the air we breathe

Nova Scotia's Air Quality Report, 2000-2007

NOVA SCOTIA
Environment

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Figures and Tables

Symbols, Initialisms, and Acronyms

BAM	beta attenuation mass (monitor)
CAC	criteria air contaminants
CBRM	Cape Breton Regional Municipality
CH_4	methane
CMA	census metropolitan area
CO	carbon monoxide
CO_2	carbon dioxide
CWS	Canada-wide Standards
EC	Environment Canada
FRM	Federal Reference Method (filter sampler)
H_2S	hydrogen sulphide
HAPs	hazardous air pollutants
HFCs	hydrofluorocarbons
Hg	mercury
HRM	Halifax Regional Municipality
$\mu g/m^3$	micrograms per cubic metre
mg/m^3	milligrams per cubic metre
NAAQO	National Ambient Air Quality Objectives
NAPS	National Air Pollution Surveillance
NSE	Nova Scotia Environment
NO_X	nitrogen oxides
O_3	ozone
ODS	ozone-depleting substances
PCBs	polychlorinated biphenyls
PFCs	perfluorocarbons
PM_{10}	particulate matter less than or equal to 10 µm in diameter
$PM_{2.5}$	fine particulate matter less than or equal to 2.5 µm in diameter
POP	persistent organic pollutants
ppb	parts per billion
ppm	parts per million
SF_6	sulphur hexafluoride
SO_2	sulphur dioxide
SO_X	sulphur oxides
TEOM	tapered element oscillating microbalance (sampler)
TPM	total particulate matter
TSP	total suspended particulate
VOCs	volatile organic compounds

Executive Summary

Air quality is important because it affects our health and the environment. Nova Scotia Environment works on the development of standards, guidelines, regulations, and policies to protect the health of our citizens and the environment. Nova Scotia has had an air quality monitoring program since 1974. This report presents results for the seven-year period 2000 to 2007.

Levels of pollutants in the ambient air are monitored across the province. Through the combined efforts of Nova Scotia Environment and Environment Canada,16 air quality monitoring stations were in operation between 2000 and 2007. The stations were located in Aylesford Mountain, Dartmouth, Dayton, Granton, Halifax(3), Jackson, Kejimkujik National Park, Kentville, Pictou, Port Hawkesbury, Sable Island, Sherbrooke, and Sydney(2).

The common air pollutants monitored in Nova Scotia are ground-level ozone, fine particulate matter, carbon monoxide, nitrogen dioxide, sulphur dioxide, volatile organic compounds, and acid precipitation.

Air quality in Nova Scotia is generally good. Although some pollutants have elevated levels at times, pollutant levels usually meet our standards and objectives.

During 2000–2007, ground-level ozone levels were highest in the western region (Kejimkujik National Park and Aylesford Mountain). Since there are few local sources of air pollutants in that region and the sites are upwind of other sources within Nova Scotia, the pollutants measured at these stations mostly come from areas outside the province. Peaks in ozone generally occur during the summer months, when sunlight and heat convert other pollutants to ozone. Lower ozone levels in some years could be due to cooler, wetter summers.

Ozone levels were lower in urban areas (Halifax and Sydney) because of higher levels of traffic there. Vehicles are one of the largest sources of nitrogen oxides, often in the form of nitric oxide, which can react with ozone to form nitrogen dioxide and oxygen. This conversion can cause ozone levels to decrease in areas where there are higher levels of nitric oxide.

Improved technologies for monitoring particulate matter now enable continuous monitoring of finer particulate matter. Hence, Nova Scotia has been moving from filter-based monitoring of total suspended particulates to continuous monitoring of fine particulate matter. Although we have recently started continuous monitoring of fine particulate matter, we still use other filter-based technology. In 2006, Nova Scotia began using a filter-based speciation sampler to measure the composition of fine particulate matter in Halifax.

Carbon monoxide levels in Halifax and Sydney were well below provincial standards and national objectives. Monitoring in Sydney began in 2005.

Nitrogen dioxide comes from vehicle emissions. Therefore, levels of nitrogen dioxide are higher in urban areas because there is more traffic, and levels are highest during rush hour. Nitrogen dioxide levels in Halifax and on Sable Island were well below provincial standards and national objectives. Problems with the instrument in Halifax resulted in insufficient data for 2001–2005. Monitoring on Sable Island began in 2003.

Sulphur dioxide has been monitored since 1974 in areas with local emission sources in Nova Scotia. Levels were almost always lower than provincial standards and national objectives.

1. Background

Introduction

Air pollution leads to smog, acid rain, thinning of the ozone layer, and climate change. Poor air quality can adversely affect the environment and human health.

Air pollutants come from emissions generated both in Nova Scotia and in neighbouring provinces and states. Nova Scotia has a smaller population and industrial base than upwind cities, but we do contribute to air pollution locally and globally through our large per-capita energy consumption, a strong dependence on fossil fuels such as coal, emissions from industries and institutions, inefficient wood burning, a heavy dependence on automobiles, and use of other fossil-fuel-powered machines.

We carry out air quality monitoring to determine the concentration of various air contaminants and to compare these levels to accepted standards for air quality. Monitoring is also useful for determining whether existing emission controls are effective and for planning emission control requirements for new industry. In Nova Scotia, monitoring stations are in Aylesford Mountain, Dartmouth, Dayton, Halifax, Jackson, Kejimkujik National Park, Kentville, Pictou, Port Hawkesbury, Sable Island, Sherbrooke, and Sydney.

This report begins with a discussion of the major air pollutants monitored in Nova Scotia, their sources, and their impacts on human health, the environment, and the economy. In section 2, we cover legislation and guidelines and what Nova Scotia Environment is doing about air quality monitoring and protection. In section 3, we present the results of the monitoring program conducted over the period 2000–2007. A glossary of terms can be found following the appendices to this report.

Major Air Pollutants Monitored in Nova Scotia

Of the many different types of pollutants in our air, some are more common and of more concern in Nova Scotia than others, and these are the ones discussed in this report.

Ozone (O_3) is a compound made up of three atoms of oxygen bonded together. In the stratosphere (upper atmosphere), naturally occurring ozone protects us from harmful ultraviolet rays. In the lower atmosphere, ground-level ozone can damage our lungs and vegetation. Ground-level ozone is formed when volatile organic compounds (VOCs) and nitrogen oxides (NO_X) react in the presence of sunlight and stagnant air.

Particulate matter (PM) refers to particles in the air such as smoke, soot, dust, and aerosols that remain suspended and do not settle out easily. In this report we use the term total suspended particulate (TSP) – also known as total particulate matter (TPM) – which includes particles with a diameter less than 100 µm in diameter (one micrometre is one-thousandth of a millimetre).

Fine particulate matter ($PM_{2.5}$) is made up of very small particles less than 2.5 µm in diameter. Particles this small are respirable; they can find their way past our natural defenses (nose hair and mucus) and end up deep in our lungs.

Sulphur dioxide (SO_2) is a colourless, poisonous gas. It is the major precursor of acid rain in Nova Scotia.

Nitrogen oxides (NO_X) include the gases nitric oxide (NO) and nitrogen dioxide (NO_2). In the presence of sunlight, NO_X react with VOCs to form O_3, a smog component. NO_X can also combine with ammonia to form secondary particulate.

Volatile organic compounds (VOCs) are substances that produce vapours at normal temperatures. VOCs can react with NO_X in the presence of sunlight to form ground-level ozone, a major component of smog.

Carbon monoxide (CO) is a poisonous, colourless, odourless, and tasteless gas, generated through combustion processes.

Hydrogen sulphide (H_2S) is a colourless gas that smells like rotten eggs at low concentrations. At high concentrations H_2S is odourless and highly poisonous.

Of these pollutants, ground-level ozone and particulate matter contribute most significantly to smog. Sulphur dioxide also contributes to smog formation.

The main pollutants contributing to acid rain are sulphur dioxide and nitrogen oxides. SO_2 is the major contributor to acidification in eastern Canada. Other air pollutants not discussed in detail here include mercury, persistent organic pollutants (POPs) (such as PCBs, pesticides, dioxins, and furans), and hazardous air pollutants (HAPs) (e.g., lead and cadmium). For more information on POPs and HAPs, contact Environment Canada: www.ec.gc.ca.

Emissions of greenhouse gases such as carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), ozone, and water vapour can cause climate change. For more information about climate change, please visit our website: www.gov.ns.ca/nse/climate.change

Sources of Major Air Pollutants Found in Nova Scotia

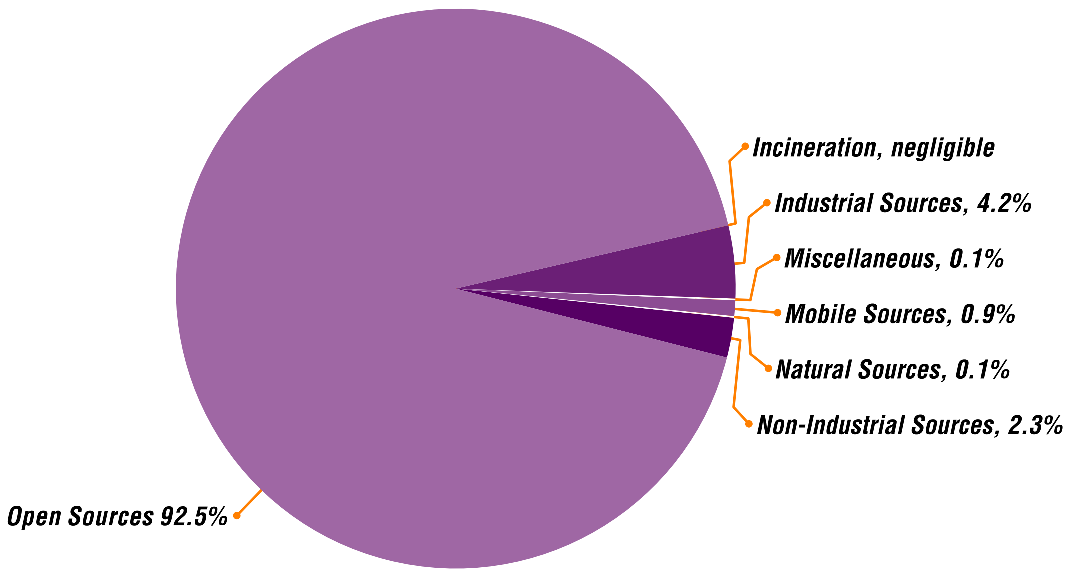
Air pollutants are emitted from a variety of sources, including industrial facilities (such as electrical power plants, pulp and paper mills), vehicles, and natural sources (such as forest fires and trees).

Nova Scotia receives much of its air pollution from sources outside the province, particularly from the eastern United States and central and eastern Canada.

Numerous local sources of air pollution include electricity generating facilities, other industry, transportation, heating, and wood burning.

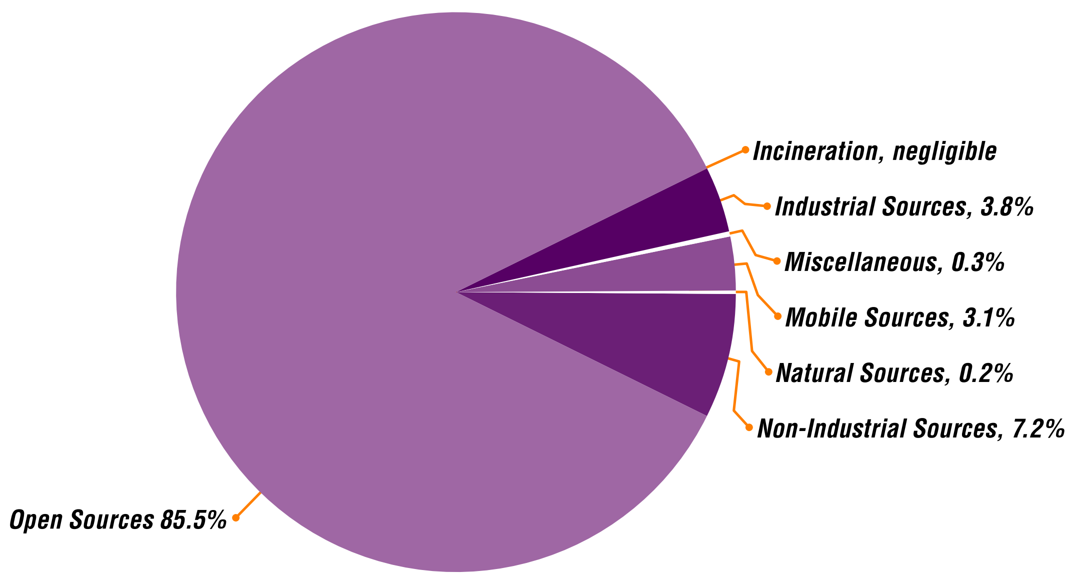
Figures 1-1 through 1-7 show the local emission sources of some of the major pollutants in Nova Scotia in 2006 (Environment Canada, Air Pollutant Emission Summaries and Trends, 2008).

Figure 1-1 Sources of total particulate matter (TPM) emissions in Nova Scotia, 2006



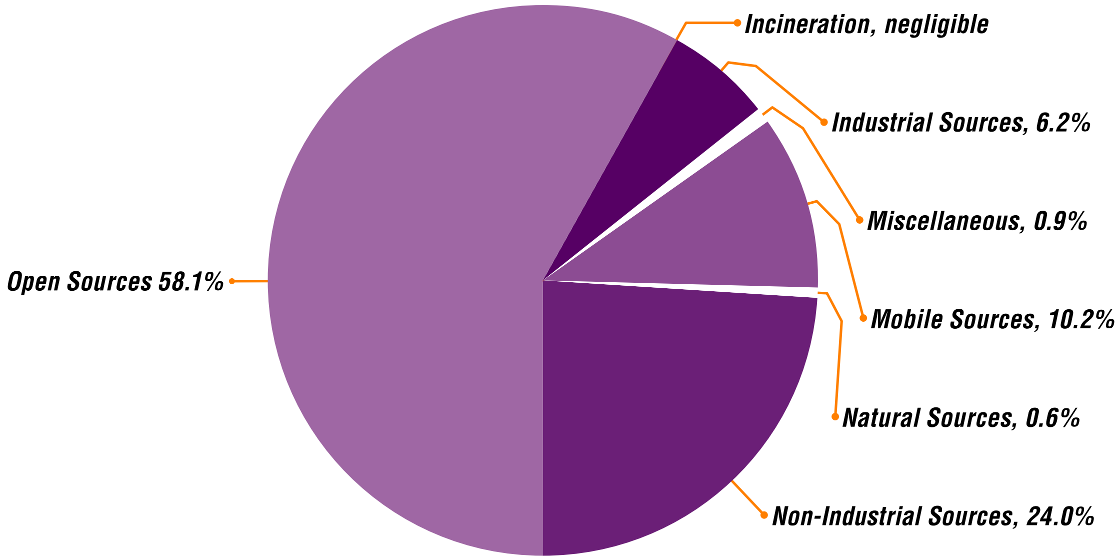
Local sources released 362 590 tonnes of TPM to the air in 2006, mostly from open sources (335 508 t, 92% of total), including road dust (312 445 t, 86% of total) and construction (16 881 t, 5% of total).

Figure 1-2 Sources of fine particulate matter (PM_{10}) emissions in Nova Scotia, 2006



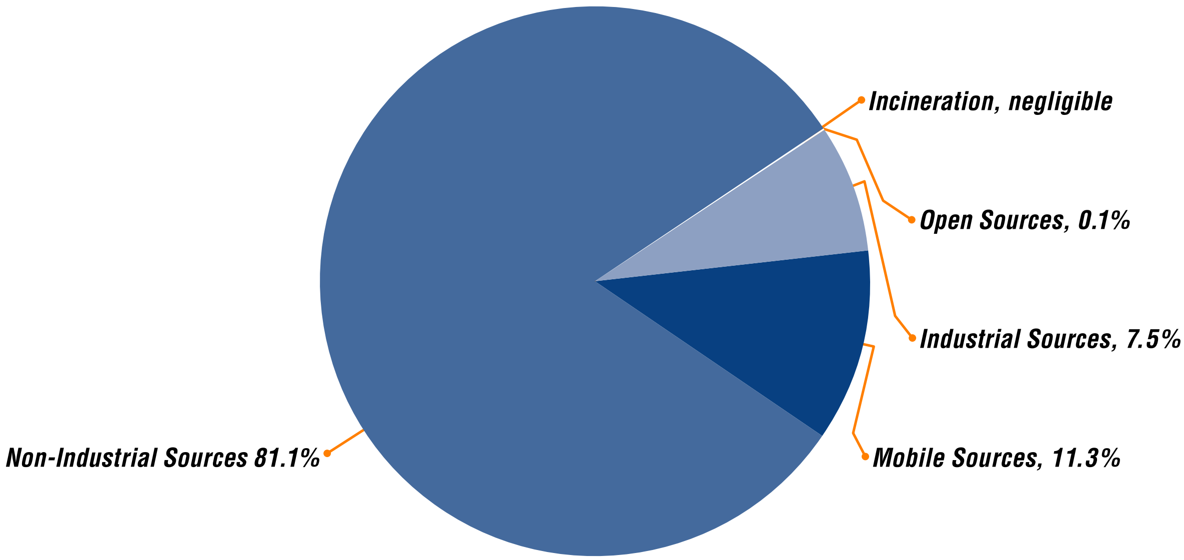
Local sources released 98 656 tonnes of PM10 to the air in 2006, mostly from open sources (84 362 t, 86% of total). Open sources included road dust (76 068 t, 77% of total) and construction (5 005 t, 5% of total). Nonindustrial fuel combustion sources included residential fuel wood combustion (5825 t, 6% of total).

