

Air Quality in Selected Binational Great Lakes Urban Regions **(Detroit-Windsor, Port Huron-Sarnia, and Sault Ste. Maries)**

A Report from the
International Air Quality Advisory Board
to the
International Joint Commission

February 2004

ISBN 1-894280-44-X

Cover photography: Three binational urban areas by Marge Beaver,
Photography Plus; Mackinaw Bridge by Mackinaw Bridge Authority

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EXECUTIVE SUMMARY

In its charge to the International Air Quality Advisory Board, the International Joint Commission requested an overview of the issues, control programs and binational or other cooperative efforts underway focused on transboundary air quality in the Detroit-Windsor, Port Huron-Sarnia and Sault Ste. Marie (Michigan and Ontario) locales.

In response, recognizing the longstanding Commission interest in both common and hazardous air pollutants in two of these locales, the Board has secured and analyzed data on ambient concentrations of ozone, particulate matter, sulphur dioxide, nitrogen oxides and total reduced sulphur, as well as concentrations and emissions of selected hazardous air pollutants in the three regions.

Based on the partial data available, elevated concentrations of common air pollutants, particularly ozone and particulate (constituents of smog) continue to occur with some frequency, particularly in the summer months, in the three regions, adversely affecting human health, particularly among sensitive subpopulations (asthmatics, youth, the elderly).

The regional contribution to smog concentrations is significant; the most recent Canada US Air Quality Agreement has recognized that these three locales are within the area requiring a joint PEMA (Pollution Emission Management Area) or regional approach to air quality management. However, the local contribution of both mobile and stationary point and areal sources is also substantial, particularly in the Detroit-Windsor and Sarnia-Port Huron locales and sizable reductions in these inputs also appear necessary to markedly reduce the deleterious impact on public health.

With regard to hazardous air pollutants (HAPs), a review of available emissions data for the three locales indicates that, in the case of Detroit-Windsor and Port Huron-Sarnia, emissions of many of the HAPs considered by the Commission in its 1991 Study appear to have been reduced; however, trichloroethylene and xylene compounds remain at or above levels estimated in the earlier report. In the Sault region, there is particular concern regarding PAH emissions from the coke ovens of the Algoma Steel facility, and ambient concentrations associated with these emissions are being closely tracked.

Ambient concentrations of selected HAPs in Ontario were largely below the MOE guidelines; however, a review of the continued validity of some of the Ministry ambient guidelines appears appropriate. For example, carbon tetrachloride is the only HAP whose concentrations approach the provincial objective; however, that objective had been revised in 2001, from 600 $\mu\text{g}/\text{m}^3$ to 2.4 $\mu\text{g}/\text{m}^3$ over a 24-hour period. Several HAPs are also at concentrations in excess of those associated with the one-in-one-million life time cancer risk benchmark in the Clean Air Act. A reconsideration of other MOE guidelines for hazardous air pollutants in light of the US Clean Air Act benchmark and other more recent data would be timely.

The Greater Detroit area is one of 10 US urban communities in which an extensive monitoring program for ambient concentrations of selected HAPs has been completed. Evaluation of the data, including an assessment of the associated risk against the one in one million lifetime cancer benchmark in the US Clean Air Act, is underway.

In all cases, the existence of distinctly different air quality standards and guidelines under the federal, state and provincial regulators made a uniform assessment of prevailing air quality difficult. While the national standards and objectives for ozone and particulates have converged in the past few years, significant distinctions remain. In the case of hazardous air pollutants, the need for further review of some of the jurisdictional guidelines, as noted above, is also evident.

Findings

- i) While the data reviewed were not the most current nor comprehensive, it is clear that, in all three regions, during episodes that occur with some frequency, particularly in the summer months, smog (ozone and fine particulate) achieves levels that would affect the well being of the entire population and have an immediate, pronounced negative impact on the most sensitive elements of the populations – youth and the elderly. Similar conditions are evident in the past few years and appear to persist to this day.

- ii) The two southerly regions are the subject of a greater number of MOE smog alerts, while the northern locale has a higher annual average ozone concentration. Continued non conformance with the Ontario interim 24 hour PM10 objective and the annual Total Suspended Particulate ambient air quality criterion (AAQC) is evident in Sault Ste Marie Ontario, particularly at the monitoring site adjacent to the Algoma Steel facility. Concentrations of benzo-a-pyrene at this industrial site were also in excess of the provincial AAQC for this contaminant.
- iii) Sources of smog are both regional (Chicago-Quebec City corridor) and local (mobile, point and areal sources). Improvement in local and downwind air quality, particularly in the two southern locales, would require significant reductions from all local source segments, including gasoline and diesel powered vehicles in the mobile sector.
- iv) With regard to hazardous air pollutants (HAPs), of those tracked by the Commission in 1991, there is evidence that emissions of several of these may have declined over the ensuing period. However, emissions of trichloroethylene and xylene compounds appear to be at or above previous estimates. Many organic HAPs are Volatile Organic Compounds (VOCs) and, as such, also contribute to the formation of ozone. There is some evidence of particular HAPs in excess of the levels associated with the one-in-one-million lifetime cancer risk benchmark in the US Clean Air Act.
- v) Concentrations of hazardous air pollutants are more strongly associated with local sources and further regional reductions from both mobile and stationary sources would be required to lower these concentrations.
- vi) Additional assessment of the health impact of these HAPs individually is complicated by the differences among the various guidelines and standards prevailing among the jurisdictions; however, the risk assessment now underway under the US Ten City Study may offer some further guidance on this issue.
- vii) A more comprehensive overview of the current prevailing situation would require a joint co-ordinated effort by the federal, state and provincial agencies.

Recommendations

- i) Senior levels of the USEPA and Environment Canada should join with their counterparts in the State of Michigan and the Province of Ontario to provide a more comprehensive, current and joint overview of air quality in these three regions. Sharing of the most current information regarding routine sampling and monitoring results should be a part of this co-operative effort.
- ii) This same body should also commit to the development of an appropriate bilateral control strategy, considering both stationary and mobile sources of common air pollutants and HAPs, to achieve significant reductions in local and regional concentrations of those pollutants adversely affecting regional air quality.
- iii) The Commission should adopt the role of facilitating discussion and communication among the Parties and Jurisdictions in supporting the development of integrated monitoring programs and control strategies in these regions.
- iv) Continued development of a mechanism to compare air quality standards and guidelines for both common and hazardous air pollutants in transboundary airsheds is also recommended.
- v) The IJC should carefully track the US Urban HAPs Study currently underway in ten cities in the United States and assess the outcomes of this study, as these would have relevance could be applied in the three regions, particularly the two southern locales, as well as a vast majority of North American urban settings.

1.0 INTRODUCTION

1.1 History of the International Joint Commission Involvement in Detroit-Windsor/Port Huron-Sarnia Regions

The 1975 Reference to the Commission from the Governments of Canada and the United States led to the creation of the International Michigan-Ontario Air Pollution Board (the Board). The Reference requested the International Joint Commission, through this Board, report annually on the state of air quality in the Detroit-Windsor and Port Huron-Sarnia areas. Ambient air quality trends and emissions of sulphur dioxide, suspended particulates, and odours were to be the focus of these reports.

