Clearing the Air

Report #2
Air Quality Trends In Sudbury 1998 to 2007

June 2009

Clean Air pur Sudbury

ABOUT CLEARING THE AIR

Clearing the Air was prepared by **Clean Air Sudbury**, a non-profit, community group focused on community air quality issues in Greater Sudbury.

Clearing the Air conveys the highlights of **Air Quality Trends, City of Greater Sudbury, 1998 -2007**, a technical report prepared for **Clean Air Sudbury** by Potvin Air Management Consulting in April 2009. The full technical report (English only) can be obtained by contacting Clean Air Sudbury.

Clearing the Air was developed by **Clean Air Sudbury** as a tool to improve community awareness of air quality issues and engage the public in activities to further improve the quality of Sudbury's air.

For more information about **Clearing the Air** or **Clean Air Sudbury**, please contact:

Clean Air Sudbury, Coordinator
MIRARCO, Laurentian University
Willet Green Miller Centre
935 Ramsey Lake Road
Sudbury, ON P3E 2C6
Phone: 705-675-1151 ext. 5079

Introduction

Clean Air Sudbury is committed to providing the residents of Greater Sudbury with information about local air quality.

Our first "Clearing the Air" report, released in 2005, summarized trends in outdoor air quality in Greater Sudbury from 1953 to 2002.

In this report, we highlight the key trends in air pollutant concentrations over the ten year period from 1998 to 2007. We also compare air pollutant concentrations in Greater Sudbury to Ontario's ambient air quality criteria and Federal standards. Finally, we compare Sudbury's air quality to other Ontario cities.

Clean air is vital to our existence and strongly linked to our quality of life. As this report reveals, we have much to celebrate in Sudbury as we are continually improving the quality of our air and identifying areas where we can do better.

What Air Pollutants are Monitored in Sudbury?

Sulphur dioxide

Sulphur dioxide (SO_2) is a colourless gas. Exposure to high levels of sulphur dioxide can cause breathing problems, respiratory illness, changes in the lung's defences and worsening respiratory and cardiovascular disease. People with asthma, chronic lung disease and heart disease are believed to be most sensitive. Under certain weather conditions, sulphur dioxide can damage trees and crops. In the atmosphere, it changes to sulphuric acid, a major component of acid rain, which can damage sensitive lakes and streams. It can be created naturally from volcanoes, forest fires and oceans, but the majority of sulphur dioxide in our air comes from human-made sources.

In Greater Sudbury, approximately 99% of sulphur dioxide emissions come from local smelters. The remaining 1% comes from transportation and fuel combustion.

Ground-level Ozone

Ozone (O_3) is a colourless gas that occurs naturally in the upper atmosphere, where it shields the earth from the sun's harmful ultra-violet (UV) radiation. Ground-level ozone is found at the earth's surface and is one of the prime components of smog. It is not directly released into the air, like other pollutants. Rather, it is formed in the air through a complex chemical reaction with other pollutants in the presence of sunlight. Because of this, its concentration in the air is highly dependent on other pollutant sources and weather conditions. In Ontario, elevated concentrations of ground-level ozone are typically found on hot, sunny days from May to September, between noon and early evening.

Ozone can irritate the eyes and respiratory tract, and can cause chest tightness, coughing and wheezing in sensitive individuals. Children playing outdoors and individuals with pre-existing respiratory disorders, such as asthma and chronic

obstructive lung disease are at greatest risk. Ground-level ozone can also cause damage to trees and crops.

The amount of locally-produced ozone in Greater Sudbury is unknown. However, more than half of the ground-level ozone present during widespread smog episodes comes from long-range transport from sources in the United States.

Particulate Matter

Particulate matter (PM) is a mixture of liquid and solid particles suspended in air. Examples of particulate matter include smoke, fumes, dust, aerosols, fly ash and pollen. Particulate matter can range in size from less than 0.1 micron to over 100 microns. A micron is a unit of length equal to one millionth of a metre. A human hair is about 50 microns thick. Particulate matter is often classified into three size fractions:

- **Total Suspended Particulate** (TSP; particles ranging in size from <1 micron to 44 microns): This fraction is mostly associated with soiling and visibility effects.
- **PM_{10}** (particles equal to or less than 10 microns in diameter): These particles can be inhaled, but most will be trapped in the nose and exhaled, or trapped in mucous and swallowed. As a result, this fraction is often referred to as the "inhalable fraction".
- **$PM_{2.5}$** (particles equal to or less than 2.5 microns in diameter): These particles can penetrate deep into the lungs. $PM_{2.5}$ is also a major component of smog. This fraction is often referred to as the "respirable fraction".

The health effects of particulate matter are mostly associated with the smaller sized particles (represented by PM_{10} and $PM_{2.5}$ fractions). Most at risk are those with asthma, cardiovascular or lung disease, children, and the elderly.

Residential, transportation and industrial sources contribute almost equally to urban concentrations province-wide. Residential sources include transportation, road dust and wood burning. Natural sources include wind-blown dust, forest fires and pollen. Similar to ozone, more than half of the $PM_{2.5}$ present during widespread smog episodes comes from long-range transport from sources in the United States.