Figure 1-3 Sources of fine particulate matter ($PM_{2.5}$) emissions in Nova Scotia, 2006



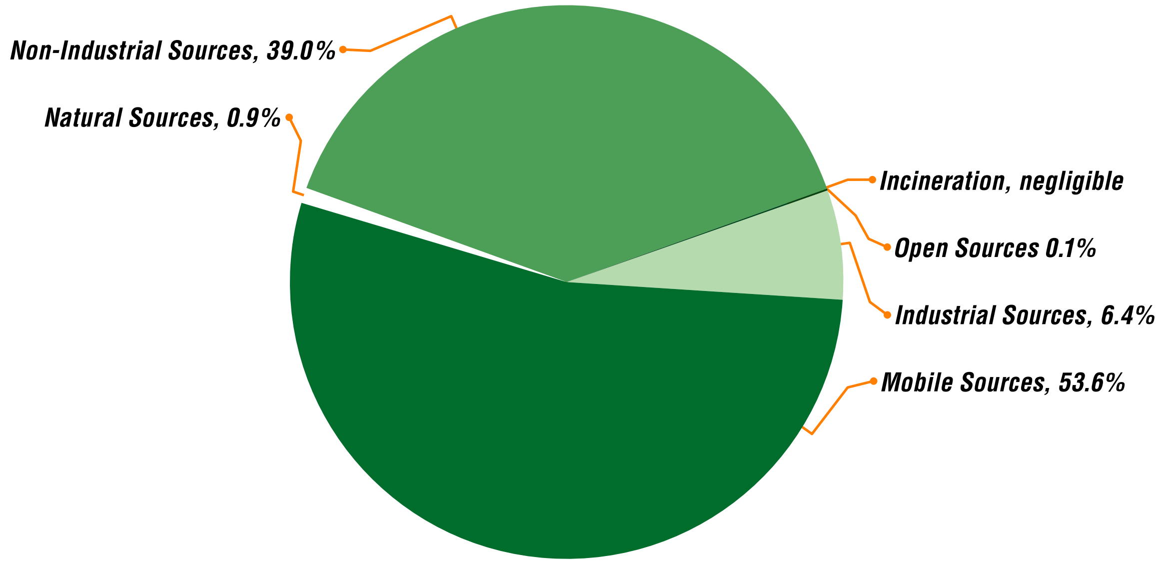
Local sources released 26 754 tonnes of $PM_{2.5}$ to the air in 2006, mostly from open sources (15 549 t, 58% of total) and non-industrial sources (6423 t, 24% of total). Open sources included road dust (14 180 t, 53% of total). Non-industrial sources included residential fuel wood combustion (5822 t, 22% of total).

Figure 1-4 Sources of sulphur oxides (SO_X) emissions in Nova Scotia, 2006



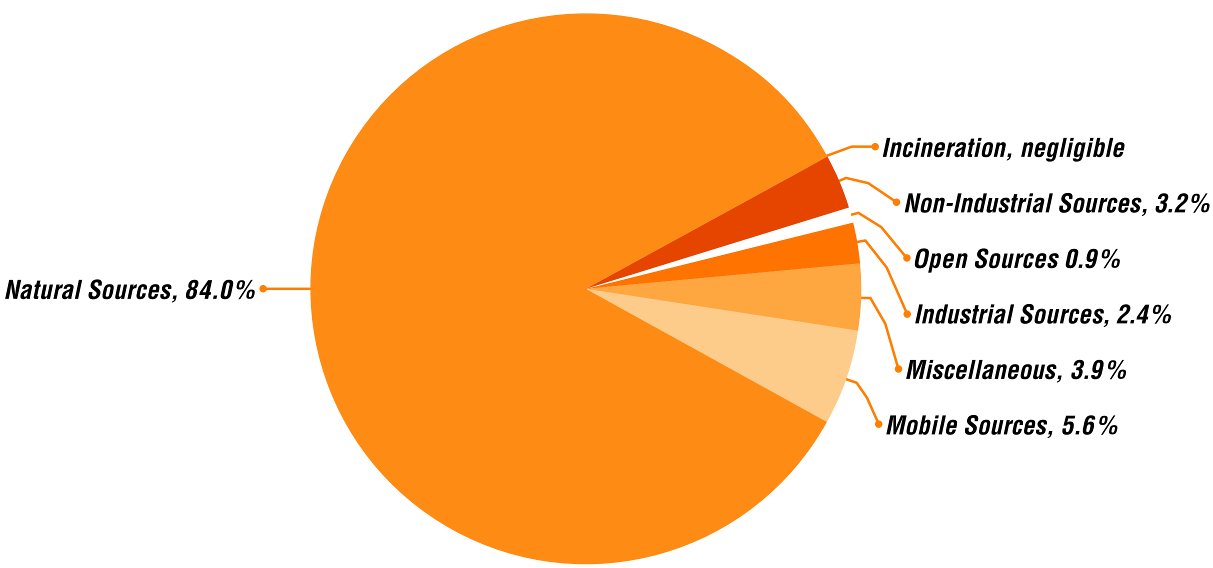
Local sources released 139 034 tonnes of SO_X to the air in 2006, mostly from non-industrial sources (112 752 t, 81% of total), of which electric power generation was the biggest source (106 823 t, 77% of total).

Figure 1-5 Sources of nitrogen oxides (NO_X) emissions in Nova Scotia, 2006



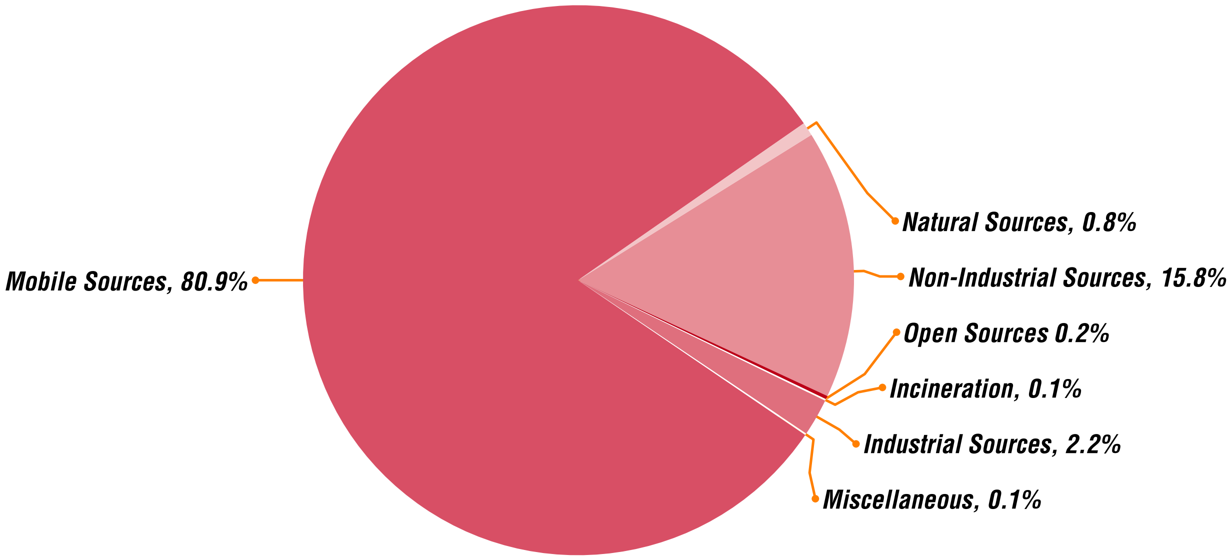
Local sources released 81 998 tonnes of NO_X to the air in 2006, mostly from mobile sources (43 968 t, 54% of total) and non-industrial sources (31 972 t, 39% of total). Mobile sources included marine transportation (20 481 t, 25% of total), diesel trucks and vehicles (7521 t, 9% of total), and gasoline trucks and vehicles (6564 t, 8% of total) and off-road use of diesel and gasoline (6441 t, 8% of total). Non-industrial sources included electric power generation (28 550 t, 35% of total).

Figure 1-6 Sources of volatile organic compounds (VOCs) emissions in Nova Scotia, 2006



Local sources released 279 961 tonnes of VOCs to the air in 2006, mostly from natural sources (235 042 t, 84% of total) which included biogenics (234 780 t, 84% of total). Other sources included mobile sources (15 617 t, 6% of total) such as gasoline trucks and vehicles (13 600 t, 5% of total), miscellaneous sources (10 896 t, 4% of total) such as general solvent use (5493 t, 2% of total), and non-industrial sources (8960 t, 3% of total) such as residential fuel wood combustion (8852 t, 3% of total).

Figure 1-7 Sources of carbon monoxide (CO) emissions in Nova Scotia, 2006



Local sources released 241 541 tonnes of CO to the air in 2006, mostly from mobile sources (195 385 t, 81% of total) and non-industrial sources (38 168 t,16% of total). Mobile sources included gasoline trucks and vehicles (121 658 t, 50% of total), off-road use of diesel and gasoline (68 137 t, 28% of total). Non-industrial sources included residential fuel wood combustion (37 298 t, 15% of total).

Impacts of Air Pollutants on Health, the Environment, and the Economy

Impacts of Air Quality on Human Health

The potential health effects of air pollutants depend on the types and concentrations of pollutants, the length of exposure time, and the health status and genetics of the individual. Short-term effects of air pollution primarily involve the respiratory system (lungs and airways) and the cardiovascular system (heart function and blood circulation).

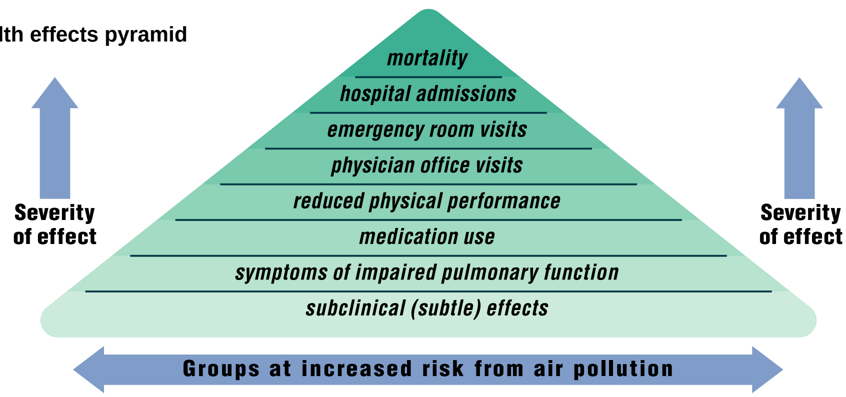
A Health Canada study of eight Canadian cities estimates that 5,900 deaths per year in these cities can be attributed to air pollution (Health Canada, 2006). Poor air quality also sends thousands more Canadians to hospital each year. Individual reactions to air pollution can vary. Groups that are especially sensitive or at risk to the adverse health effects of air pollution include young children, the elderly, and people with pre-existing cardiac or respiratory diseases such as coronary artery disease, heart rhythm problems, chronic obstructive pulmonary disease, asthma, and bronchitis. Diabetics also appear to be at greater risk, probably because of the relationship between diabetes and heart disease.

Negative health effects increase as air pollution worsens. Even modest increases in air pollution can cause small but measurable increases in emergency room visits, hospital admissions, and death, and can exacerbate illness among sensitive or at-risk people. Although air pollution is known to affect people with pre-existing heart and lung disorders or diseases, it is not yet known whether it is a contributing cause of these conditions.

Short-term effects of air pollutants typically include wheezing, coughing, difficulty in breathing, and aggravation of existing respiratory and cardiac conditions. Other health risks linked to longer-term or cumulative exposures to air pollution include cancer (from such pollutants as diesel emissions, benzene, dioxins, and furans). The route of exposure can be either directly from the air or indirectly via airborne pollutant deposition and contamination of other media (e.g., dioxins and furans from air end up in soil and are taken up by food grown in it; mercury from air emissions is deposited on land and into water, contaminating fish and wildlife).

Figure 1-8 shows the relationship between the health effects of air pollution and the number of people affected. Of the population affected by air pollution, more people experience milder symptoms, while fewer experience the more severe effects.

Figure 1-8 Health effects pyramid



Source: Health Effects of Air Pollution (Health Canada, 2006).

Figure 1-9 lists the groups typically most at risk from exposure to air pollution. On days when air pollution levels are significantly elevated, even people not in higher-risk groups might notice symptoms.

Figure 1-9 Groups at increased risk from air pollution

People with existing respiratory or cardiovascular conditions

People who have existing respiratory illnesses and those with existing cardiovascular conditions are sensitive to air pollution. Air pollution makes it even harder for people to breathe, and can make existing lung or heart related symptoms worse; for example, it can trigger heart and asthma attacks.

Young children

Young children are a sensitive group because on the basis of body size they tend to inhale relatively more air than adults. Their higher metabolic rate and developing defence systems make them more susceptible to air pollution.

The elderly

The elderly are also more likely to be affected by air pollution, perhaps due to generally weaker defence systems or undiagnosed respiratory or cardiovascular health conditions.

People who are active outdoors

People participating in sports or strenuous work outdoors breathe more deeply and more rapidly, allowing more air pollution to enter the lungs.

Impacts of Air Quality on the Environment

Air pollution can cause a broad range of environmental effects (addressed in detail in several of the publications listed in the references at the end of this report).

Pollutants such as ground-level ozone and sulphur dioxide can interfere with biochemical and physiological processes in plants. Plants can become injured, or even die, as a result of exposure to some air pollutants. Plant productivity can also be affected.

In addition to their effect on vegetation, smog-causing pollutants can deteriorate materials (e.g., rubber), buildings, and other structures, and they can impair visibility.

Acid rain adversely affects water bodies, vegetation, and the built environment. Damage to land and water ecosystems occurs when the land, water, or plants cannot neutralize the acid being deposited by the rain. Nova Scotia has low tolerance for acid precipitation because of the low buffering capacity and neutralization abilities of water and land ecosystems in most of the province, especially in southwestern Nova Scotia. High levels of acidity can destroy life in lakes and rivers and reduce forest growth. Acid precipitation affects fish in a variety of ways, including decreasing their growth rate and making them susceptible to diseases. A decline in fish stocks will also affect some birds because of the loss of food. Plants too are affected by acid rain. Leaves and needles can be damaged, and trees can become more susceptible to disease.

Impacts of Air Quality on the Economy

Air pollution can affect productivity of key resource sectors such as fisheries, forestry, and agriculture. For example, the 2004 Acid Deposition Science Assessment found that acid deposition causes soil nutrient depletion that results in over half a million cubic metres of wood being lost in Atlantic Canadian forests every year (Environment Canada, Meteorological Service, 2004). The value of lost wood is estimated to be in the hundreds of millions of dollars annually. The assessment also found that acidification continues to negatively affect Atlantic Salmon populations, particularly in the Southern Upland region. The decline in such fish populations hurts the sport fishing industry.

In addition to its economic effect on natural resources, air pollution contributes to increased health care costs and loss of productivity.

2. Air Quality Monitoring and Protection in Nova Scotia

Roles and Responsibilities of Nova Scotia Environment

The Air Quality Branch of Nova Scotia Environment (NSE) strives to monitor and protect outdoor air quality in Nova Scotia. The Branch works on the development of standards, guidelines, regulations, and policies, both within the province and as a participant in national and international initiatives, to protect Nova Scotia's environment and the health of its citizens. Staff of NSE collect, analyse, and report air quality data from monitoring stations across the province.