In 1983, the Commission noted that domestic regulatory programs and control strategies in the region(s), combined with the decommissioning of some older industrial facilities and the upgrading of pollution control systems at others, had resulted in significant improvements in levels of sulphur dioxide, particulates and odours. While noting these trends, the Commission informed the Governments that reporting solely on these three pollutants did not provide an adequate overview of the atmospheric environment for the region. However, the objectives of the Reference having essentially been met, the Commission informed the Governments of the effective completion of the Reference and the Commission disbanded the International Michigan-Ontario Air Pollution Board.

In 1988, the Commission was asked by the Governments to report on the hazards posed to human and environmental health from airborne emissions in the Detroit-Windsor region. The Commission formed the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region. Particular expertise on the impact of air pollution on human health was represented on this Board, to allow analysis of the impact of the emissions and concentrations of selected hazardous air pollutants in the two regions.

This latter Board identified a list of 125 chemicals for consideration and summarized emission and air monitoring data for these pollutants. Using this information, the Board was able to estimate how widespread the exposure to specific pollutants could be, while considering relevant toxicity. Combining this information with screening techniques for both carcinogens and chemicals

with reproductive and teratogenic effects, the Board identified those pollutants which they considered of greatest concern. With respect to carcinogenic potential, the Board identified fifteen chemicals having the highest level of concern relative to direct inhalation, including 1,2-dichloroethane, 1,3 butadiene, 1,4 dichlorobenzene, arsenic compounds, benzene, benzo(a)pyrene, beryllium, cadmium, carbon tetrachloride, chloroform, chromium compounds, formaldehyde, nickel compounds, perchloroethylene (tetrachloroethylene) and trichloroethylene.

The Board determined the calculated risk of cancer for these two regions resulting from the presence of these hazardous pollutants through application of a benchmark established in the U.S. Clean Air Act for hazardous air pollutants of one in one million lifetime cancer risk. The 1990 Board report to the Commission concluded that the calculated risk of cancer associated with several contaminants in these two regions was significantly higher than the Clean Air Act benchmark of one-in-one-million over a lifetime.

The Board concluded that the highest priority for any pollution prevention initiative should be focused on benzene, formaldehyde and 1,3-butadiene. Contaminants of concern identified by the Board for their association with reproductive and teratogenic potential include benzene, chloroform, formaldehyde, nickel compounds, styrene and xylene.

The Commission held public meetings on the findings and recommendations of the Board. Following a review of the recommendations of the Board, public comments and written submissions, the Commission issued their 1992 Air Quality in the Detroit-Windsor/Port Huron-Sarnia Region – Report to the Governments. Among the conclusions in that report were the following statements:

- sufficient information exists on airborne toxic chemicals in the region to conclude that there is a significant health issue which requires immediate implementation of additional air emission abatement and preventive measures;
- ambient concentrations of the examined airborne toxics in the two regions were similar to other urban centers of comparable size and industrial development; and further,

- a lack of ambient air monitoring data, emissions inventories and health related studies....make it difficult to analyze the potential human health and environmental effects of many toxic chemicals. **(Ref. 1)**

1.2 Current Joint Government Activities

In 2002, Canada and the United States published the Progress Report under Canada-United States Air Quality Agreement in which both governments emphasized the importance of the Ozone Annex, including the development of PEMAs (Pollutant Emission Management Areas). Their stated intent in these areas is the coordination of air quality improvements and joint management of the airshed. The Ozone Annex commits the United States and Canadian governments to report ozone, VOCs and NO_x ambient air concentrations monitored within 500 km (310 miles) of the US-Canada border starting in 2002, and industrial facility emissions by 2004.

In Canada, the PEMA includes an area of 301,330km² (116,300 sq. miles) **(Ref. 2)** which covers all of the Canadian territory south of about the 48th parallel beginning east of Lake Superior to the Ottawa River, and south of the corridor that extends from the Outaouais Region east to Quebec City. For the United States, the area includes the states of Connecticut, Delaware, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New York, New Jersey, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin and the District of Columbia.

While the airsheds of interest in this report (Detroit-Windsor, Port Huron-Sarnia and Sault Ste. Marie, Michigan and Sault Ste. Marie, Ontario) are included within the PEMAs, they are only a small portion of these designed areas and not a particular focus of this effort.

1.3 The United States Ten City Study

The USEPA and 10 states and local agencies are participating in a pilot project to generate information on the spatial and temporal variability of ambient concentra-

tions of selected air toxics in large and small urban settings. Areas in which sampling networks are to be operated include Seattle, Washington; San Jacinto, California; Grand Junction, Utah; Rio Rancho, New Mexico; Cedar Rapids, Iowa; Detroit, Michigan; Charleston, West Virginia; Providence, Rhode Island; Tampa, Florida; and San Juan, Puerto Rico.

All areas will provide at least 12 months of data; sampling for 18 core volatile organic compounds (VOCs), carbonyls and metals (smaller centers will not sample for this latter class of contaminants) will be conducted with a one-in-six-day sampling frequency in the large urban areas and on a one-in-12 day basis in the smaller centers.

The data generated will be combined with other sampling and analytical outputs from urban settings into a larger air toxics data analyses project which, in addition to providing information on spatial and temporal trends, will allow estimation of the risks associated with these contaminants in various urban settings, using the Clean Air Act one in one million lifetime cancer risk as one benchmark. The sampling program in Detroit will be described further later in this report.

1.4 Air Pollutants of Interest: Sources, Impacts, and Standards

1.4.1 Measuring Air Pollution

Measuring or monitoring ambient air concentrations, compiling emission inventories and the subsequent application of air quality models are all important tools used to determine air quality in a region.

Ambient concentration is the direct measurement of the quantity of a pollutant in outdoor air. Monitoring air pollution at stations throughout the area is the basis for determining ambient air quality. Generally, the more extensive the ambient monitoring program, the more precise the determination of air quality in a particular region will be. Ambient air quality monitoring networks are used to determine the extent to which a region is complying with applicable ambient air quality standards or guidelines. Trends in air quality can also be determined using data from these networks. Such networks often require a substantial investment of resources, thus

their determination of air quality on an airshed scale or at a particular location can be limited.

Emissions inventories are a compilation of estimates of the amounts and types of pollutants emitted by various sources over a given period within a certain geographical region. Emission inventories are comprised of information from point (or stationary) sources, area sources and mobile sources. Point sources are generally large industrial or public sector facilities (e.g. coke operations, petroleum refineries, municipal refuse incinerators). Area sources are an aggregation of several smaller commercial operations (e.g. dry cleaning, auto body shops) within a select geographic region. Individually, these latter sources may emit only small amounts of pollutants, but collectively their contribution can be significant. Mobile sources are separated into two categories, on-road and off-road. On-road sources includes cars, buses, trucks, and motorcycles. Off-road sources include railway locomotives, aircraft, ships and boats, and construction equipment.

Models use mathematical formulas to link a region's meteorological conditions, physical features and emission sources and estimate regional air quality. Models provide estimates of the ambient air quality characteristics, including prevailing concentrations. Models should be validated with ambient measurements. Air quality modeling is a necessary tool for estimating current and future air quality trends and devising appropriate control strategies.