Metals

Metals are elements that exist naturally in rocks, soil, air, water, plants and animals. The metal-containing rocks in Greater Sudbury are the source of our rich mining deposits. During the mining and smelting process, small particles containing metals are released through stacks and as wind-blown dust from fugitive sources. The metals can be measured by chemically analyzing particulate matter samples collected from air monitoring stations. Thus, the concentrations of metals are expressed relative to the size fraction of particulate matter measured (typically TSP or PM_{10}). The metals typically measured in Greater Sudbury include arsenic, cadmium, cobalt, chromium, copper, iron, lead, nickel, selenium, vanadium and zinc.

Air Quality Index

The Air Quality Index is a rating of overall air quality developed by the Ministry of Environment that is based on hourly measurements of up to six air pollutants. The Air Quality Index translates the concentrations of these pollutants into air quality ratings of very poor, poor, moderate, good, or very good. In Greater Sudbury, concentrations of three air pollutants are used to generate the Air Quality Index: sulphur dioxide, ozone and $PM_{2.5}$. The ratings are posted every day on the Ministry of Environment website (www.airqualityontario.com).

How is Air Quality Monitored?

Air Quality Monitoring Stations

A network of air monitoring stations record air quality information throughout Greater Sudbury as shown in Figure 1. Air quality monitoring stations record the amount of a pollutant in a volume of air. Typically, sulphur dioxide and ozone are measured in units of parts per billion (ppb), while particulate matter and metals are measured in micrograms per cubic metre ($\mu g/m^3$).

What is a Part per Billion?

One part air pollutant in one billion parts of air.

To visualize this, here are some comparisons:

- 1 grain of salt in 1 billion grains of sugar
- 1 drop of water in an Olympic-sized swimming pool

What is a Microgram per Cubic Metre?

One millionth of a gram of air pollutant in a metre-sized cube of air.

To visualize this, here is a comparison:

- 1 grain of sand in the cardboard box from a washing machine

Air Quality Monitoring

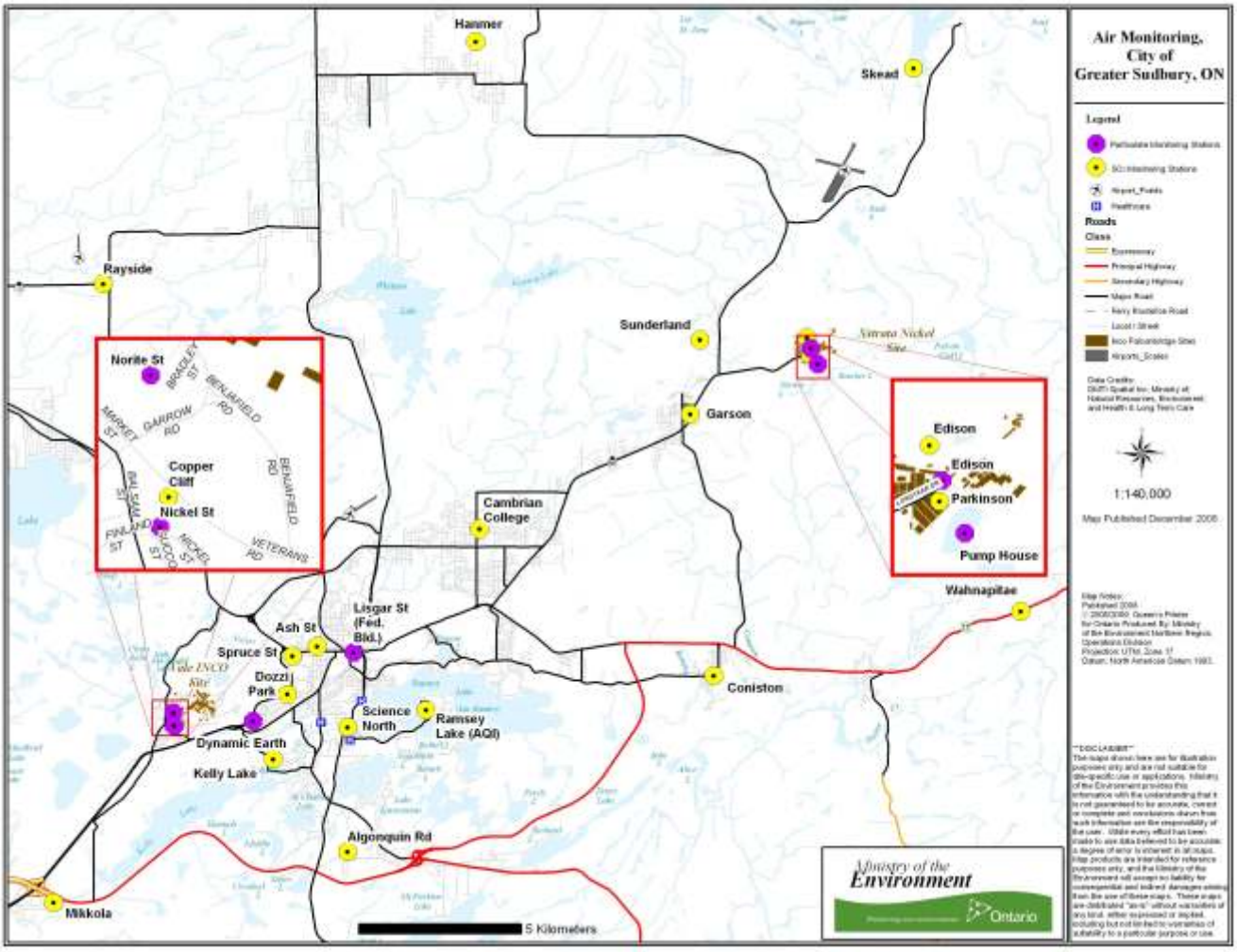


Figure 1: Air Quality Monitoring Stations in Greater Sudbury

The Ministry of the Environment operates the Air Quality Index station on Ramsey Lake Road and the particulate matter station on Lisgar Street. The remainder of the stations are currently operated by industry. The Ministry of the Environment regularly audits the monitoring network to ensure that the equipment is functioning properly and collecting accurate information.

What Is Acceptable?

In order to determine whether the concentrations of a pollutant in the air are safe for human health and the environment, they are compared to air quality criteria or standards. In this report, Greater Sudbury's air quality was compared to the following provincial criteria and national standards:

- **Ambient Air Quality Criteria:** These are criteria developed by the Ontario Ministry of the Environment. They are concentrations in the air that are considered to be low enough to protect human health and the environment. They may also protect against nuisance effects, such as soiling, visibility, corrosion or odour. The provincial criteria apply to specific time periods (typically 1 hour, 8 hour, 24 hour and/or 1 year). This means that the air quality measurements collected at the monitoring stations must be averaged over 1 hour, 8 hours, 24 hours or a year and then compared to the appropriate criteria. These provincial criteria were used to assess community air quality for sulphur dioxide, ground-level ozone, particulate matter and metals in this report.
- **Canada Wide Standards:** These standards developed by the Canadian Council of Ministers of the Environment apply to ground-level ozone and the smallest size fraction of particulate matter, $PM_{2.5}$. Although these standards do not officially come into effect until 2010, they have been used as additional benchmarks for evaluation of these pollutants in this report.

What Has Changed Since 2002?

The first Clearing the Air report released in 2005 summarized air quality information collected between 1953 and 2002. Air quality monitoring in Greater Sudbury has changed in the following ways since 2002:

- The Ministry of Environment no longer monitors carbon monoxide, nitrogen oxides and total reduced sulphur compounds at their station on Ramsey Lake Road because concentrations of these parameters were always low and far below the criteria.
- In 2002, monitoring in real-time of the smaller size fraction of particulate matter ($PM_{2.5}$) commenced in Greater Sudbury.
- Canada Wide Standards have been developed for ground-level ozone and particulate matter, although they don't officially come into effect until 2010.
- In 2005, the Ontario Ministry of the Environment released new, stronger regulations for industries that emit air pollutants (Ontario Regulations 419/05 and 194/05). The new regulations establish stronger air quality standards that come into effect for the mining industry on February 1, 2010.

Air Quality in Greater Sudbury: 1998 to 2007

Sulphur Dioxide

Between 1960 and 2007, sulphur dioxide (SO_2) emissions from local smelters have been reduced by 93%, as shown in Figure 2. Since 2002, further reductions in SO_2 emissions have been undertaken to meet the new Ministry of the Environment emission limits. A new Vale Inco abatement program involving capture of fluid bed roaster gases is helping industry meet the 2007 limit. In 2015, the Ministry of the Environment emission limit will be further reduced, requiring industry to implement additional emission reduction programs.

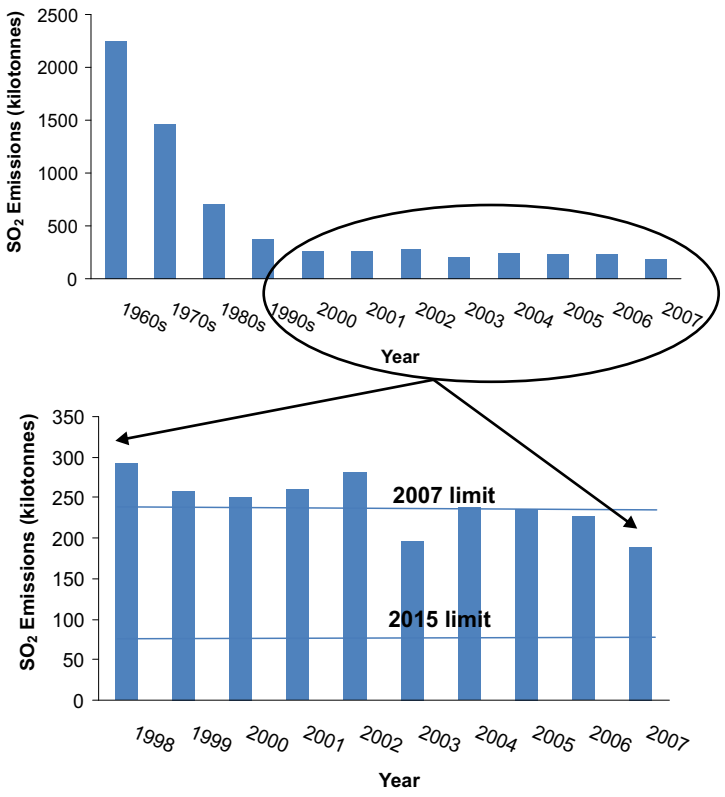


Figure 2
Sulphur Dioxide Emissions
from Sudbury Area Smelters

Sulphur dioxide was monitored at 16 stations throughout Greater Sudbury from 1998 to 2007. Annual average sulphur dioxide concentrations continued to decrease across the monitoring network from 1998 to 2007 as shown in Figure 3. On an annual basis, sulphur dioxide concentrations from 1998 to 2007 remained less than the annual criterion, which hasn't been exceeded since 1976. Between 1998 and 2007, the 24-hour criterion was exceeded once at Copper Cliff, Kelly Lake and Science North stations.