The Branch conducts public education to help citizens understand the effects of air pollution and the actions they can take to reduce pollution and minimize its effects. For example, in cooperation with other agencies NSE issues an Air Quality Health Index (launched June 1, 2009), which is a numeric scale indicating current air quality. Information on how to help improve the air quality in Nova Scotia is also available on the Branch's website: www.gov.ns.ca/nse/air/.

For air quality issues, the Branch provides support to the regional and district offices of NSE. Its services include consulting on specific issues or initiatives, developing approval terms and conditions, and providing information and advisories about any air quality initiatives or events of concern.

The Regional and District Offices of NSE issue industrial approvals that contain terms and conditions related to air quality. The terms and conditions are developed to make facilities compliant with regulations and any policies, standards, or guidelines prescribed or adopted by the Minister.

Staff of the regional and district environmental monitoring and compliance offices investigate and act on local air quality complaints. Staff also assist with periodic routine maintenance of ambient air monitors located in their areas.

For a list of offices in your area, please visit the NSE Environmental Monitoring and Compliance offices web page: www.gov.ns.ca/nse/offices/emcoffices.asp.

Air Quality Legislation and Guidelines

Legislation

Nova Scotia's Environmental Goals and Sustainable Prosperity Act came into effect in April 2007. The Act includes goals related to air quality: reductions in nitrogen dioxide, sulphur dioxide, and mercury emissions; and commitments to meet the Canada-wide Standards for fine particulate matter and ground-level ozone.

Air Quality Regulations

Nova Scotia's Air Quality Regulations specify maximum permissible concentrations for six air pollutants. The criteria in the regulations are based on the National Ambient Air Quality Objectives (NAAQOs), although the two do differ slightly (see Table 2.1). The Air Quality Regulations are legally binding in Nova Scotia, whereas the NAAQOs are guidelines used as a benchmark to assess the effects of air pollutants.

National Ambient Air Quality Objectives (NAAQOs)

The NAAQOs use the terminology "maximum desirable level" and "maximum acceptable level" to describe the criteria, while the Air Quality Regulations use the term "maximum permissible ground-level concentration." The maximum desirable level is the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of pollution control technology. The maximum acceptable level is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, and personal comfort and well-being. The province's maximum permissible ground level concentration corresponds to the national maximum acceptable level.

For each contaminant, several averaging periods are given. The shorter periods (e.g., one hour) capture peaks, whereas the longer periods (e.g., one year) capture the long-term trends. The different averaging times are used to protect against both acute and chronic effects.

Note that the criteria discussed here are for ambient air, not emissions from specific sources.

Table 2-1
Air Quality Criteria

		Nova Scotia Air Quality Regulations		*National Ambient Air Quality Objectives (NAAQO)*			
Air Contaminant	Averaging Period	Maximum Permissible Ground Level Concentration (ppb)*	(µg/m³)	Maximum Acceptable Level (ppb)*	(µg/m³)	Maximum Desirable Level (ppb)*	(µg/m³)
O_3	1 hour	82	160	80	160	50	100
TSP	24 hour 1 Year	— —	120 70 (geometric mean)	— —	120 70	— —	— 60
CO	1 Year 8 hours	30 ppm 11 ppm	34.6 mg/m³ 12.7 mg/m³	31 ppm 13 ppm	35 mg/m³ 15 mg/m³	13 ppm 5 ppm	15 mg/m³ 6 mg/m³
NO_2	1 hour 1 year	210 50	400 100	210 50	400 100	— 30	— 60
SO_2	1 hour 24 hour 1 year	340 110 20	900 300 60	340 110 20	900 300 60	170 60 10	450 150 30
H_2S	1 hour 24 hour	30 6	42 8	—	—	— —	— —

Source: Nova Scotia Air Quality Regulations (Nova Scotia, 2007); NAAQO (Environment Canada, National Air Pollution Surveillance (NAPS) Network, 2007, p. 156). Note: NAAQO uses conditions of 25 °C and 101.3 kPa in converting from µg/m3 to ppm.

*For consistency and ease of comparison, we show all levels in parts per billion (ppb), except for CO levels in parts per million (ppm). The source documents use parts per hundred million (Nova Scotia) and parts per million (National), respectively.

Canada-wide Standards (CWS)

While the National Ambient Air Quality Objectives look at desirable, acceptable, and tolerable levels of pollutants for a shorter period, the CWS focus on trends over the longer-term, looking at peaks and averages over three year periods. CWS also allow for comparison nationally.

For ambient air, there are CWS for particulate matter ($PM_{2.5}$) and ozone, as well as for mercury, benzene, and dioxins and furans. Only the standards for particulate matter and ozone will be discussed in this report.

CWS for particulate matter and ozone were endorsed by the Canadian Council of Ministers of the Environment in June 2000, with ambient air quality targets to be achieved by 2010 (see table 2.2).

Table 2-2 Canada-wide Standards

	Canada-wide Standard	*Input Criteria*
Particulate matter ($PM_{2.5}$)	30 µg/m³	Annual 98th percentile 24-hour-average concentration of $PM_{2.5}$, averaged over three consecutive years.
Ozone (O_3)	65 ppb	Annual fourth-highest 8-hour-average concentration of O_3, averaged over three consecutive years.

Source: Canada-wide Standards (Canadian Council of Ministers of the Environment, 2000, p. 4).

Outdoor Air Quality Monitoring Network

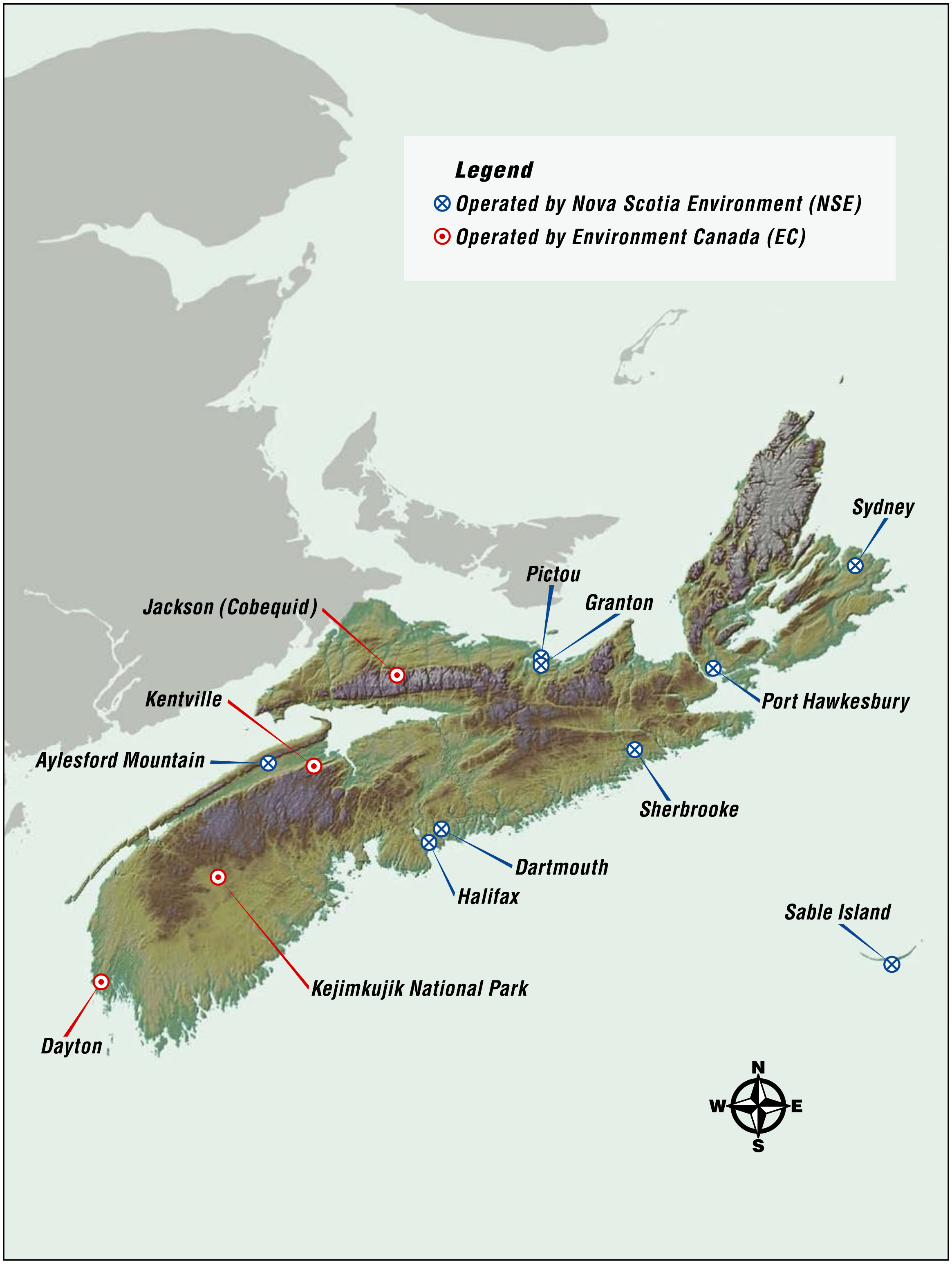
Through the combined efforts of Nova Scotia Environment (NSE) and Environment Canada (EC), 16 air quality monitoring stations were in operation between 2000 and 2007.

Table 2-3 Monitoring stations in Nova Scotia, 2000–2007

Region	Station	Pollutants Monitored	Instrument	Timeline	Site Operator
Central Region	Daltech, Halifax	TSP	High-volume sampler	1974–2005	NSE
		$PM_{2.5}$ PM_{10}	Dichot	1984–2005	NSE
	Roy building, Halifax	CO		1990–present	NSE
		NO_x NO NO_2		1990–present	NSE
		O_3		1990–present	NSE
		SO_2		1990–present	NSE
		VOC		1990–present	NSE
	Johnston building, Halifax	$PM_{2.5}$	BAM	2006–present	NSE
		$PM_{2.5}$	TEOM	2006–present	NSE
		$PM_{2.5}$	Speciation	2006–present	NSE
		$PM_{2.5}$ PM_{10}	Dichot	2006–present	NSE
	Lake Major, Dartmouth	NO_x NO NO_2		2006–present	NSE
		O_3		2006–present	NSE
		$PM_{2.5}$	BAM	2006–present	NSE
		$PM_{2.5}$	TEOM	2001–present	NSE
		SO_2		2006–present	NSE
Eastern Region	Old post office, Port Hawkesbury	SO_2		1994–2007	NSE
	Whitney Pier, Sydney	TSP		1974–2003	NSE
	Welton Street, Sydney	NO_x NO NO_2		2005–present	NSE
		O_3		2000–present	NSE
		$PM_{2.5}$	TEOM	1998–present	NSE
		SO_2		1974–present	NSE
		CO		2005–present	NSE
Northern Region	Jackson/Cobequid	Acid precipitation		1977–present	EC
	Pictou	O_3		2001–present	NSE
		$PM_{2.5}$		2003–present	NSE
	Granton	VOC		2006–present	NSE
	Sherbrooke	Acid precipitation		1996–present	NSE
Western Region	Aylesford Mountain	O_3		1991–present	NSE
		$PM_{2.5}$	BAM	2007–present	NSE
	Dayton	O_3		1993–present	EC
	Kejimkujik National Park	Acid precipitation		1983–present	EC
		Hg			EC
		O_3		1985–present	EC
		PHA			EC
		Pb			EC
		$PM_{2.5}$ PM_{10}	Dichot	1992–present	EC
		$PM_{2.5}$	FRM	2001–present	NSE
		$PM_{2.5}$	TEOM	1998–present	NSE
		POP			EC
	Kentville	VOC		1994–present	EC
		O_3		2002–present	EC
Offshore	Sable Island	NO_x NO NO_2		2003–present	NSE
		O_3		2003–present	NSE
		H_2S SO_2		2003–present	NSE
		$PM_{2.5}$	BAM	2003–present	NSE

Outdoor Air Quality Monitoring Network Station Locations

Figure 2-1 Locations of air quality monitoring stations in Nova Scotia, 2000–2006



3. Data Summary

For each air pollutant monitored in Nova Scotia, we describe where it is monitored, the standards and objectives for that pollutant, and the results of monitoring for the years 2000 to 2007. Depending on monitoring criteria for averaging periods, results are presented in a variety of ways, including text, tables, and charts.

To be reported, data must meet completeness criteria – the amount of data required to calculate and report valid hourly, monthly, quarterly, and annual averages. The National Air Pollution Surveillance Network (NAPS) has established data completeness criteria for various pollutants. Based generally on those criteria, here are the ones we have used for this report:

- *At least 75% of the five-minute averages are required to calculate the hourly average.*
- *At least 50% of the hourly averages are required to calculate the monthly average.*
- *At least 75% of the monthly averages are required to calculate the quarterly average.*
- *Four quarterly averages are required to calculate the annual average.*

Relevant notes to charts and tables explain the lack of data where completeness criteria were not met. Typical reasons are equipment failure and establishment of a new monitoring station during a given year.

In this section, we will refer to the Nova Scotia *permissible* levels (standards set by regulation) and the national *acceptable* and *desirable* levels (objectives) discussed in section 2 and laid out in table 2.1. For ozone and particulate matter, we will also refer to the Canada-wide Standards outlined in section 2 and laid out in table 2.2. The term *exceedance* refers to a sampling result above the regulated or guideline limit.

Two authorities monitor air pollutants in Nova Scotia: Nova Scotia Environment (NSE) and Environment Canada (EC). Monitoring site operators are identified in this section. The year that each station began monitoring is also given.

Ground-level Ozone (O_3)

Monitoring Stations

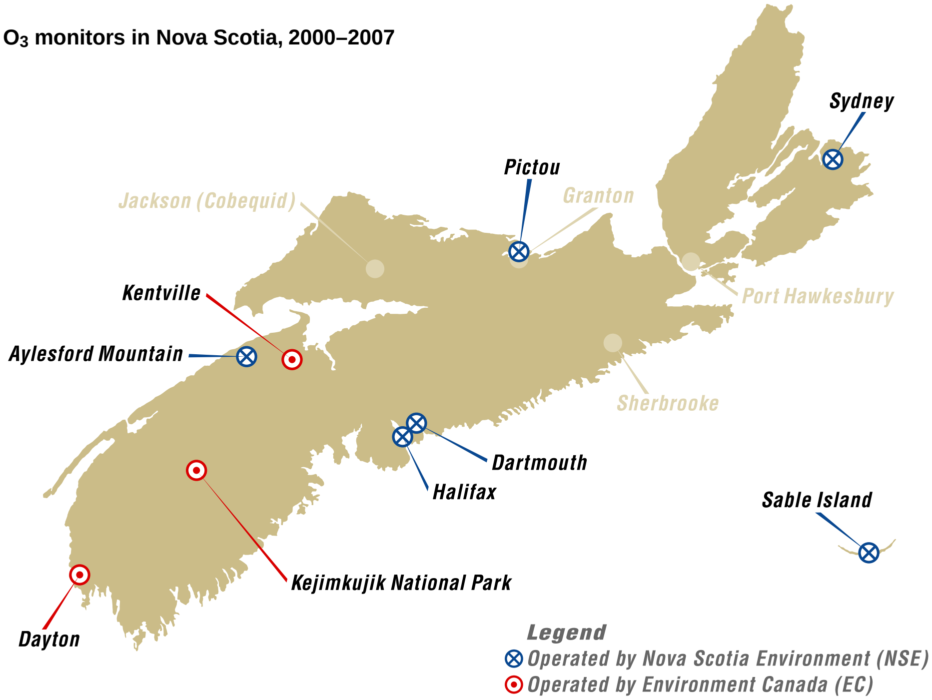
Ground-level ozone, a major component of smog, is continuously monitored at nine locations across the province (see table 3-1 and figure 3-1). Five of the monitors were added over the last six years. Monitors in the western region (Aylesford Mountain, Dayton, Kejimkujik National Park, and Kentville) also provide information about pollution coming from areas outside Nova Scotia.

Table 3-1, O_3 monitors in Nova Scotia, 2000–2007

Station	Start Date	Site Operator
Aylesford Mountain	1991	NSE
Dartmouth	July 2006	NSE
Dayton	1993	EC
Halifax	1990	NSE
Kejimkujik National Park	1985	EC (CAPMoN)*
Kentville	September 2002	EC
Pictou	September 2000	NSE
Sable Island	December 2003	NSE
Sydney	August 2000	NSE

* Canadian Air and Precipitation Monitoring Network

Figure 3-1, O_3 monitors in Nova Scotia, 2000–2007



Standards and Objectives

The provincial one-hour maximum permissible level of ground-level ozone (O_3) is 82 parts per billion (ppb) and the national one-hour maximum acceptable level is 80 ppb (see table 2.1). Nationally, the one-hour maximum desirable level of O_3 is 50 ppb. Neither a provincial nor a national maximum annual level of O_3 has been established.