Ambient air quality monitoring is crucial in order to provide information needed to assess whether a region is currently complying with the applicable ambient air quality criteria, largely established to protect human health. Emission inventories and modeling can provide insight on air quality on larger scales and predict air quality or estimate it in areas where the ambient monitoring network is not adequate to entirely determine the prevailing air quality. All of these tools are necessary for effective air quality management.

1.4.2 Pollutants of Interest

For the purpose of this report, air contaminants will be divided into two groups: criteria or common air contaminants and airborne toxic or hazardous air pollutants.

Criteria Pollutants

Criteria pollutants are those which are widespread, common to or associated with many anthropogenic activities and for which there are established national ambient quality standards or objectives for the protection of human health and the environment.

In the United States, the Criteria pollutants, as designated under the Clean Air Act, are: Ground Level Ozone; Sulphur Dioxide; Nitrogen Dioxide; Carbon Monoxide; Particulate Matter; and Lead. The Canadian list is similar, but does not include lead. Although not considered a criteria pollutant, a discussion of Total Reduced Sulphur is included in this report as it has been a prevalent pollutant in the Windsor and Sault Ste. Marie areas and has been part of the calculation of the AQI in Ontario.

In the United States, the Clean Air Act, last amended in 1990, also required the U.S. EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to human health and the environment. The Clean Air Act established two types of air quality standards (**Ref. 3**). *Primary standards* were established to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. *Secondary standards* were set to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Both standards will be discussed in this document and are listed in Table 1.

A geographic area that meets the NAAQS for a particular pollutant is referred to as being in attainment: those that do not meet the NAAQS are called nonattainment areas. States containing nonattainment areas are required to submit air quality plans, known as State Implementation Plans (SIPs) for approval by the U.S. EPA detailing how they intent to attain the standard. Failure by a state to meet these and other requirements is to be penalized in accordance with the Clean Air Act. Penalties can include a reduction of federal support to the nonattainment areas, such as funding of highway construction.

In Canada, the provincial and territorial governments are primarily responsible for many air quality issues. As a result, these governments adopt their own air quality objectives which may or may not be consistent with those promulgated by the federal government. The Ambient

TABLE 1

Summary of United States Ambient Air Quality Standard, Environment Canada's Maximum Acceptable levels, the Province of Ontario's Ambient Air Quality Criteria, and Canada-Wide Standards

Pollutant	Time Unit	US EPA-National Ambient Air Quality Standards P-Primary S-Secondary	Environment Canada (Maximum Acceptable Level)	Province of Ontario Ambient Air Quality Criteria	Canadian Council of Ministers of the Environment Guidelines	Canada-wide Standards
Ozone	1-hour	235 µg/m ³ 0.12 ppm (P&S) 120 ppb	0.082 ppm 82 ppb	0.08 ppm 80 ppb	100-300 µg/m ³	
	8-hour	157 µg/m ³ 0.08 ppm (P&S) 80 ppb*		0.065 ppm 65 ppb* (adopting the CWS)	0.065 ppm 65 ppb*	0.065 ppm 65 ppb* (to be achieved by 2010)
	24-hour		0.025 ppm 25 ppb		30-50 µg/m ³	
	Annual		0.015 ppm 15 ppb		30 µg/m ³	
Sulphur Dioxide	1-hour	n/a	0.334 ppm 334 ppb	0.250 ppm 250 ppb		450 µg/m ³
	3-hour	1300 µg/m ³ 0.50 ppm (S) 500 ppb				
	24-hour	365 µg/m ³ 0.14 ppm(P) 140 ppb	0.115 ppm 115 ppb	0.10 ppm 100 ppb	150-800 µg/m ³	
	Annual	80 µg/m ³ 0.030 ppm 30 ppb	0.023 ppm 23 ppb	0.02 ppm 20 ppb	30-60 µg/m ³	
Nitrogen Dioxide	1-hour		0.213 ppm 213 ppb	0.2 ppm 200 ppb	400-1000 µg/m ³	
	24-hour		0.106 ppm 106 ppb	0.10 ppm 100 ppb	200-300 µg/m ³	
	Annual	100 µg/m ³ 0.053 ppm (P&S) 53 ppb	0.053 ppm 53 ppb		60-100 µg/m ³	
Carbon Monoxide	1-hour	40,000 µg/m ³ 40 mg/m ³ 35 ppm(P) 35,000 ppb	31 ppm 31,000 ppb	30 ppm 30,000 ppb	6000 µg/m ³	
	8-hour	10,000 µg/m ³ 10 mg/m ³ 9 ppm (P) 9,000 ppb	13 ppm 13,000 ppb	13 ppm 13,000 ppb	15,000- 35,000 µg/m ³ 15-35 µg/m ³	
PM ₁₀	24-hour	150 µg/m ³ (P&S)		50 µg/m ³	25 µg/m ³	
	Annual	50 µg/m ³ (P&S)				
PM _{2.5}	24-hour	65 µg/m ³ *		30 µg/m ³ * (adopting the CWS)		30 µg/m ³ * (to be achieved by 2010)
	Annual	15 µg/m ³ *				
Lead	Quarterly Average	1.5 µg/m ³				

* Indicates statistical calculation necessary to determine compliance with standard

Air Quality Criteria (AAQC) for Ontario are listed in **Table 1**. Environment Canada provides a Maximum Acceptable level for many of these pollutants which is also provided in the table. The Canadian Council of the Ministers of the Environment (CCME) publishes a compilation of Canadian Environmental Quality Guidelines which is intended to serve as the national benchmark for many air pollutants; these guidelines are

also found in **Table 1**. Where available, the CCME Canada-Wide Standard is also provided.

Agencies often provide their standards in different units of measurement, which can make direct comparison of various standards, objectives, and criteria difficult.

Table 1 attempts to provide each standard in a common unit of measurement where possible.

Ground Level Ozone (O₃)

Formed

- There are no significant point, area or mobile sources of ozone. Rather, it is a pollutant formed under sunny conditions by the reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). Its occurrence is more prevalent during summer months.
- Levels of ozone often follow a trend based on the amount of available sunlight and the patterns of rush hour traffic, particularly morning traffic.

Sources

- See sources of nitrogen oxide and VOCs

Standards/Criteria

TABLE 2 Standards (Michigan) / Guidelines (Ontario) for Ozone

Michigan (U.S. EPA NAAQS)			
Pollutant	Primary Standard (Health Related)		Secondary Standard
O ₃	1-hour	0.12 ppm (235µg/m ³)	Same as Primary Standard
	The area is in compliance with the standard when the 3-year average of the expected number of exceedance days per calendar year is equal to or less than one		
O ₃	Pending 8-hour	0.08 ppm (157µg/m ³)	Same as Primary Standard
	The standard would be met when the 3-year average of the 4 th highest daily maximum 8-hour concentration is less than or equal to 0.08 ppm		
Ontario (MOE)			
Pollutant	Criteria		
O ₃	1-hour AAQC	0.080 ppm	
	8-hour averaging time, achievement to be based on the 4 th highest annual ambient measurement average over three consecutive yrs. The Province of Ontario will adhere to the Canada-Wide Standard - to be achieved by the year 2010	65 ppb	

See Note next page

NOTE for TABLE 2: In July 1997, the U.S. EPA revised the National Ambient Air Quality Standard, establishing the threshold value for both the primary and secondary 8-hour standard as 0.08 ppm measured as a maximum daily 8-hour average concentrations. These standards were challenged by several business and state groups. In February 2001, the U.S. Supreme Court unanimously upheld the EPA's interpretation of its role in standard setting under the Clean Air Act.

