Air Quality in Ontario

2006 Report

Protecting our environment.

Ontario

ACKNOWLEDGEMENTS

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

PIBS 6552e

2006 Report Findings

- The 2006 air quality report marks 36 years of reporting on the state of air quality in Ontario. This report summarizes province-wide monitoring of ambient air quality.

- Overall, air quality in Ontario has improved significantly over the past 36 years, especially for nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2). However, ozone (O_3) and fine particulate matter ($PM_{2.5}$), both major components of smog, continue to exceed the ambient air quality criteria and set reference levels and thus, remain the pollutants of most concern.

- In contrast to the record-breaking smog advisories and smog advisory days in 2005 (15 smog advisories covering 53 days), the year 2006 recorded the lowest such statistics since $PM_{2.5}$ was included in the Smog Alert Program in 2002; only six smog advisories covering 17 days were issued in 2006.

- Also, unlike 2005, there were no smog events in the winter, spring and autumn of 2006. All the events occurred during the traditional smog season, between May and August inclusive.

- Analysis of smog and weather data strongly indicates that the American Midwest and Ohio Valley Region of the U.S. continue to be significant contributors to elevated O_3 and $PM_{2.5}$ in southern Ontario during the smog season.

- The provincial ambient air quality criteria (AAQC) for NO_2 and CO were not exceeded at any of the air monitoring sites in 2006. The one-hour AAQC for SO_2 was exceeded at the Sudbury site for two hours; and the 24-hour criterion was exceeded at Sarnia on two occasions.

- In 2006, Ontario's AAQC for ozone was exceeded at 35 of the 38 Air Quality Index (AQI) stations on at least one occasion. Peterborough, Barrie and Thunder Bay were the only sites that did not record any hours of ozone above the one-hour AAQC of 80 parts per billion (ppb).

- The 20 designated Canada-wide Standard (CWS) reporting sites recorded 8-hour ozone averages above the CWS of 65 ppb for ozone in 2006 with the exception of Thunder Bay where the CWS calculated ozone value was 57 ppb.

2006 Report Findings continued…

- Five of the 18 designated CWS reporting sites in 2006 recorded 24-hour $PM_{2.5}$ averages above the CWS of 30 micrograms per cubic metre ($\mu g/m^3$).

- A comparison of O_3 and $PM_{2.5}$ at 12 cities in the Great Lakes Basin area was conducted for 2001 to 2005. Overall, based on these two pollutants, the air quality of the six Ontario cities, Windsor, London, Hamilton, Toronto, Sault Ste. Marie and Thunder Bay, was generally better than the other six U.S. cities, Milwaukee, Chicago, Grand Rapids, Detroit, Cleveland and Buffalo.

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Chapter 1

Overview

Air pollution is of concern to many people who live in Ontario. Although the average levels for the majority of air pollutants in Ontario have decreased over the past 36 years, smog remains an important issue, especially in southern Ontario where elevated levels of the airborne pollutants comprising smog are common. 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 cars, buses, trucks, planes, marine vessels and trains; and, natural sources such as forest fires, windblown dust and biogenic emissions from 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/or their precursors are generated locally, regionally, nationally and internationally, and can travel from province to province and country to country, affecting areas far removed from their respective sources.

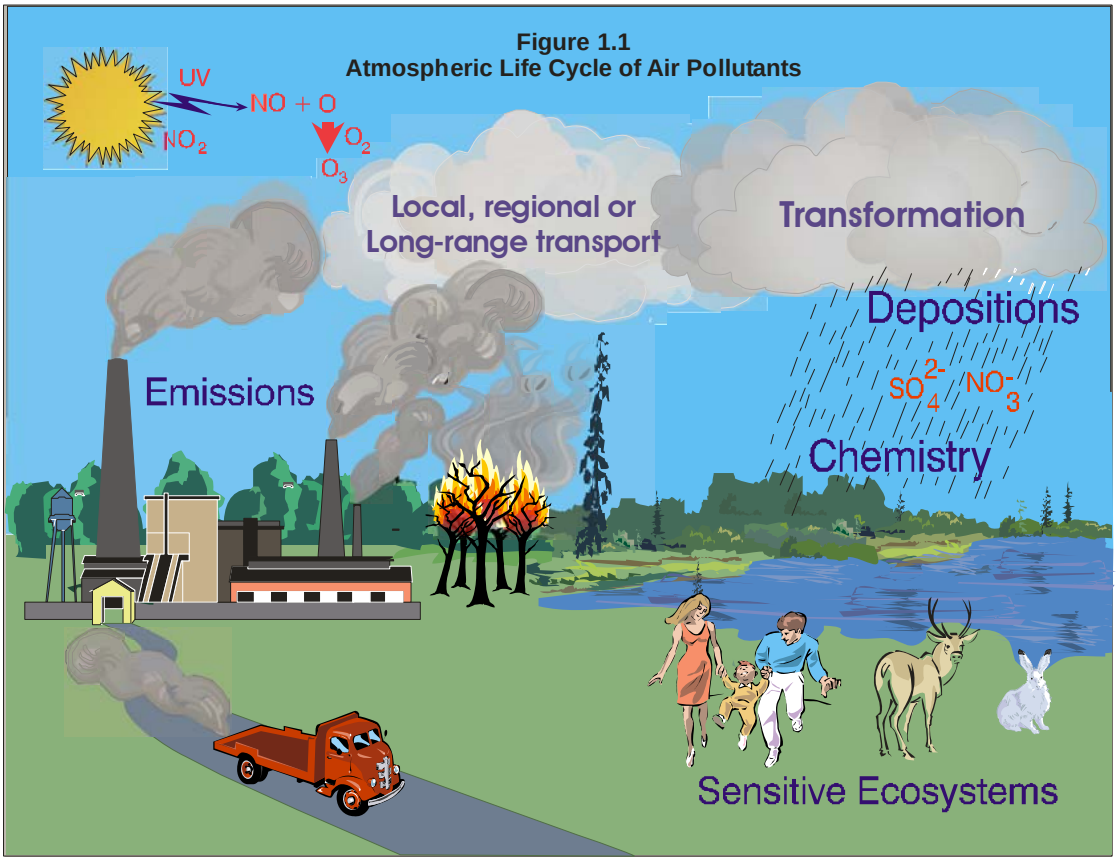


Figure 1.1
Atmospheric Life Cycle of Air Pollutants

The release of pollutants into the atmosphere and removal of pollutants from the atmosphere are ongoing processes. Pollutant levels are affected by source strengths, sunlight, moisture, clouds, precipitation, geography, and regional and local weather conditions.

This report focuses on air concentrations based on measurements of key criteria pollutants in the ambient outdoor air to assess the state of air quality in the province of Ontario during 2006 and over the last 36 years.

The Ontario Ministry of the Environment collects continuous ambient air quality data at 38 Air Quality Index (AQI) monitoring sites across the province. These data are used to determine the state of air quality in Ontario and help develop abatement programs to reduce the burden of air pollutants, address key air issues and assess the efficacy of policies and programs. Ambient air monitoring provides information on the actual concentrations of selected pollutants in communities across Ontario. Table 1.1 shows the relationship between monitored air pollutants and current air issues.

Table 1.1: Linkages between Air Pollutants and Current Air Issues

Pollutant	Smog	Global Warming	Acid Deposition	Odour	Visibility/ Soiling
Ozone	Yes	Yes	Yes	No	No
Sulphur Dioxide	Yes	Yes	Yes	No	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

The data collected by the province's state-of-the-art air monitoring network have contributed to several air quality initiatives and regulations. The Ministry of the Environment continues to monitor air quality across Ontario and uses this information to:

- inform the public about outdoor ambient air quality;
- assess Ontario's air quality and evaluate long-term trends;
- identify areas where criteria are exceeded and identify the origins of pollutants;
- provide the basis for air policy/program development;
- provide quantitative measurements to enable abatement of specific sources;

- determine the significance of pollutants from U.S. sources and their effects on Ontario;
- provide air quality researchers with data to link environmental and human health effects to air quality; and
- provide smog advisories for public health protection and public outreach.

This annual report, the 36th in a series, summarizes the state of ambient air quality in Ontario during 2006 and examines trends over time. It covers the measured levels of six contaminants: 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. An overview of the air quality of 12 cities in the Great Lakes Basin area is also provided in the report based on ground-level ozone and $PM_{2.5}$ concentrations. Monitoring methods and siting procedures may vary from country to country; therefore, comparisons between Canada and the United States are not intended to be used as a comprehensive ranking.

The report also summarizes the results from the Air Quality Index (AQI) and Smog Alert programs, and briefly examines smog episodes in 2006.

The main focus of the 2006 publication is to report on the state of Ontario's ambient air quality from the analysis of data recorded at the 38 AQI sites. The annual statistics and 10-year trends of ambient data are presented in the attached appendix. Ontario continues to benefit from one of the most comprehensive air monitoring systems in North America. The ambient network is designed to measure continuous air quality at 38 monitoring sites across the province and undergoes regular maintenance to ensure a high standard of quality. With these data, informed decisions can be made on what needs to be done to protect and improve the quality of air for all Ontarians.

Chapter 2

Ground-Level Ozone

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

Characteristics, sources and effects

Ozone is a colourless, odourless gas at ambient concentrations, and is a major component of smog. Ground-level ozone is not emitted directly into the atmosphere. The formation and transport of ground-level ozone are strongly dependent on meteorological conditions. Changing weather patterns contribute to short-term and year-to-year differences in ozone concentrations. In Ontario, elevated concentrations of ground-level ozone are generally recorded on hot and sunny days from May to September, between noon and early evening. The diurnal variation of ozone and its relationship to NO_x is explained below.

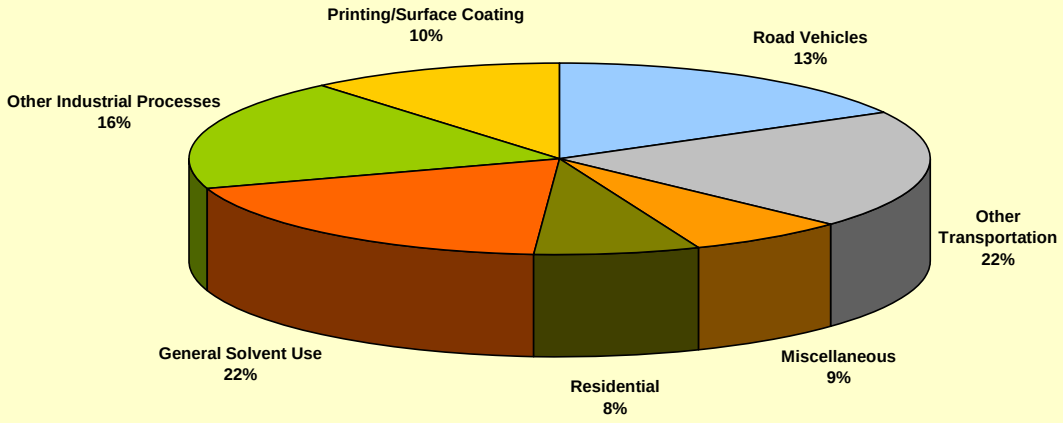
The increase in NO_x concentrations, measured as nitric oxide (NO) and nitrogen dioxide, during the morning rush-hour is mainly the result of vehicular traffic; however, the ozone concentrations can decrease over the same period due to the scavenging effect of NO. By the late morning, ground-level ozone continues to be produced as a result of chemical reactions of VOCs and NO_x in the presence of sunlight. Ozone concentrations start to increase and peak by mid-afternoon when the sunlight is still relatively intense. As the sun goes down, ozone concentrations typically decrease.

Figure 2.1 shows the 2005 estimates of Ontario's VOC emissions from point, area and transportation sources. Transportation sectors accounted for approximately 35 per cent of VOC emissions. General solvents and other industrial processes were the second and third largest sources of VOC emissions, accounting for approximately 22 per cent and 16 per cent, respectively.

Figure 2.2 shows the 2005 estimates of Ontario's NO_x emissions from point, area and transportation sources. Transportation sectors accounted for approximately 65 per cent of NO_x

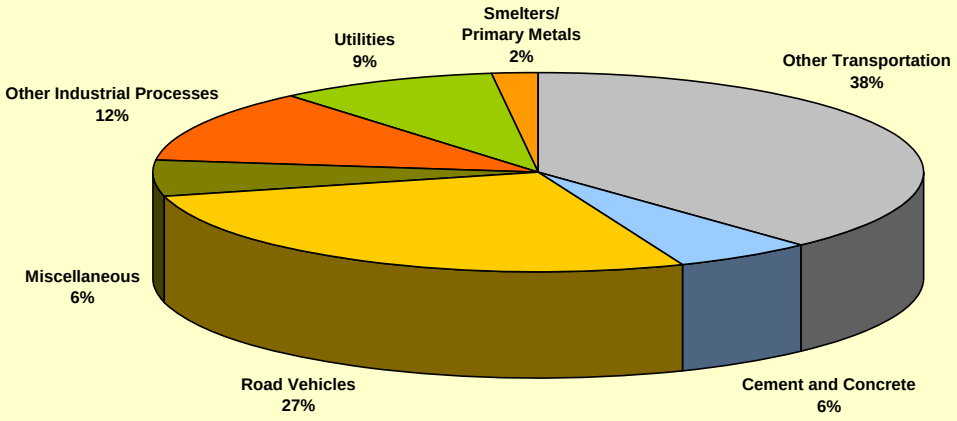
emissions. Other industrial processes were the second largest source of NO_x emissions, accounting for approximately 12 per cent.

Figure 2.1
Ontario Volatile Organic Compounds Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2005 Estimates)



Note: 2005 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 2.2
Ontario Nitrogen Oxides Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2005 Estimates)



Note: 2005 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

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. Ground-level ozone is 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 2006

During 2006, ground-level ozone was monitored at all 38 Ontario Ministry of the Environment Air Quality Index monitoring stations. The highest annual mean was 32.4 parts per billion (ppb), measured at Port Stanley, a rural and transboundary-influenced site on the northern shore of Lake Erie. The lowest annual mean, 19.0 ppb, was measured at Toronto West, a site located near Highway 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.

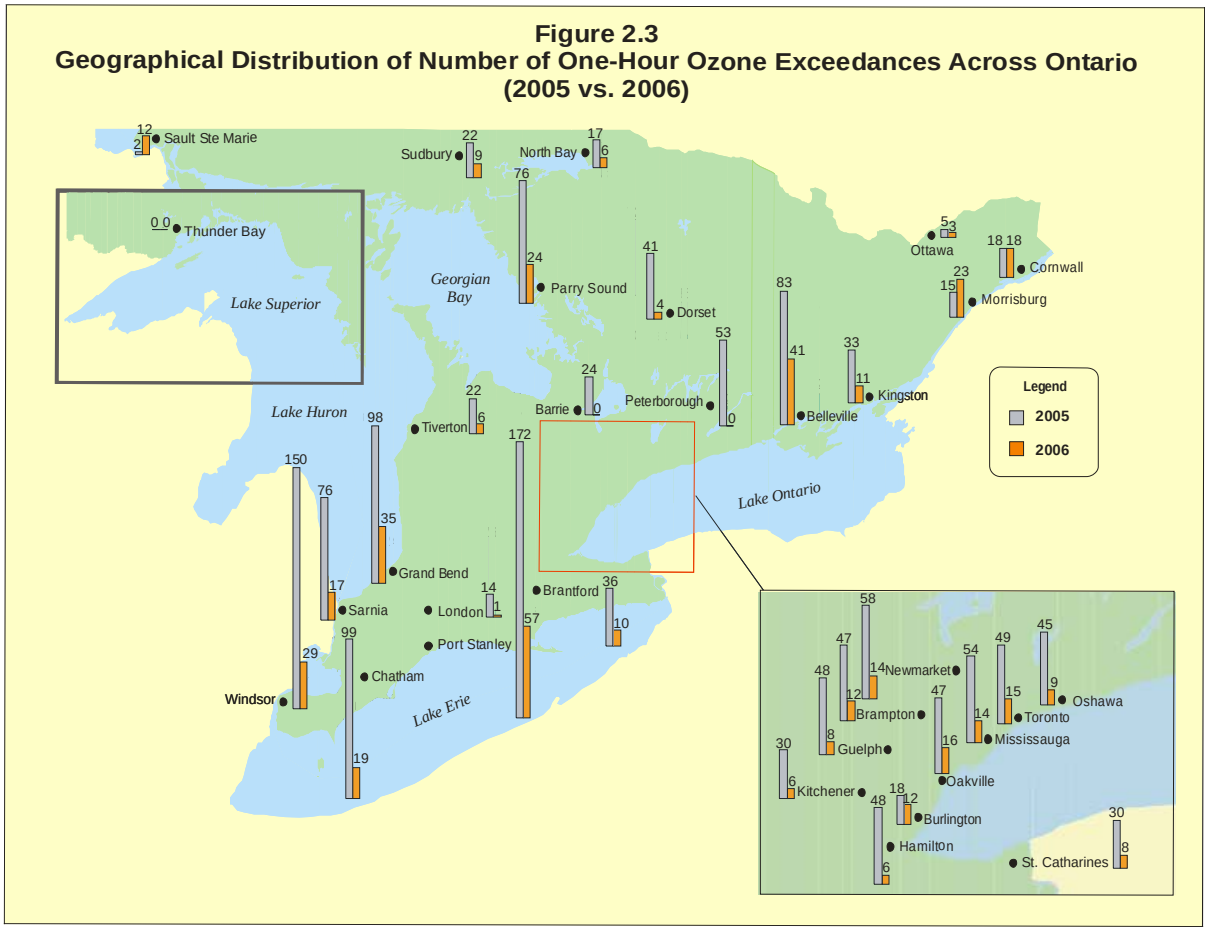
Ground-level ozone concentrations continued to exceed the provincial AAQC across the province. In 2006, Ontario's one-hour AAQC for ozone was exceeded at 35 of the 38 AQI stations on at least one occasion.

The maximum one-hour ozone concentrations ranged from 74 ppb recorded in Thunder Bay to 127 ppb recorded in Grand Bend. Port Stanley had the most instances (57) above Ontario's one-hour AAQC, followed by Grand Bend where the AAQC was exceeded 35 times. Both sites, Port Stanley and Grand Bend, are impacted significantly by U.S. emissions. Peterborough, Barrie and Thunder Bay reported one-hour maximums of 80 ppb, 76 ppb and 74 ppb, respectively, and were the only sites that did not record any hours of ozone above 80 ppb in 2006.