The Canada-wide Standard (CWS) for ozone, established in 1998, is 65 ppb, based on the annual fourth highest of the daily 8-hour average concentration measurements, averaged over three consecutive years (see section 2, table 2.2). This standard is to be achieved by 2010 in areas with a population over 100,000. Nova Scotia has two of these Census Metropolitan Areas (CMAs): Halifax Regional Municipality (population 360,000) and Cape Breton Regional Municipality (population 109,000), which includes Sydney. They account for 52% of the province's total population.

Results

Summary

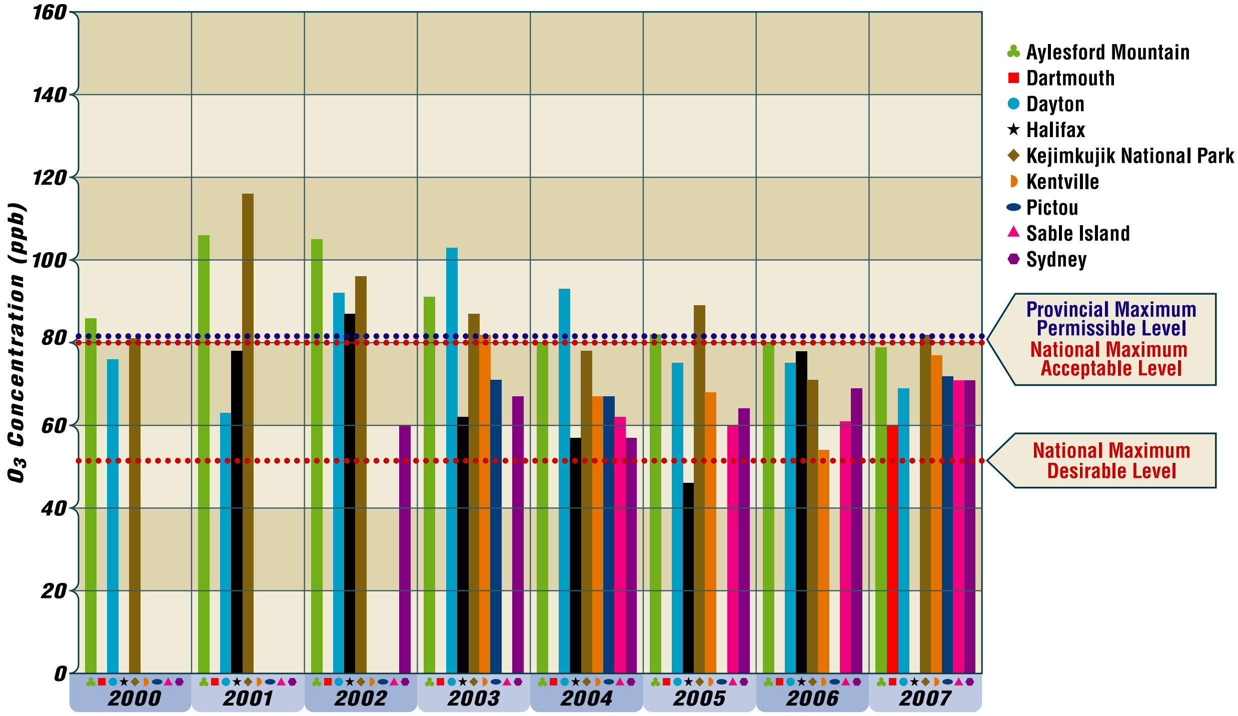
Ozone levels were higher in the western region (Aylesford Mountain, Dayton, Kejimkujik National Park). Since there are few local sources of air pollutants in that region and the sites are upwind of other sources within Nova Scotia, the pollutants measured at these stations mostly come from areas outside the province. There are also background levels of pollutants measured here. Higher O_3 levels measured at Aylesford Mountain are influenced by the higher elevation of this station (259 m above sea level), which is located on the North Mountain.

Peaks in O_3 generally occur during the summer months, when sunlight and heat convert other pollutants to O_3. Lower O_3 levels may be due to cooler, wetter summers. Ozone levels were lower in urban areas (Halifax and Sydney) because of higher levels of traffic there. Vehicles are one of the largest sources of nitrogen oxides, often in the form of nitric oxide (NO), which can react with O_3 to form nitrogen dioxide and oxygen. This conversion can result in a decrease of O_3 levels in areas with higher levels of NO.

One-hour Average

Stations in the western end of the province recorded the highest one-hour average concentrations of O_3 (see figure 3-2 and Appendix 3.2): Kejimkujik National Park measured 116 ppb in 2001, Aylesford Mountain recorded 106 ppb in 2001 and 105 ppb in 2002, and Dayton recorded 103 ppb in 2003. Annual data summary charts in Appendix 3.5 show, for each station, monthly one-hour maximum and average concentrations, and distribution of concentration levels.

Figure 3-2 Annual maximum one-hour average O_3 concentration, 2000–2007



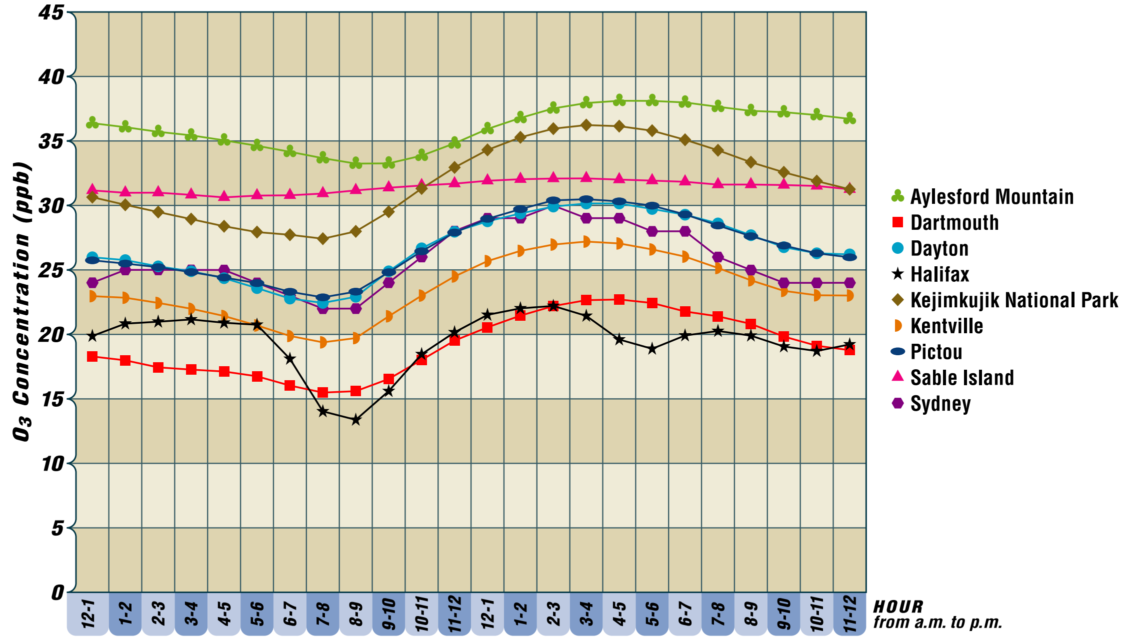
Notes: Insufficient data available from, Dartmouth (2006), Halifax (2000, 2007), Kentville (2002), Pictou (2000–2002, 2005–2006), Sable Island (2003), Sydney (2001).

Time of Day Variations

Diurnal hourly variations in average O_3 concentrations (over the course of 24 hours) for 2000–2007 are shown in figure 3-3. All stations recorded their highest average O_3 concentrations during the afternoon. Stations in Halifax and Sydney reached their peaks between 2 and 3 pm, while the stations at Aylesford Mountain and Dartmouth reached their peaks between 4 and 5 pm.

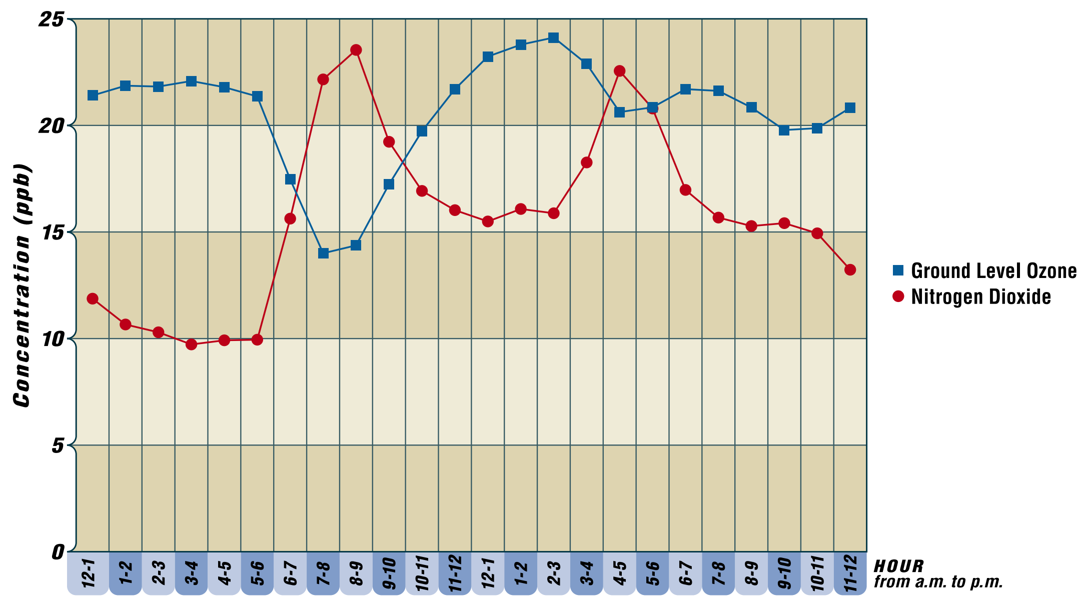
Ozone levels are lower during rush hour when traffic levels are higher and O_3 is being converted to NO and O by nitric oxide from vehicle emissions (see figure 3-4).

Figure 3-3 Diurnal variation of average O_3 concentration for nine sites, 2000–2007



Note: These records are not all based on the same amount of data (see figure 3-2 for relevant years for each station).

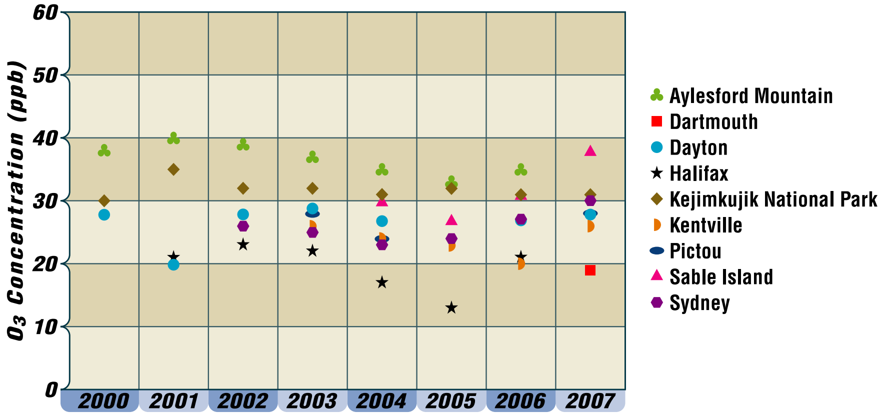
Figure 3-4 Diurnal variation of O_3 and NO_2 concentrations for Halifax, 2006



Annual Average

Annual average O_3 levels from 2000 to 2006 were highest at Aylesford Mountain and Kejimkujik National Park, and Sable Island in 2007. Levels were lowest at Halifax (see figure 3-5 and Appendix 3.3).

Figure 3-5 Annual average O_3 concentration, 2000–2007

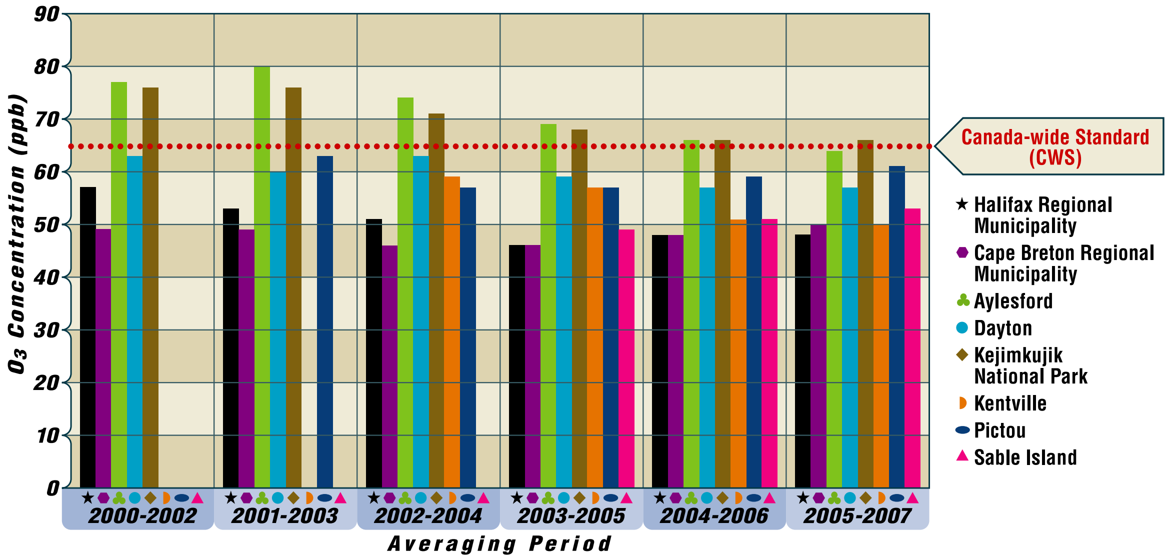


Note: Insufficient data available from Dartmouth (2006), Halifax (2000, 2007), Kentville (2002), Pictou (2000–2002, 2005–2006), Sable Island (2003), Sydney (2001).

Canada-wide Standard

Nova Scotia has been in the process of setting up monitoring stations and reporting areas for determination of Canada-wide Standard (CWS) achievement by 2010. We show data here for interest, but having been generated prior to 2010, these three-year averages should not be related to formal achievement of the CWS. Ozone levels for the two reporting areas, Halifax Regional Municipality (HRM) and Cape Breton Regional Municipality (CBRM), were below the CWS (see figure 3-6 and Appendix 3.4). The three-year averages for non-reporting areas (non-CMA locations) are included to provide a more complete provincial picture.

Figure 3-6 O_3 levels in the form of the CWS target, 2000–2007



Note: For each averaging period, this chart shows annual fourth-highest 8-hour-average O_3 concentration averaged over three consecutive years (see CWS input criteria, table 2-2).
Sable Island not in service, insufficient data to calculate averages for Pictou and Kentville in 2000-2002. Insufficient data to calculate averages for Sable Island and Kentville in 2001-2003. Insufficient data to calculate average for Sable Island in 2002-2004.

Particulate Matter (PM)

The results of monitoring particulate matter are in three parts: continuous monitoring of fine particulate matter ($PM_{2.5}$), intermittent monitoring of fine particulate matter ($PM_{2.5}$ and PM_{10}), and monitoring of total suspended particulate (TSP). $PM_{2.5}$ is the primary health hazard and a contributor to smog.

Monitoring Stations

Nova Scotia began to continuously monitor $PM_{2.5}$ in 1998 and currently has monitors in six locations across the province (see figure 3-7 and table 3-2). $PM_{2.5}$ is continuously monitored using either the tapered element oscillating microbalance (TEOM) or the beta attenuation mass (BAM) monitor.

$PM_{2.5}$ and PM10 have also been monitored on an intermittent basis (once every 6 days, for 24 hours), using dichotomous and Partisol samplers (see table 3-3). In 2006, Nova Scotia began to measure the composition of fine particulate matter in Halifax with a speciation sampler.

Total suspended particulate (TSP) was monitored on an intermittent basis at two stations, Halifax and Sydney (see table 3-4). High-volume samplers were used to collect samples of TSP once every six days according to a schedule established by the National Air Pollution Surveillance (NAPS) Network. Outside air is drawn over a filter for a 24-hour period, and the filter is analysed for total suspended particulates. TSP monitoring was suspended in 2004.