The United States EPA is to publish its ozone implementation approach before designating areas for the eight-hour standard. At the present time, this implementation plan is not available as this rule is still in the approval stage, and has not yet been finalized. State Implementation Plans (SIPs) for meeting the new standard are due three years after final nonattainment area designations. The U.S. EPA plans to designate eight-hour ozone nonattainment areas on or about mid-2004, so ozone SIPs would be required approximately three years later (2007).

The United States Ozone Transport Reduction Rule

The development of the Ozone Transport Reduction Rule, often referred to as the NO_x SIP Call, is addressed in more detail in the Canada-United States Air Quality Agreement 2002 Progress Report. Briefly, the NO_x SIP Call requires 19 eastern states plus the District of Columbia to reduce their emissions of NO_x, which reacts with other chemicals in the air to produce ground-level ozone.

The State of Michigan is currently in the process of submitting its revised SIP for NO_x reductions. The revisions are the result of the EPA decision to modify the NO_x budget for Michigan. Facilities located in a "coarse grid area," an area largely outside of the (Greater) Detroit region, would be allowed reduced emission controls as provided for under Section 126 of the Clean Air Act. Section 126 authorizes "a downwind state, or *political division thereof*, to petition EPA for a finding that emissions from major stationary sources in an upwind state contribute significantly to nonattainment, or interfere with maintenance of a NAAQS in the petitioning state." (Ref. 5). (The terms upwind/downwind refer to the relative orientation of two areas. The area in which the wind passes first is upwind and the second area is considered downwind). Modeling showed that implementation of NO_x transport

emissions controls in the coarse-grid areas of Michigan would have little impact on 1-hour ozone concentrations as the levels are predominantly the result of upwind sources such as Chicago.

Additional Information on the Development of the Canada-Wide Standard for Ozone

Studies undertaken by Health Canada concluded that statistically significant adverse health effects begin in some portion of the population at ozone concentration as low as 15 ppb. This information prompted the Canadian Federal government and Provinces to examine the ozone guideline. Previously, the guideline was 82 ppb averaged over one hour. Of the 22 mortality studies reviewed in preparation of a background paper for the federal-provincial group examining the guideline, 17 reported a consistent and significant association between increases in mortality and ozone air pollution. The result of this review is the new Canada-wide Standard for Ozone, which is 65 ppb averaged over eight hours, to be achieved by the year 2010.

Sulphur Dioxide (SO₂)

Sources

- combustion of sulphur-containing fuels such as coal, oil and vehicle fuels, and the heating of materials that contain sulphur (i.e. certain metallurgical and cement production processes). Diesel vehicles are a significant source of SO₂.

Effects

- SO₂ contributes to the formation of fine particulate aerosols and causes respiratory discomfort and aggravation of existing respiratory and cardiovascular disease in humans. Individuals with asthma, chronic lung disease or heart disease are particularly sensitive to SO₂.

Standards/Criteria

TABLE 3 Standards (Michigan) / Guidelines (Ontario) for Sulphur Dioxide

Michigan (U.S. EPA NAAQS)				
Pollutant	Primary Standard (Health Related)		Secondary Standard	
SO ₂₃	Annual Arithmetic Mean	80 µg/m ³ (0.03 ppm)	3-hour	1300 µg/m ³ (0.50 ppm)
	24-hour Not to be exceeded more than once per year	365 µg/m ³ (0.14 ppm)	Not to be exceeded more than once per year	
Ontario (MOE)				
Pollutant	Criteria			
SO ₂₃	Annual Arithmetic Mean	20 ppb (0.02 ppm)		
	1-hour Average	250 ppb (0.250 ppm)		
	24-hour Average	100 ppb (0.10 ppm)		

Nitrogen Dioxide (NO₂) and Nitrogen Oxides (NO_x)

Nitrogen dioxide is a reddish-brown gas with a strong odor created from combustion sources principally the burning of fossil fuels. Nitrogen Oxides (NO_x) form when nitrogen and oxygen combine. ‘Nitrogen oxides (NO_x)’ is a term used to describe NO, NO₂, and other oxides of nitrogen. NO_x plays an indispensable role in the formation of ground level ozone.

Sources

- Sources of NO_x emissions are those related to high-temperature combustion processes such as electrical utilities, refuse and sludge incinerators, and automobiles.

Effects

- NO₂ contributes to the formation of fine particulate aerosols. Individuals suffering from pre-existing respiratory illness, the elderly, and children react to short-term exposures (e.g. less than three hours) to low levels of NO₂. **(Ref. 6)**
- Long-term exposures to NO₂ may lead to increased susceptibility to respiratory infection and may cause irreversible alterations in lung structure, particularly in young children. **(Ref. 7)**
- NO_x (typically a mixture of NO and NO₂) reacts in the air to form ground-level ozone and fine particle pollution, which are both associated with adverse health effects. **(Ref. 8)**

Standards/Criteria

TABLE 4 Standards (Michigan) / Criteria (Ontario) for Nitrogen Dioxide

Michigan (U.S. EPA NAAQS)			
Pollutant	Primary (Health Related)		Secondary
NO ₂	Annual Arithmetic Mean	0.053 ppm (53 ppb) (100µg/m ³)	Same as Primary
Ontario (MOE)			
Pollutant	Criteria		
NO ₂	1-hour	200 ppb	
	24-hour average	100 ppb	

Carbon Monoxide (CO)

Formed

- Carbon monoxide is formed by the incomplete combustion of fossil fuel, mainly from mobile sources. Additional sources include: heating, industrial process, and electrical generation.
- Concentrations in urban areas depend principally upon traffic density, topography, and weather conditions.

Sources

- Motor vehicles are the dominant source. Fossil fuel combustion from electrical utility, industrial, commercial, and residential sources, as well as steel and iron manufacturing also contribute to emissions.

Effects

- CO affects the human central nervous system by limiting oxygen distribution to the body (**Ref. 9**).

Standards/Criteria

TABLE 5 Standards (Michigan) / Criteria (Ontario) for Carbon Monoxide

Michigan (U.S. EPA NAAQS)			
Pollutant	Primary (Health Related)		Secondary
CO	8-hour	9 ppm (10mg/m ³)	No Secondary Standard
	Not to be exceeded more than once per year		
CO	1-hour	35 ppm (40mg/m ³)	No Secondary Standard
	Not to be exceeded more than once per year		
Ontario (MOE)			
Pollutant	Criteria		
CO	8-hour	13 ppm	
	1-hour average	30 ppm	

Particulate Matter: Total Suspended Particulates (TSP); (Inhalable Particulate Matter (PM₁₀); and Respirable Particulate Matter (PM_{2.5}))

Particulate matter can include dust, dirt, smoke, soot and liquid droplets (aerosols) and can originate from a variety of natural and anthropogenic sources. Two classes of airborne particulate matter are of particular importance to human health; fine/respirable particulate matter (PM_{2.5} - particles 2.5 µm (microns) in diameter or smaller) or coarse/inhalable particulate matter (PM₁₀ - particles 2.5 to less than 10 µm in diameter). Total Suspended Particulates (TSP) includes both PM₁₀ and PM_{2.5} as well as larger particles (typically up to 40 µm).