The geographical distribution of the number of ozone exceedances across Ontario is shown in Figure 2.3. Higher numbers of one-hour ozone exceedances were recorded on the northern shores of Lake Erie and Lake Ontario 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 that may be carried throughout the province during a smog episode. As shown in Figure 2.3, for most sites, the number of ozone exceedances in 2006 was significantly lower than

those recorded in 2005. (Sault Ste. Marie was the only site that recorded an increase in ozone exceedances in 2006, which is further explained in Chapter 5). Ontario experienced significantly less transboundary polluted air in 2006 compared to that in 2005 as the weather conditions upwind, in the U.S., were often cloudy, unstable and wet, thus smog formation and subsequent transport occurred less frequently. Also, significantly less *hot* days occurred across southern Ontario in 2006.

Figure 2.3
Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario (2005 vs. 2006)

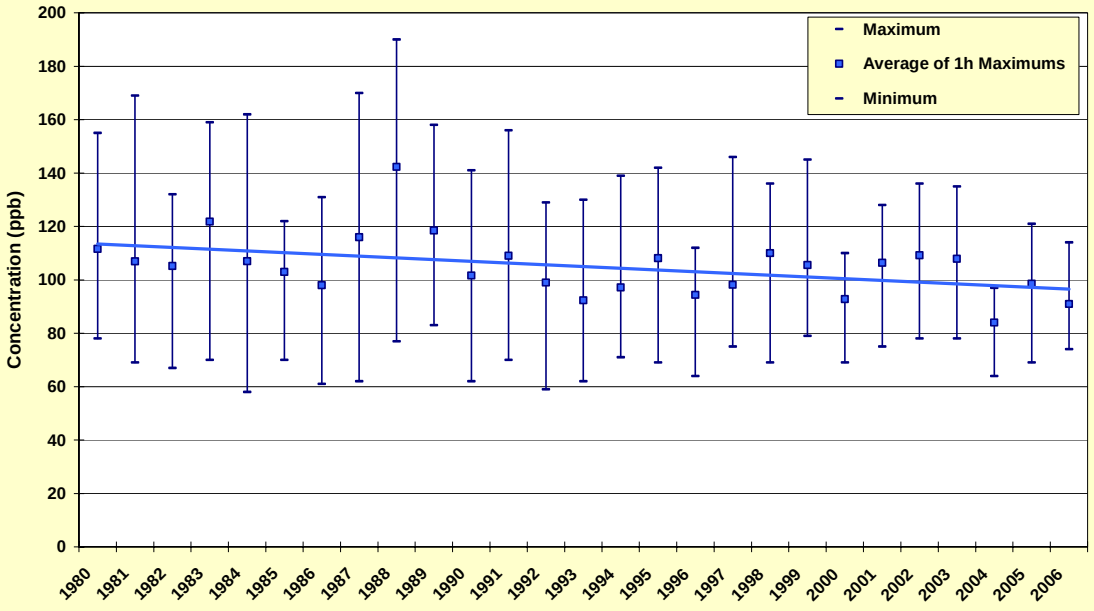


Trends

The range of the annual one-hour maximum ozone concentrations is shown for the 27-year period of 1980 to 2006 in Figure 2.4. For this period, the average of the annual one-hour maximum concentrations ranges from a low of 84 ppb, recorded in 2004, to a high of 142 ppb, recorded in 1988. The data show random fluctuations year-to-year but an overall decreasing trend (15 per cent) in the average annual one-hour maximum ozone concentrations from 1980 to 2006 is evident. Over the past 10 years (1997 to 2006), the annual composite means of the one-

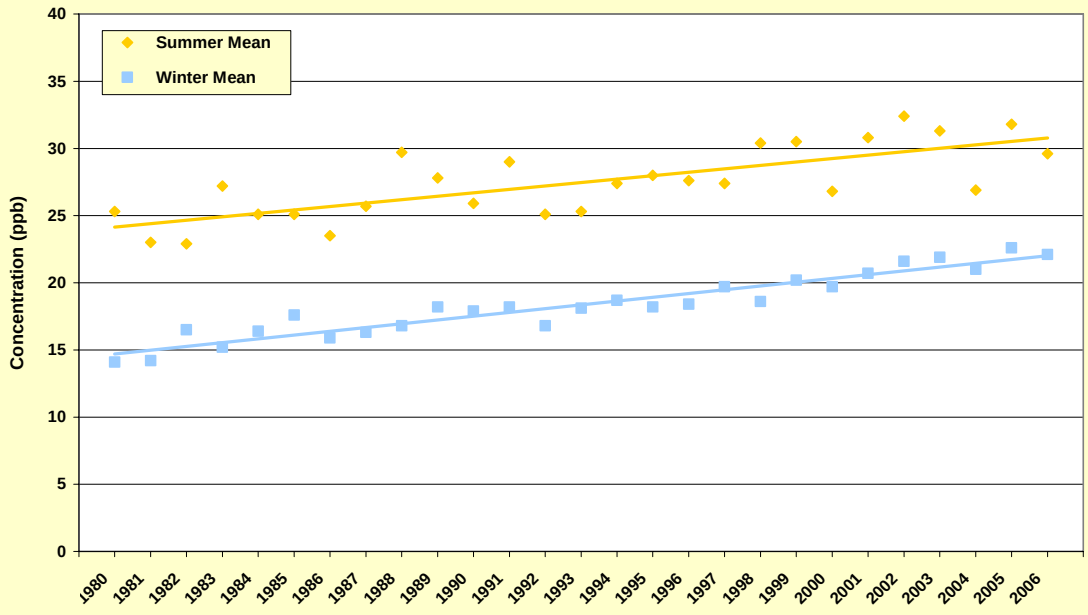
hour maximum concentrations of ozone have decreased by approximately 11 per cent on average; most of this change has occurred over the last three years.

Figure 2.4
Range of Ozone One-Hour Maximum Concentrations in Ontario
(1980 - 2006)



Note: Based on data from 23 ambient ozone sites operated over 27 years.
Ontario 1h AAQC = 80 ppb.

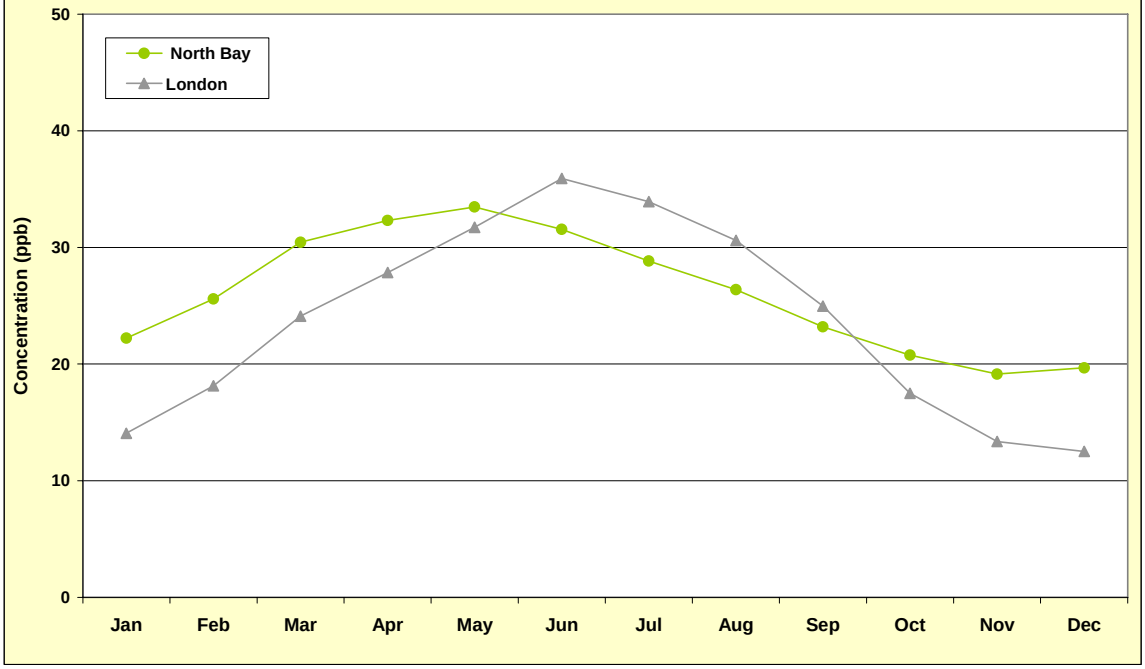
Figure 2.5
Trend of Ozone Seasonal Means at Sites Across Ontario
(1980 - 2006)



Note: Based on data from 22 ozone sites operated over 27 years.
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).

The trend of the ozone seasonal composite means (summer and winter) as recorded at 22 long-term ozone sites for the period 1980 to 2006 is shown in Figure 2.5. It shows that there has been an increasing trend in the ozone seasonal means during the 27-year period where the ozone summer means have increased by approximately 27 per cent and the winter means by approximately 50 per cent. For the 10-year period, 1997 to 2006, summer composite means increased by approximately 5 per cent and winter composite means increased by approximately 17 per cent. The increases in summer and winter ozone means appear to be largely related to the reductions in NO_x emissions and the rising global background ozone concentrations. 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.

Figure 2.6
Trend of Ozone Monthly Means in North Bay and London, Ontario
(1992 - 2006)



In Figure 2.6, the averaged ozone monthly means are compared between two locations for the period 1992 to 2006. This figure shows the typical behaviour of ozone concentrations 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 during the colder months of the year. For the month of January, the ozone mean concentration in North Bay is approximately 8 ppb (63 per cent) 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,

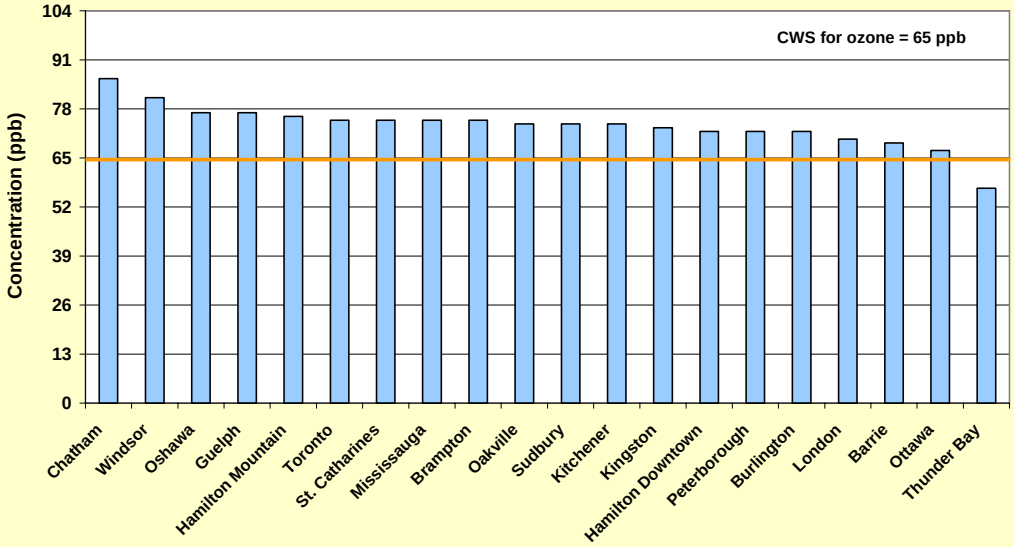
there is greater potential for stratospheric ozone to be mixed into the lower troposphere in northern Ontario. During the summer months of June and July, the ozone mean concentrations in London are approximately 4 to 5 ppb (between 12 and 15 per cent) greater than those reported in North Bay. It is more common for ozone and/or 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 2.7 displays the 2006 CWS for ozone – based on the 4th highest ozone eight-hour daily maximum – for designated sites across Ontario. (The 2006 CWS consists of an average over a three-year period, 2004 to 2006). All of the sites exceeded the CWS of 65 ppb for ozone, with the exception of Thunder Bay where its 2006 CWS was 57 ppb.

Figure 2.7
Ozone Levels at Designated CWS Sites Across Ontario
Based on the CWS for Ozone
(2004 - 2006)



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 (2004 - 2006).
The values displayed for Chatham and Oshawa are based on 2-year averages (2005 - 2006).

Great Lakes Basin Perspective

There were a total of 12 cities selected within the Great Lakes Basin area for this analysis. The selected cities include six from Ontario and six from the United States. The Ontario cities consisted of Windsor, London, Hamilton, Toronto, Sault Ste. Marie and Thunder Bay; while those in the U.S. were Milwaukee, Chicago, Grand Rapids, Detroit, Cleveland and Buffalo.

Figure 2.8 displays the average number of days, between 2001 and 2005, when the eight-hour average ozone concentrations were greater than 84 ppb at the selected cities within the Great Lakes Basin. The U.S. Environmental Protection Agency (EPA) considers an eight-hour average ozone concentration greater than 84 ppb *unhealthy for sensitive groups*. Air quality standards and/or criteria vary between Ontario and neighbouring states south of the border; therefore, the U.S. EPA ozone standard is used in Figure 2.8 to allow for a consistent assessment of ozone levels between the cities examined within the Great Lakes Basin.

Figure 2.8
Average Annual Days when the Eight-Hour Average Ozone Concentrations are > 84 ppb at Select Cities within the Great Lakes Basin (2001 - 2005)

Note: The U.S. EPA considers an eight-hour average ozone concentration greater than 84 ppb *unhealthy for sensitive groups.*.

Over the five-year period studied here, the number of days that were considered *unhealthy for sensitive groups* due to ozone ranged, on average, from 9.2 to 13.0 in the U.S. cities. For Ontario cities, the number of days that were considered *unhealthy for sensitive groups* ranged between zero days in Thunder Bay to 6.8 days in Windsor. The Ontario cities, London, Toronto, Hamilton and Sault Ste. Marie had 3.8, 3.6, 2.4 and 0.2 annual days of ozone levels that were considered *unhealthy for sensitive groups* as defined by the U.S. EPA standards.

Chapter 3

Fine Particulate Matter

Airborne particulate matter is the general term used to describe a mixture of microscopic solid particles 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, a fine particle 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

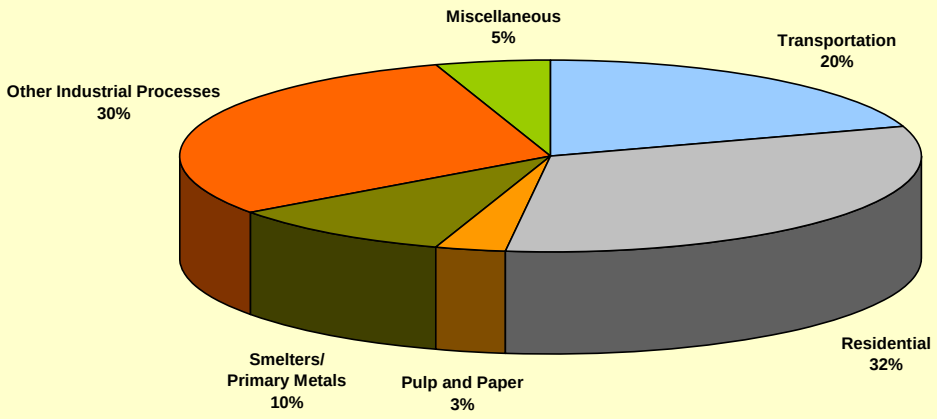
Particulate matter includes aerosols, smoke, fumes, dust, fly ash and pollen. Its composition varies with origin, residence time in the atmosphere, time of year and environmental conditions. Fine particulate matter may be emitted directly to the atmosphere through fuel combustion (e.g. motor vehicles, smelters, power plants, industrial facilities, residential fireplaces and wood stoves, agricultural burning and forest fires) or formed indirectly in the atmosphere through a series of complex chemical reactions.

Figure 3.1 shows estimates of Ontario's primary $PM_{2.5}$ emissions from point, area and transportation sources. Other industrial processes and residential sectors accounted for 30 per cent and 32 per cent of $PM_{2.5}$ emissions, respectively, while the transportation sector accounted for 20 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 on the eastern shore of Lake Huron, and Parry Sound in the Georgian Bay area.

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2005 Estimates)



Note: 2005 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Exposure to $PM_{2.5}$ is associated with hospital admissions and 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 2006

In 2006, each of Ontario's ambient air monitoring sites operated a Tapered Element Oscillating Microbalance (TEOM) instrument at 30°C with a Sample Equilibration System (SES) to measure the $PM_{2.5}$ concentrations on an hourly basis. The 2006 annual summary statistics for 24-hour $PM_{2.5}$ for sites across Ontario are shown in Figure 3.2. The annual mean concentrations ranged from 4.5 micrograms per cubic metre ($\mu g/m^3$) in Dorset to 11.3 $\mu g/m^3$ in Sarnia. The 24-hour $PM_{2.5}$ maximum concentrations measured at urban sites ranged from 22 $\mu g/m^3$ in Thunder

Bay to 49 μg/m³ in Burlington; and at rural sites ranged from 25 μg/m³ in Dorset to 37 μg/m³ in Morrisburg.