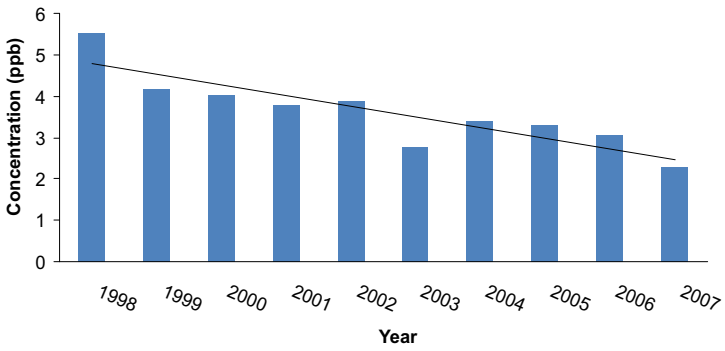


Figure 3
Annual Average Sulphur Dioxide Concentrations (1998 to 2007)

Figure 4 shows the number of hours in which the 1-hour criterion was exceeded across the monitoring network from 1998 to 2007. The 1-hour criterion was exceeded for a total of 353 hours between 1998 and 2007 (approximately 0.03% of the hours monitored). The Copper Cliff station recorded the highest frequency of exceedances with a total of 54 hours (0.06% of the hours monitored).