The size of the particle affects its deposition in the human respiratory tract and consequently its potential to impair health. Smaller particles are believed to pose the greatest health risk due to their deposition deep in the human respiratory track (**Ref. 10**).

Total Suspended Particulate (TSP)

In addition to the PM₁₀ and PM_{2.5} AAQC, Ontario also has AAQC for Total Suspended Particulate Matter. Total suspended particulate includes particles of various sizes. Some proportion of TSP consists of particles too large to enter the respiratory tract; therefore, TSP is not considered a good indicator of health-related exposure.

TABLE 6 Criteria (Ontario) for Total Suspended Particulate (TSP)

Ontario (MOE)		
Total Suspended Particulates	24-hour AAQC	120µg/m ³
	1-year AAQC	60 µg/m ³

Inhalable Particulate Matter (PM₁₀)

Formed

- May be directly emitted by a source or formed in the atmosphere by the transformation of gaseous precursor emissions, such as NO_x and SO₂ (Ref. 11).

Standards/Criteria

Sources

- Sources are numerous and include combustion, incineration, construction, mining, metal smelting and metal processing. Other sources include motor vehicle exhaust, road dust, wind blown soil, and forest fires.

Effects

- Respiratory diseases such as asthma are aggravated by exposure to high concentrations of PM₁₀ and PM_{2.5}.

TABLE 7 Standards (Michigan) / Criteria (Ontario) for Inhalable Particulate Matter

Michigan (U.S. EPA NAAQS)			
Pollutant	Primary (Health Related)		Secondary
PM ₁₀	Annual Arithmetic Mean The PM ₁₀ standard is attained when the expected annual arithmetic mean concentration is less than or equal to 50 µg/m ³ (three-year average)	50 µg/m ³	same as Primary standard
	24-hour The 24-hour standard is attained when the expected number of days above 150 µg/m ³ is equal to or less than one per year.	150 µg/m ³	
Ontario (MOE)			
Pollutant	Criteria		
PM ₁₀	24-hour Interim AAQC	50 µg/m ³	

Fine/Respirable Particulate Matter (PM_{2.5})

Formed

- Fine PM (PM_{2.5}) is derived mainly from combustion material that has volatilized and then condensed, or from the condensation or transformation of emitted gases in the atmosphere, such as sulfur dioxide (SO₂), nitrogen oxides (NO_x) and volatile organic compounds (VOC) (Ref. 12).

Sources

- Major sources of PM_{2.5} are fossil fuel combustion by electric utilities, industry, and motor vehicles; residential fireplaces and wood stoves; vegetation burning; and the smelting or other processing of metals

Effects

- Depend on the exposure, concentration and chemical nature of the particulate. Fine particulates can

be especially harmful as they can be deposited further into the human lung, from which they are difficult to expel. Particulate matter has been linked to aggravated respiratory symptoms such as coughing, chronic bronchitis, emphysema and decreased lung function (Ref. 13).

- Epidemiological studies have found associations between exposure levels and decreased lung function, increased hospital admissions and emergency room visits, increased respiratory symptoms and disease and premature deaths (Ref. 14).

Standards/ Criteria

TABLE 8 Standards (Michigan) / Criteria (Ontario) for Fine/Respirable Particulate Matter

Michigan (U.S. EPA NAAQS)

Pollutant	Primary (Health Related)		Secondary
PM _{2.5}	Annual Arithmetic Mean attained when annual average of the quarterly mean PM _{2.5} concentration is less than or equal to 15 µg/m ³ , when averaged over three years.	15 µg/m ³	same as Primary standard
	24-hour-98 th percentile attained when the 3-year average of the 98 th percentile 24-hour concentration is less than or equal to 65 µg/m ³	65 µg/m ³	
Ontario (MOE)			
Pollutant	Criteria		
PM _{2.5}	24-hour averaging time, achievement to be based on the 98 th percentile annually averaged over three consecutive years. Province of Ontario will comply with this CWS standard by year 2010.	30 µg/m ³	

Lead

Lead is considered a Criteria pollutant in the United States, where it is used as an indicator of air quality. The Canadian AAQC is included to complete the comparison of the Criteria pollutants.

Formed

- lead is an element found in nature and a highly toxic metal

Sources

Since the banning of lead additives in gasoline, the primary sources are from mining and metal smelting

operations. Battery manufacturing plants, particularly automotive and similar types of batteries, also contribute lead to the environment (Ref. 15).

Effects

- Affects the human nervous system. Exposure can result in behavioral and learning disabilities; higher concentration can cause seizure and possibly death in humans.
- Children, 6 years old and younger, are most at risk.
- Degrades kidney function, impairs hemoglobin synthesis and affects the nervous system.

Standards/Criteria

TABLE 9 Standards (Michigan) / Criteria (Ontario) for Lead

Michigan (U.S. EPA NAAQS)			
Pollutant	Primary (Health Related)		Secondary
Lead	Maximum Quarterly Average Values are collected for three consecutive months (by calendar quarter), averaged and then compared to the standard.	1.5 µg/m ³	same as Primary standard
Ontario (MOE)			
Pollutant	Criteria		
Lead	24-hour AAQC	2.0 µg/m ³	

Smog

Formed

- The term *smog* frequently refers to a mixture of ozone and (fine) particulate matter.

Sources

- See sources for ozone and particulate matter

Effects

- Individuals with respiratory or cardiovascular disease, the elderly and small children are most affected. Those with compromised immune systems who spend a large amount of time outside may also experience symptoms of distress (Ref. 16). U.S. researchers have found that inhalation of smog laden air has a direct effect on the cardiovascular system (Ref. 17).

Standards/Criteria

- At present time, there are no direct measurements, standards, objectives or established criterion for smog *per se*. Although not considered a Criteria pollutant, recent research indicates that there is no ‘safe’ or threshold level of human exposure to either ground-level ozone or particulate matter below which health effects do not occur (National Ambient Air Quality Objectives For Ground-Level Ozone and For Particulate Matter, Science Assessment Documents, 1999) (Ref. 18.).

Ontario Air Quality Index (AQI)

In Ontario, the Ministry of Environment (MOE) operates the Air Quality Index (AQI) program. The AQI provides real-time air quality information to the public. Concentrations of pollutants that have adverse effects on human health and the environment, including SO₂, O₃, NO₂, TRS compounds, CO, and fine particulate matter (PM_{2.5}), are determined and at the end of each hour the concentration of each pollutant is converted into a number that ranges from zero upwards. The calculated number for each pollutant is called a sub-index. The highest sub-index for any given hour becomes the AQI. As a result, in any given time-frame, values associated with a single pollutant determine the Index (Table 10). The lower the index, the better the air quality is.