Figure 3.2
Annual Statistics for 24-Hour Average $PM_{2.5}$ Across Ontario
(2006)

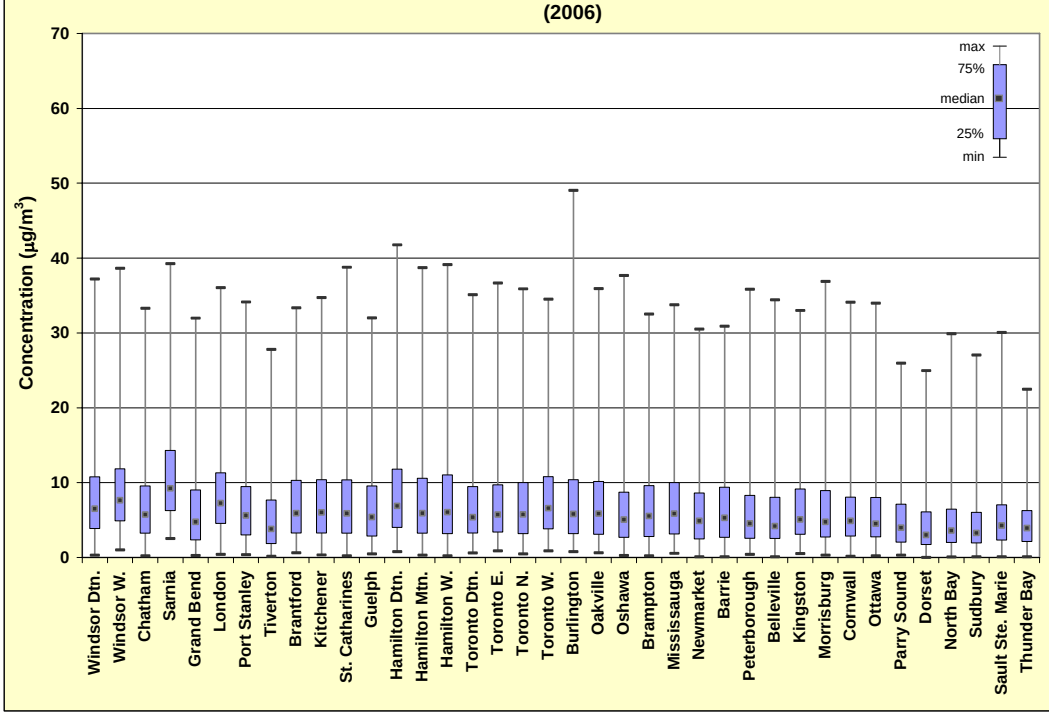


Figure 3.3
Number of Days $PM_{2.5}$ 24-Hour Concentrations > 30 μg/m³ Across Ontario
(2006)

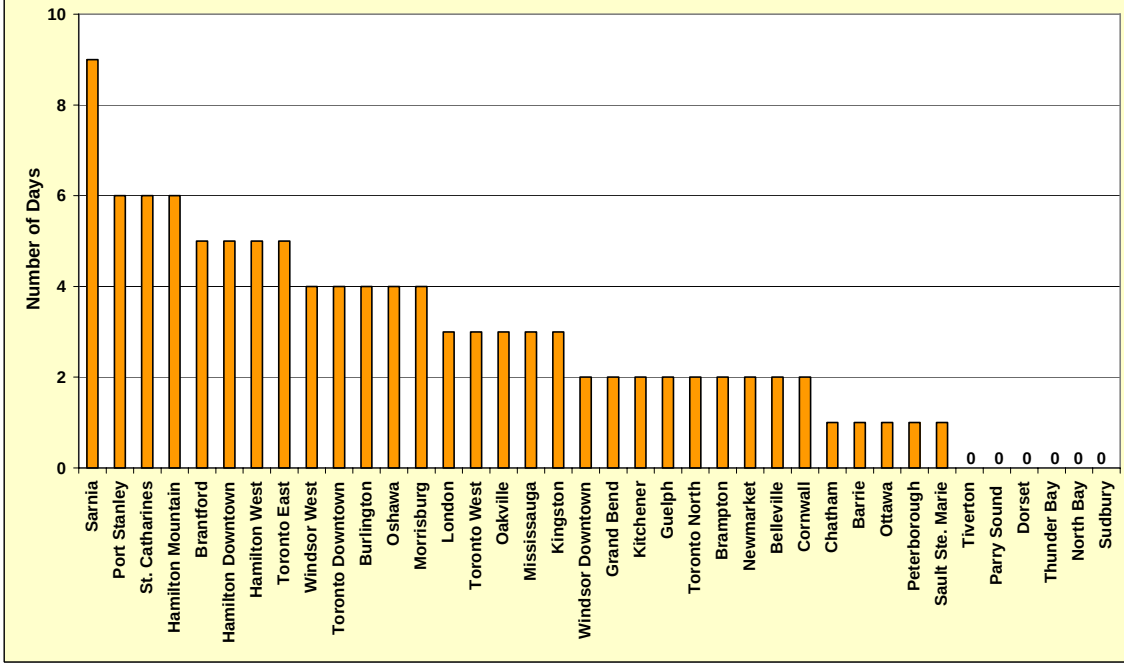
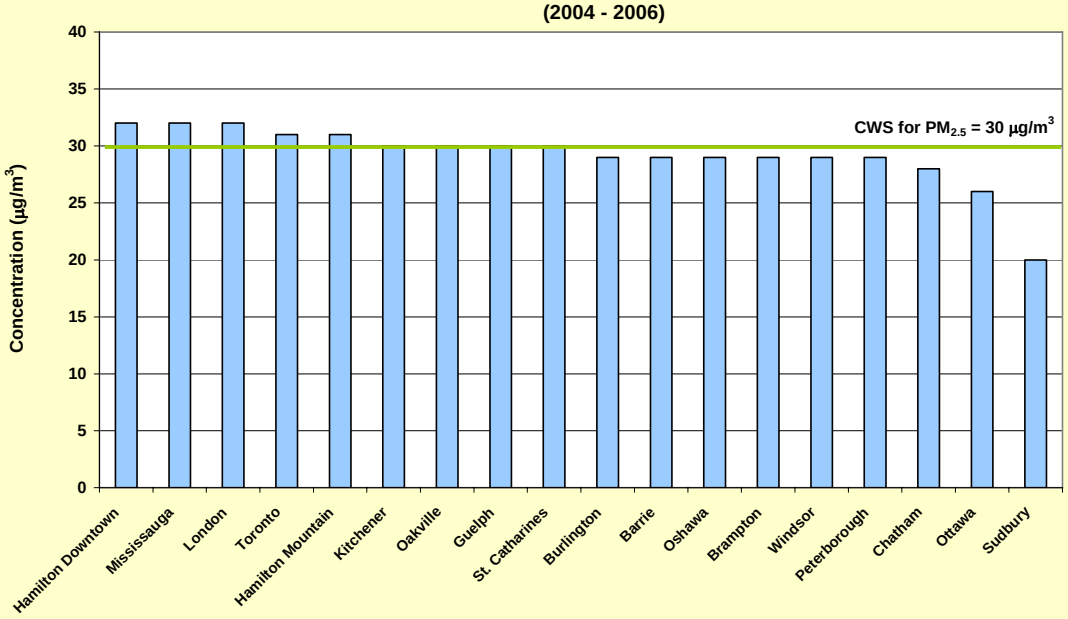


Figure 3.3 shows the number of days when $PM_{2.5}$ 24-hour concentrations were greater than 30 µg/m³ across Ontario. The $PM_{2.5}$ reference level of 30 µg/m³ for a 24-hour period was exceeded at 32 of the 38 sites in 2006. Sarnia recorded the highest number of days (nine) in Ontario with 24-hour $PM_{2.5}$ concentrations greater than 30 µg/m³ whereas, Tiverton, Parry Sound, Dorset, North Bay, Sudbury and Thunder Bay were the six locations that did not record a 24-hour average $PM_{2.5}$ concentration above 30 µg/m³. The provincial ambient average for $PM_{2.5}$ during 2006 was 7.1 µg/m³ which is a decrease of approximately 1 µg/m³ when compared to 2005.

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 µg/m³, 24-hour averaging time, based on the 98th percentile annual ambient measurement averaged over three consecutive years. Jurisdictions are required to meet the CWS by 2010 and commence reporting by year 2011. In the interim, comprehensive reporting on progress toward meeting the CWS for $PM_{2.5}$ commenced in 2006.

Figure 3.4
$PM_{2.5}$ Levels at Designated CWS Sites Across Ontario
Based on the CWS for $PM_{2.5}$
(2004 - 2006)



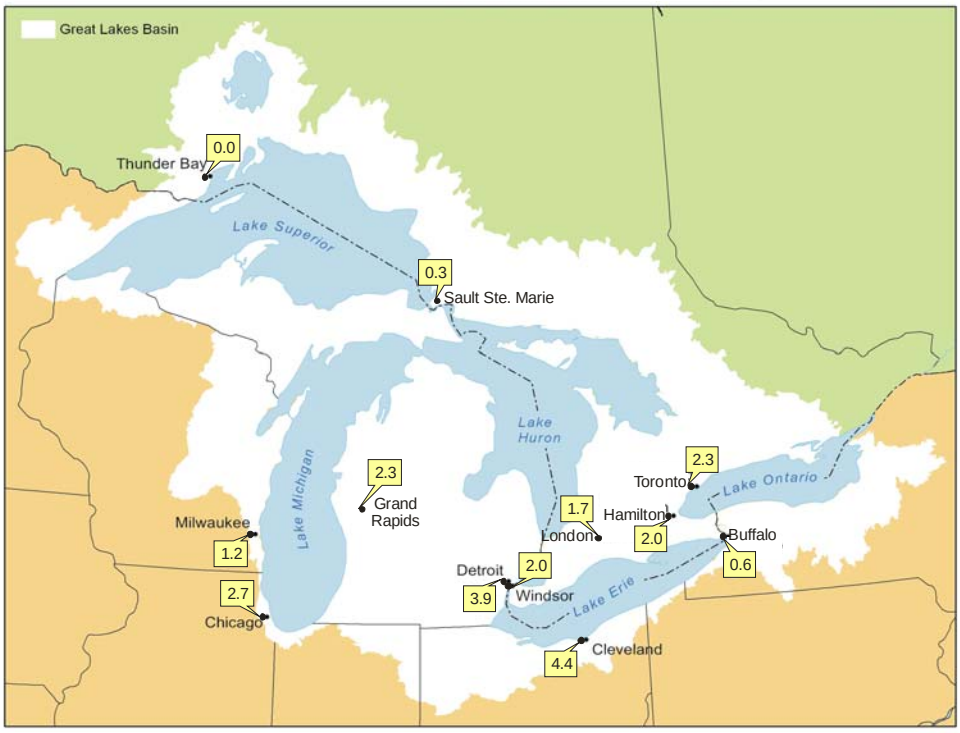
Note: Displayed sites are based on requirements for Canada-wide Standard (CWS) reporting commencing in 2010.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
The CWS for $PM_{2.5}$ (30 µg/m³) is based on the 24-hour, 98th percentile, annual ambient measurement averaged over 3 years (2004-2006).
The values displayed for Oshawa, Chatham and Sudbury are based on 2-year averages (2005-2006).

Figure 3.4 displays the 2006 CWS for $PM_{2.5}$ – based on the 98th percentile of the daily average for 18 designated sites across Ontario. (The 2006 CWS consists of an average over a three-year period, 2004 to 2006). The CWS for $PM_{2.5}$ ranged from 32 μg/m³ in Hamilton Downtown, Mississauga and London to 20 μg/m³ in Sudbury, which was based on a two-year average. Only five (Hamilton Downtown, Mississauga, London, Toronto and Hamilton Mountain) of the 18 designated sites exceeded the CWS target of 30 μg/m³.

Great Lakes Basin Perspective

There were a total of 12 cities selected within the Great Lakes Basin area for this analysis. The selected cities include six from Ontario and six from the United States. The Ontario cities consisted of Windsor, London, Hamilton, Toronto, Sault Ste. Marie and Thunder Bay; while those in the U.S. were Milwaukee, Chicago, Grand Rapids, Detroit, Cleveland and Buffalo.

Figure 3.5
Average Annual Days when the 24h $PM_{2.5}$ Concentrations are > 40 μg/m³
at Select Cities within the Great Lakes Basin
(2003 - 2005)



Note: The U.S. EPA considers a 24-hour average $PM_{2.5}$ concentration greater than 40 μg/m³ *unhealthy for sensitive groups.*.

Figure 3.5 displays the average number of days, between 2001 and 2005, when 24-hour $PM_{2.5}$ concentrations were greater than 40 μg/m³ at the selected cities within the Great Lakes

Basin. The U.S. EPA considers a 24-hour average $PM_{2.5}$ concentration greater than 40 $\mu g/m^3$ *unhealthy for sensitive groups*. Air quality criteria and/or reference levels vary between Ontario and neighbouring states south of the border; therefore, the U.S. EPA $PM_{2.5}$ criteria is used in Figure 3.5 to allow for a consistent assessment $PM_{2.5}$ levels between the cities examined within the Great Lakes Basin.

Over the five-year period studied here, the number of days that were considered *unhealthy for sensitive groups* due to $PM_{2.5}$ ranged, on average, from 0.6 to 4.4 in the U.S. cities. For Ontario cities, the number of days that were considered *unhealthy for sensitive groups* ranged between zero days in Thunder Bay to 2.3 days in Toronto. The Ontario cities, Windsor, Hamilton, London and Sault Ste. Marie had 2.0, 2.0, 1.7 and 0.3 annual days of $PM_{2.5}$ levels that were considered *unhealthy for sensitive groups* as defined by U.S. EPA criteria.

Chapter 4

Other Criteria Contaminants

Characteristics, sources and effects of nitrogen dioxide, carbon monoxide and sulphur dioxide are discussed in this chapter, as well as their ambient concentrations during 2006 and, where appropriate, trends over time.

NITROGEN DIOXIDE

Characteristics, sources and effects

Nitrogen dioxide is a reddish-brown gas with a pungent odour, which transforms in the air to form gaseous nitric acid and nitrates. It also plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. Nitrogen dioxide reacts in the air to form organic nitrates, 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 processes. Ontario's nitrogen oxides emission estimates are displayed by sector in Figure 2.2 of Chapter 2.

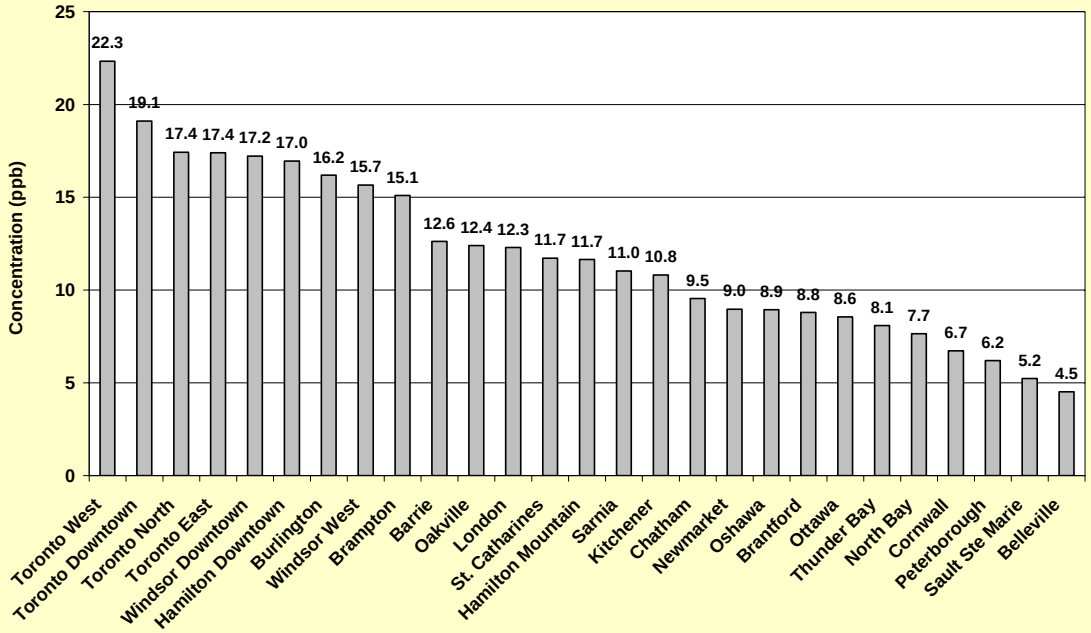
Nitrogen dioxide can irritate the lungs and lower the resistance to respiratory infection. People with asthma and bronchitis have increased sensitivity to NO_2. Nitrogen dioxide chemically transforms into nitric acid in the atmosphere and, when deposited, contributes to the acidification of lakes and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

Monitoring results for 2006

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 (22.3 ppb) for NO_2 during 2006. 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 Downtown and Toronto East air monitoring stations recorded the highest 24-hour average concentration (45 ppb), whereas the Windsor West site recorded the

highest one-hour concentration (80 ppb) in 2006. 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 2006.

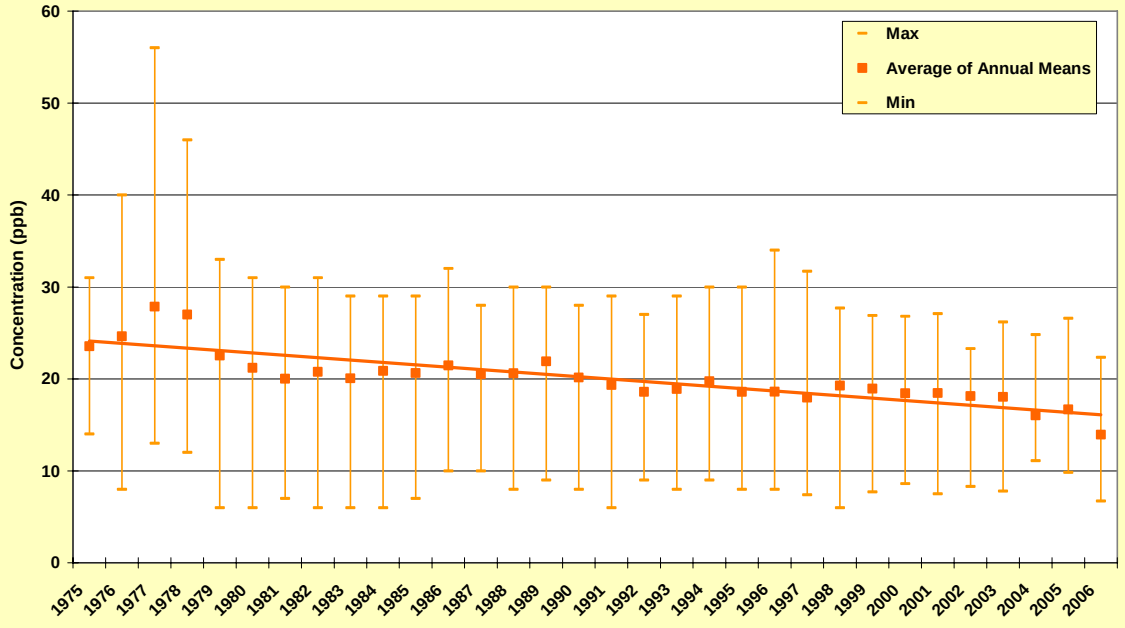
Figure 4.1
Nitrogen Dioxide Annual Means Across Ontario
(2006)



Trends

The trend of the composite annual means for ambient NO_2 concentrations shows a decreasing trend from 1975 to 2006 as displayed in Figure 4.2. Average concentrations decreased by approximately 33 per cent over the 32-year period. Average NO_2 concentrations decreased approximately 26 per cent from 1975 to 1996, and decreased approximately 20 per cent over the last decade, 1997 to 2006.