Figure 3-7 PM monitors in Nova Scotia, 2000–2007

Table 3-2 Continuous $PM_{2.5}$ monitors in Nova Scotia, 2000–2007

Station	Instrument*	Start Date**	Site Operator
Dartmouth	TEOM	1998	NSE
Dartmouth	BAM	July 2006	NSE
Halifax	TEOM	April 2006	NSE
Halifax	BAM	May 2006	NSE
Kejimkujik National Park	TEOM	1998	EC
Pictou	BAM	July 2003	NSE
Sable Island	BAM	June 2003	NSE
Sydney	TEOM	1998	NSE

***TEOM** = tapered element oscillating microbalance; **BAM** = beta attenuation mass monitor
**In 2005, TEOM monitors in Kejimkujik National Park, Dartmouth (April 5), and Sydney (April 24) were modified to use SES (sample equilibration system) dryers.

Table 3-3 Intermittent $PM_{2.5}$ and PM_{10} monitors in Nova Scotia, 2000–2007

Station	Instrument	Start Date	Site Operator
Halifax	speciation sampler	April 2006	NSE
Halifax	dichotomous sampler	1984–2002	NSE
Kejimkujik National Park	dichotomous sampler	1992	EC
Kejimkujik National Park	partisol sampler*	2001	NSE

* using the Federal Reference Method (FRM)

Table 3-4 TSP monitors in Nova Scotia, 2000–2004

Station	Dates of Operation	Site Operator
Halifax	1974–2004	NSE
Sydney – Whitney Pier	1974–2004	NSE

Standards and Objectives

Standards for maximum hourly or annual levels of fine particulate matter have not been established provincially or nationally.

The Canada-wide Standard (CWS) for $PM_{2.5}$ is 30 µg/m^3, based on the annual 98th percentile of the daily 24-hour average concentration measurements, averaged over three consecutive years (see section 2, table 2.2). This standard is to be achieved by 2010 in areas with a population over 100,000. Nova Scotia has two of these Census Metropolitan Areas (CMAs): Halifax Regional Municipality (population 360,000), and Cape Breton Regional Municipality (population 109,000). They account for 52% of the province's total population.

The provincial 24-hour maximum permissible level and the national 24-hour maximum acceptable level of TSP is 120 µg/m^3 (see table 2.1). The corresponding annual level is 70 µg/m^3. Nationally, the annual maximum desirable level is 60 µg/m^3. A 24-hour maximum desirable level has not been established.

Results – Continuous Monitoring of $PM_{2.5}$

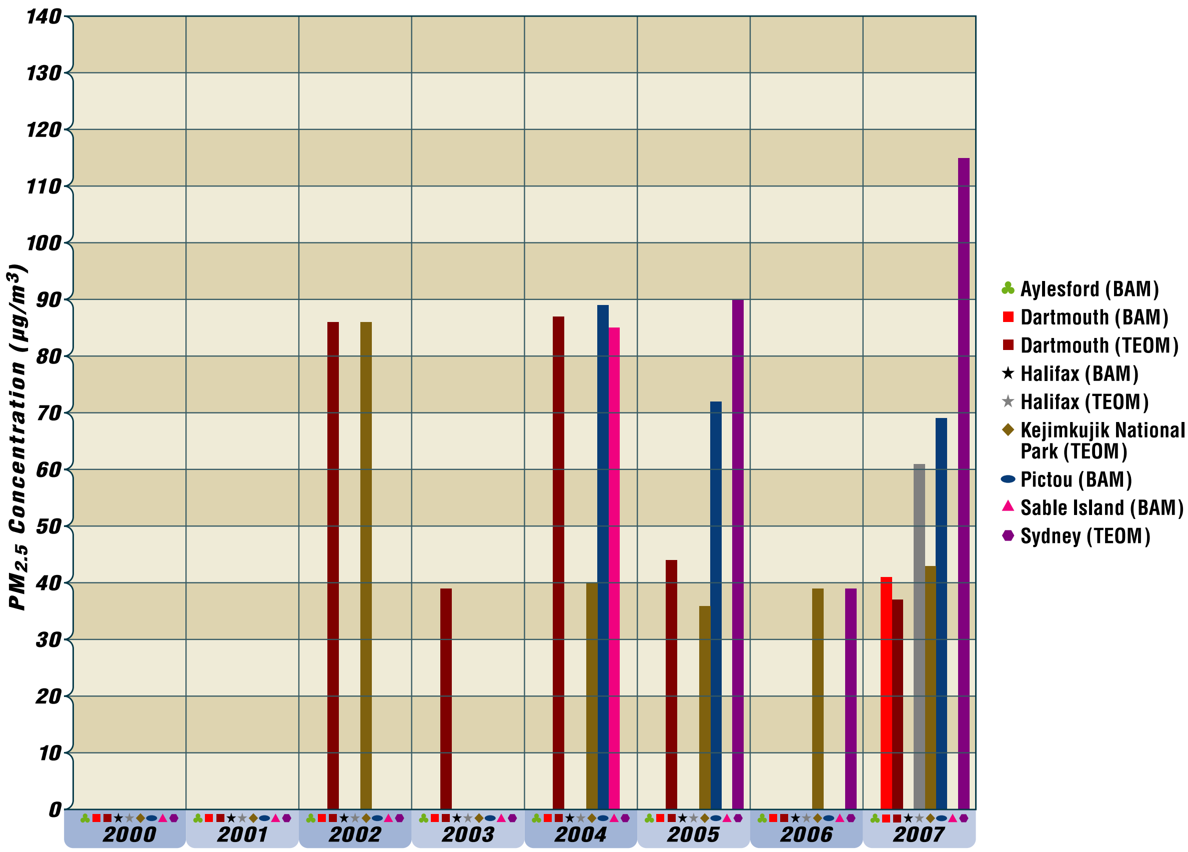
Summary

Particulate monitoring technologies have improved to enable continuous monitoring of fine particulate matter. Nova Scotia and all other provinces and territories in Canada have been moving from filter-based monitoring of total suspended particulate to continuous monitoring of fine particulate matter and filter-based monitoring of particulate composition.

One-hour Average

The highest one-hour fine particulate levels from 2000 to 2007 are shown in figure 3-8 and in Appendix 4.2. Annual data summary charts in Appendix 4.6 show, for each station, monthly one-hour maximum and average concentrations, and distribution of concentration levels.

Figure 3-8 Annual maximum one-hour average $PM_{2.5}$ concentration, 2000–2007

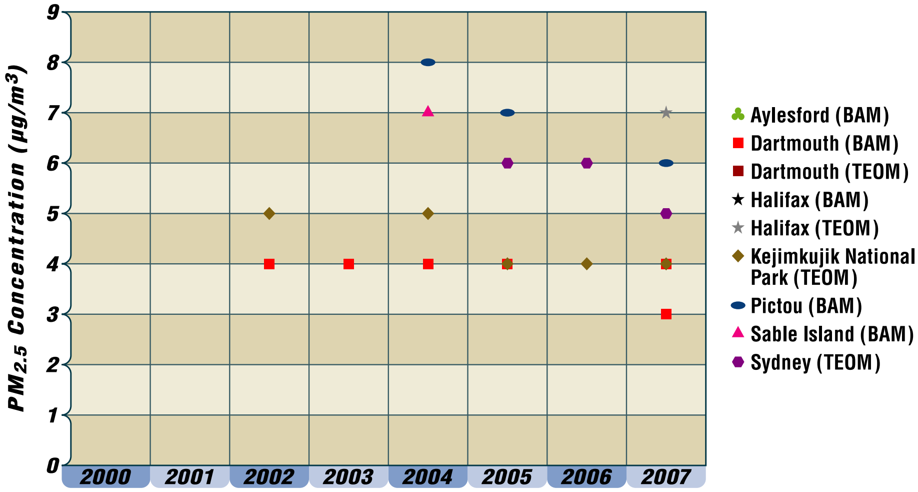


Notes: Insufficient data available from Aylesford (2007), Dartmouth BAM (2006), Dartmouth TEOM (2000–2001, 2006), Halifax BAM (2006-2007), Halifax TEOM (2006), Kejimkujik National Park (2000–2001, 2003), Pictou (2003, 2006), Sable Island (2003, 2005–2007), Sydney (2000–2004).

Annual Average

Annual average fine particulate levels from 2000 to 2007 are shown in figure 3-9.

Figure 3-9 Annual average $PM_{2.5}$ concentration, 2000–2007



Note: Insufficient data available from Aylesford (2007), Dartmouth BAM (2006), Dartmouth TEOM (2000–2001, 2006), Halifax BAM (2006-2007), Halifax TEOM (2006), Kejimkujik National Park (2000–2001, 2003), Pictou (2003, 2006), Sable Island (2003, 2005–2007), Sydney (2000–2004).

Canada-wide Standard

Nova Scotia has been in the process of implementing and designating monitoring stations and reporting areas for Canada-wide Standard (CWS) achievement by 2010. We show data here for interest, but these three-year averages, having been generated prior to 2010, should not be related to formal achievement of the CWS. The $PM_{2.5}$ concentration for Halifax Regional Municipality (HRM) for the three periods during 2002–2006 was steady at 14 µg/m^3, and increased to 16 in 2007, which is below the CWS of 30 µg/m^3, (see table 3-5). There were insufficient data to calculate a corresponding value for Cape Breton Regional Municipality (CBRM). The three-year averages for non-reporting areas (non-CMA locations) are included to provide a more complete provincial picture. All values are below the CWS. (See also Appendix 4.4.)

Table 3-5 $PM_{2.5}$, levels in the form of the CWS target, 2000–2007 (µg/m^3)

Community Name	2000-2002	2000-2003	2002-2004	2003-2005	2004-2006	2005-2007
Census Metropolitan Areas (CMAs)						
Cape Breton Regional Municipality (CBRM)	-	-	-	-	-	-
Halifax Regional Municipality (HRM)	-	-	14	14	14	16
Stations in other areas						
Kejimkujik National Park (TEOM)	22	22	-	-	14	15
Pictou (BAM)		-	-	-	-	-
Sable Island (BAM)		-	25*	25*	-	-

Note: For each averaging period, this chart shows annual 98th percentile 24-hour-average $PM_{2.5}$ concentration averaged over three consecutive years (see CWS input criteria, table 2-2).

Insufficient data available from CBRM (2000-2007), HRM (2000-2003), Kejimkujik National Park (2002-2005), Pictou (2001-2007), Sable Island (2001-2003, 2004-2007).

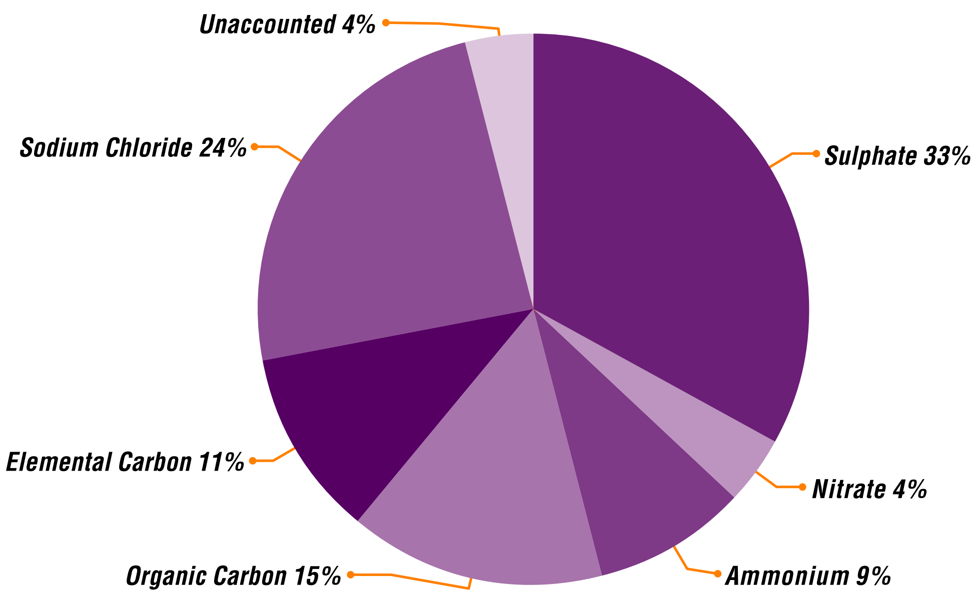
*In 2003, the Sable Island annual 98th percentile (32µg/m^3) exceeded the CWS (30µg/m^3) and was included in the three year average for 2002–2004 and 2003–2005, even though the annual data set was incomplete.

Results – Intermittent Monitoring of $PM_{2.5}$ and PM_{10}

Speciation Sampler

The speciation sampler in Halifax is a filter-based monitor that measures the composition of particles in air samples. Samples are collected once every 3 days for 24 hours, according to a schedule established by the National Air Pollution Surveillance Network (NAPS). The samples are analysed for concentrations of ammonium (NH_4^+), elemental carbon (EC), nitrate (NO_3), organic carbon (OC), sodium chloride (NaCl), and sulphate (SO_4). $PM_{2.5}$ samples collected in Halifax contain mostly sulphate and sodium chloride, as well as organic carbon, elemental carbon, ammonium, nitrate and sodium chloride, as shown in figure 3-10.

Figure 3-10 Composition of $PM_{2.5}$ in Halifax, 2007



Source: Environment Canada
Note: "Unaccounted" mass could be soil, metals, particle-bound water, or other elements or compounds not analysed for.

Dichotomous Sampler

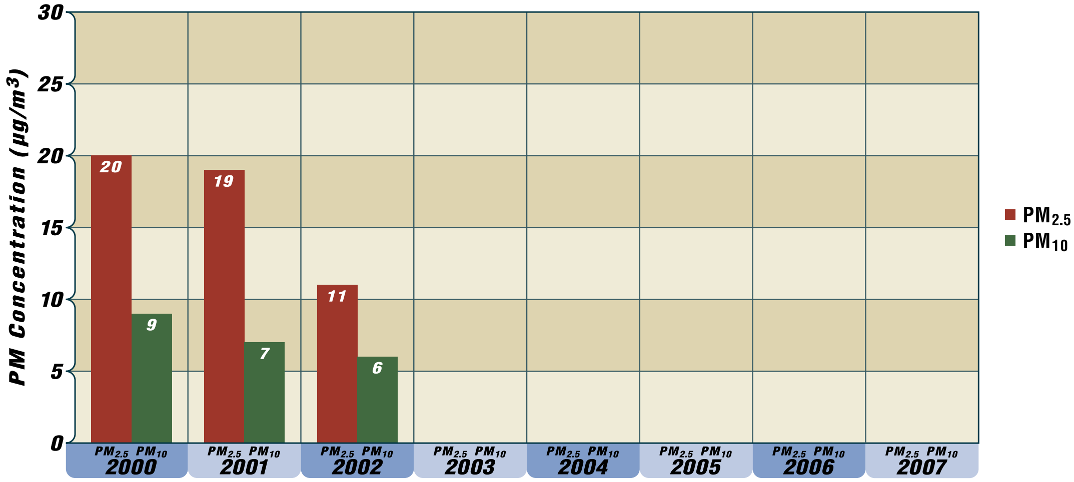
The dichotomous sampler measures the mass concentration (micrograms of particles per cubic metre of air) in two different size fractions: $PM_{2.5}$ (particles with aerodynamic diameter less than or equal to 2.5 µm) and PM_{10} (aerodynamic diameter less than or equal to 10 µm). The fraction between them is known as $PM_{2.5-10}$ (greater than 2.5 µm and less than or equal to 10 µm).

These samples contain many different types of particles, such as lead and sulphate. The samples are also analysed for the $PM_{2.5}$ and PM_{10} concentrations of the metals listed in Appendix 4.5.

Twenty-four-hour Average

The maximum 24-hour $PM_{2.5}$ and PM_{10} levels from 2000 to 2003 are shown in figure 3-11. For charts of the mass concentration and composition for each 24-hour reading, see Appendix 4.6. Of the two sites with dichotomous samplers, Kejimkujik National Park and Halifax, only Kejimkujik had sufficient data over the period.

Figure 3-11 Annual maximum 24-hour concentration of $PM_{2.5}$ and PM_{10}, 2000-2003, at Kejimkujik National Park.



Note: Insufficient data available from Kejimkujik National Park (2003). Data for 2004-2007 are not yet available.

Annual Average

Annual average fine particulate levels from 2000 to 2007 are shown in table 3-6. The dichotomous sampler was not in operation in Halifax from 2003 through 2005, and 2007. It was moved from the Daltech building to the Johnston building in 2006.