The Ministry of the Environment will declare a “smog watch” or a “smog advisory” if a forecast indicates the AQI may exceed a reading of 50 over a wide geographic area. A 50 percent chance of poor air quality in the next three days would trigger a smog watch. A smog advisory is issued when there is a high probability that widespread, elevated and persistent smog levels are expected within next 24 hours. The Ministry of the Environment publishes information for citizens regarding actions to be taken when such events are issued (Ref. 19).

TABLE 10 Ontario's Air Quality Index Pollutants and Their Impact

Pollutant	Index / Category				
	0-15 / Very Good	16-31 / Good	32-49 / Moderate	50-99 / Poor	100-over / Very Poor
Carbon Monoxide (CO)	No known harmful effects	No known harmful effects	Blood chemistry changes, but no noticeable impairment	Increased symptoms in smokers with heart disease	Increasing symptoms in non-smokers with heart diseases; blurred vision; some clumsiness
Nitrogen Dioxide (NO ₂)	No known harmful effects	Slight odour	Odour	Air smells and looks brown. Some increase in bronchial reactivity in people with asthma	Increasing sensitivity for people with asthma and bronchitis
Ozone (O ₃)	No known harmful effects	No known harmful effects*	Respiratory irritation in sensitive people during vigorous exercise; people with heart/lung disorders at some risk; damages very sensitive plants	Sensitive people may experience irritation when breathing and possible lung damage when physically active; people with heart/lung disorders at greater risk; damages some plants	Serious respiratory effects, even during light physical activity; people with heart/lung disorders at high risk; more vegetation damage
Sulphur Dioxide (SO ₂)	No known harmful effects	Damages some vegetation in combination with ozone	Damages some vegetation	Odourous; increasing vegetation damage	Increasing sensitivity for people with asthma and bronchitis
Fine Particulate Matter (PM _{2.5})	Sensitive populations may want to exercise caution	Sensitive populations may want to exercise caution	People with respiratory disease at some risk	People with respiratory disease should limit prolonged exertion; general population at some risk	Serious respiratory effects even during light physical activity; people with heart disease, the elderly and children at high risk; increased risk for general population
Total Reduced Sulphur (TRS) Compounds	No known harmful effects	Slight odour	Odour	Strong odour	Severe odour; some people may experience nausea and headaches

* not consistent with some current studies

AQI and Public Health

The Toronto Board of Health conducted a study to examine whether the air quality classifications under the Ontario AQI values appropriately reflected the state of the air quality and the associated burden of illness in Toronto. The study found that more than an estimated 92 percent of premature mortality and hospitalization occurs when the AQI was in the “Very Good” or “Good” range, while the remaining eight percent of the burden of illness occurred when the air quality is in the “Moderate” or “Poor-Very Poor” range. This indicates that the breakpoints (which are derived from the concentration range of a single pollutant) used to classify the “Good” and “Very Good” AQI which do not always correspond with pollutant levels that do not cause significant adverse health effects (**Ref. 20**).

Air Pollution Index (API)

The Ontario Ministry of the Environment is also responsible for the Air Pollution Index (API). This index is derived from the 24-hour running averages of sulphur dioxide (SO₂) and suspended particles (SP). These averages are evaluated in conjunction with the current or expected meteorological conditions. Various API values may result in emission reduction requirements from industries not essential to public health or safety.

The Minister of the Environment is authorized under the Ontario Protection Act (1971), to order non-essential point sources to reduce or cease operations when air pollution levels are considered harmful to human health.

In Sarnia, the Sarnia-Lambton Environmental Association (SLEA) utilizes criteria similar to that described above to advise industry to curtail or reduce emissions of sulphur dioxide. This is referred to as a Lambton Industrial Meteorological Alert (LIMA). Further discussion regarding LIMA is provided in the Sarnia section of this report.

On August 23, 2002, the Ministry incorporated PM_{2.5} into Ontario’s AQI. PM_{2.5} is a better indicator of

impacts to human health from air quality than the former category, Suspended Particles. Although data available to the Board while compiling this report pre-date the introduction of this revised AQI, the Board considers it prudent to highlight the Ministry’s current, revised AQI (Table 10). Appendix A contains the AQI used in Ontario prior to August 23, 2002.

United States Air Quality Index

In United States, the Air Quality Index (AQI) is a national index, so the values and colors used to show local air quality and the associated level of health concern would be identical throughout the country (**Table 11**). In large metropolitan areas (more than 350,000 people), state and local agencies are required to report the Air Quality Index to the public daily. Although it is not required, many smaller communities also report the AQI as a public health service. Concentrations of the major pollutants, including ground-level ozone, particulate matter, carbon monoxide, sulphur dioxide and nitrogen dioxide are converted into AQI values using formulas developed by the EPA. The highest of the AQI values for the individual pollutants becomes the AQI value for that day (**Ref. 21**). If two or more pollutants have AQI values above 100 on a given day, agencies report to all of the sensitive populations (e.g. children with asthma, people with heart disease) affected by those pollutants.

In the United States, the U.S. EPA will announce Ozone Action Days when weather forecasts predict days that are conducive to ozone formation; typically summer days that are hot and sunny. On these days, industries and individuals will be asked to voluntarily reduce emissions that cause ozone pollution.

TABLE 11 United States' Air Quality Index - Pollutants and their Impacts

AQI Values	0-50	51-100	101-150	151-200	201-300	301-500
Levels of Health Concern	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous
Color Code	Green	Yellow	Orange	Red	Purple	Maroon
Ozone- Cautionary Statements	None	Limit prolonged outdoor exertion in sensitive people	Active children and adults, limit prolonged outdoor exertion	Those with respiratory disease should avoid prolonged outdoor exertion; everyone should limit prolonged outdoor exertion	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion	Everyone should avoid all outdoor exertion
PM _{2.5} - Cautionary Statements	None	None	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors
PM ₁₀ - Cautionary Statements	None	None	People with respiratory disease, such as asthma, should limit outdoor exertion	People with respiratory disease, such as asthma, should avoid outdoor exertion; everyone else should limit prolonged outdoor exertion	People with respiratory disease should avoid any outdoor activity; everyone else should limit outdoor exertion	Everyone should avoid any outdoor exertion; people with respiratory disease, such as asthma, should remain indoors
Carbon Monoxide Cautionary Statements	None	None	People with cardiovascular disease should limit heavy exertion and avoid sources of CO (heavy traffic)	People with cardiovascular disease should limit moderate exertion and avoid sources of CO (heavy traffic)	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO (heavy traffic)	People with cardiovascular disease should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion
Sulphur Dioxide Cautionary Statements	None	None	Asthmatics should consider limiting outdoor exertion	Children, asthmatics and people with heart or lung disease should limit outdoor exertion	Children, asthmatics, and people with heart or lung disease should avoid outdoor exertion; everyone else should limit outdoor exertion	Children, asthmatics, and people with heart or lung disease should remain indoors; everyone else should avoid outdoor exertion
Nitrogen Dioxide Cautionary Statements	None	None	None	None	Children and people with respiratory disease, such as asthma, should limit heavy outdoor exertion	Children and people with respiratory disease should limit moderate or heavy outdoor exertion

Hazardous Air Pollutants

Hazardous Air Pollutants (HAPs), sometimes referred to as air toxics, are chemicals and trace metals present in the atmosphere as gases, liquid droplets and solid particulates. HAPs are released into the atmosphere as Volatile Organic Compounds (VOCs) or particulates from a variety of sources.