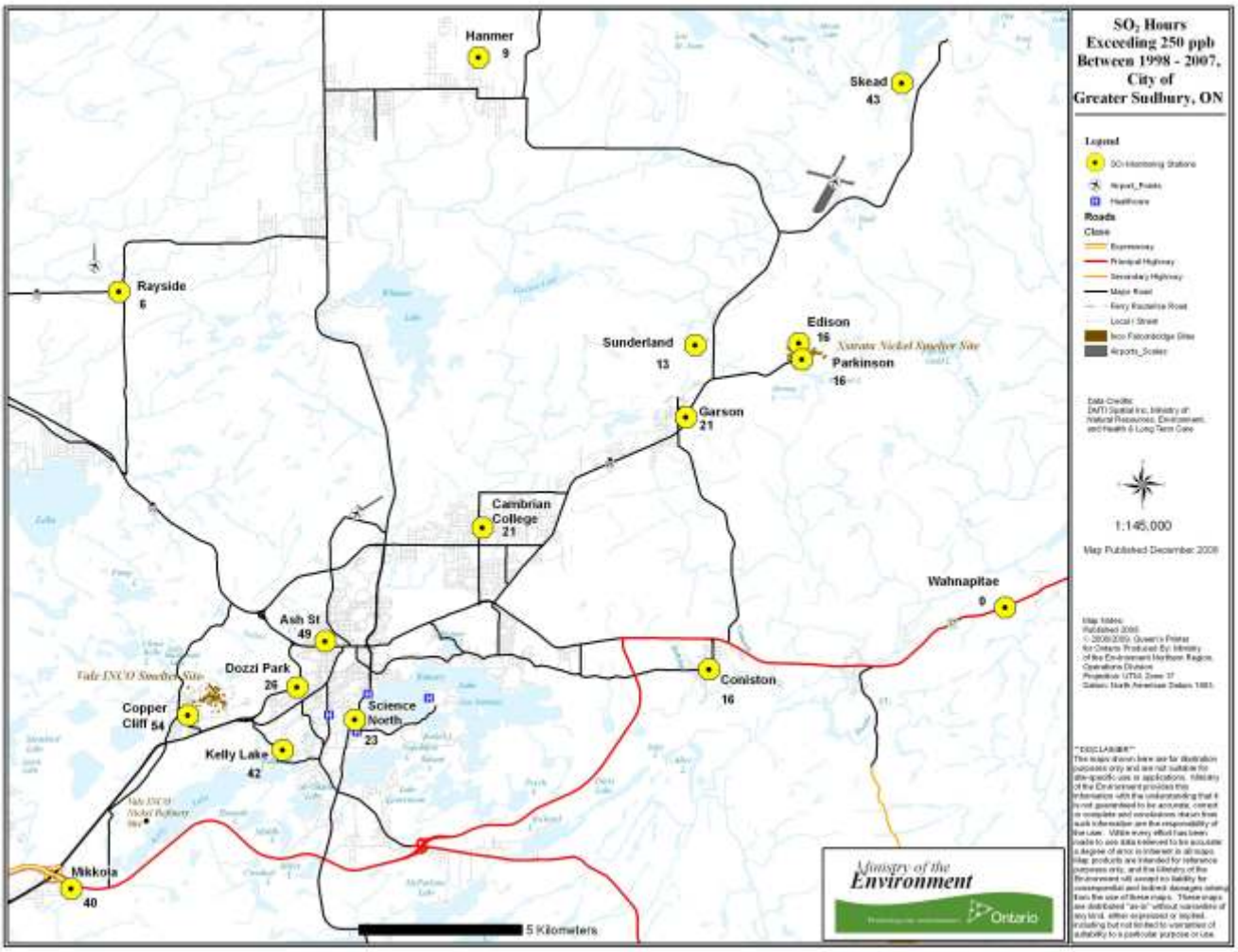


Figure 4
Number of Hours Exceeding the 1-Hour SO_2 Criterion (1998-2007)

Ground-level Ozone

Ground-level ozone was monitored at the Ministry of the Environment station on Ramsey Lake Road. Annual average concentrations of ground-level ozone in Sudbury were variable from 1998 to 2007, with no noticeable trend, similar to previous years. Ground-level ozone concentrations met the provincial 1-hour criterion most of the time. But, there were a number of hours each year where concentrations exceeded the criterion, as shown in Figure 5. Many of these ozone episodes resulted from long-range transport of ozone from the United States into northern Ontario under specific meteorological conditions during the summer months. From 2005 to 2007, average ozone concentrations in Greater Sudbury, along with 19 of the other 20 Ontario cities evaluated, exceeded the Canada Wide Standard. Sudbury was in the middle of the range of the 20 cities.

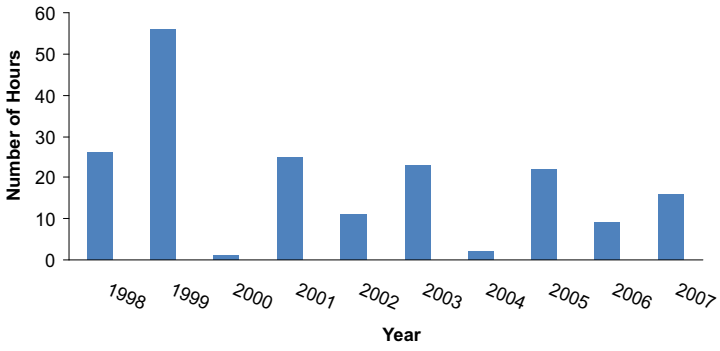


Figure 5
Number of Hours Exceeding the 1-hour Ozone Criterion (1998 to 2007)

Particulate Matter

Coarse Fractions (TSP and PM_{10})

Between 1997 and 2007, the coarse fractions of particulate matter were monitored at six stations: Lisgar Street (PM_{10}), Nickel Street (PM_{10}), Norite Street (PM_{10} and TSP), Dynamic Earth (PM_{10} and TSP), Edison Street (TSP) and the Pumphouse southwest of the Falconbridge townsite (TSP). This time period has been a time of transition for particulate matter monitoring because some stations have been relocated and other stations have been added to the monitoring network. As a result, some of the stations have only a few years of monitoring information. Only the Lisgar Street station has been consistently monitoring particulate matter from 1997 to 2007.

Annual average concentrations of TSP and PM_{10} at Nickel Street and Lisgar Street were variable during this time period with no noticeable trend, as shown in Figure 6. Annual average TSP concentrations were always less than the annual criterion at the four stations where TSP was measured. An annual criterion for PM_{10} has not yet been developed. While the 24-hour criteria for TSP and PM_{10} were met most of the time, there were a few exceedances at all of the stations.

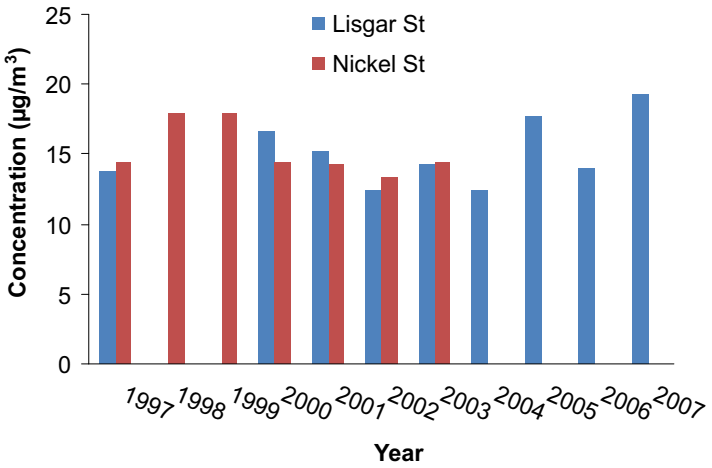


Figure 6
Annual Average PM_{10} Concentrations (1997-2007)

Fine Fraction ($PM_{2.5}$)

$PM_{2.5}$ has been measured in Sudbury at the Ministry of Environment station on Ramsey Lake Road since the summer of 2004. The annual average concentration was relatively constant and showed no noticeable trend. High short-term concentrations have typically occurred during smog episodes where hot, hazy and humid conditions combine with air pollution carried into Ontario by strong south-westerly winds from the United States.