Table 3-6 Annual average 24-hour concentrations of $PM_{2.5}$ and PM_{10}, 2000–2007 (µg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Halifax ($PM_{2.5}$)		-	-				-	
Halifax (PM_{10})		-	-				-	
Kejimkujik National Park ($PM_{2.5}$)	4 (4)	5 (5)	3 (2)	-				
Kejimkujik National Park (PM_{10})	3 (2)	3 (1)	2 (1)	-				

Note: The dichotomous sampler was not in operation in Halifax from 2003 through 2005 and was moved from the Daltech building to the Johnston building in 2006.

Note: Insufficient data available from Halifax (2001-2002, 2006), and Kejimkujik National Park (2003). Data from Kejimkujik National Park for 2004-2007 are not yet available. Standard deviation in parentheses.

Results – Monitoring of Total Suspended Particulate (TSP)

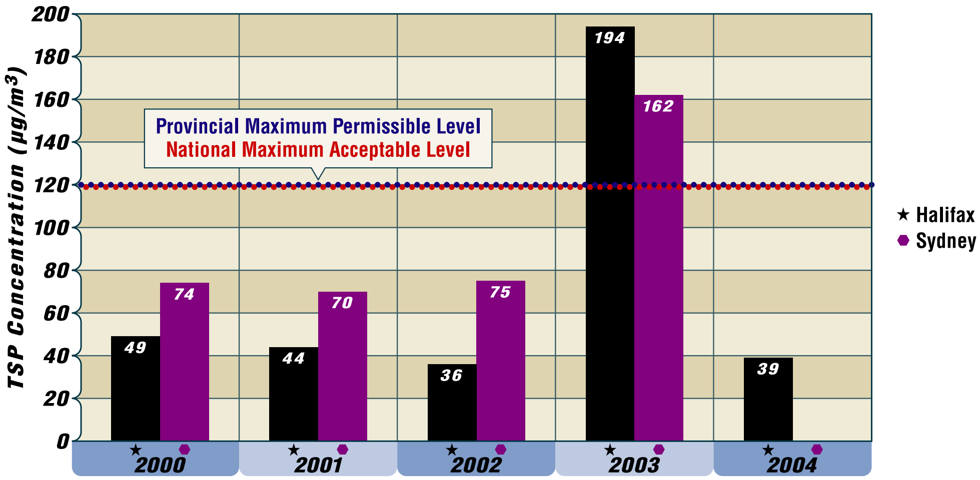
Summary

Nova Scotia has been moving from filter-based monitoring of TSP to continuous monitoring of fine particulate matter ($PM_{2.5}$).

Twenty-four-hour Average

The highest 24-hour concentrations each year are shown in figure 3-12 and in Appendix 4.2. Total suspended particulate levels were higher than the maximum permissible and acceptable levels (120 µg/m^3) only once at each station in 2003. In Sydney the highest TSP was 162 µg/m^3 on February 26, 2003. In Halifax the highest TSP was 194 µg/m^3 on May 21, 2003.

Figure 3-12 Annual maximum 24-hour average TSP concentration, 2000–2004

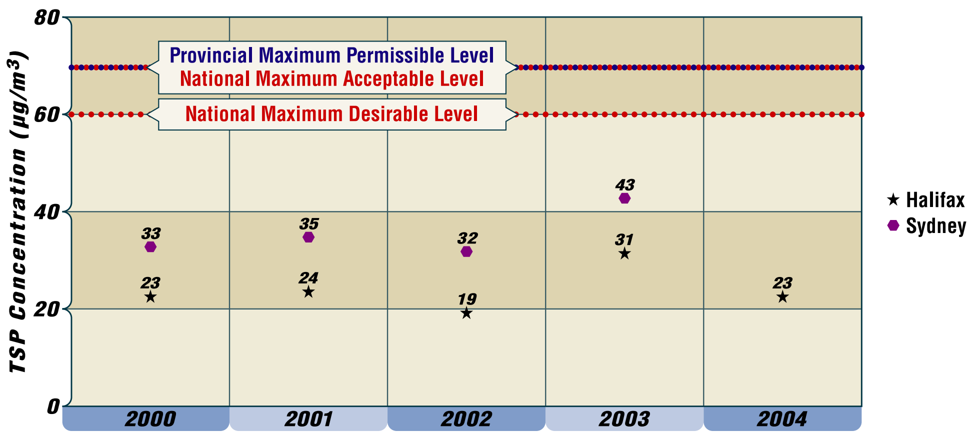


Note: TSP monitoring ended in Halifax in 2004, and in Sydney in 2003.

Annual Average

Annual average total suspended particulate matter levels were well below provincial standards and national objectives (70 µg/m^3) as shown in figure 3-13 and Appendix 4.3. Annual averages were higher in Sydney than in Halifax.

Figure 3-13 Annual average TSP concentration, 2000–2004



Note: TSP monitoring ended in Halifax in 2004, and in Sydney in 2003.

Carbon Monoxide (CO)

Monitoring Stations

Carbon monoxide has been continuously monitored in Halifax since 1990 (see table 3-7). A monitor in Sydney started in 2005.

Figure 3-14 CO monitors in Nova Scotia, 2000–2007

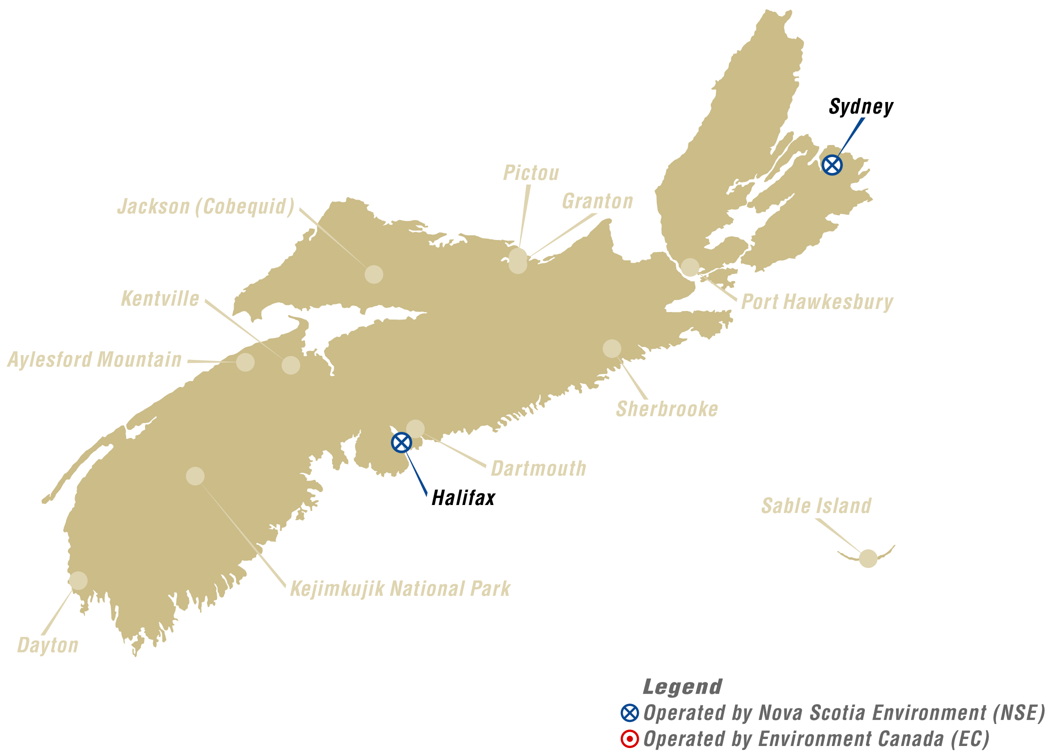


Table 3-7 CO monitors in Nova Scotia, 2000–2007

Station	Start Date	Site Operator
Halifax	1990	NSE
Sydney	September 2005	NSE

Standards and Objectives

The provincial one-hour maximum acceptable level of CO is 30 ppm. Nationally, the one-hour maximum acceptable level of carbon monoxide is 31 ppm, and the one-hour maximum desirable level is 13 ppm (see section 2, table 2.1). The provincial eight-hour maximum permissible level of carbon monoxide is 11 ppm. Nationally, the eight-hour maximum acceptable level of carbon monoxide is 13 ppm and the eight-hour maximum desirable level is 5 ppm. Annual permissible or acceptable levels have not been established.

Results – Monitoring of Carbon Monoxide (CO)

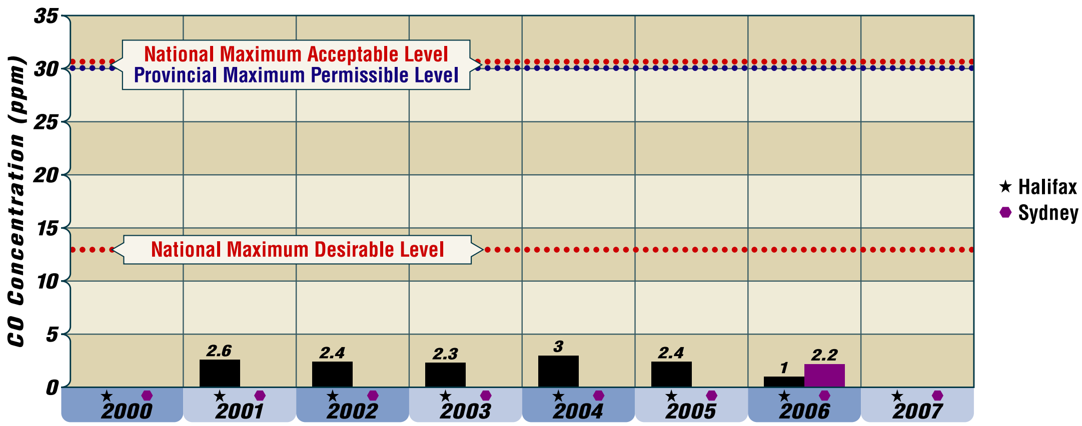
Summary

Carbon monoxide levels in Halifax and Sydney were well below provincial standards and national objectives for the period.

One-hour Average

One-hour average CO levels in Halifax and Sydney did not exceed provincial standards and national objectives. Highest one-hour concentrations were well below provincial standards and national objectives (see figure 3-15 and Appendix 5.2). Annual data summary charts in Appendix 5.4 show, for each station, monthly one-hour maximum and average concentrations, and distribution of concentration levels.

Figure 3-15 Annual maximum one-hour average CO concentration, 2000–2007

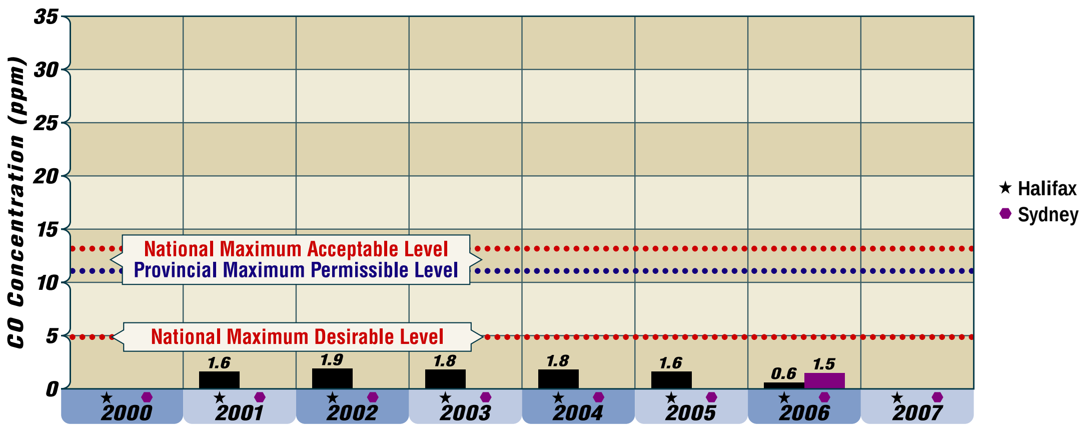


Note: Insufficient data available for Halifax (2000, 2007) and Sydney (2005, 2007).

Eight-hour Average

The highest eight-hour concentrations were well below provincial standards and national objectives (see figure 3-16).

Figure 3-16 Annual maximum eight-hour average CO concentration, 2000–2007



Note: Insufficient data available for Halifax (2000, 2007) and Sydney (2005, 2007).

Annual Average

Annual average CO levels from 2000 to 2007 were less than 1 ppm (see Appendix 5.3).

Nitrogen Dioxide (NO_2)

Monitoring Stations

Nitrogen dioxide has been continuously monitored in Halifax since 1990 (see figure 3-17 and table 3-8). Three other stations have been established since 2003.

Figure 3-17 NO_2 monitors in Nova Scotia, 2000–2007

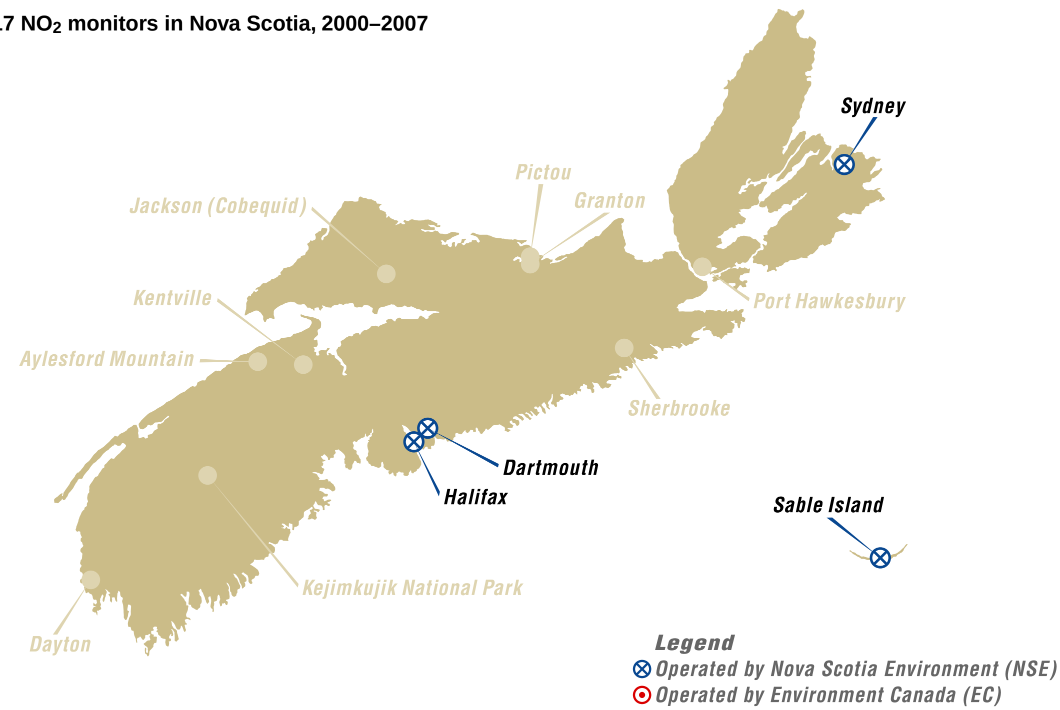


Table 3-8 NO_2 monitors in Nova Scotia, 2000–2007

Station	Start Date	Site Operator
Dartmouth	July 2006	NSE
Halifax	1990	NSE
Sable Island	June 2003	NSE
Sydney	November 2005	NSE

Standards and Objectives

The provincial one-hour maximum permissible level and the national one-hour maximum acceptable level for NO_2 is 210 ppb. A national one-hour maximum desirable level has not been established. The provincial annual maximum permissible level and the national annual maximum acceptable level of nitrogen dioxide is 50 ppb, and the national maximum annual desirable level is 30 ppb (see table 2.1).

Results – Monitoring of Nitrogen Dioxide (NO_2)

Summary

Nitrogen dioxide comes from vehicle emissions. Therefore, there are higher levels of NO_2 in urban areas because there is more traffic, and levels are highest during rush hour. Levels of NO_2 in Halifax and on Sable Island were well below provincial standards and national objectives. Recently established sampling sites in Dartmouth and Sydney had insufficient data for this report. Halifax also reported insufficient data for the years 2001–2005, Sable Island for 2003 and 2005.

One-hour Average

For the three reporting sites, NO_2 levels were well below provincial standards and national objectives. (see table 3-9). Annual data summary charts in Appendix 6.4 show, for each station, monthly one-hour maximum and average concentrations, and distribution of concentration levels.

Table 3-9 Annual maximum one-hour average NO_2 concentration, 2004–2007 (ppb)

Station	2004	2005	2006	2007
Halifax	-	-	67	58
Sable Island	16	-	24	20

Note: Insufficient data available from, Halifax (2004-2005), Sable Island (2005).