The U.S. Clean Air Act of 1970 required the U.S. EPA to set National Emission Standards for Hazardous Air Pollutants (NESHAPS) to provide an “ample margin of safety to human health.” However, by definition, many HAPs are chemicals that cause serious health and environmental hazards and have no exposure threshold. No minimum exposure is to be considered safe. As a result, national emission standards were developed for only eight HAPs some twenty years later (**Ref. 22**).

Under the 1990 Clean Air Act, a new approach for regulating HAPs was established. Emissions standards are now determined on the basis of Maximum Achievable Control Technology or MACT. The U.S. EPA is required under the Clean Air Act to regulate 188 HAPs. Sources of HAPs are categorized as either major or area sources.

Major sources are considered to be those which have the potential to emit ten or more tons per year of any individual HAP or 25 tons per year of any combinations of HAPs. A distinction is made between new and existing sources of HAPs in regard to the implementation of MACT. All new sources of HAPs are required to adopt the MACT for that industry. Existing sources are required to implement MACT to ensure that they achieve emissions which are equivalent to the average of the best-performing 12 percent of the existing sources. Existing sources have three years to comply with the applicable MACT standard (**Ref. 23**).

Area sources are stationary sources which do not qualify as major sources. If the area source poses a threat to public health or the environment, an emission standard must be developed. To date, MACT has been applied to eight area source categories. These categories include: asbestos processing; chromic acid anodizing; commercial dry cleaning transfer machines; commercial dry cleaning dry-to-dry machines; commercial sterilization facilities; decorative chromium electroplating; hard chromium

electroplating; and halogenated solvent cleaners (**Ref. 24**).

In the state of Michigan’s air regulation, toxic air contaminants (TACs) are defined as all non-criteria pollutants that may be “harmful to public health or the environment when present in the outdoor atmosphere in sufficient quantities and duration.” (**Ref. 25**)

The Canadian Environmental Protection Act defines a substance as being “toxic” if it is entering, or may enter the environment in a quantity or concentration or under conditions that:

- have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
- constitute or may constitute a danger to the environment on which life depends; or
- constitute or may constitute a danger to human life or health in Canada.

International Joint Commission

As discussed previously, in 1989, the International Joint Commission formed the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region (the Board), at the request of both Federal governments, to study the trends in ambient air quality, particularly the risks to human health associated with airborne toxic chemical pollutants in the regions.

To complete this task, the Board developed a risk assessment protocol based on a “Levels of Concern Algorithm,” which is a screening technique to identify the chemicals that present the greatest concern from a human health perspective, based on the direct inhalation route of exposure (**Ref. 26**). The risk to human health is based on knowledge of the severity of toxic effects (Toxicity Rating), the population of the region exposed to the chemical (Exposure Index), and whether the levels of the chemical in the air exceed screening levels used by government agencies (Level of Exposure). Based on this assessment, the Board identified fifteen chemicals present in the region which posed the highest level of concern relative to direct inhalation.

Of the fifteen hazardous air pollutants identified by the Detroit-Windsor Board:

1. Five are metals

Arsenic compounds,
beryllium,
cadmium,
chromium and
nickel compounds

2. One is a Semi-Volatile Organic Compound (SVOCs)

Benzo(a)pyrene

3. Nine are Volatile Organic Compounds (VOCs)

1,2-dichloroethane,
1,3-butadiene,
1,4-dichlorobenzene,
benzene,
carbon tetrachloride,
chloroform,
formaldehyde,
perchloroethylene, and
trichloroethylene

The following is a list of the fifteen chemicals selected by the Board and their major emission sources.

1,2-dichloroethane (ethylene dichloride)

Sources include manufacturing industry, wastewater treatment plants and other waste disposal and treatment operations.

1,3 butadiene

Principal emitter is the mobile source sector with some contribution from industrial sources - prescribed burning can also contribute.

1,4 dichlorobenzene

Emissions are the result of its use in chemical manufacturing and many consumer solvents.

Arsenic compounds

Emitted from sources of coal combustion as well as utility boilers, waste oil burning, smelters and glass manufacturing and motor vehicle manufacturing.

Benzene

General sources include road vehicles, gasoline marketing, and petroleum refining. Coke manufacturing and other steel operations are also major sources.

Benzo(a)pyrene

Sources include the use of wood and coal in small combustion units, coke production, vehicles (diesel), and utilities.

Beryllium

Coal combustion and cement manufacture.

Cadmium

Emitters include motor vehicle manufacturing, other steel mill and coke operations, utilities and fuel combustion.

Carbon tetrachloride

Motor vehicle manufacturing, utilities and other combustion sources. Carbon tetrachloride is also emitted from wastewater treatment plants and other waste disposal and treatment operations.

Chloroform

Solvent usage in motor vehicle manufacturing and utilities, as well as other combustion sources. Wastewater treatment and other waste disposal operations contribute to these emissions.

Chromium compounds

Emissions are produced by fuel combustion, steel/metal manufacturing and processing, motor vehicle and refractory manufacturing. Dry cement manufacturing also contributes to chromium compound emissions.

Formaldehyde

Motor vehicles, formaldehyde production, petroleum refining, oil and gas combustion and building materials. Fireplaces and solvents also contribute to emission levels.

Nickel compounds

Various smelting manufacturing processes

Perchloroethylene (tetrachloroethylene)

The dry cleaning industry, textile processing and metal degreasing

Trichloroethylene

Emissions attributed to metal degreasing and motor manufacturing

Volatile Organic Compounds (VOCs)

Formed

VOCs refers to a varied group of chemicals that are easily vaporized at room temperature. They are called organic because their molecular structures are based on carbon atoms frequently linked to one another in chains. VOCs can react with other air pollutants to generate ozone, and also react with ozone to form other toxic air pollutants. The contribution of individual VOCs to such reactions is dependant on the VOCs' photochemical reactivity (**Ref. 27**). Included in the group of VOCs is a variety of hydrocarbons such as alkanes, alkenes, alkynes, aromatics (such as benzene and toluene, aldehydes, ketones, esters and some chlorinated compounds) (**Ref. 28**). VOCs can also react to form particulate matter.

Sources

Sources of VOCs are diverse, including: fossil fuel vaporation and combustion, solvent use, and industrial processes. Gasoline handling and fuel transfer and distribution operations are among the significant contributors of these emissions.

Effects

The chemicals grouped as VOCs are very diverse, and, as a result, their effects are also wide ranging. Several of them are HAPs and include some of the individual pollutants discussed above. Health effects may include eye, nose, and throat irritation, headaches, loss of coordination, and nausea. More toxic VOCs may cause damage to liver, kidney, and central nervous system. Some VOCs have been shown to cause cancer in animals and some are suspected or known to cause cancer in humans. For example, long-term exposure to benzene may increase susceptibility to leukemia in humans.

