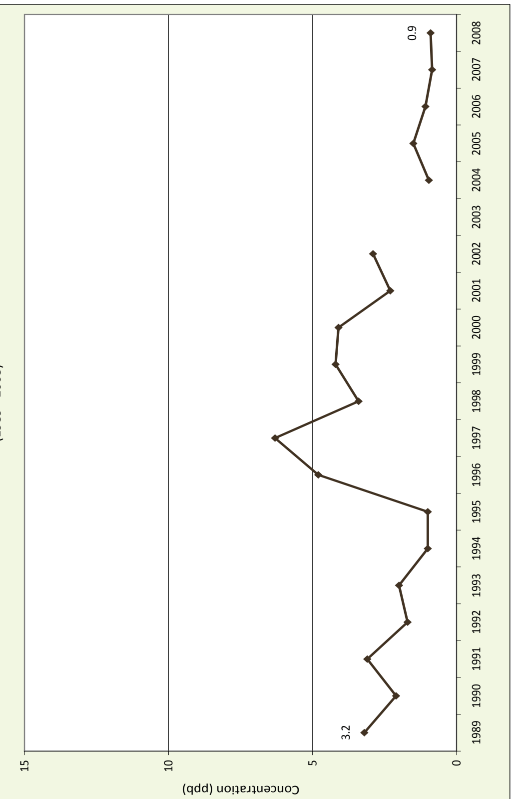


Figure F8:
SO_2 Annual Mean at Ottawa Downtown
(1989 - 2008)

Figure F9:
SO_2 Annual Mean at Sudbury
(1989 - 2008)