Figure 4.2
Range of Nitrogen Dioxide Annual Means in Ontario
(1975 - 2006)



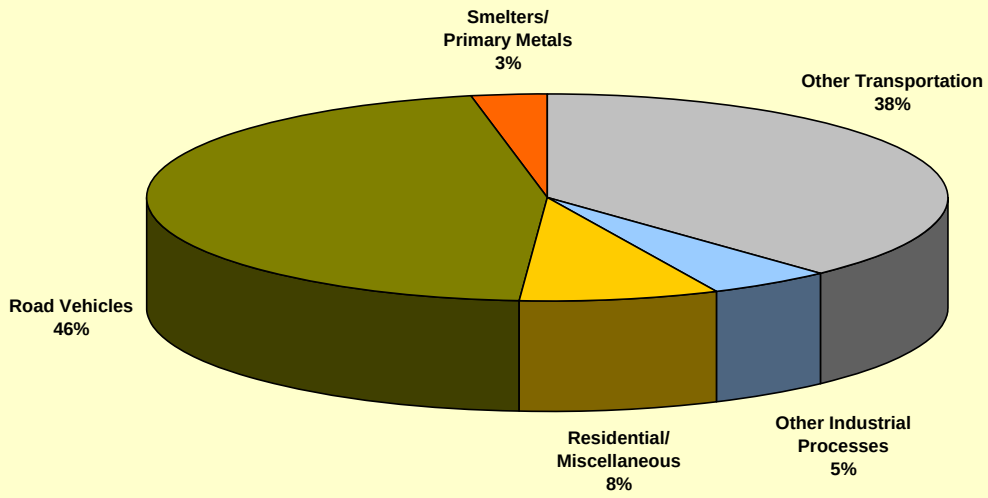
Note: Annual composite mean based on 16 ambient sites operated over 32 years.

CARBON MONOXIDE

Characteristics, sources and effects

Carbon monoxide is a 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 4.3, the transportation sector accounted for 84 per cent of all CO emissions.

Figure 4.3
Ontario Carbon Monoxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2005 Estimates)



Note: 2005 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

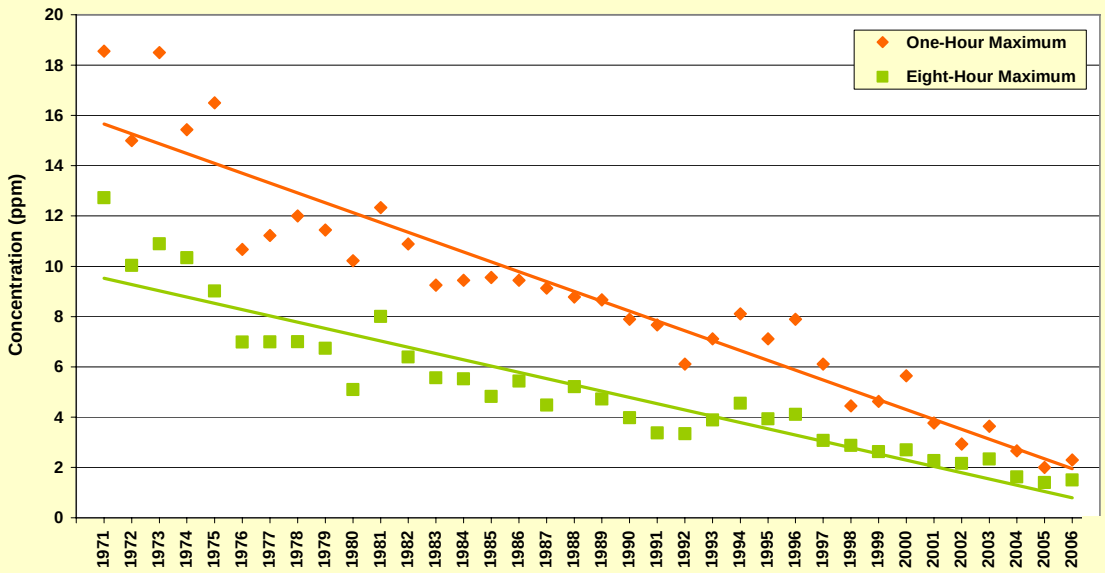
Monitoring results for 2006

In 2006, the highest annual mean of 0.35 parts per million (ppm) was recorded at the Toronto West site. The highest one-hour and eight-hour maximum CO values, 2.98 ppm and 2.48 ppm were also measured at the Toronto West site. Typically, higher CO concentrations are recorded in urban centres as a result of vehicle emissions. Ontario's one-hour (30 ppm) and eight-hour (13 ppm) ambient air quality criteria for CO have not been exceeded at any of the monitoring sites in Ontario since 1991.

Trends

The trends in provincial averaged one-hour and eight-hour maximum CO concentrations from 1971 to 2006 are shown in Figure 4.4. Ambient CO concentrations, as measured by the composite average of the one-hour and eight-hour maximums, decreased by approximately 87 per cent and 92 per cent, respectively, over this 36-year period.

Figure 4.4
Trends of Carbon Monoxide One-Hour and Eight-Hour Maximums in Ontario
(1971 - 2006)



Note: Data are based on nine ambient CO sites operated over 36 years.
Ontario's one-hour AAQC = 30 ppm.
Ontario's eight-hour AAQC = 13 ppm.

SULPHUR DIOXIDE

Characteristics, sources and effects

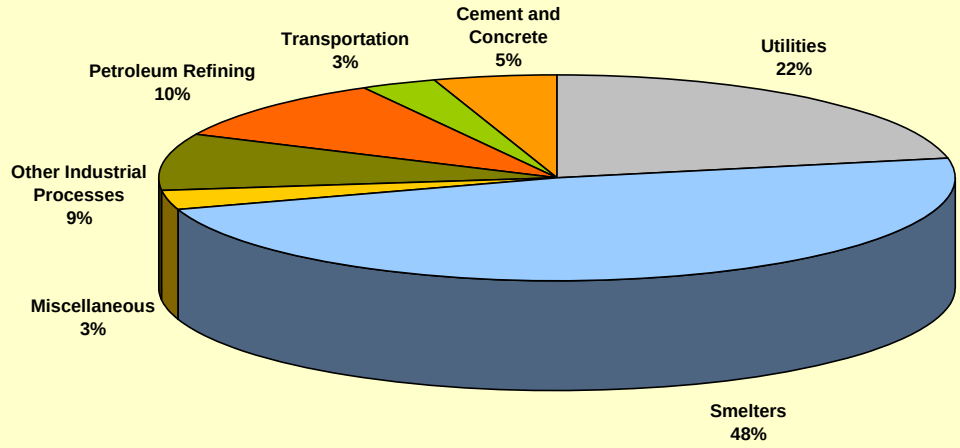
Sulphur dioxide is a colourless gas that smells like burnt matches. Sulphur dioxide can also be oxidized to form sulphuric acid aerosols. In addition, sulphur dioxide is a precursor to sulphates, which are one of the main components of airborne fine particulate matter.

Approximately 70 per cent of the SO_2 emitted in Ontario comes from smelters and utilities as shown in Figure 4.5. Petroleum refineries accounted for approximately 10 per cent of SO_2 emissions. Lesser sources of SO_2 include transportation, cement and concrete, and other industrial processes.

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 causes the formation of microscopic acid aerosols, which have serious health implications and contribute to climate change.

Figure 4.5
Ontario Sulphur Dioxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2005 Estimates)



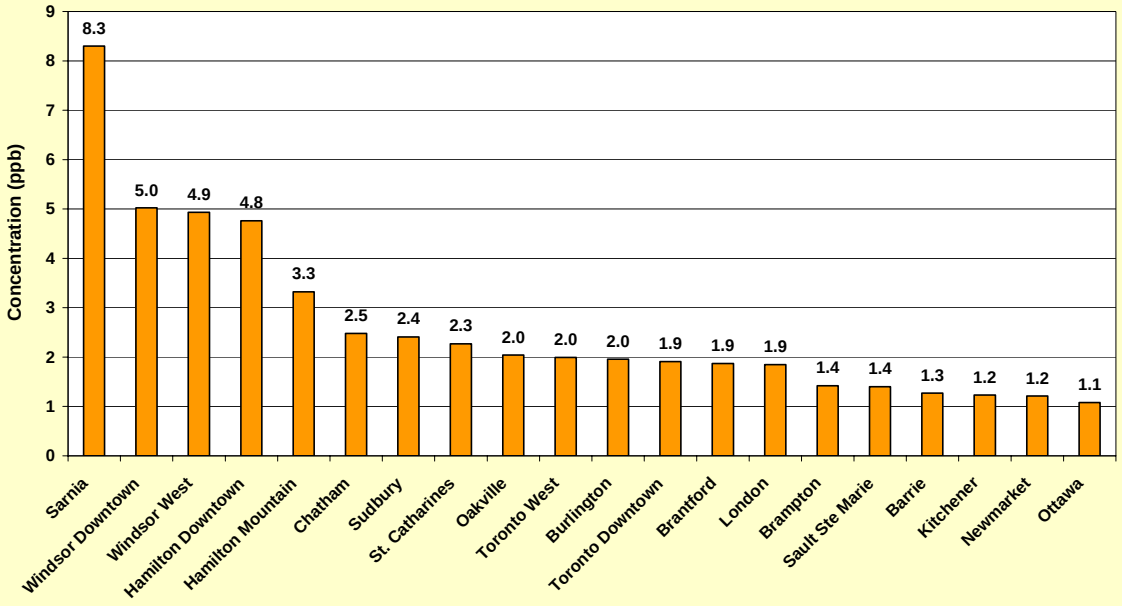
Note: 2005 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Monitoring results for 2006

Sarnia recorded the highest annual mean (8.3 ppb) and 24-hour maximum concentration (107 ppb) of SO_2 during 2006. Sudbury recorded the highest one-hour concentration (808 ppb). The highest concentrations of SO_2 historically have been recorded in the vicinity of large industrial facilities such as smelters and utilities. The provincial one-hour criterion for SO_2 of 250 ppb was exceeded at the Sudbury site for two hours; and the 24-hour criterion (100 ppb) for SO_2 was exceeded at Sarnia on two occasions.

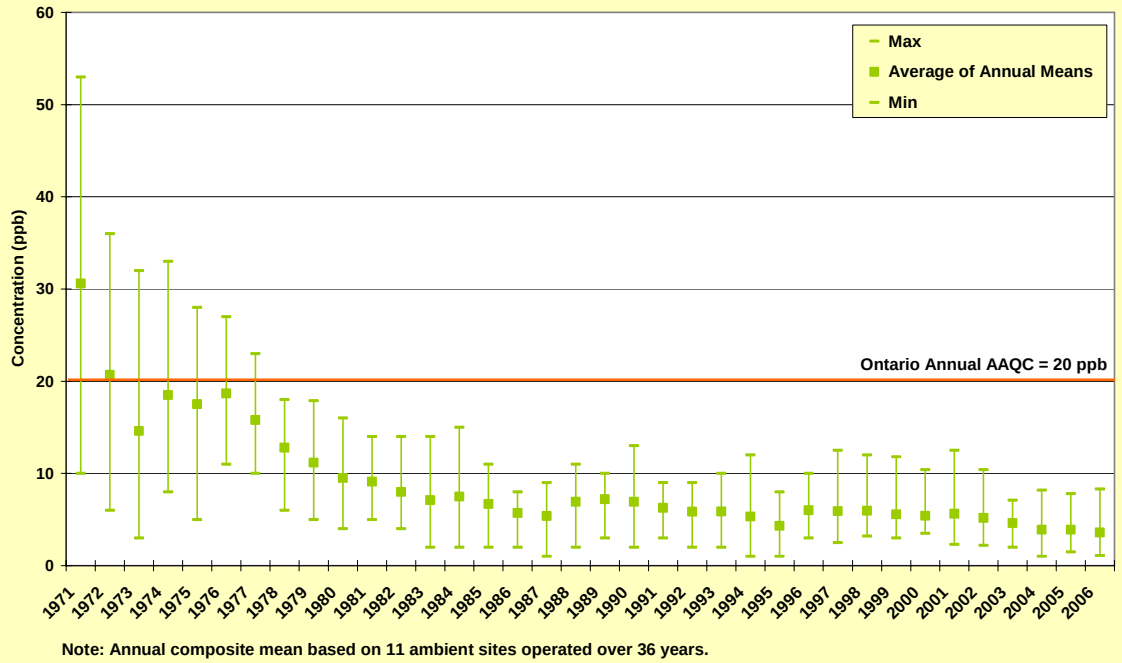
The SO_2 annual means at ambient AQI sites across Ontario are displayed in Figure 4.6. As mentioned previously, Sarnia recorded the highest annual mean in 2006. The annual levels across the province ranged from a low of 1.1 ppb in Ottawa to a high of 8.3 ppb in Sarnia. The annual criterion of 20 ppb for SO_2 was not exceeded at any site in Ontario during 2006.

Figure 4.6
Sulphur Dioxide Annual Means Across Ontario
(2006)



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

Figure 4.7
Range of Sulphur Dioxide Annual Means in Ontario
(1971 - 2006)



Note: Annual composite mean based on 11 ambient sites operated over 36 years.

Trends

Figure 4.7 shows the composite annual means for ambient SO_2 concentrations from 1971 to 2006. The composite annual mean for SO_2 in 2006 is 88 per cent lower than the 1971 value. Control orders on smelting operations and the Countdown Acid Rain program resulted in significant decreases of SO_2 emissions prior to the early 1990s. Based on relatively low concentrations over the last decade, there has been a decrease of approximately 40 per cent in SO_2 concentrations from 1997 to 2006.

Chapter 5

Air Quality Indices, Smog Alert Program and Smog Episodes

Air Quality Indices

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2006, 38 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 38 sites.

The AQI network, shown in Figure 5.1, provides the public with air quality information, in near real-time, 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.

Figure 5.1
Air Quality Index (AQI) Monitoring Sites in Ontario (2006)

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.

Computed AQI values 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.

Table 5.2 shows the percentage distribution of hourly AQI readings for the 38 monitoring sites by the AQI descriptive category and the number of days with at least one hour AQI reading greater than 49. On average, the AQI sites in 2006 reported air quality in the very good and good categories approximately 91 per cent of the time and moderate to poor categories about 9 per cent of the time.

Table 5.2: Air Quality Index Summary (2006)

City/Town	Valid Hours	Percentage of Valid Hours AQI in Range					No. of Days At Least 1 Hour > 49
		Very Good	Good	Moderate	Poor	Very Poor	
		0-15	16-31	32-49	50-99	100+	
Windsor Downtown	8754	41.6	47.2	10.9	0.4	0	7
Windsor West	8735	39.8	47.4	12.3	0.4	0	9
Chatham	8747	35.3	53.6	10.7	0.3	0	11
Sarnia	8750	24.9	61.1	13.5	0.4	0	11
Grand Bend	8709	33.1	57.3	9.2	0.4	0	10
London	8742	40.3	50.1	9.5	0.1	0	4
Port Stanley	8621	27.0	60.2	12.1	0.7	0	15
Tiverton	8633	35.7	57.6	6.6	0.1	0	5
Brantford	8748	35.0	53.7	11.0	0.2	0	7
Kitchener	8740	34.6	55.5	9.7	0.1	0	4
St. Catharines	8727	38.1	50.6	11.1	0.2	0	5
Guelph	8752	36.5	53.6	9.7	0.2	0	4
Hamilton Downtown	8691	40.8	48.2	10.7	0.3	0	5
Hamilton Mountain	8726	33.7	54.4	11.6	0.4	0	9
Hamilton West	8743	47.1	44.1	8.5	0.3	0	5
Toronto Downtown	8747	48.7	43.3	7.7	0.3	0	9
Toronto East	8738	48.6	43.2	7.9	0.4	0	9
Toronto North	8746	42.0	49.9	8.0	0.1	0	5
Toronto West	8679	52.9	38.6	8.3	0.2	0	6
Burlington	8752	44.5	46.1	9.1	0.3	0	7
Oakville	8667	37.9	52.7	9.1	0.2	0	4
Oshawa	8669	40.7	52.5	6.5	0.3	0	9
Brampton	8737	37.2	53.5	9.1	0.2	0	7
Mississauga	8748	45.0	45.9	8.9	0.2	0	8
Barrie	8748	40.4	52.4	7.2	0.0	0	1
Newmarket	8751	31.7	58.5	9.6	0.2	0	8
Parry Sound	8748	28.0	62.7	9.0	0.3	0	6
Dorset	8651	34.6	58.6	6.7	0.0	0	1
Ottawa	8737	45.9	49.6	4.5	0.0	0	1
Kingston	7076	40.3	51.3	8.2	0.2	0	4
Belleville	8733	31.7	58.8	8.9	0.5	0	11
Morrisburg	8738	32.5	59.0	8.1	0.4	0	9
Cornwall	8716	32.6	59.7	7.3	0.3	0	7
Peterborough	8715	41.2	53.4	5.3	0.0	0	1
Thunder Bay	8750	44.7	52.8	2.5	0.0	0	0
Sault Ste. Marie	8751	32.5	60.7	6.7	0.1	0	2
North Bay	8733	39.3	54.6	6.1	0.1	0	3
Sudbury	8724	33.8	60.5	5.6	0.1	0	5

Air quality in the very good and good categories ranged from approximately 86 per cent at Sarnia to 98 per cent at Thunder Bay. At Windsor Downtown, approximately 80 per cent of the hours when air quality exceeded the poor threshold, the poor air quality was due to ozone. In contrast, approximately 84 per cent of the hours of poor air quality were due to fine particulate matter at Hamilton Downtown. In the greater Toronto area approximately 55 per cent of the hours of poor air quality were due to fine particulate matter and 45 per cent due to ozone. During 2006, two hours of poor air quality due to sulphur dioxide were recorded at Sudbury. There were no hours of very poor air quality recorded at any site in Ontario during 2006.

Figure 5.2 shows the composite pie diagrams of the percentages of very good, good, moderate and poor air quality recorded at all sites across the province in 2006. 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. Sixty three per cent of the poor AQI values were due to ozone, and the remaining 37 per cent were due to fine particulate matter. By way of contrast, in 2005, 55 per cent of the poor AQI values were due to fine particulate matter, and 45 per cent due to ozone (see Air Quality in Ontario 2005 report).