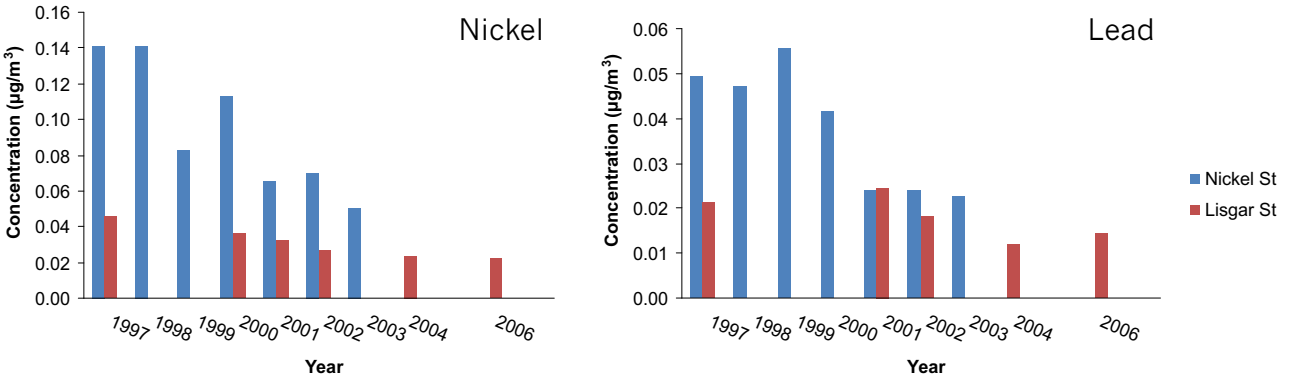
There are currently no provincial criteria for $PM_{2.5}$. From 2005 to 2007, average $PM_{2.5}$ concentrations in Greater Sudbury met the Canada Wide Standard and were the second lowest of the 20 Ontario cities evaluated.

Metals

Annual concentrations of nickel and lead in PM_{10} have been decreasing since the late 1990s at Nickel Street in Copper Cliff and Lisgar Street in Sudbury, as shown in Figure 7. The trend is similar for copper. While the 24-hour criteria for metals in TSP were met most of the time, there were a few exceedances for nickel at the Dynamic Earth, Norite Street and Pumphouse stations and a few exceedances of cobalt at the Edison Street and Pumphouse stations. Concentrations of many metals, such as arsenic, cadmium, selenium and vanadium were not detected in the majority of the samples.

Criteria have not yet been developed for metals in the PM_{10} size fraction. However, metal concentrations are typically lower in the PM_{10} size fraction than the TSP size fraction. This is to be expected since the PM_{10} size fraction represents a subset (<10 microns) of the much larger TSP size fraction (<44 microns).

Figure 7
Annual Average Nickel and Lead Concentrations in PM_{10} (1997-2007)



Air Quality Index

According to air quality information collected at the Air Quality Index monitoring station on Ramsey Lake Road, Greater Sudbury's air was rated as very good to good 94.1% of the time from 1998 to 2007. It was rated as moderate 5.6% of the time and as poor 0.2% of the time. It was never rated as very poor. Ground level ozone (O_3) and fine particulate matter ($PM_{2.5}$) are the primary pollutants responsible for moderate and poor ratings. Occasionally, SO_2 contributes to moderate or poor ratings (less than 5% of the time).

Figure 8 shows that the number of hours of poor air quality in Greater Sudbury varied considerably from 1998 to 2007. This is because of the influence and great variability of regional weather patterns. The high years correspond to years with many hot, sunny days in the summer which are ideal conditions for the creation of smog. The low years (2000 and 2004) correspond to years with fewer sunny and hot days in the summer.

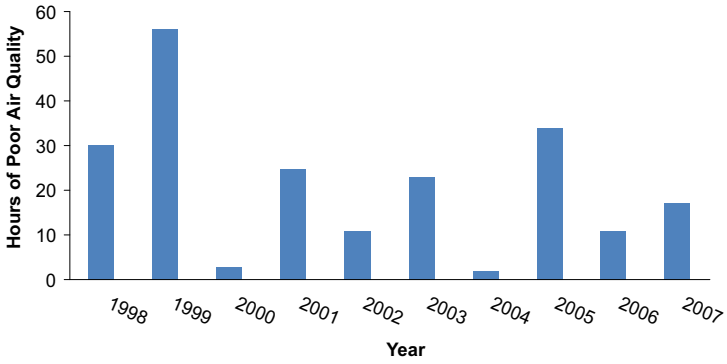


Figure 8
Number of Hours of Poor Air Quality in Greater Sudbury (1998 to 2007)

How Does Sudbury Compare to other Cities?

For the period 1998 to 2007, Sudbury's air quality was compared with a number of other Ontario cities. These include: Hamilton, North Bay, Ottawa, Sault Ste. Marie, Thunder Bay, Toronto and Windsor. Sudbury ranks in the middle of the range for sulphur dioxide, ozone and the Air Quality Index and has the second lowest concentrations of fine particulate matter, as shown in Figure 9. In general, Sudbury's air quality is better than Hamilton, Toronto and Windsor and comparable to cities in northern Ontario.