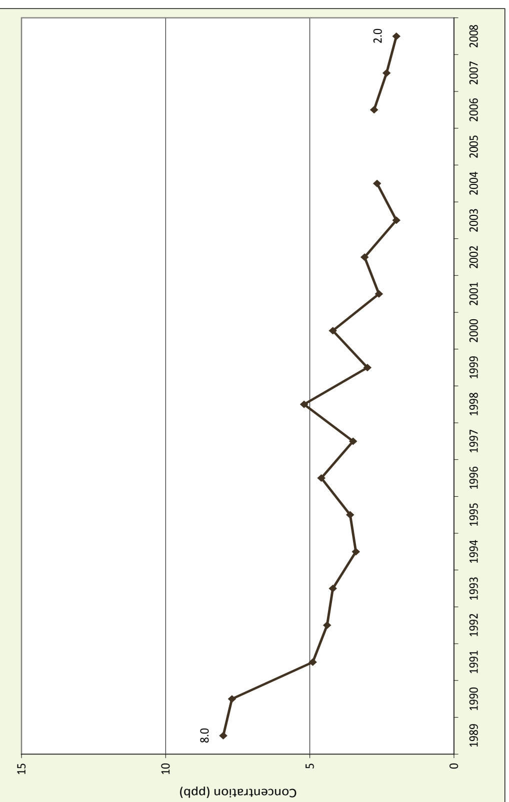
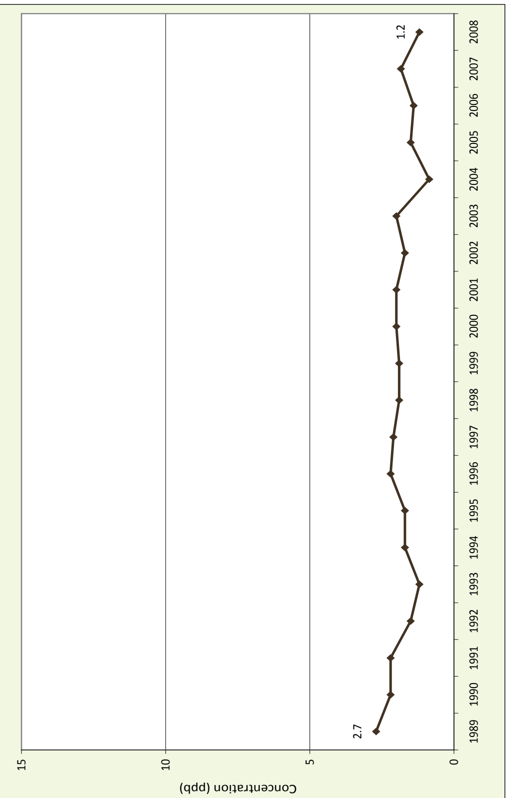
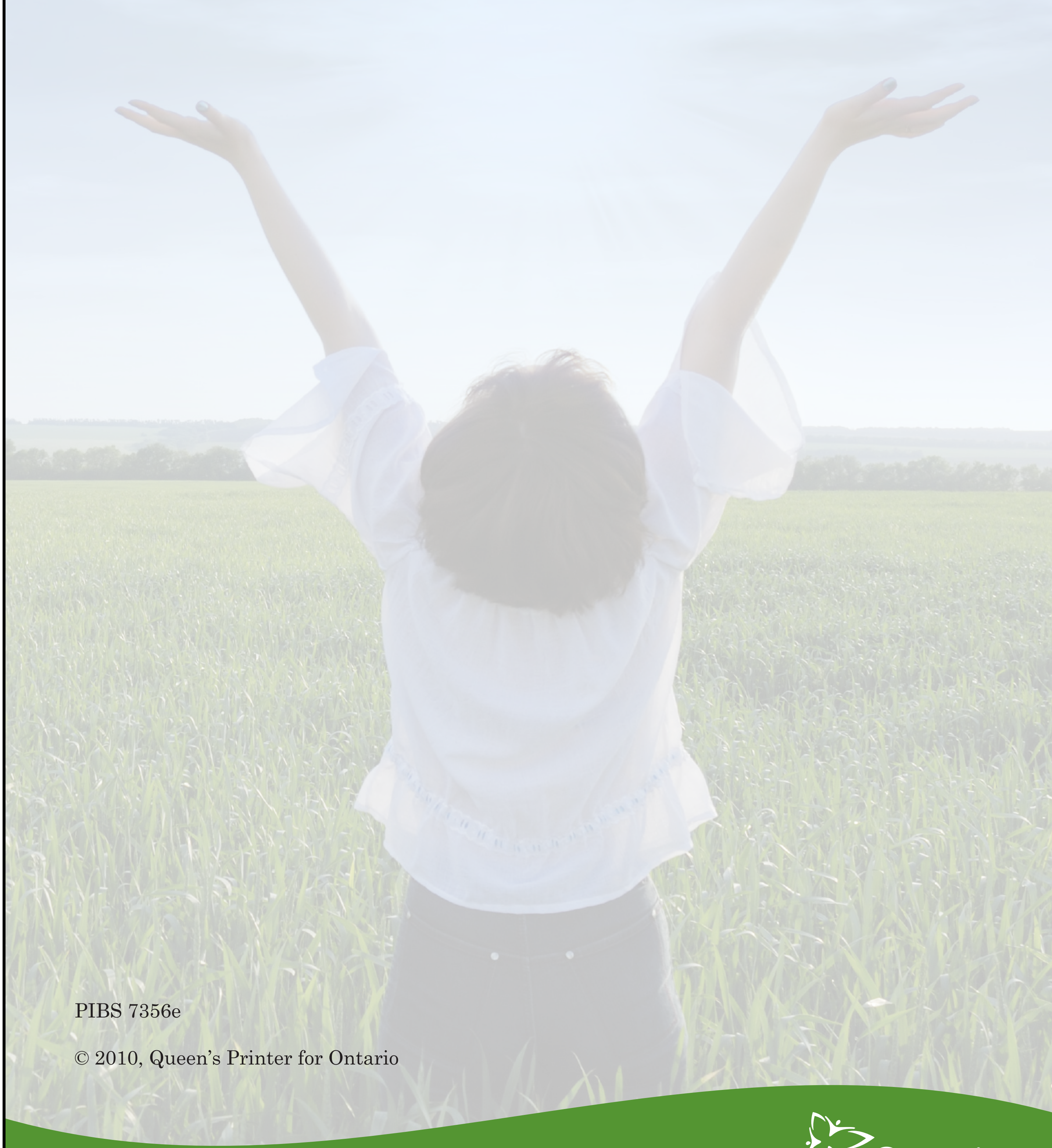


Figure F10:
SO_2 Annual Mean at Sault Ste. Marie
(1989 - 2008)



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.



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