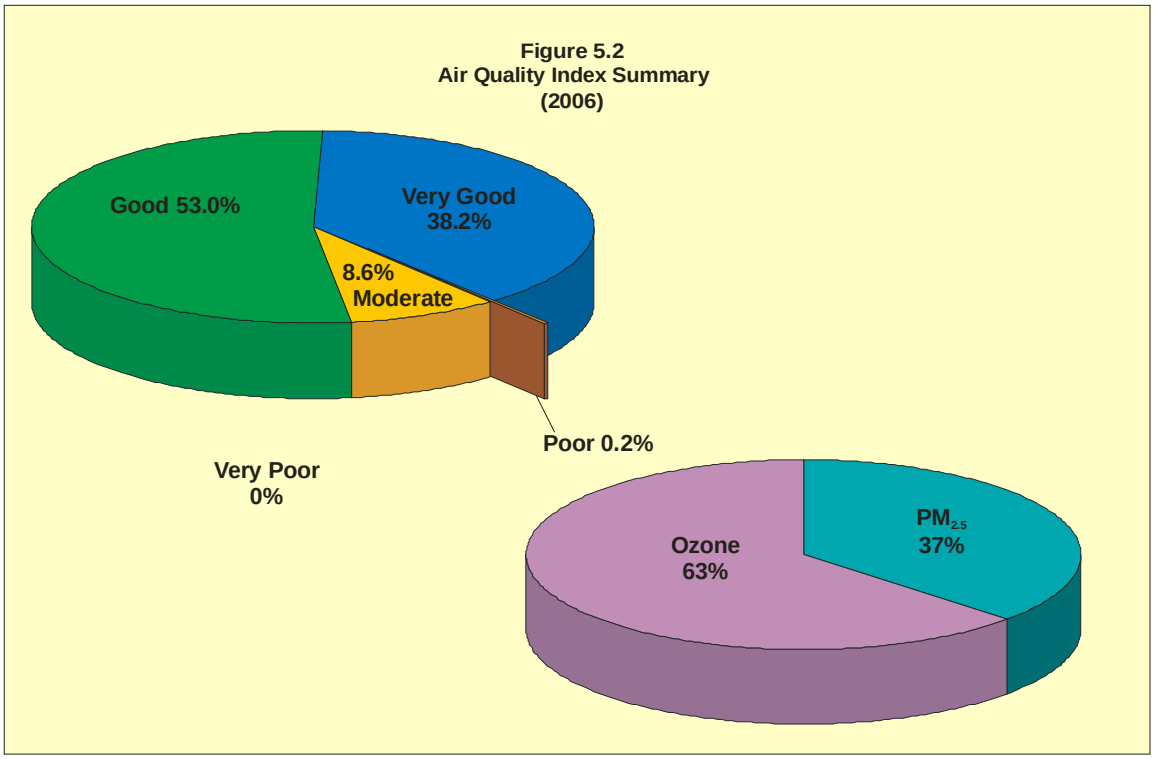
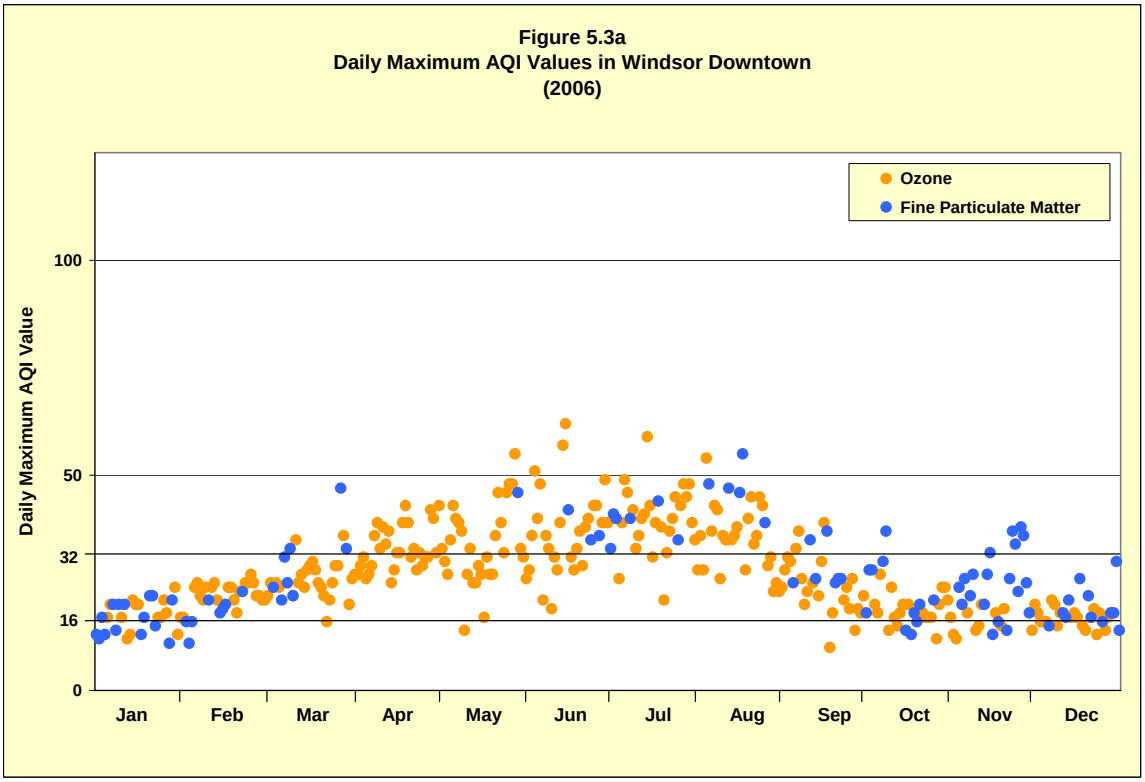


Table 5.3 shows the number of days that poor air quality was recorded for at least one hour at major cities in southern Ontario and also North Bay in northeastern Ontario during the period 2003-2006. The large variability from year to year in the number of days of poor air quality in these cities is due primarily to prevailing meteorological conditions. During the record-breaking hot, humid conditions of 2005, there were a large number of poor air quality days, whereas during the relatively cooler and more cloudy summers of 2004 and 2006, less days of poor air quality were recorded. During 2004 and 2006 weather conditions were not as conducive for photochemical production of ozone and fine particulate matter.

Table 5.3 Number of Days with at Least One Hour AQI > 49 (2003-2006)

City/Town	2003	2004	2005	2006
Windsor Downtown	17	7	37	7
Hamilton Downtown	22	12	20	5
Toronto Downtown	12	6	20	9
Ottawa	5	1	13	1
North Bay	7	0	10	3

In 2006, Toronto Downtown recorded the highest number of days (nine) with at least one hour of poor air quality. On some days, both ozone and fine particulate matter caused the AQI to exceed the poor threshold of 49.



Figures 5.3a-c display the daily maximum AQI values at Windsor Downtown, Toronto Downtown, and Ottawa, respectively, for 2006. Over the entire year, ozone was the determining pollutant at these three sites, accounting for 73 per cent of the daily maximum AQI values at Windsor Downtown, 77 per cent at Toronto Downtown, and 80 per cent at Ottawa. From Figure 5.3a, it is apparent that ozone was even more dominant at Windsor Downtown during the period of May to September by the fact that 86 per cent of daily maximums during this period were due to ozone, and only 14 per cent due to $PM_{2.5}$. Also, all seven of the poor days (days with at least

one hour in the poor category) occurred during the May to September period, and six of these days were due to ozone.

Figure 5.3b
Daily Maximum AQI Values in Toronto Downtown
(2006)

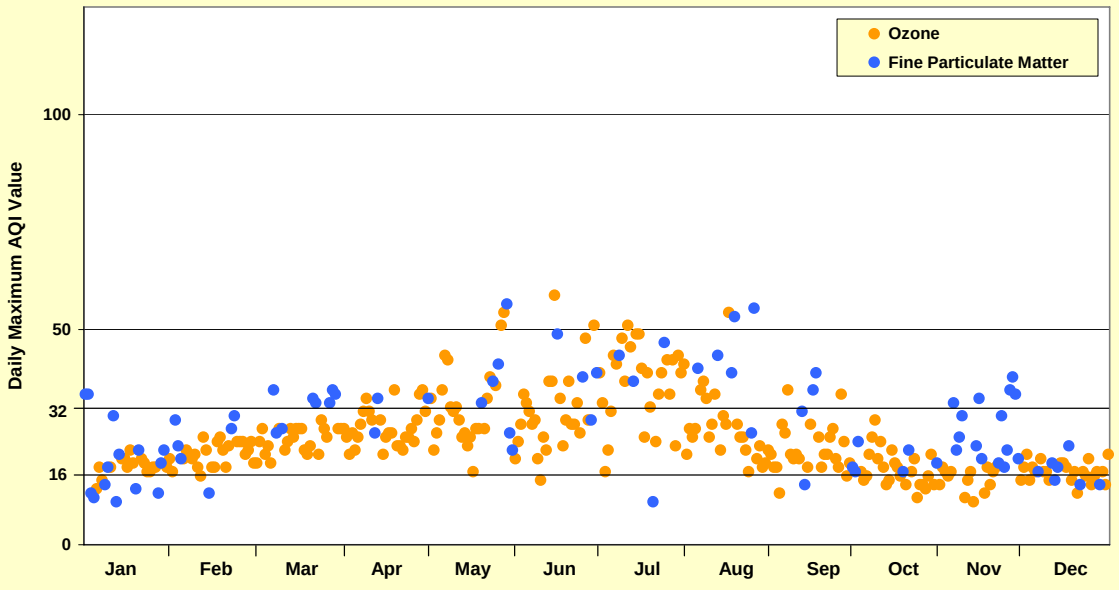
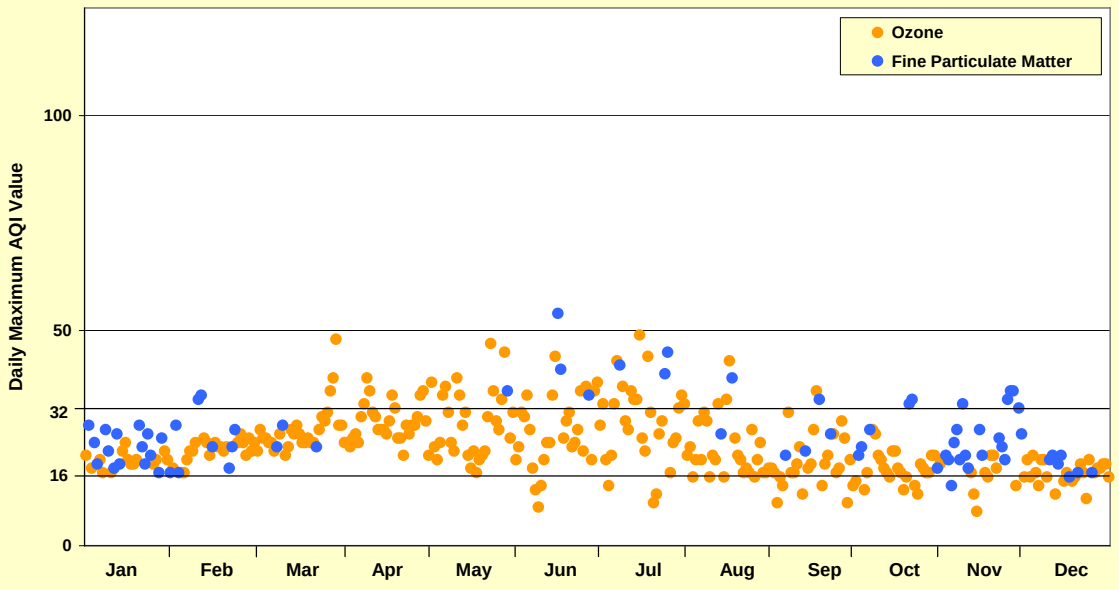


Figure 5.3c
Daily Maximum AQI Values in Ottawa
(2006)



Similar to Windsor Downtown, daily maximum AQI values at Toronto Downtown (Figure 5.3b) from May to September were dominated by ozone resulting in 84 per cent of the daily maximums recorded; $PM_{2.5}$ accounted for the remaining 16 per cent. Toronto Downtown also showed a similar pattern to Windsor Downtown with exceedances of the poor threshold, with all of the poor days occurring during the summer, and six out of the nine exceedances due to ozone. Ottawa (Figure 5.3c) also showed the same tendency of ozone dominating the period from May to September, however the one daily maximum in the poor category was due to $PM_{2.5}$.

Smog alert program

The ministry began issuing smog advisories in 1993 under the Air Quality Advisory program, and then expanded to the Smog Alert program in 2000. The program is a joint effort between the Ontario Ministry of the Environment and Environment Canada. Smog advisories are issued to the public 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 widespread poor air quality occurs (AQI values greater than 49) and weather conditions are conducive for the elevated smog levels to continue for several hours. The Smog Alert program covers southern, eastern and central Ontario where it is most likely for ozone to exceed the one-hour AAQC of 80 ppb and for $PM_{2.5}$ levels to exceed 45 $\mu g/m^3$ based on a three-hour running average.

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

- A public website, www.airqualityontario.com, where current AQI readings, smog forecasts and other air quality information are available;
- A two-level air quality forecast that provides a three-day outlook known as a smog watch, in addition to the current 24-hour smog advisory;
- A Smog Watch is called when there is a 50 per cent chance that elevated smog levels are forecast within the next three days;
- A Smog Advisory is called when there is a strong likelihood that elevated smog levels are forecast within the next 24 hours;
- If widespread, poor AQI readings occur, and weather conditions conducive to the persistence of such levels are expected to continue for several hours, then a smog advisory is issued immediately;
- 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 Michigan and Quebec

Since May 2000, during the traditional smog season from May to September, air quality and meteorological discussions between Michigan and Ontario meteorologists are held twice per week or more frequently if there is potential for a smog advisory in Ontario or an ozone action day in Michigan. 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 Lake Michigan Air Director's Consortium (LADCO) on the issuance and harmonizing of smog advisories and ozone action days during the summer, as well as $PM_{2.5}$ 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 during the smog season are 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.

2006 smog advisories

For 2006, Ontarians experienced six smog advisories covering 17 days, and all of these events occurred during the traditional smog season (May 1 to September 30 inclusive). The details of these smog advisories are shown in Table 5.4.

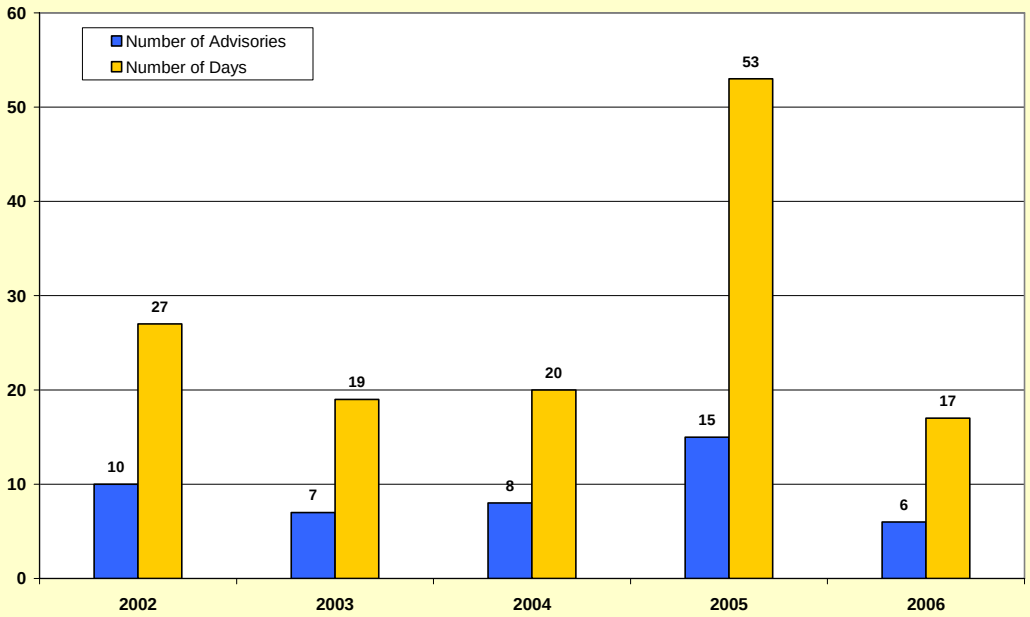
Table 5.4 Smog Advisory Statistics for Ontario (2006)

Advisory	Advisory Period	Duration of Advisory
1	May 27-31	5 days
2	June 16-19	4 days
3	July 16-17	2 days
4	July 27-28	2 days
5	July 31-August 2	3 days
6	August 27	1 day

In contrast to the record-breaking smog advisories in 2005 (15 smog advisories covering 53 days), the year 2006 recorded the lowest number of smog advisories (6 smog advisories

covering 17 days) since 2002 when fine particulate matter was added to the index. Also, unlike 2005, there were no smog events in the winter, spring and autumn of 2006; all the events occurred during the traditional smog season, between May and August inclusive. A history of smog advisories and smog advisory days issued by the Ministry of the Environment since 2002 is shown in Figure 5.4.

Figure 5.4
Summary of Smog Advisories Issued
(2002 - 2006)



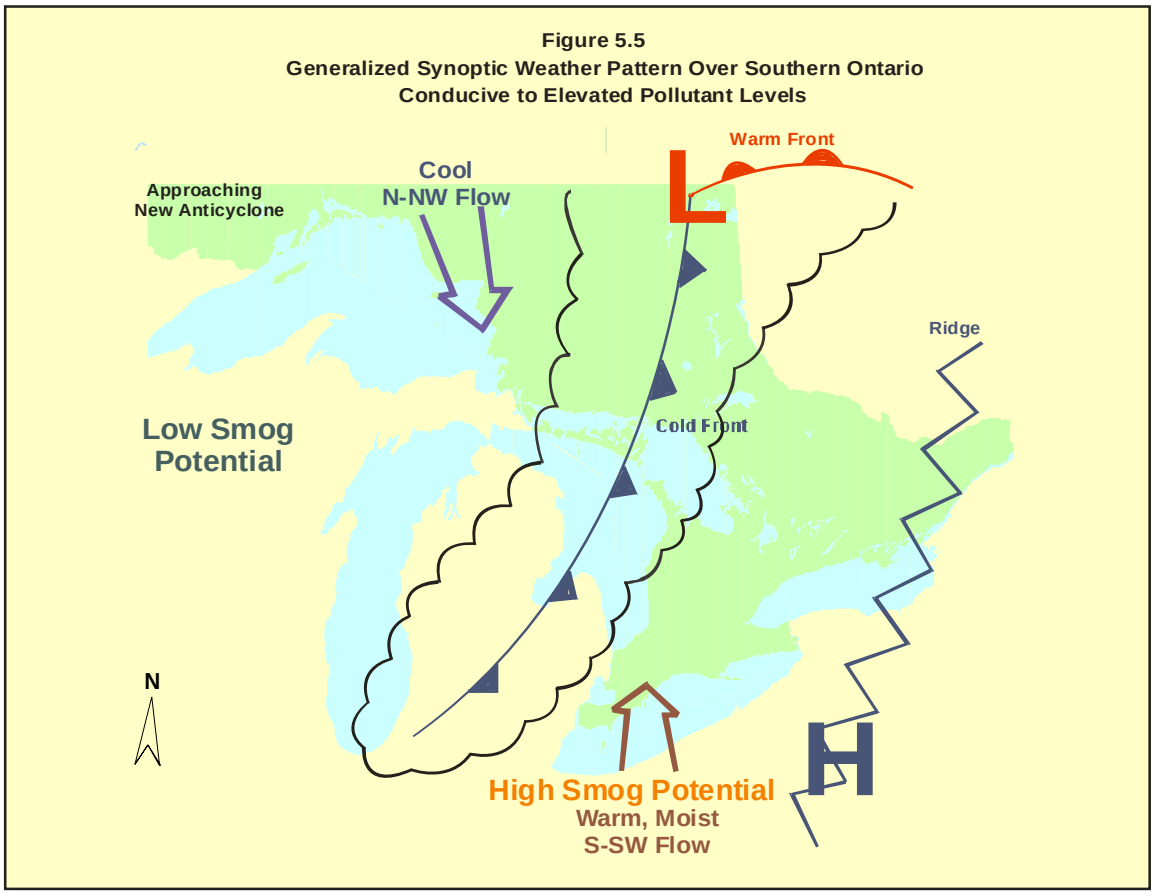
2006 smog episodes

Smog episodes are defined here as days with widespread and persistent ozone levels greater than the Ontario one-hour ozone AAQC of 80 ppb and/or days with widespread and persistent $PM_{2.5}$ levels greater than a three-hour average of 45 µg/m^3. Such episodes in the winter in Ontario are due primarily to fine particulate matter, and are typically associated with relatively stagnant conditions and the development of strong temperature inversions overnight. Under normal atmospheric conditions, the temperature of the atmosphere decreases with height, whereas an inversion is formed when the temperature increases with height. Within the inversion layer, the atmosphere is very stable and is therefore unable to mix vertically, and can lead to pollutants being trapped in that layer. During the day, the sun shines on the earth's surface, heating it up, and, in turn, the air closest to the surface is heated, resulting in normal atmospheric conditions. When the sun sets, the Earth's surface no longer receives radiation from the sun, so it cools rapidly provided the sky is clear (clouds act as insulation). If winds are light,

the temperature of the air near the surface decreases faster than the air above it, establishing a surface inversion.