Time of Day Variations

Diurnal variations in average NO_2 concentrations in Halifax, Dartmouth, and Sable Island (2007) are shown in figure 3-18. In Halifax, NO_2 levels are higher during the morning (7 am to 10 am) and afternoon rush hours (3 pm to 6 pm) due to higher levels of nitric oxide emitted by vehicles during these times. Figure 3-19 illustrates the difference in NO_2 levels between weekdays and weekends.

Figure 3-18 Diurnal variation of NO_2 concentration at three sites, 2007

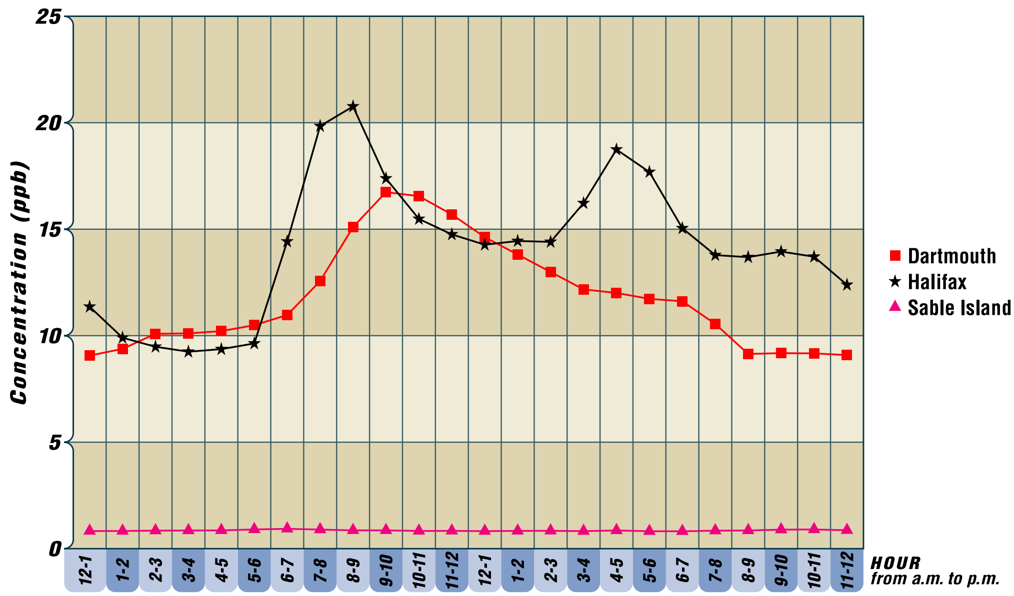
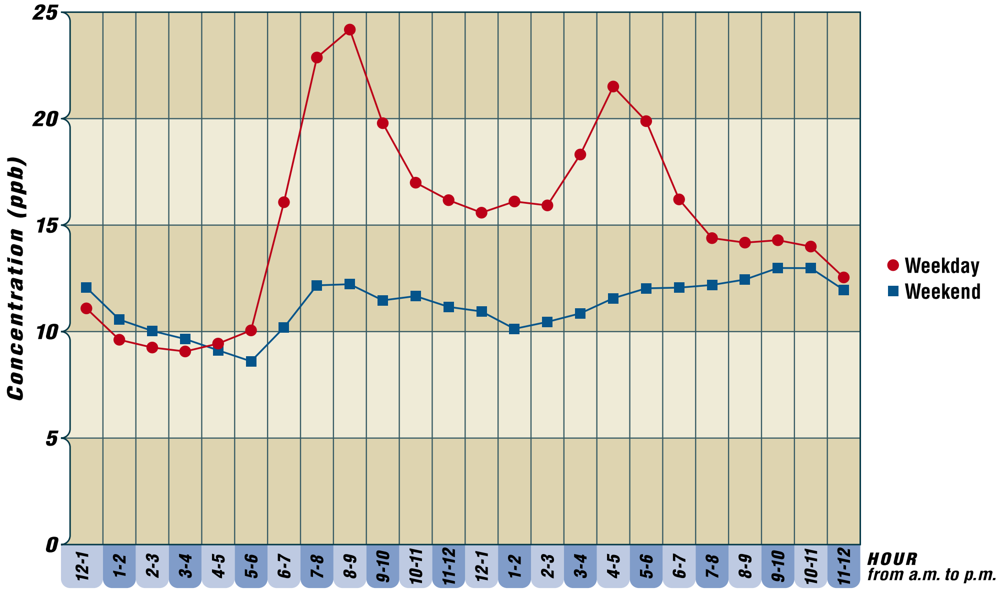


Figure 3-19 Comparison of diurnal weekday and weekend NO_2 concentrations in Halifax, 2007



Annual Average

Annual average concentrations were well below provincial standards and national objectives (see table 3-10 and Appendix 6.3).

Table 3-10 Annual average one-hour concentration of NO_2, 2004–2007 (ppb)

Station	2004	2005	2006	2007
Halifax	-	-	16	14
Sable Island	1	-	0	1

Note: Insufficient data available from, Halifax (2004-2005), Sable Island (2005).

Sulphur Dioxide (SO_2)

Monitoring Stations

Sulphur dioxide monitors have operated in Nova Scotia since 1974 in areas where there are local emission sources (see figure 3-20 and table 3-11). These monitors continuously measure the amount of SO_2 in the air. The monitor on Sable Island measures SO_2 one hour and hydrogen sulphide the next.

Figure 3-20 SO_2 monitors in Nova Scotia, 2000–2007

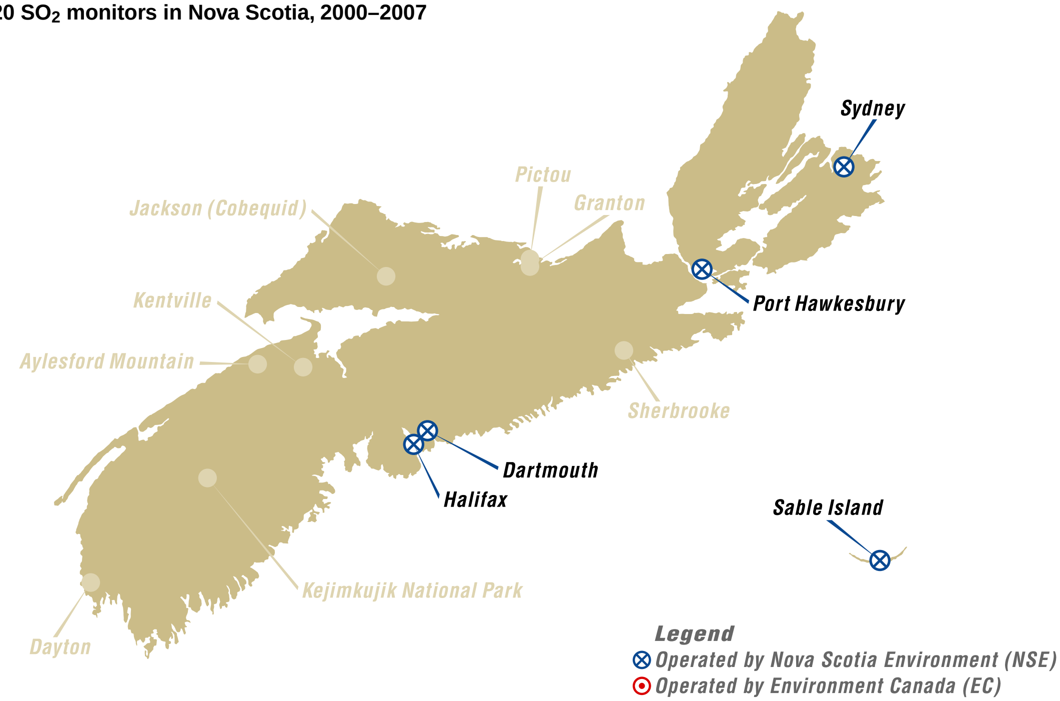


Table 3-11 SO_2 monitors in Nova Scotia, 2000–2007

Station	Start Date	Site Operator
Dartmouth	2005	NSE
Halifax	1990	NSE
Port Hawkesbury	1994	NSE
Sable Island	December 2003	NSE
Sydney	1974	NSE

Standards and Objectives

The provincial one-hour maximum permissible level and the national one-hour maximum acceptable level of SO_2 is 340 ppb. Nationally, the one-hour maximum desirable level of SO_2 is 170 ppb. The provincial twenty-four-hour maximum permissible level and the national twenty-four-hour maximum acceptable level of SO_2 is 110 ppb. Nationally, the twenty-four-hour maximum desirable level of SO_2 is 60 ppb.
The provincial annual maximum permissible level and the national annual maximum acceptable levels of SO_2 are 20 ppb. The national annual maximum desirable level is 10ppb (see section 2, table 2.1).

Results – Monitoring of Sulphur Dioxide (SO_2)

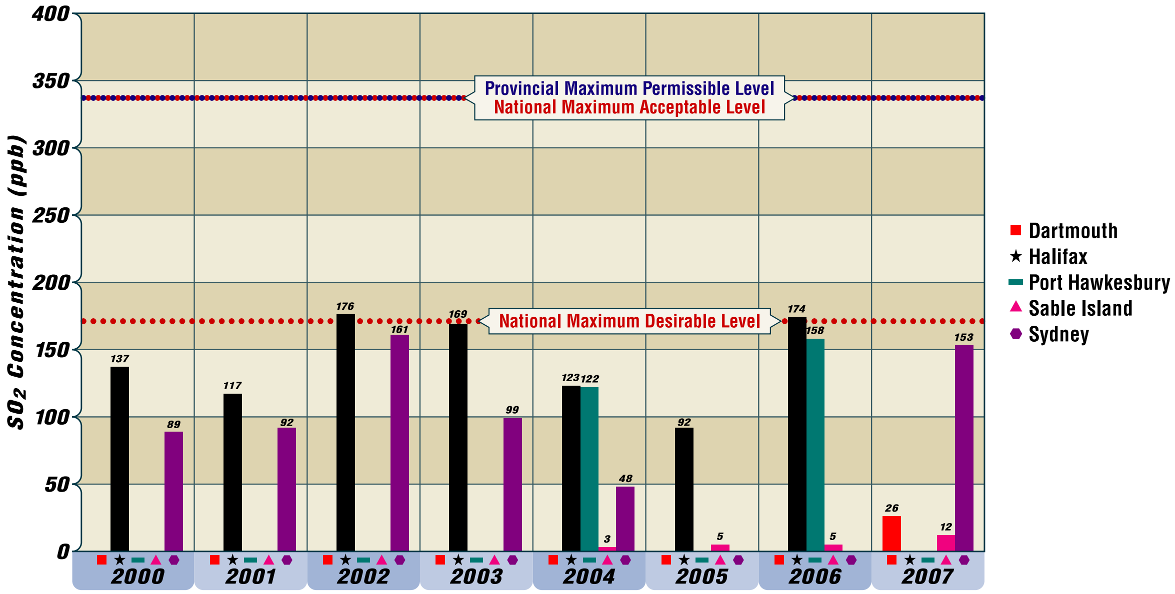
Summary

Sulphur dioxide levels were almost always lower than the standards and objectives from 2000 to 2007. Only in Halifax were levels higher than the hourly national maximum *desirable* level (170 ppb) for only two hours, and the annual national maximum *desirable* level (10 ppb) for two years in 2001 and 2002.

One-hour Average

One-hour average concentration of SO_2 did not exceed the permissible level anywhere in the province (see figure 3-21 and Appendix 7.2). On only two occasions did the level of SO_2 in Halifax slightly exceed the national maximum desirable level: October 7, 2002 at 1 pm (176 ppb) and April 15, 2006 at 10 am (174 ppb).

Figure 3-21 Annual maximum one-hour average SO_2 concentration, 2000–2007

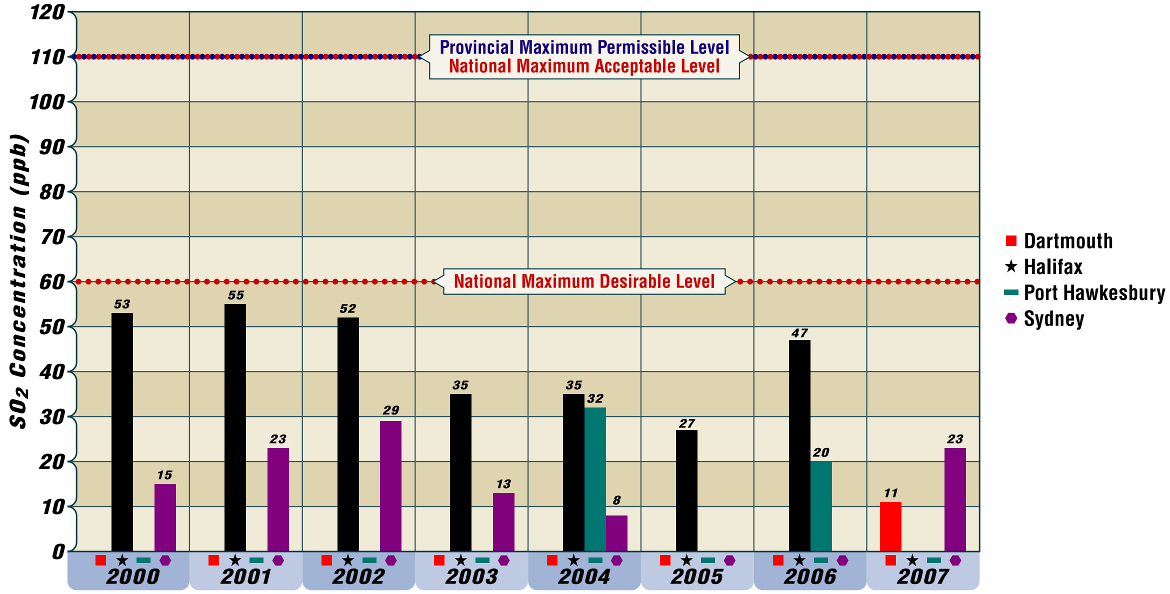


Note: Insufficient data available from Dartmouth (2006), Halifax (2007), Port Hawkesbury (2005, 2007), Sable Island (2003), Sydney (2005-2006).

24-hour Average

The highest 24-hour concentrations were below provincial standards and national objectives (see figure 3-22 and Appendix 7.2).

Figure 3-22 Annual maximum 24-hour average SO_2 concentration at four sites, 2000–2007

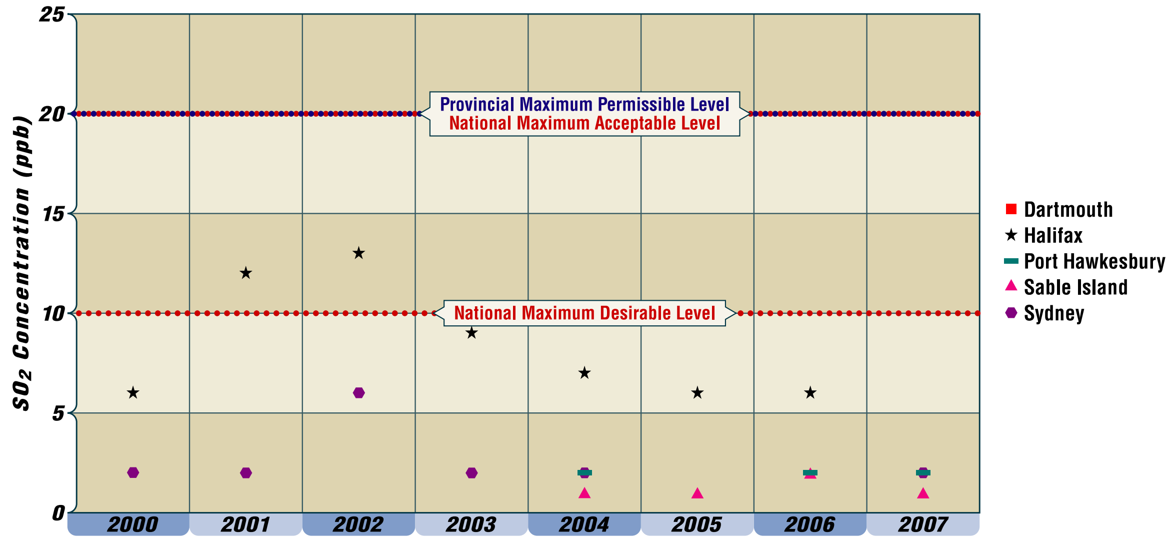


Note: Insufficient data available from Dartmouth (2006), Halifax (2007), Port Hawkesbury (2005, 2007), Sydney (2005-2006).

Annual Average

Levels of SO_2 at all stations were below the standards and objectives. The annual average in Halifax was higher than other locations and in 2001 and 2002 exceeded the national annual maximum desirable level (see figure 3-23 and Appendix 7.3).