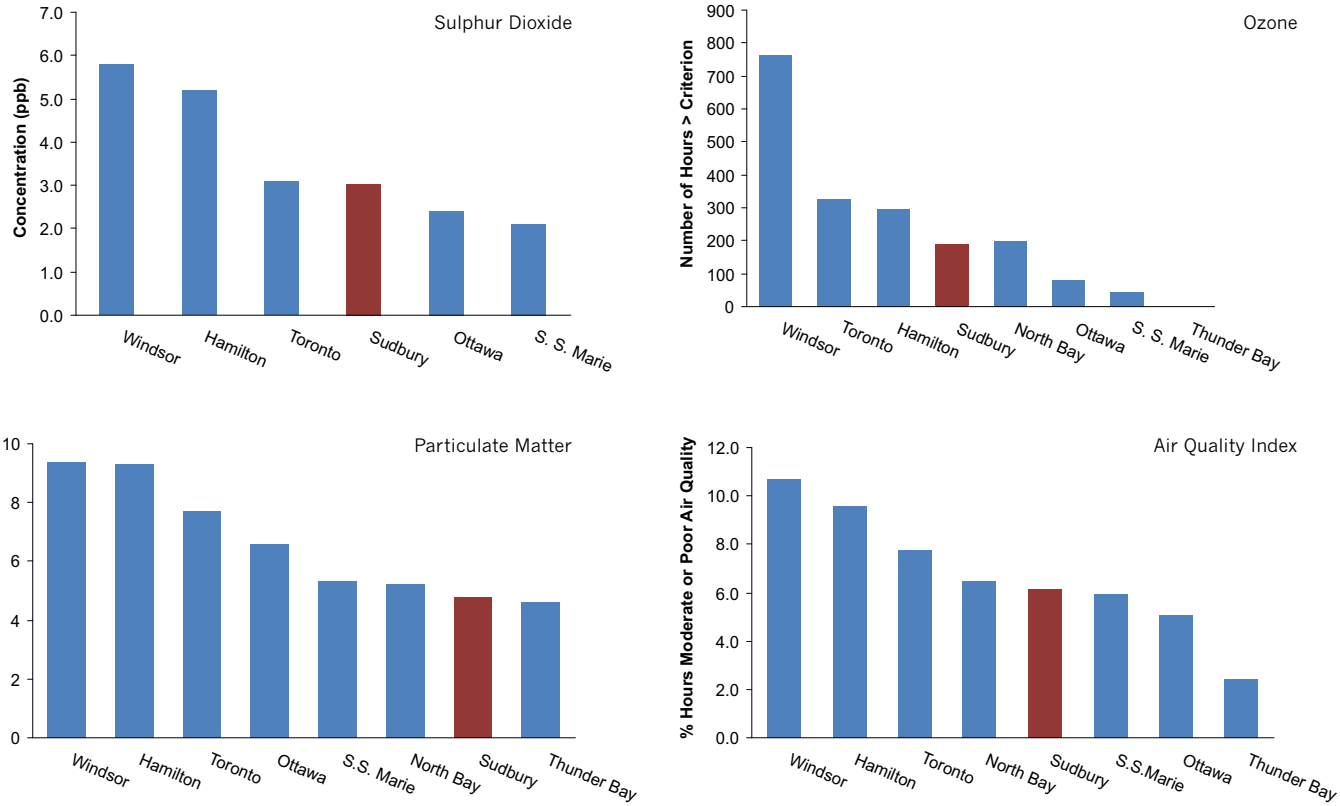
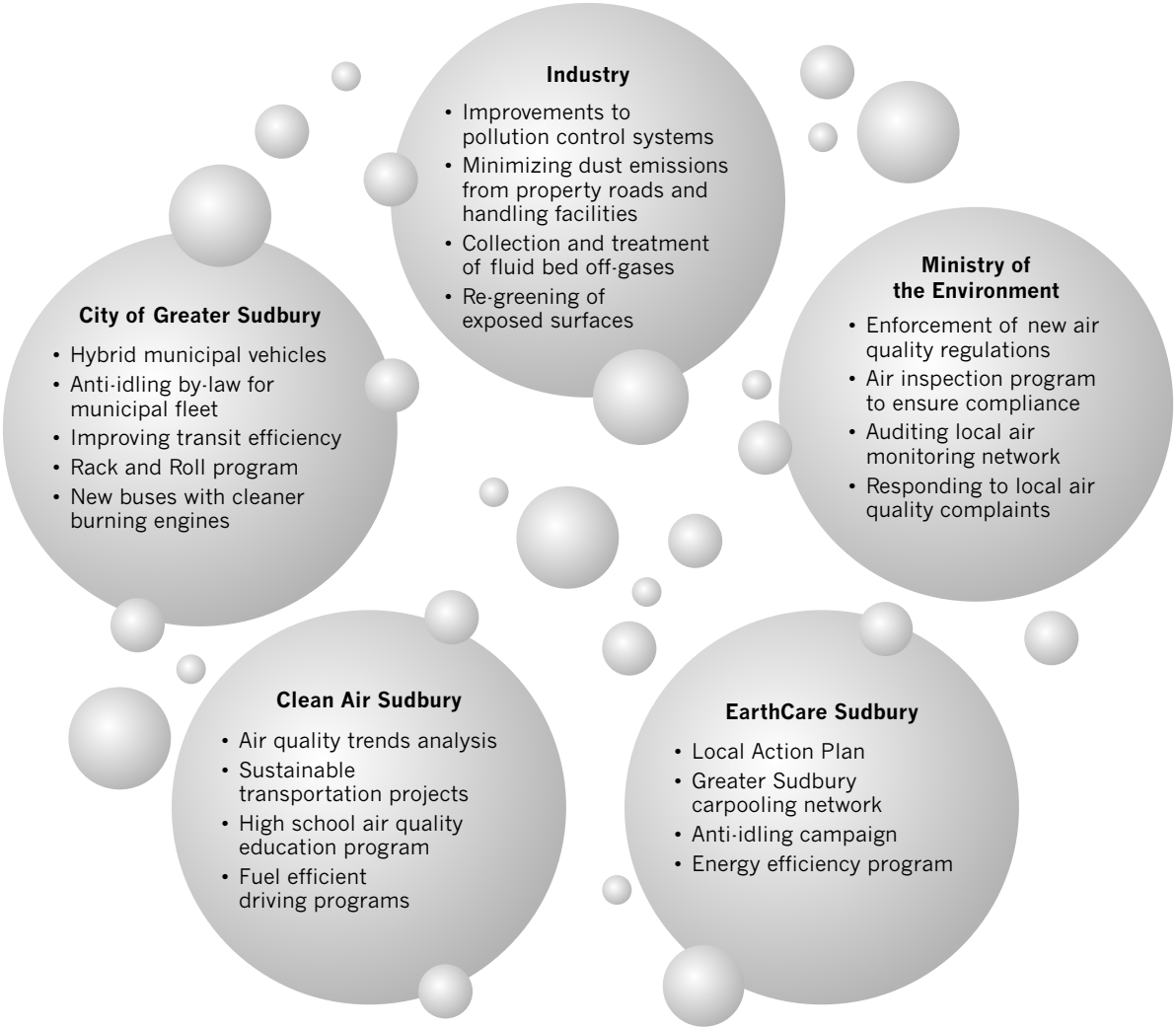