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 systems 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 5.5 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 southwestward across Lake Huron, which results in cloudiness and precipitation. It is the passage of this cold front that typically ends a smog episode and smog advisory. Behind the cold front, another high pressure system approaches from the northwest, causing a north to northwesterly flow of cooler, drier, and cleaner air.

Figure 5.5
Generalized Synoptic Weather Pattern Over Southern Ontario
Conducive to Elevated Pollutant Levels



In 2006, Ontario experienced significantly less transboundary flow of polluted air as the conditions upwind in the U. S. were often cloudy, unstable and wet, thus favouring less opportunity for smog formation there and subsequent transport. Temperature conditions were also less conducive in 2006 compared to that of 2005 for the development of elevated smog levels across southern Ontario. For example, in 2006 Windsor recorded 16 hot days (days on which the maximum temperature was greater than 30°C) which was in marked contrast to the 47 such days in 2005. For Toronto, there were 17 hot days in 2006, compared to 41 such days in 2005, and for Ottawa, there were 10 hot days in 2006 compared to 26 such days in 2005. These contrasting weather conditions between 2006 and 2005 resulted in significantly fewer smog incidences in 2006 compared to that in 2005.

Smog episodes were typically of one or two-day duration in 2006. Moreover, most of the events were dominated by ozone or ozone and fine particulate matter. Only one event, on August 27, was dominated by only fine particulate matter.

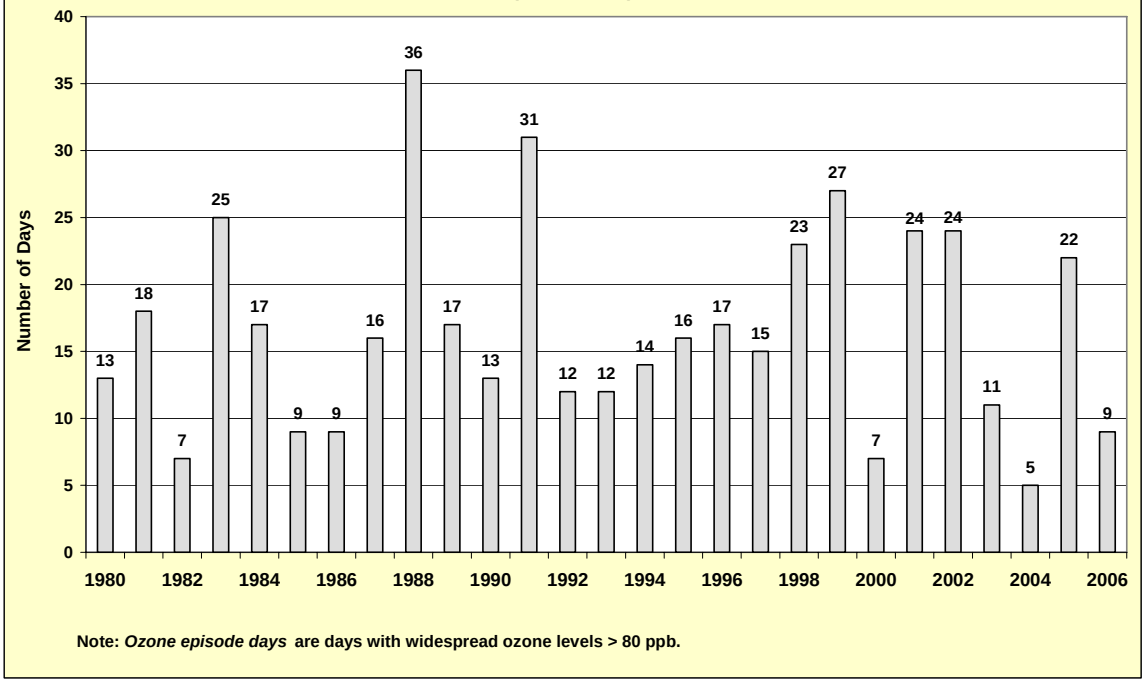
The most extensive smog event of the season occurred during the period June 16 to June 19, 2006. On June 16, hot, sunny conditions combined with a light southerly flow of polluted air from the U. S. and build-up of local pollutants began to impact areas of extreme southwestern Ontario and parts of northern Ontario in the Sault Ste. Marie region. Poor air quality due to ozone occurred at six sites, and the maximum one-hour level of 110 ppb occurred at Sault Ste. Marie. By June 17, hot, sunny conditions coupled with a southwesterly flow of polluted air had invaded all of southern, and parts of eastern and northern Ontario. On this day, 34 of the 38 AQI sites across Ontario recorded poor air quality due to ozone, and the maximum one–hour level of 127 ppb occurred at Grand Bend, on the eastern shores of Lake Huron. Hot, hazy and humid conditions persisted into June 18, and as a result, there was a build-up of both ozone and fine particulate matter. Twenty sites recorded poor air quality and of these, seven had poor levels due to ozone, nine had poor levels due to fine particulate matter, and four had poor levels due to both ozone and fine particulate matter. The maximum one-hour ozone reading was 89 ppb, and this occurred at Belleville, near the north shore of Lake Ontario. For fine particulate matter, the maximum three-hour average concentration was 60 $\mu g/m^3$, and this occurred at Sarnia. By June 19, weather conditions had changed with increasing cloudiness, cooler temperatures and a change in wind direction to a more westerly flow of cleaner air across southern, central and northern Ontario. Only the extreme eastern areas of the province reported poor air quality due to fine particulate matter on this date, at two sites, namely, Morrisburg and Cornwall, both for one hour duration and both with a maximum three-hour average concentration of 46 $\mu g/m^3$.

The single fine particulate matter episode occurred on August 27, 2006 and was confined to parts of southwestern Ontario and the Golden Horseshoe area including the Greater Toronto Area. A slow moving weather system combined with foggy conditions resulted in an accumulation of local and transported pollutants. Thirteen sites in the area reported poor air

quality readings due to fine particulate matter, and the maximum observed three-hour average concentration of 59 µg/m^3 occurred at St. Catharines. By late evening of the same day, a cold front had moved across the region and this resulted in northerly winds and cleaner air.

Elevated ozone and fine particulate matter levels 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 2006 is depicted in Figure 5.6. This shows that the number of *ozone episode days* in 2006 was relatively low, a total of nine, and was in marked contrast to the total of 22 such days in 2005.

Figure 5.6
Number of Ozone Episode Days in Ontario
(1980 - 2006)



Note: *Ozone episode days* are days with widespread ozone levels > 80 ppb.

In terms of *smog episode days* (due to ozone and/or $PM_{2.5}$) there were 11 such days in 2006, 31 such days in 2005, 15 in 2004, and 12 in 2003. For 2006, all cases occurred in the summertime and were driven by ozone or ozone and fine particles (nine of the 11 cases). This was also the lowest number of days since 2003 and stands in marked contrast to the 31 such days in 2005. Moreover, of the four years, *smog episode days* were dominated by fine particulate matter in only one year, namely, 2004 (10 of the 15 days). The results for the four years are summarized in Table 5.5.

Table 5.5 Smog Episode Days in Ontario (2003 – 2006)

Year	Smog Episode Days Due to			Total Number of Smog Episode Days
	Ozone	Ozone and $PM_{2.5}$	$PM_{2.5}$	
2003	5	6	1	12
2004	2	3	10	15
2005	14	8	9	31
2006	6	3	2	11

The air flow into Ontario, as shown with 48-hour back trajectories on the 11 *smog episode days* during 2006, is depicted in Figure 5.7. This qualitatively confirms the fact that ozone and fine particulate matter episode days in Ontario are typically associated with south to southwesterly flows from the heavily industrialized and urbanized regions of the United States.

Figure 5.7
48-Hour Back Trajectories at 500m Arriving at London, Ontario
at 1300 EDT on Smog Episode Days in 2006

GLOSSARY

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 pollutant - 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.

Glossary continued...

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 $PM_{2.5}$. 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.

Glossary continued...

Secondary pollutant	-	pollutant formed from other pollutants in the atmosphere.
Smog	-	a contraction of smoke and fog; colloquial term used for photochemical smog, which includes ozone, fine particulate matter, and other contaminants; tends to be a brownish haze.
Smog advisory	-	smog advisories are issued to the public when there is a strong likelihood that widespread, elevated and persistent smog levels are expected.
Smog episode day	-	A day with widespread and persistent ozone levels greater than the Ontario one-hour AAQC of 80 ppb and/or a day with widespread and persistent $PM_{2.5}$ levels greater than the three-hour average of 45 $\mu g/m^3$.
Stratosphere	-	atmosphere 10 to 40 kilometres above the Earth's surface.
Stratospheric ozone	-	ozone formed in the stratosphere from the conversion of oxygen molecules by solar radiation; ozone found there absorbs much ultraviolet radiation and prevents it from reaching the Earth.
Sulphur dioxide	-	a colourless gas that smells like burnt matches.
Toxic deposition	-	deposition of an airborne toxic pollutant at ground, vegetative or surface levels.
Toxic pollutant	-	substance that can cause cancer, genetic mutations, organ damage, changes to the nervous system, or even physiological harm as a result of prolonged exposure, even to relatively small amounts.
Troposphere	-	atmospheric layer extending from the surface up to about 10 kilometres above the Earth's surface.

ACRONYMS

AAQC	-	Ambient Air Quality Criteria (Ontario)
AQI	-	Air Quality Index
CCME	-	Canadian Council of Ministers of the Environment
CO	-	carbon monoxide
COPD	-	Chronic obstructive pulmonary disease
CWS	-	Canada-wide Standard
GTA	-	Greater Toronto Area
IVR	-	Integrated Voice Response
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
TEOM	-	Tapered Element Oscillating Microbalance
TRS	-	total reduced sulphur
VOCs	-	volatile organic compounds

$\mu g/m^3$	-	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
2006 REPORT
APPENDIX

AIR MONITORING & REPORTING SECTION
ENVIRONMENTAL MONITORING AND REPORTING BRANCH
ONTARIO MINISTRY OF THE ENVIRONMENT

ACKNOWLEDGEMENTS

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

APPENDIX
TABLE OF CONTENTS

INTRODUCTION

This appendix is intended for use in conjunction with the 2006 Annual Air Quality in Ontario report. The first section of the Appendix briefly describes the provincial air monitoring network, quality assurance and quality control procedures and the Ministry of the Environment's air quality database. The second part of the Appendix 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.

MONITORING NETWORK OPERATIONS

Network Description

In 2006, the ambient network comprised of 151 continuous monitoring instruments at 43 sites, including research sites, where 42 real-time $PM_{2.5}$ monitors were operated. These instruments have the capability of recording minute data (approximately 79. 4 million data points per year) that are used to scan and validate the continuous hourly data. During 2006, the Environmental Monitoring and Reporting Branch (EMRB) operated all of the ambient sites. Monitoring site locations for the continuous 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 2006 ambient air quality monitoring network had greater than 96 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.

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 1997-2006.

NETWORK DESCRIPTIVE TABLES AND ANNUAL STATISTICS

The ambient continuous (hourly) network for 2006 is summarized in Table 1 and Map 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 2006 statistical data and 10-year trends for various continuous pollutants are provided in Tables 2-15.

Table 1: 2006 Ontario Continuous Ambient Air Monitoring Network

ID	CITY/TOWN	STATION LOCATION	YEAR	LATITUDE	LONGITUDE	AIR INTAKE	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	CO	SO_2	TRS
12008	WINDSOR DOWNTOWN	467 UNIVERSITY AVE.	1969	42°18`59``	83°02`40``	8	A/C/N	Y	T	T	T	T	T	.
12016	WINDSOR WEST	COLLEGE/SOUTH ST.	1975	42°17`34``	83°04`24``	4	A/N	Y	T	T	T	.	T	T
12059	ESSEX	360 FAIRVIEW DR. W.	2004	42°09`36``	82°50`00``	5	N/R	.	T	T	T	.	T	.
13001	CHATHAM	435 GRAND AVE. W.	2005	42°24`12``	82°12`31``	15	A/C/N	Y	T	T	T	T	T	.
14064	SARNIA	FRONT ST./CN TRACKS/CENTENNIAL PARK	1976	42°59`01``	82°24`16``	3	A/N	Y	T	T	T	.	T	T
15020	GRAND BEND	WATER TREATMENT PLANT	1991	43°20`02``	81°44`20``	10	A/N	S	T	T	.	.	.	.
15025	LONDON	900 HIGHBURY AVE.	1995	43°00`32``	81°12`34``	4	A/C/N	Y	T	T	T	T	T	.
16015	PORT STANLEY	43665 DEXTER LINE/ ELGIN WATER T. PLANT	2002	42°39`36``	81°13`08``	5	A/N	S	T	T	.	.	.	.
18007	TIVERTON	CONCESSION RD. 2/ LOT A	1979	44°18`50``	81°33`08``	4	A/N	S	T	T	.	.	.	.
21005	BRANTFORD	324 GRAND RIVER AVE.	2004	43°08`25``	80°17`46``	5	A/N	Y	T	T	T	.	T	.
22071	SIMCOE	HWY 3/BLUE LINE RD./ EXPERIMENTAL FARM	1975	42°51`08``	80°15`50``	4	N/R	.	T	T	.	.	.	.
26060	KITCHENER	WEST AVE./HOMEWOOD	1990	43°26`34``	80°30`14``	5	A/C/N	Y	T	T	T	.	T	.
27067	ST. CATHARINES	ARGYLE CRES./ PUMP STN.	1987	43°09`38``	79°14`02``	4	A/C/N	Y	T	T	T	.	T	.
28028	GUELPH	EXHIBITION ST./CLARK ST.	2000	43°33`09``	80°15`59``	4	A/C/N	Y	T	T	.	.	.	.
29000	HAMILTON DOWNTOWN	ELGIN/KELLY	1987	43°15`30``	79°51`41``	4	A/C/N	Y	T	T	T	T	T	T
29114	HAMILTON MOUNTAIN	VICKERS RD./E. 18TH ST.	1985	43°13`47``	79°51`43``	3	A/C/N	Y	T	T	T	.	T	.
29118	HAMILTON WEST	MAIN ST. W./ HWY 403	1985	43°15`31``	79°54`09``	3	A	Y	T	T	.	.	.	.
31103	TORONTO DOWNTOWN	BAY/WELLESLEY ST.	2000	43°39`51``	79°23`14``	10	A/C/N	Y	T	T	T	T	T	.
31190	TORONTO	CN TOWER/ 301 FRONT ST. W.	1989	43°38`26``	79°23`13``	444	R	.	T	.	T	.	.	.
33003	TORONTO EAST	KENNEDY/LAWRENCE	1970	43°44`57``	79°16`30``	4	A/C/N	Y	T	T	T	.	.	.
34020	TORONTO NORTH	HENDON/YONGE ST.	1988	43°46`47``	79°24`56``	5	A/C/N	Y	T	T	T	.	.	.
35003	ETOBICOKE WEST	ELMCREST RD./CENTENNIAL PARK	1969	43°38`58``	79°35`18``	5	N/R	.	T	T	T	.	.	.
35033	ETOBICOKE SOUTH	185 JUDSON ST.	1967	43°36`49``	79°30`28``	5	N/R	.	T	T	T	.	.	.
35125	TORONTO WEST	125 RESOURCES RD.	2003	43°42`40``	79°32`33``	8	A/C/N	Y	T	T	T	T	T	.
44008	BURLINGTON	HWY 2/NORTH SHORE BLVD. E.	1979	43°19`08``	79°48`06``	5	A/C/N	Y	T	T	T	.	T	.
44017	OAKVILLE	8^{TH} LINE/GLENASHTON DR./ HALTON RESERVOIR	2003	43°29`09``	79°42`08``	12	A/C/N	Y	T	T	T	.	T	.
45026	OSHAWA	2200 SIMCOE ST. N./ DURHAM COLLEGE	2005	43°57`06``	78°53`52``	7	A/C/N	Y	T	T	T	.	.	.
46089	BRAMPTON	525 MAIN ST. N./ PEEL MANOR	2000	43°41`59``	79°46`41``	5	A/C/N	Y	T	T	T	.	T	.
46109	MISSISSAUGA	FRANK McKECHNIE COMM. CTR	2004	43°36`57``	79°39`09``	10	A/C/N	Y	T	T	.	.	T	.