Figure 3-23 Annual average SO_2 concentration, 2000–2007



Note: Insufficient data available from Dartmouth (2006), Halifax (2007), Port Hawkesbury (2005, 2007), Sable Island (2003), Sydney (2005-2006).

Volatile Organic Compounds (VOCs)

Monitoring Stations

Volatile organic compounds were monitored on an intermittent basis at three stations (see figure 3-24 and table 3-12). Air samples were collected in a canister once every 6 days for 24 hours, according to a schedule established by the National Air Pollution Surveillance (NAPS) network. The samples were sent to a lab to determine concentrations of benzene, toluene, tetrachloroethylene, dichloromethane, 1,1,1-trichloroethane, and 1,3-butadiene, among others listed in Appendix 8.2.

Figure 3-24 VOC monitors in Nova Scotia, 2000–2007

Table 3-12 VOC monitors in Nova Scotia, 2000–2007

Station	Start Date	Site Operator
Granton	April 2006	NSE
Halifax	1990	NSE
Kejimkujik National Park	1994	EC

Standards and Objectives

There are no official standards or objectives for VOCs.

Results–Volatile Organic Compounds (VOCs)

Summary

The following tables (3-13–3-18) show the annual average concentrations and standard deviations of six measured VOCs in Granton, Halifax, and Kejimkujik National Park. Insufficient data were available for Halifax for 2000 and 2001. Granton began operating in April 2006.

Benzene

Table 3-13 Annual average concentration of Benzene, 2000–2007 (µg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Granton							0.2 (0.1)	0.2 (0.2)
Halifax	-	-	1.5 (0.6)	1.6 (1)	1.4 (0.6)	1.1 (0.5)	0.9 (0.3)	0.9 (0.3)
Kejimkujik National Park	0.3 (0.2)	0.2 (0.1)	0.3 (0.2)	0.3 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)

Source: NAPS **Note:** Standard deviation in parentheses

Toluene

Table 3-14 Annual average concentration of Toluene, 2000–2007 (µg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Granton							0.5 (0.5)	1.7 (2.1)
Halifax	-	-	3.8 (2)	3.8 (2.3)	6 (10.2)	4.4 (13.5)	2.4 (1.1)	2.5 (2.7)
Kejimkujik National Park	0.3 (0.8)	0.1 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.2)	0.2 (0.6)	0.1 (0.2)	0.2 (0.6)

Source: NAPS **Note:** Standard deviation in parentheses

Tetrachloroethylene

Table 3-15 Annual average concentration of Tetrachloroethylene, 2000–2007 (µg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Granton							0 (0)	0.2 (0.8)
Halifax	-	-	0.2 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Kejimkujik National Park		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: NAPS **Note:** Standard deviation in parentheses

Dichloromethane

Table 3-16 Annual average concentration of Dichloromethane, 2000–2007 (µg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Granton							0.1 (0)	0.2 (0.1)
Halifax	-	-	0.7 (2.2)	0.8 (2.7)	3 (9.6)	0.7 (2.7)	0.3 (0.1)	0.3 (0.1)
Kejimkujik National Park	(0.1)	0.1 (0)	0.1 (0)	0.2 (0)	0.2 (0.1)	0.2 (0)	0.2 (0.2)	0.2 (0)

Source: NAPS **Note:** Standard deviation in parentheses

1,1,1-Trichloroethane

Table 3-17 Annual average concentration of 1,1,1-Trichloroethane, 2000–2007 (μg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Granton							0.1 (0)	0.1 (0.0)
Halifax	-	-	0.2 (0)	0.2 (0)	0.1 (0)	0.1 (0)	0.1 (0)	0.1 (0)
Kejimkujik National Park	0.3 (0)	0.2 (0)	0.2 (0)	0.2 (0)	0.1 (0)	0.1 (0)	0.1 (0)	0.1 (0)

Source: NAPS **Note:** Standard deviation in parentheses

1,3-Butadiene

Table 3-18 Annual average concentration of 1,3-Butadiene, 2000–2007 (μg/m³)

Station	2000	2001	2002	2003	2004	2005	2006	2007
Granton							0 (0)	0 (0)
Halifax	-	-	0.3 (0.1)	0.3 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)	0.1 (0)
Kejimkujik National Park	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: NAPS **Note:** Standard deviation in parentheses

Acid Precipitation

Monitoring Stations

Acid precipitation was monitored at three stations in Nova Scotia (see figure 3-25 and table 3-19).

Figure 3-25 Acid precipitation monitors in Nova Scotia, 2000–2007

Table 3-19 Acid precipitation monitors in Nova Scotia, 2000–2007

Station	Start Date	Site Operator
Jackson (Cobequid)	1977	EC
Kejimkujik National Park	1983	EC
Sherbrooke	1996	NSE

Standards and Objectives

The critical load is the amount of deposition that an ecosystem can accept before long-term harmful effects occur. Before 2004, the only critical load threshold value available for acid deposition was for lakes and based on wet deposition for sulphur components only. In Nova Scotia the critical load for lakes was estimated to be 8 kg of sulphate per hectare per year.

New critical load estimates for sulphur and nitrogen and for both wet and dry deposition were introduced in 2004 in the Canadian Acid Deposition Science Assessment 2004 (Environment Canada, Meteorological Service, 2004). The new estimates were developed based on steady-state models and are expressed in equivalences per hectare per year.

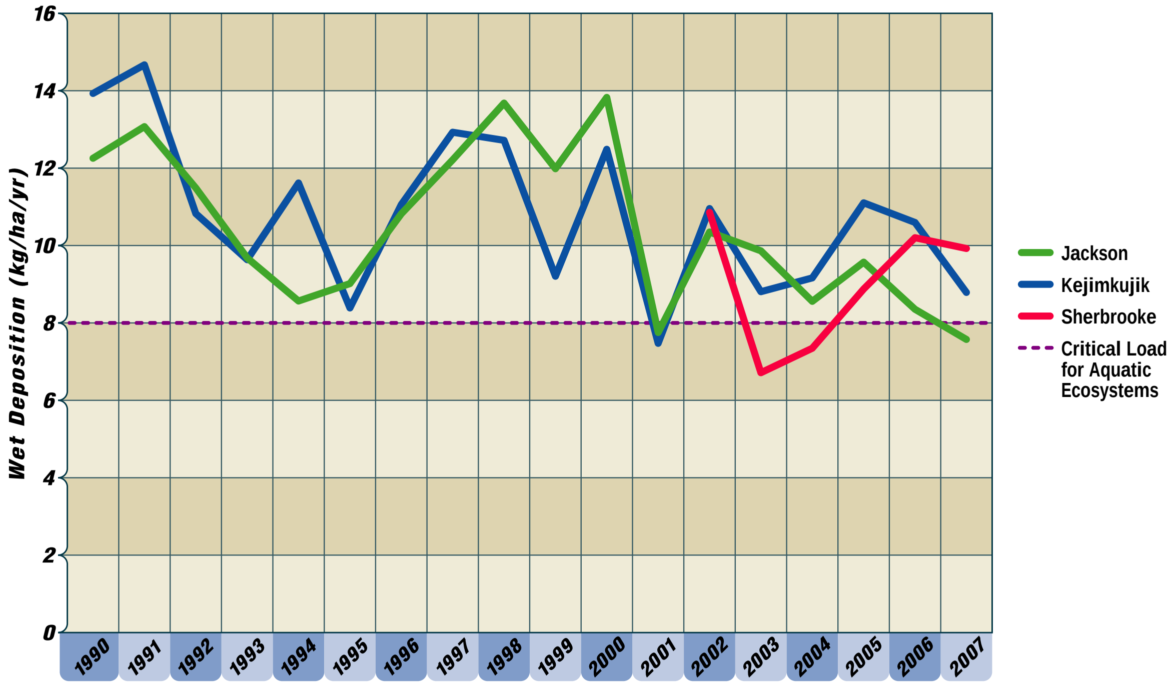
In this report we use the pre-2004 critical load (8 kg/ha/y) as the standard for comparison. In subsequent reports, the new critical load estimates will be used.

Results–Acid Precipitation

Summary

Figure 3-26 shows the results for wet sulphate deposition for the period 1990 to 2007. With the exception of 2001 at both the Jackson and Kejimkujik sites, 2003–2004 at the Sherbrooke site, and Jackson in 2007, the annual wet sulphate deposition was above the critical-load threshold. Deposition rates at all three sites followed a similar pattern, ranging over the 15 years from lows of 7–8 kg/ha/y to highs of 13–14 kg/ha/y.

Figure 3-26 Annual sea-salt corrected sulphate deposition in Nova Scotia, 1990–2007



Source: Environment Canada, Canadian National Atmospheric Chemistry (NAtChem) Database, www.msc.ec.gc.ca/natchem/precip/index_e.html

Glossary

Acid deposition
The end product of reactions between sulphur oxides, nitrogen oxides, and water in the atmosphere. Acid deposition reaches the earth as precipitation (wet deposition: acid rain, fog, snow) and as gases, acid aerosols, and particles (dry deposition or sedimentation).

Acidification
The process of changing into an acid or becoming more acidic (i.e., having lower pH). For example, acid rain causes soils and lakes to acidfy.

Acid rain
(see acid deposition)

Air Quality and Health Advisory
A warning to the public that air quality will be poor. This allows people to plan their activities to reduce the risk of exposure to air pollutants for themselves or those under their care. Also see Special Air Quality Statements.

Ambient air quality
Outdoor air quality. It does not refer to indoor air or to emissions discharged from a source (such as a stack or a vehicle).

Ambient monitoring
Measurement of pollutants in outdoor air.

Atmosphere
The mass of air surrounding the earth. It is composed of approximately 78% nitrogen (N_2), 21% oxygen (O_2), 0.9% argon (Ar), 0.04% carbon dioxide (CO_2), and trace amounts of other gases.

Buffering capacity
The ability to resist changes in pH. Buffering capacity in soil and water depends on the presence of naturally occurring compounds that help to counteract the harmful effects of acid rain. If these compounds are not abundant or have already buffered to their maximum capacity, the soil or water has low buffering capacity and the soil and water acidifies more rapidly.

Carbon dioxide (CO_2)
A colourless, odourless gas. CO_2 is present in the atmosphere at about 0.038% by volume. Since the Industrial Revolution, atmospheric CO_2 levels have increased by about 31%. It is the most common greenhouse gas.

Carbon monoxide (CO)
A poisonous, colourless, odourless, and tasteless gas, generated through combustion processes.

Common air pollutants
Contaminants such as ground-level ozone, particulate matter, sulphur dioxide, nitrogen oxides, volatile organic compounds, and carbon monoxide. Some common air pollutants are emitted directly, while others such as ozone may be formed through chemical reactions of precursor (primary) air pollutants.

Criteria air contaminants (CACs)

Key primary air pollutants emitted directly from a number of sources (including industrial production, fuel combustion, transportation vehicles, incineration, dust from paved and unpaved roads, forest fires) that contribute to air pollution and affect human health. In Canada, CACs include common air pollutants. Pollutants defined as CACs may differ among countries and jurisdictions.

Critical load

The amount of acid deposition that an ecosystem can accept before long-term harmful effects occur. The critical load threshold for acid deposition to lakes in Nova Scotia is 8 kg of sulphate per hectare per year, based on wet deposition only. New critical load estimates for sulphur and nitrogen for both wet and dry deposition are being developed based on recent scientific studies.

Fine particulate matter ($PM_{2.5}$)

Very small particles less than 2.5 microns (µm) in diameter. These particles can find their way past our natural defences (nose hair and mucus) and end up deep in our lungs.

Fine particulate matter (PM_{10})

Very small particles less than or equal to 10 microns (µm) in diameter.

Fossil fuels

Hydrocarbons formed from the remains of ancient plant and animal life. They include coal, oil, natural gas, and their derivatives.

Greenhouse Gases

Chemical compounds in the atmosphere that trap heat in the atmosphere by absorbing infrared energy radiated by the earth's surface and radiating it back to earth. Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halocarbons, and sulphur hexafluoride (SF_6).

Halocarbons

Chemicals that contain carbon plus chlorine, fluorine, or bromine. Halocarbons can be toxic at very high levels. They include chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). They are created by human activities and act as greenhouse gases.

Haze

Small particles in ambient air that reduce visibility.

Hydrogen sulphide (H_2S)

A colourless gas that smells like rotten eggs at low concentrations. At high concentrations H_2S is odourless and highly poisonous.

Lead (Pb)

A soft, malleable, dense, and toxic metallic element.

Mercury (Hg)

A silvery metallic, toxic element that is liquid at standard temperature and pressure. It is present naturally in the environment but is also released by human activity.

Methane (CH_4)

A colourless, odourless, flammable gas. CH_4 is the main constituent of natural gas and is a potent greenhouse gas.

Neutralize
Create a neutral solution (with a pH of 7) by adding acid to reduce alkalinity, or by adding alkali (e.g., lime) to reduce acidity. Acid precipitation can be neutralized if there is enough alkalinity in the water or soil. See buffering capacity.

Nitric oxide (NO)
A colourless, toxic gas that combines with oxygen in the atmosphere to form nitrogen dioxide. NO is a common constituent of automobile and power plant emissions.

Nitrogen dioxide (NO_2)
A reddish-brown poisonous gas produced when nitric oxide combines with oxygen.

Nitrogen oxides (NO_x)
Gases that include nitric oxide and nitrogen dioxide. In the presence of sunlight, NO_x react with volatile organic compounds to form the smog component ozone. NO_x can also combine with ammonia to form secondary particulate.

Nitrogen oxides (NO_x)
A colourless, sweet-tasting gas. N_2O is a greenhouse gas.

Ozone (O_3)
A poisonous gas made up of three atoms of oxygen bonded together. In the stratosphere, naturally occurring ozone protects us from harmful ultraviolet rays (see stratospheric ozone layer). In the lower atmosphere, ground-level ozone is a pollutant that can damage lungs and vegetation (see smog). Pollutant emissions destroy stratospheric ozone and make more ground-level ozone.

Ozone-depleting substances (ODS)
Manufactured chemicals that contain chlorine or bromine, are gases when not under pressure, and when released at the earth's surface are stable enough to be transported into the stratosphere before they start to break down. When ODS break down, chlorine and bromine help to accelerate the natural destruction of ozone molecules and the thinning, or depleting, of the ozone layer. Among the most potent ODS are chlorofluorocarbons (CFCs), which are used in refrigeration, foams, and solvents and halons, which are used to suppress fires. Other ODS include hydrochlorofluorocarbons, carbon tetrachloride, methyl bromide, and methyl chloroform. Countries around the world are working to eliminate the production and use of ODS in an effort to protect the ozone layer.

Ozone layer
A relative concentration of ozone located in the stratosphere, 15 to 35 km above the earth's surface. About 90% of the ozone in the atmosphere is concentrated in the ozone layer, where ozone is constantly being created and destroyed by natural processes. The ozone absorbs ultraviolet (UV) radiation from the sun, which is harmful to life on earth. Certain synthetic chemicals accelerate the destruction of ozone, causing the ozone layer to become thinner (see ozone-depleting substances) and allowing more harmful UV to reach the earth.

Particulates* or *particulate matter
See total suspended particulate or fine particulate matter.

pH
A measurement of the acidity or alkalinity of a solution. On the pH scale of 0 to 14, a pH of 7 is neutral, a pH below 7 has increasing acidity as the number decreases, and a pH above 7 has increasing alkalinity as the number increases.

Polluter pays principle
The belief that those who pollute should pay for the costs their activities impose on society.

Secondary particulate
Particulate matter that is not emitted directly from stationary or mobile sources but is formed within the atmosphere as a result of reactions between other pollutants.

Smog
The mixture of pollutants in the air that we breathe. The main contributors to smog in Nova Scotia are ground-level ozone and fine particulate matter.

Smog advisory
See Air Quality and Health Advisory.

Smog forecast
See air quality forecast.

Special air quality statements
Warnings issued to the public when unusual large-scale air quality–related events (such as smoke from large forest fires) are forecast or are already in progress in the region.

Sulphate
A salt of sulphuric acid.

Sulphate deposition
See acid deposition.

Sulphur dioxide (SO_2)
A colourless, poisonous gas. It is the major precursor to acid rain in Nova Scotia.

Total particulate matter (TPM)
See total suspended particulate.

Total suspended particulate (TSP)
Particles in the air such as smoke, soot, dust, and aerosols that remain suspended and do not settle out easily. TSP includes particles with a diameter less than 100 µm in diameter.

Volatile organic compounds (VOCs)
Substances that produce vapours at normal temperatures. VOCs can react with nitrogen oxides in the presence of sunlight to form ground-level ozone, a major component of smog.

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