Figure 9
Comparison of Sudbury's Air Quality to Other Ontario Cities

How is Sudbury Improving Air Quality?

Many things are being done by industry, the Ministry of the Environment, the City of Greater Sudbury, EarthCare Sudbury and Clean Air Sudbury to improve local air quality. Industry programs are focused on reducing mining and smelting emissions, while community programs generally target transportation and residential emissions. The Ministry of the Environment has introduced stricter limits on emissions and tougher regulations for air emitters, which have helped to improve air quality in Greater Sudbury.



Individual Actions

We all have a role to play in improving the air quality within our community. It may not seem like our individual actions will make a difference. But if enough of us make the effort, air quality will improve. Here are some things we can do to reduce our personal contributions to air pollution:

- Reduce personal vehicle use by walking, cycling, carpooling or taking public transit whenever possible
- Properly maintain personal vehicles, keep tire pressure at the correct level and drive at moderate speeds
- Do not idle and avoid drive-thru restaurants
- Choose fuel efficient vehicles
- Use electric rather than gas-powered lawn mowers
- Avoid open burning of yard wastes
- Do not use pesticides
- Reduce energy consumption by turning off lights and using less heat and air conditioning
- Choose air-friendly household cleaners and other products
- Participate in community events such as Clean Air Day, Earth Day and Car Free Day

Further Information

Consult these websites for further information about air quality:

- **Clean Air Sudbury:** www.cleanairsudbury.ca
- **Sudbury & District Health Unit:** www.sdhu.com/content/health_hazards (click on environment and air quality)
- **Vale Inco:** www.inco-sudbury-airquality.com
- **Xstrata Nickel:** www.sudburysmelterfalconbridge.com
- **Ontario air quality index, smog alerts and forecasts:** www.airqualityontario.com
- **Ontario Ministry of the Environment:** www.ene.gov.on.ca/en/air/index.php
- **Environment Canada:** www.ec.gc.ca/cleanair-airpur
- **Health Canada:** www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/smog-eng.php
- **Natural Resources Canada:** www.nrcan-rncan.gc.ca/com/subsuj/tratra-eng.php

ABOUT CLEAN AIR SUDBURY

Clean Air Sudbury is a non-profit community group focused on air quality issues in Greater Sudbury.

Our mission is:

- To compile, summarize and disseminate local air quality information;
- To promote education and awareness of community air quality issues; and
- To provide opportunities for the public to get involved in air quality improvements.

The benefits of bringing together stakeholders and engaging the public in dialogue and action on air issues are many. They include improved local air quality, greater community awareness of air pollutants, and increased opportunities for business, industry and individuals to contribute to improving our air quality.

The Clean Air Sudbury Steering Committee includes representatives from:

- BESTECH;
- Cambrian College;
- City of Greater Sudbury;
- Laurentian University;
- MIRARCO;
- Northern Ontario School of Medicine;
- Ontario Ministry of the Environment;
- Potvin Air Management Consulting;
- Science North;
- Sudbury & District Health Unit;
- Vale Inco; and
- Xstrata Nickel.