Table 1: 2006 Ontario Continuous Ambient Air Monitoring Network

ID	CITY/TOWN	STATION LOCATION	YEAR	LATITUDE	LONGITUDE	AIR INTAKE	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	CO	SO_2	TRS
47045	BARRIE	83 PERRY ST.	2001	44°22`55``	79°42`15``	5	A/C/N	Y	T	T	T	.	T	.
48006	NEWMARKET	EAGLE ST./McCAFFREY RD.	2001	44°02`38``	79°28`55``	5	A/N	Y	T	T	T	.	T	.
49005	PARRY SOUND	7 BAY ST.	2001	45°20`21``	80°02`15``	5	A/N	S	T	T	.	.	.	.
49010	DORSET	HWY 117 / PAINT LAKE RD.	1981	45°13`35``	78°55`08``	3	A/N	S	T	T	.	.	.	.
51001	OTTAWA	RIDEAU/WURTEMBURG ST.	1971	45°26`00``	75°40`30``	4	A/C/N	Y	T	T	T	T	T	.
52020	KINGSTON	133 DALTON ST.	1988	44°15`57``	76°30`06``	5	A/C/N	Y	T	T	.	.	.	.
54012	BELLEVILLE	2 SIDNEY ST./ WATER TREATMENT PLANT	2002	44°09`07``	77°23`41``	10	A/N	Y	T	T	T	.	.	.
56010	MORRISBURG	COUNTY RD. 2/ MORRISBURG WATER TOWER	2005	44°53`23``	75°11`24``	5	A/N	S	T	T	.	.	.	.
56051	CORNWALL	BEDFORD/THIRD ST.	1970	45°01`05``	74°44`09``	4	A/N	Y	T	T	T	.	.	.
59006	PETERBOROUGH	10 HOSPITAL DR.	1998	44°18`05``	78°20`51``	10	A/C/N	Y	T	T	T	.	.	.
63203	THUNDER BAY	421 JAMES ST. N.	2004	48°22`46``	89°17`25``	15	A/C/N	Y	T	T	T	.	.	.
71078	SAULT STE MARIE	SAULT COLLEGE	2004	46°31`59``	84°18`34``	8	A/N	Y	T	T	T	T	T	T
75010	NORTH BAY	CHIPPAWA ST./ DEPT. NATIONAL DEFENCE	1979	46°18`58``	79°27`01``	4	A/N	Y	T	T	T	.	T	.
77219	SUDBURY	RAMSEY LAKE RD.	2004	46°28`32``	80°57`47``	3	A/C/N	Y	T	T	.	.	T	.

Note:
A single CWS metric for Toronto is produced using data from four sites (Toronto Downtown, Toronto North, Toronto East and Toronto West) according to the procedure laid out in 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, R = research
AQI - Air Quality Index site: Y = year-round AQI site (January to December), S = seasonal rural AQI site (May 1 to September 30)
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 2: 2006 Ozone (O_3) Statistics

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

				PERCENTILES							Maximum		No. of Times Above Criterion
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
12008	Windsor Downtown	467 University Ave.	8722	4	14	23	32	47	72	24.6	98	64	29
12016	Windsor West	College/South St.	8698	3	13	22	32	48	72	24.3	98	68	29
12059	Essex	360 Fairview Dr. W.	8559	9	18	25	34	48	67	27.1	90	65	18
13001	Chatham	435 Grand Ave. W.	8732	10	19	27	36	49	72	28.7	89	66	19
14064	Sarnia	Front St./CN Tracks, Centennial Park	8721	7	18	26	35	45	69	26.7	100	60	17
15020	Grand Bend	Water Treatment Plant	8413	11	21	29	37	48	74	29.7	127	73	35
15025	London	900 Highbury Ave.	8712	6	16	24	32	44	66	25.1	82	66	1
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plant	8603	15	23	31	39	52	78	32.4	100	76	57
18007	Tiverton	Concession Rd. 2, Lot A	8570	14	21	27	36	45	64	28.9	91	71	6
21005	Brantford	324 Grand River Ave.	8732	6	18	26	34	48	70	27.0	94	69	10
22071	Simcoe	Hwy 3/Blue Line Rd., Experimental Farm	8726	14	23	30	38	51	72	31.7	97	73	19
26060	Kitchener	West Ave./Homewood	8724	6	18	26	34	46	66	26.6	82	71	6
27067	St. Catharines	Argyle Cres., Pump Stn.	8708	5	17	25	34	48	70	26.2	85	69	8
28028	Guelph	Exhibition St./Clark St.	8742	6	18	26	34	46	67	26.8	86	71	8
29000	Hamilton Downtown	Elgin/Kelly	8675	4	15	22	30	43	66	23.2	82	69	5
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8717	7	19	26	34	48	69	27.5	86	70	6
29118	Hamilton West	Main St. W./Hwy 403	8730	2	12	20	27	39	61	20.9	84	64	1
31103	Toronto Downtown	Bay/Wellesley St.	8727	4	13	21	29	42	68	22.6	92	66	15
31190	Toronto	CN Tower, 301 Front St. W.	8713	19	28	35	43	57	78	36.4	118	81	56
33003	Toronto East	Kennedy/Lawrence	8692	4	13	20	29	41	66	22.0	88	62	14
34020	Toronto North	Hendon/Yonge St.	8737	3	13	22	31	43	66	23.3	96	62	6
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8641	2	11	20	29	43	68	21.4	91	66	13
35033	Etobicoke South	185 Judson St.	8264	2	9	17	26	38	61	19.1	98	49	5
35125	Toronto West	125 Resources Rd.	8656	3	8	16	25	40	66	19.0	94	62	9
44008	Burlington	Hwy 2/North Shore Blvd. E.	8731	4	14	22	31	45	67	23.4	106	64	12
44017	Oakville	8th Line/Glenashton Dr., Halton	8647	6	17	25	33	45	69	26.1	93	71	16
45026	Oshawa	2200 Simcoe St. N., Durham College	8646	7	17	24	32	42	65	25.1	87	57	9
46089	Brampton	525 Main St. N., Peel Manor	8702	4	16	25	33	46	68	25.5	92	68	12
46109	Mississauga	Frank McKechnie Community Center	8705	2	12	21	30	43	70	22.4	90	71	14

Table 2: 2006 Ozone (O_3) Statistics

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

				PERCENTILES							Maximum		No. of Times Above Criterion
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
47045	Barrie	83 Perry St.	8733	4	16	24	31	43	61	24.1	76	66	0
48006	Newmarket	Eagle St./McCaffrey Rd.	8740	8	21	28	36	48	69	28.8	94	71	14
49005	Parry Sound	7 Bay St.	8737	13	23	30	38	49	73	30.7	89	77	24
49010	Dorset	Hwy 117/Paint Lake Rd.	8637	10	21	29	36	47	64	28.9	88	55	4
51001	Ottawa	Rideau/Wurtemburg St.	8625	7	15	22	30	41	60	23.6	85	66	3
52020	Kingston	133 Dalton St.	7065	3	17	25	32	44	69	24.9	89	59	11
54012	Belleville	2 Sidney St., Water Treatment Plant	8725	11	21	28	35	48	76	29.2	103	73	41
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8726	9	21	27	34	46	69	28.0	88	72	23
56051	Cornwall	Bedford/Third St.	8705	9	20	27	34	45	66	27.5	96	71	18
59006	Peterborough	10 Hospital Dr.	8681	8	18	24	32	41	58	24.9	80	62	0
63203	Thunder Bay	421 James St. N.	8742	4	16	24	31	42	54	23.5	74	51	0
71078	Sault Ste Marie	Sault College	8734	13	22	28	35	46	68	29.1	114	80	12
75010	North Bay	Chippawa St., Dept. National Defence	8674	7	19	26	33	45	66	26.7	88	65	6
77219	Sudbury	Ramsey Lake Road	8714	13	21	28	34	44	66	28.4	94	69	9

Notes:

CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 3: 2006 Fine Particulate Matter ($PM_{2.5}$) Statistics

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

				PERCENTILES							Maximum		No. of Times Above Reference Level
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	24h
12008	Windsor Downtown	467 University Ave.	8632	1	4	6	10	18	33	8.2	53	37	2
12016	Windsor West	College/South St.	8693	2	4	7	11	19	35	9.2	52	39	4
12059	Essex	360 Fairview Dr. W.	7734	1	3	6	9	16	29	7.3	44	32	1
13001	Chatham	435 Grand Ave. W.	8261	1	3	5	9	17	32	7.4	59	33	1
14064	Sarnia	Front St./CN Tracks, Centennial Park	8706	4	6	9	13	23	40	11.3	69	39	9
15020	Grand Bend	Water Treatment Plant	8478	0	2	4	8	16	32	6.5	49	32	2
15025	London	900 Highbury Ave.	8629	2	4	7	10	18	35	8.7	58	36	3
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plant	8545	1	3	5	8	17	35	7.3	48	34	6
18007	Tiverton	Concession Rd. 2, Lot A	8530	0	2	3	7	14	28	5.6	54	28	0
21005	Brantford	324 Grand River Ave.	8710	1	3	5	9	17	34	7.6	54	33	5
22071	Simcoe	Hwy 3/Blue Line Rd., Experimental Farm	8707	1	3	5	9	17	35	7.4	47	32	4
26060	Kitchener	West Ave./Homewood	8672	1	3	6	9	18	33	7.7	52	35	2
27067	St. Catharines	Argyle Cres., Pump Stn.	8666	1	3	6	9	18	37	7.9	60	39	6
28028	Guelph	Exhibition St./Clark St.	8715	0	2	5	8	16	33	7.0	52	32	2
29000	Hamilton Downtown	Elgin/Kelly	8622	1	4	6	11	20	39	9.1	82	42	5
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8679	1	3	6	9	19	39	8.1	72	39	6
29118	Hamilton West	Main St. W./Hwy 403	8696	1	3	6	10	19	38	8.2	73	39	5
31103	Toronto Downtown	Bay/Wellesley St.	8716	1	3	5	8	16	35	7.3	52	35	4
33003	Toronto East	Kennedy/Lawrence	8718	1	3	5	9	17	36	7.6	62	37	5
34020	Toronto North	Hendon/Yonge St.	8619	1	3	5	9	17	35	7.6	52	36	2
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8637	1	3	6	10	18	36	8.3	56	34	4
35033	Etobicoke South	185 Judson St.	8232	1	4	6	11	19	40	8.8	56	38	6
35125	Toronto West	125 Resources Rd.	8541	1	3	6	10	18	35	8.2	53	35	3
44008	Burlington	Hwy 2/North Shore Blvd. E.	8729	1	3	5	9	17	35	7.6	59	49	4
44017	Oakville	8th Line/Glenashton Dr., Halton	8601	1	3	5	9	17	34	7.4	58	36	3
45026	Oshawa	2200 Simcoe St. N., Durham College	8632	1	3	5	8	15	36	6.8	57	38	4
46089	Brampton	525 Main St. N., Peel Manor	8689	1	3	5	9	16	33	7.2	51	33	2
46109	Mississauga	Frank McKechnie Community Center	8713	1	3	5	9	17	34	7.6	53	34	3
47045	Barrie	83 Perry St.	8692	0	2	5	8	16	30	6.7	50	31	1
48006	Newmarket	Eagle St./McCaffrey Rd.	8707	0	2	4	8	15	30	6.4	53	31	2

Table 3: 2006 Fine Particulate Matter ($PM_{2.5}$) Statistics

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

				PERCENTILES							Maximum		No. of Times Above Reference Level
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	24h
49005	Parry Sound	7 Bay St.	8701	0	2	3	6	12	25	5.2	38	26	0
49010	Dorset	Hwy 117/Paint Lake Rd.	8602	0	1	3	5	11	23	4.5	38	25	0
51001	Ottawa	Rideau/Wurtemburg St.	8639	1	2	4	7	14	27	6.1	53	34	1
52020	Kingston	133 Dalton St.	7011	1	3	5	8	16	33	7.0	56	33	3
54012	Belleville	2 Sidney St., Water Treatment Plant	8688	1	2	4	7	14	31	6.2	51	34	2
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8609	1	3	4	8	16	33	6.8	56	37	4
56051	Cornwall	Bedford/Third St.	8675	1	3	4	7	15	30	6.5	52	34	2
59006	Peterborough	10 Hospital Dr.	8677	1	2	4	7	15	32	6.3	53	36	1
63203	Thunder Bay	421 James St. N.	8695	0	2	3	6	11	22	4.8	46	22	0
71078	Sault Ste Marie	Sault College	8714	0	2	3	6	12	25	5.2	51	30	1
75010	North Bay	Chippawa St., Dept. National Defence	8669	0	2	3	6	11	25	4.9	43	30	0
77219	Sudbury	Ramsey Lake Road	8680	0	2	3	5	11	23	4.6	36	27	0

Notes:

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

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

Table 4: 2006 Nitric Oxide (NO) Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave.	8730	0	1	3	6	17	73	7.2	272	86
12016	Windsor West	College/South St.	8485	0	1	2	4	15	91	7.2	350	153
12059	Essex	360 Fairview Dr. W.	7322	0	0	1	2	6	21	2.3	82	16
13001	Chatham	435 Grand Ave. W.	8082	0	0	1	2	6	23	2.6	154	32
14064	Sarnia	Front St./CN Tracks, Centennial Park	8724	0	1	1	2	8	40	3.7	204	64
15025	London	900 Highbury Ave.	8530	0	1	2	3	9	50	4.4	255	36
21005	Brantford	324 Grand River Ave.	8733	0	1	1	1	6	29	2.5	100	36
26060	Kitchener	West Ave./Homewood	8709	0	1	1	2	6	50	3.5	189	55
27067	St. Catharines	Argyle Cres., Pump Stn.	8708	1	1	2	3	11	68	5.5	314	88
29000	Hamilton Downtown	Elgin/Kelly	8676	1	1	3	5	19	87	8.0	291	93
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	7281	0	0	1	2	7	51	3.6	338	61
31103	Toronto Downtown	Bay/Wellesley St.	8713	1	2	3	5	16	63	6.9	170	55
31190	Toronto	CN Tower, 301 Front St. W.	8650	0	0	1	1	3	14	1.4	104	18
33003	Toronto East	Kennedy/Lawrence	8729	1	3	6	11	27	113	12.5	400	94
34020	Toronto North	Hendon/Yonge St.	8255	0	1	3	7	27	104	10.0	213	95
35003	Etobicoke West	Elmcrest Rd., Centennial Park	2910	1	2	3	7	33	183	INS	410	141
35033	Etobicoke South	185 Judson St.	8268	1	4	9	20	62	174	23.0	492	148
35125	Toronto West	125 Resources Rd.	8647	1	3	9	19	49	174	20.0	429	154
44008	Burlington	Hwy 2/North Shore Blvd. E.	8698	1	1	3	7	23	108	9.8	306	79
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8558	0	1	1	2	9	54	4.3	213	74
45026	Oshawa	2200 Simcoe St. N., Durham College	7952	0	1	2	4	8	33	3.8	132	27
46089	Brampton	525 Main St. N., Peel Manor	7977	1	1	2	5	21	114	9.1	314	125
47045	Barrie	83 Perry St.	8733	1	1	2	4	16	103	8.0	415	95
48006	Newmarket	Eagle St./McCaffrey Rd.	8743	0	0	0	1	6	47	3.0	168	60
51001	Ottawa	Rideau/Wurtemburg St.	8685	0	0	1	2	7	36	3.0	91	28
54012	Belleville	2 Sidney St., Water Treatment Plant	8724	1	1	1	2	5	37	3.0	121	41
56051	Cornwall	Bedford/Third St.	7422	0	1	1	1	4	57	3.1	196	62
59006	Peterborough	10 Hospital Dr.	7452	0	0	1	2	5	37	2.5	109	31

Table 4: 2006 Nitric Oxide (NO) Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
63203	Thunder Bay	421 James St. N.	6589	0	1	2	4	16	70	6.1	202	44
71078	Sault Ste Marie	Sault College	8734	0	0	1	1	4	17	1.6	57	13
75010	North Bay	Chippawa St., Dept. National Defence	8664	0	1	1	3	9	52	4.4	221	50

Notes:

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

CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 5: 2006 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

				PERCENTILES								Maximum		No. of Times Above Criteria	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean		1h	24h	1h	24h
12008	Windsor Downtown	467 University Ave.	8730	6	11	15	21	31	47	17.2		71	44	0	0
12016	Windsor West	College/South St.	8485	5	10	14	19	29	45	15.7		80	41	0	0
12059	Essex	360 Fairview Dr. W.	7322	3	5	7	10	16	27	8.3		44	21	0	0
13001	Chatham	435 Grand Ave. W.	8082	3	5	8	11	19	33	9.5		62	27	0	0
14064	Sarnia	Front St./CN Tracks, Centennial Park	8724	3	5	9	14	23	36	11.0		50	32	0	0
15025	London	900 Highbury Ave.	8530	4	7	10	15	25	41	12.3		66	32	0	0
21005	Brantford	324 Grand River Ave.	8733	3	5	7	10	18	30	8.8		53	24	0	0
26060	Kitchener	West Ave./Homewood	8709	4	5	8	12	22	41	10.8		62	36	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8708	4	7	9	14	23	38	11.7		50	31	0	0
29000	Hamilton Downtown	Elgin/Kelly	8676	7	11	15	20	31	48	17.0		64	43	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	7281	4	6	9	13	24	43	11.7		72	32	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8713	8	12	17	23	33	51	19.1		75	45	0	0
31190	Toronto	CN Tower, 301 Front St. W.	8650	2	4	6	9	14	26	7.3		65	21	0	0
33003	Toronto East	Kennedy/Lawrence	8729	6	11	15	21	31	50	17.4		68	45	0	0
34020	Toronto North	Hendon/Yonge St.	8255	5	9	15	23	34	49	17.4		70	42	0	0
35003	Etobicoke West	Elmcrest Rd., Centennial Park	2910	6	11	15	20	29	45	INS		74	41	0	0
35033	Etobicoke South	185 Judson St.	8268	8	15	21	30	43	62	24.0		89	53	0	0
35125	Toronto West	125 Resources Rd.	8647	9	15	21	27	37	53	22.3		73	43	0	0
44008	Burlington	Hwy 2/North Shore Blvd. E.	8698	5	9	14	20	30	48	16.2		69	41	0	0
44017	Oakville	8^{th} Line/Glenashton Dr., Halton Reservoir	8558	3	6	10	15	26	43	12.4		62	35	0	0
45026	Oshawa	2200 Simcoe St. N., Durham College	7952	3	5	7	11	18	30	8.9		43	25	0	0
46089	Brampton	525 Main St. N., Peel Manor	7977	4	7	11	19	33	52	15.1		75	42	0	0
47045	Barrie	83 Perry St.	8733	4	6	9	14	27	48	12.6		66	35	0	0
48006	Newmarket	Eagle St./McCaffrey Rd.	8743	2	3	6	10	21	40	9.0		54	40	0	0
51001	Ottawa	Rideau/Wurtemburg St.	8685	2	4	6	10	19	32	8.6		55	26	0	0

Table 5: 2006 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

				PERCENTILES							Maximum		No. of Times Above Criteria	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
54012	Belleville	2 Sidney St., Water Treatment Plant	8724	0	1	3	5	11	25	4.5	44	18	0	0
56051	Cornwall	Bedford/Third St.	7422	2	3	5	7	15	29	6.7	46	23	0	0
59006	Peterborough	10 Hospital Dr.	7452	1	3	4	7	14	28	6.2	41	25	0	0
63203	Thunder Bay	421 James St. N.	6589	2	4	6	9	17	31	8.1	50	22	0	0
71078	Sault Ste Marie	Sault College	8734	1	2	3	6	12	25	5.2	41	16	0	0
75010	North Bay	Chippawa St., Dept. National Defence	8664	1	3	4	8	18	41	7.7	58	31	0	0

Notes:

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

CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 6: 2006 Nitrogen Oxides (NO_x) Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave.	8730	8	12	18	27	46	109	24.4	319	121
12016	Windsor West	College/South St.	8485	6	11	16	24	42	128	22.8	398	191
12059	Essex	360 Fairview Dr. W.	7322	3	6	8	12	20	45	10.6	115	37
13001	Chatham	435 Grand Ave. W.	8082	3	6	9	14	24	54	12.1	200	54
14064	Sarnia	Front St./CN Tracks, Centennial Park	8724	3	6	10	17	30	70	14.7	234	89
15025	London	900 Highbury Ave.	8530	5	8	12	18	33	86	16.7	316	66
21005	Brantford	324 Grand River Ave.	8733	4	6	8	12	23	55	11.3	120	55
26060	Kitchener	West Ave./Homewood	8709	4	6	9	14	28	85	14.3	235	81
27067	St. Catharines	Argyle Cres., Pump Stn.	8708	5	8	11	17	34	99	17.2	354	110
29000	Hamilton Downtown	Elgin/Kelly	8676	8	13	18	25	50	127	24.9	339	126
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	7281	4	7	10	16	31	88	15.3	410	89
31103	Toronto Downtown	Bay/Wellesley St.	8713	10	15	21	28	49	106	26.1	239	91
31190	Toronto	CN Tower, 301 Front St. W.	8650	2	4	6	9	16	36	8.1	162	35
33003	Toronto East	Kennedy/Lawrence	8729	8	15	22	32	57	151	29.9	468	131
34020	Toronto North	Hendon/Yonge St.	8255	5	11	19	31	59	142	27.5	256	134
35003	Etobicoke West	Elmcrest Rd., Centennial Park	2910	8	13	19	28	59	227	INS	478	182
35033	Etobicoke South	185 Judson St.	8268	11	20	32	51	103	222	47.0	558	186
35125	Toronto West	125 Resources Rd.	8647	11	20	31	47	83	213	42.4	493	191
44008	Burlington	Hwy 2/North Shore Blvd. E.	8698	6	11	18	27	53	149	26.0	357	113
44017	Oakville	8^{th} Line/Glenashton Dr., Halton Reservoir	8558	4	7	11	17	34	90	16.7	261	108
45026	Oshawa	2200 Simcoe St. N., Durham College	7952	3	7	10	14	24	60	12.7	154	52
46089	Brampton	525 Main St. N., Peel Manor	7977	5	8	14	24	54	154	24.2	360	161
47045	Barrie	83 Perry St.	8733	5	8	12	18	45	139	20.6	462	125
48006	Newmarket	Eagle St./McCaffrey Rd.	8743	1	3	6	12	28	80	11.8	208	83
51001	Ottawa	Rideau/Wurtemburg St.	8685	2	5	7	12	26	63	11.5	129	52
54012	Belleville	2 Sidney St., Water Treatment Plant	8724	1	2	4	7	15	59	7.5	152	59
56051	Cornwall	Bedford/Third St.	7422	2	4	6	9	18	82	9.8	219	83

Table 6: 2006 Nitrogen Oxides (NO_x) Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
59006	Peterborough	10 Hospital Dr.	7452	2	3	5	9	19	60	8.8	148	52
63203	Thunder Bay	421 James St. N.	6589	3	5	8	14	32	99	14.2	232	64
71078	Sault Ste Marie	Sault College	8734	1	3	4	7	16	39	6.9	90	26
75010	North Bay	Chippawa St., Dept. National Defence	8664	2	4	6	11	27	89	12.1	276	79

Notes:

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

CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 7: 2006 Carbon Monoxide (CO) Statistics

Unit: parts per million (ppm)
CO 1-hour AAQC is 30 ppm
CO 8-hour AAQC is 13 ppm

				PERCENTILES							Maximum		No. of Times Above Criteria	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	8h	1h	8h
12008	Windsor Downtown	467 University Ave.	8557	0.11	0.20	0.26	0.33	0.49	1.04	0.29	2.89	1.92	0	0
13001	Chatham	435 Grand Ave. W.	8423	0.09	0.15	0.18	0.22	0.29	0.44	0.19	0.91	0.61	0	0
15025	London	900 Highbury Ave.	7191	0.05	0.12	0.18	0.23	0.31	0.58	0.19	1.83	1.24	0	0
29000	Hamilton Downtown	Elgin/Kelly	8380	0.13	0.21	0.29	0.38	0.54	0.96	0.32	2.83	1.33	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8530	0.16	0.24	0.30	0.39	0.51	0.79	0.33	1.46	1.02	0	0
35125	Toronto West	125 Resources Rd.	8285	0.17	0.25	0.31	0.39	0.55	1.18	0.35	2.98	2.48	0	0
51001	Ottawa	Rideau/Wurtemburg St.	8697	0.19	0.26	0.31	0.38	0.50	0.80	0.33	1.39	0.96	0	0
71078	Sault Ste Marie	Sault College	8288	0.11	0.18	0.23	0.29	0.40	0.73	0.25	2.48	0.97	0	0

Table 8: 2006 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

				PERCENTILES								Maximum		No. of Times Above Criteria		
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h	1y
12008	Windsor Downtown	467 University Ave.	8699	1	1	3	5	12	37	5.0	73	22	0	0	0
12016	Windsor West	College/South St.	8680	0	1	2	5	12	35	4.9	96	28	0	0	0
12059	Essex	360 Fairview Dr. W.	7802	0	1	2	3	6	17	2.8	62	12	0	0	0
13001	Chatham	435 Grand Ave. W.	8730	0	1	1	3	6	14	2.5	39	9	0	0	0
14064	Sarnia	Front St./CN Tracks, Centennial Park	8721	0	1	2	4	19	105	8.3	243	107	0	2	0
15025	London	900 Highbury Ave.	8710	0	1	1	2	5	10	1.9	34	9	0	0	0
21005	Brantford	324 Grand River Ave.	8725	0	1	1	2	4	11	1.9	32	8	0	0	0
26060	Kitchener	West Ave./Homewood	7827	0	0	1	1	3	10	1.2	23	7	0	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	7497	0	1	1	2	5	12	2.3	36	9	0	0	0
29000	Hamilton Downtown	Elgin/Kelly	8669	0	1	2	4	12	40	4.8	77	27	0	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	7291	0	1	2	3	8	25	3.3	72	19	0	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8091	0	1	1	2	5	11	1.9	38	13	0	0	0
35125	Toronto West	125 Resources Rd.	8654	0	1	1	2	5	10	2.0	27	9	0	0	0
44008	Burlington	Hwy 2/North Shore Blvd. E.	8738	0	1	1	2	4	12	2.0	45	11	0	0	0
44017	Oakville	8^{th} Line/Glenashton Dr., Halton	8656	0	1	1	2	5	13	2.0	31	10	0	0	0
46089	Brampton	525 Main St. N., Peel Manor	8723	0	0	1	2	4	9	1.4	23	8	0	0	0
46109	Mississauga	Frank McKechnie Community Center	1590	1	1	2	3	5	11	INS	20	8	0	0	0
47045	Barrie	83 Perry St.	8681	0	1	1	1	3	6	1.3	19	9	0	0	0
48006	Newmarket	Eagle St./McCaffrey Rd.	7764	0	0	1	1	3	9	1.2	19	8	0	0	0
51001	Ottawa	Rideau/Wurtemburg St.	8595	0	0	0	1	3	11	1.1	39	8	0	0	0
71078	Sault Ste Marie	Sault College	8728	0	0	0	1	3	19	1.4	70	13	0	0	0
75010	North Bay	Chippawa St., Dept. National Defence	3937	0	0	0	1	2	9	INS	26	6	0	0	0
77219	Sudbury	Ramsey Lake Road	8706	0	0	1	1	4	33	2.4	808	77	2	0	0

Notes:

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

Table 9: 2006 Total Reduced Sulphur (TRS) Compounds Statistics

Unit: parts per billion (ppb)
TRS 1-hour AAQC is 27 ppb

				PERCENTILES							Maximum		No. of Times Above Criterion
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
12016	Windsor West	College/South St.	8671	1	1	1	1	2	5	1.3	30	5	2
14064	Sarnia	Front St./CN Tracks, Centennial Park	8474	0	0	0	0	1	1	0.3	7	2	0
29000	Hamilton Downtown	Elgin/Kelly	8662	0	0	0	1	1	4	0.5	12	3	0
71078	Sault Ste Marie	Sault College	8172	0	0	0	0	1	1	0.1	5	1	0

Table 10: 10-Year Trend for O_3

Annual Mean (ppb)

ID	City	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
12008	Windsor Downtown	20.7	21.4	21.7	18.6	20.5	21.9	22.9	20.2	26.0	24.6
12016	Windsor West	17.9	18.7	18.9	17.0	19.0	20.2	22.8	22.6	25.6	24.3
14064	Sarnia	24.5	26.1	26.5	24.3	25.6	26.5	24.7	23.8	27.4	26.7
15020	Grand Bend	31.2	31.2	32.5	32.6	31.6	29.8	30.7	25.8	32.5	29.7
15025	London	22.8	25.1	25.8	21.1	24.2	25.3	26.9	23.6	26.1	25.1
18007	Tiverton	32.5	32.2	INS	32.3	34.7	34.7	33.2	28.1	31.8	28.9
22071	Simcoe	28.6	31.1	31.3	n/a	31.0	33.5	33.9	30.5	33.6	31.7
26060	Kitchener	23.4	25.4	25.2	23.0	25.7	27.3	28.1	24.8	28.0	26.6
27067	St. Catharines	20.9	20.8	21.7	18.9	21.2	24.1	25.3	23.6	26.3	26.2
29000	Hamilton Downtown	18.1	19.1	19.5	17.0	18.8	20.4	21.7	20.1	23.2	23.2
29114	Hamilton Mountain	22.2	24.1	24.1	22.6	24.2	27.7	28.4	24.6	28.2	27.5
29118	Hamilton West	18.6	19.3	20.0	16.9	18.6	20.5	22.0	19.2	21.2	20.9
31103	Toronto Downtown	INS	17.8	20.2	19.7	22.0	24.0	23.6	22.8	24.5	22.6
31190	Toronto	37.3	INS	40.3	34.2	37.2	37.4	36.9	36.0	39.1	36.4
33003	Toronto East	18.0	20.6	21.5	19.6	21.7	21.0	21.8	19.9	22.4	22.0
34020	Toronto North	21.6	22.0	22.8	20.6	23.4	25.1	23.6	22.5	24.5	23.3
35033	Etobicoke South	17.2	18.4	21.5	17.4	19.9	20.2	19.2	18.9	21.1	19.1
44008	Burlington	21.7	22.5	26.2	23.4	24.6	26.3	22.8	21.0	23.9	23.4
44017	Oakville	20.8	21.8	22.4	21.0	22.9	25.1	INS	24.6	27.7	26.1
45026	Oshawa	23.2	23.1	25.0	21.2	23.4	23.2	24.1	23.3	28.6	25.1
46109	Mississauga	20.0	20.8	22.2	19.9	22.4	23.1	24.8	20.7	23.1	22.4
49010	Dorset	30.9	30.6	31.0	29.3	31.0	32.4	30.1	28.8	32.3	28.9
51001	Ottawa	20.5	19.1	21.2	19.9	25.0	24.9	24.7	21.7	23.3	23.6
52020	Kingston	20.1	21.5	21.5	19.1	20.7	23.0	24.0	22.5	24.8	24.9
56051	Cornwall	22.8	24.2	25.8	24.0	29.0	24.8	25.9	23.8	27.7	27.5
59006	Peterborough	INS	INS	31.4	28.1	30.7	30.5	29.7	27.1	31.2	24.9
63203	Thunder Bay	23.9	21.5	22.5	22.6	24.4	23.4	26.1	22.0	22.3	23.5
71078	Sault Ste. Marie	24.9	22.3	24.1	24.8	25.2	24.2	26.8	27.0	30.2	29.1
75010	North Bay	26.6	27.4	29.1	22.1	26.6	26.8	27.0	25.2	28.0	26.7
77219	Sudbury	28.0	29.1	30.7	26.1	29.1	29.2	28.5	27.7	31.0	28.4

Notes:

n/a indicates pollutant not monitored.

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

CN Tower Site (Station 31190) measurements taken at 444 m above ground-level.

Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.

Station 35033 was relocated in 2001.

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 11: 10-Year Trend for NO

Annual mean (ppb)

ID	City	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
12008	Windsor Downtown	15.9	16.3	13.3	13.9	11.0	10.9	INS	10.5	7.8	7.2
14064	Sarnia	7.0	6.9	7.1	8.9	6.7	7.1	5.0	3.7	3.8	3.7
26060	Kitchener	5.5	6.9	6.6	7.4	5.7	3.8	INS	4.9	4.4	3.5
29000	Hamilton Downtown	10.8	12.6	12.0	14.7	11.5	10.4	11.7	9.6	9.9	8.0
31103	Toronto Downtown	INS	24.3	15.8	14.4	10.0	8.2	8.7	7.6	7.2	6.9
33003	Toronto East	24.9	23.2	20.7	23.0	17.9	16.1	17.0	16.0	14.4	12.5
34020	Toronto North	16.3	16.5	16.5	16.8	14.3	12.4	12.4	INS	10.8	10.0
35033	Etobicoke South	33.8	29.8	27.1	34.6	25.0	23.3	26.7	24.5	23.3	23.0
44008	Burlington	12.2	14.1	22.6	21.8	13.2	11.8	15.5	11.1	12.3	9.8
45026	Oshawa	16.4	15.6	15.1	14.2	13.7	10.0	9.3	8.2	INS	3.8

Notes:

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

Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.

Station 35033 was relocated in 2001.

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

Table 12: 10-Year Trend for NO_2

Annual Mean (ppb)

ID	City	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
12008	Windsor Downtown	23.8	23.8	22.9	21.6	19.4	19.1	INS	18.3	16.9	17.2
14064	Sarnia	16.9	18.0	16.7	16.3	16.8	17.5	13.0	11.7	12.7	11.0
26060	Kitchener	13.7	16.5	14.0	14.7	14.1	11.9	INS	13.1	12.9	10.8
29000	Hamilton Downtown	18.6	22.4	21.6	21.8	22.5	20.9	21.3	16.8	19.3	17.0
31103	Toronto Downtown	INS	27.7	26.9	26.8	27.1	23.3	23.1	20.1	20.6	19.1
33003	Toronto East	23.4	25.5	24.6	23.7	22.9	22.0	21.3	19.8	20.1	17.4
34020	Toronto North	20.2	23.4	24.3	22.7	22.0	21.0	20.3	17.3	19.2	17.4
35033	Etobicoke South	29.2	29.7	28.4	28.2	26.1	26.1	26.6	26.1	27.6	24.0
44008	Burlington	13.2	16.6	22.9	20.3	16.5	17.9	17.3	15.3	17.2	16.2
45026	Oshawa	18.6	20.0	21.5	19.7	19.0	17.2	16.2	14.2	INS	8.9

Notes:

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

Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.

Station 35033 was relocated in 2001.

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

Table 13: 10-Year Trend for NO_x

Annual Mean (ppb)

ID	City	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
12008	Windsor Downtown	39.3	38.5	37.0	36.0	30.5	29.2	INS	29.3	24.9	24.4
14064	Sarnia	24.9	25.1	23.5	25.0	23.6	24.6	18.1	15.7	16.8	14.7
26060	Kitchener	19.2	23.9	20.5	21.9	19.5	15.5	INS	18.2	17.4	14.3
29000	Hamilton Downtown	29.5	34.7	34.0	37.0	34.4	31.4	33.3	27.7	30.0	24.9
31103	Toronto Downtown	INS	51.6	41.9	40.4	36.6	31.5	32.1	28.1	28.2	26.1
33003	Toronto East	47.5	48.3	44.9	46.3	40.3	37.7	37.9	36.3	34.7	29.9
34020	Toronto North	36.7	39.9	40.7	39.3	36.2	33.4	33.0	28.3	30.4	27.5
35033	Etobicoke South	62.1	59.9	56.6	63.1	51.0	49.3	53.1	49.4	49.9	47.0
44008	Burlington	25.6	30.7	45.4	42.2	29.0	28.4	32.5	26.1	29.3	26.0
45026	Oshawa	34.9	35.1	35.8	33.6	32.6	27.2	25.5	22.5	INS	12.7

Notes:

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

Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.

Station 35033 was relocated in 2001.

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

Table 14: 10-Year Trend for CO

Annual Mean (ppm)

ID	City	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
12008	Windsor Downtown	0.6	0.7	0.6	0.3	0.3	0.5	INS	0.5	0.2	0.3
29000	Hamilton Downtown	0.7	1.1	0.8	0.8	0.7	INS	INS	0.4	0.3	0.3
44008	Burlington	0.4	0.3	0.7	1.4	0.5	0.8	0.4	0.4	n/a	n/a
51001	Ottawa	0.4	1.1	0.8	0.7	0.6	0.7	0.6	0.5	0.4	0.3

Notes:

n/a indicates pollutant not monitored.

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

Station 35033 was relocated in 2001.

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

Station 63203 replaced station 63200 as the Thunder Bay site in 2004.

Table 15: 10-Year Trend for SO_2

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

ID	City	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
12008	Windsor Downtown	6.7	7.4	6.7	6.2	6.1	5.7	5.9	4.8	4.9	5.0
12016	Windsor West	12.5	12.0	9.6	8.8	9.3	7.9	6.3	4.6	5.1	4.9
14064	Sarnia	8.7	10.3	11.8	10.4	12.5	10.4	7.1	8.2	7.8	8.3
15025	London	2.5	3.2	4.9	3.5	3.5	2.2	INS	2.2	2.3	1.9
29000	Hamilton Downtown	5.8	6.3	6.6	5.1	6.0	4.9	5.0	4.0	5.3	4.8
44008	Burlington	5.1	3.2	4.9	5.2	4.9	5.9	2.5	2.4	2.3	2.0
44017	Oakville	4.8	5.1	4.0	4.8	3.7	4.3	INS	2.8	2.5	2.0
51001	Ottawa	6.3	3.4	4.2	4.1	2.3	2.9	INS	1.0	1.5	1.1
71078	Sault Ste. Marie	2.1	1.9	1.9	2.0	2.0	1.7	2.0	0.9	1.5	1.4
77219	Sudbury	3.5	5.2	3.0	4.2	2.6	3.1	2.0	INS	2.8	2.4

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 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.

Map 1: Locations of Ambient Air Monitoring Stations in Ontario (2006)