2.0 REGIONAL REPORTS

2.1 Windsor

The City of Windsor (population approximately 209,000) lies in close proximity to Detroit, a large metropolitan area which has a population of approximately four million people. Detroit is a major center of the automotive industry for the United States, containing large facilities for Ford, Chrysler and General Motors. Several ancillary industries are located in Detroit as well as in Windsor.

Windsor's proximity to Detroit, in conjunction with dominant westerly winds, often has a negative impact on Windsor air quality. Emissions from Detroit point, areal and mobile sources are carried across the Detroit River increases Windsor's susceptibility to poor air quality. Point sources include steel mills, petroleum refineries, and municipal waste and sewage incinerators. The operation of millions of vehicles in the Greater Detroit area also contributes significantly to emissions of criteria and hazardous pollutants. Also, the long range transport of ozone and particulate matter adds to the mix of air contaminants measured in the Windsor air shed.

2.1.1 Common Air Pollutants

Ambient Concentrations

In Windsor, the Ontario Ministry of the Environment operates two (urban) ambient air quality monitoring sites: Windsor Downtown (University Ave.) and Windsor West (College St.) (Table 12), and four sites affiliated with various concentrated industrial activities: Wright/Water St., Richmond/Drouillard Rd, Wyandotte St. and Howard Ave. Appendix A, Diagram 1 provides the location of Windsor's monitoring stations and the pollutants measured at each station.

During the year 2000, the Windsor West (College St.) site recorded 14 days with an Air Quality Index (AQI) greater than 49 or in the "poor" range. Ten of these days can be attributed to high levels of Total Reduced Sulphur (TRS). Poor air quality associated with TRS tends to be a localized, point source problem. Emissions from the integrated steel mills and refinery on Zug Island in Detroit, as well as the sewage treatment plant located in West Windsor, are the likely source of TRS at this station.

In 2000, the Windsor Downtown (University Ave.) recorded nine days of poor air quality due to high levels of ozone (this station does not measure TRS). The frequency of moderate-to-poor air quality, determined from the ambient air quality reporting system, was higher in the second half of the review period (1990-2001) at the Windsor Downtown (University Ave.) site; ground level ozone was the pollutant largely responsible for this trend. Unlike TRS, ozone levels can be attributed to contributions from more distant sources.

TABLE 12 Windsor Urban Ambient Monitoring Stations and Pollutants Measured

Ambient Monitoring Station	Pollutants Measured
Windsor Downtown (University Ave.)	SO ₂ , Suspended Particulates (as Co-efficient of Haze (COH), Nitrogen Oxide, Nitrogen Dioxide, Carbon Monoxide, Total Suspended Particulate, Coarse/Inhalable Particulate Matter (PM ₁₀) and selected metals
Windsor West (College St.)	COH, Total Reduced Sulphur, Sulphur Dioxide, Ozone, Total Suspended Particulate, Coarse/Respirable Particulate Matter (PM ₁₀) Fine/Respirable Particulate Matter (PM _{2.5})*

*Began monitoring PM_{2.5} in 2002

2.1.2 The Common Pollutant Trends between 1991-2000

Sulphur Dioxide (SO₂)

Over the last two decades, the ground level concentrations of sulphur dioxide in Windsor have for the most part been well below the OMOE's air quality objectives.

During the 1990-2001 period, mean annual concentrations at the three SO₂ monitoring sites ranged from about four ppb to over 12 ppb, all within the annual Province's AAQC of 20 ppb. Data are provided for the monitoring station in downtown Windsor.

Annual means of SO₂ concentrations were below the Ministry of the Environment's Ambient Air Quality Criteria (AAQC)(Table 13) of 20 ppb; the annual mean peaked between the years 1996-1997. In 1997, 12 exceedances of the 1-hour objective (250 ppb) were measured at the Windsor West site (College St). That same year, the 24-hour objective (100 ppb) was exceeded once.

TABLE 13 Trend for Annual Mean SO₂ (ppb) (Annual AAQC - 20 ppb)

Year	Station* Windsor-Downtown
1991	7.0
1992	6.0
1993	6.0
1994	6.0
1995	5.0
1996	10.0
1997	6.7
1998	7.4
1999	6.7
2000	6.2

* Data only available for Windsor-Downtown (OMOE-Air Quality Report-2000)

The lowest annual means were observed at the Windsor Downtown site (University Ave.)(Table 13), whereas the highest means were observed at the Windsor West site (College St.); this trend continues from 1997 to present. Peak annual means were observed in 1996 and 1997. These trends are not supported by the emissions inventory of point sources in Windsor, suggesting that the sources for these emissions are located outside of the city.

The maximum 1-hour averages varied from about 60 ppb to over 540 ppb. The highest hourly averages were measured at the Windsor West site (College St.). The only exceedances of the 1-hour objective of 250 ppb were observed at this site, with 12 exceedances in 1997. Again in 1997, the same site experienced one exceedance of the 24-hour objective (100 ppb).

Nitrogen Dioxide (NO₂)

The annual average NO₂ concentration at the downtown Windsor monitoring site has begun to show a slight decrease over the past few years, from 1997-2000 (Table 14). This downward trend is consistent with the composite provincial trend during the 1990s. It is attributed to emission reductions from the industrial and transportation sectors.

The maximum 1-hour averages, except in 1993, were all within the provincial AAQC of 200 ppb. That year, this objective was exceeded during six hours. The 24-hour objective (100 ppb) was also exceeded in 1993. With the exception of the period 1993 to 1995, the trend in the annual maximum 1-hour averages was rather constant, with values near 100 ppb. .

TABLE 14 Trend for NO₂ Annual Mean (ppb) No Annual Mean AAQC

Year	Station Windsor-Downtown
1991	25.0
1992	25.0
1993	26.0
1994	28.0
1995	25.0
1996	26.0
1997	23.8
1998	23.8
1999	22.9
2000	21.6

(OMOE - Air Quality Report - 2000)

TABLE 15 A 3-Year Summary for 1-hour and 24-hour Maximum Concentration for NO₂ (in ppb)
 NO₂ 1-hour AAQC is 200 ppb; NO₂ 24-hour AAQC is 100 ppb

Station	1998			1999			2000		
	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)
Windsor Downtown (University)	23.8	46.0	117	22.9	49.5	90	21.6	44.7	104
Windsor-Tecumseh Water Treatment Plant (Riverside)	No data			14.1	40.3	85	16.0	39.6	73
Windsor West (College)	No data			No data			INS*	41.5	61

(A) Annual Mean (B) 24-hour max (C) 1-hour max INS* insufficient data

Nitrogen Oxides (NO_x)

No provincial AAQC

(NO_x included for consideration as NO_x is an important precursor to ozone formation. NO_x measurement is not used in the AQI)

The Ontario Ministry of the Environment NO_x (a mixture of NO and NO₂) emissions inventory for point sources in Windsor shows increasing levels throughout most of the reporting period (1990-2001), largely due to an increase in the number of sources reporting their emissions. Thus, although the inventory shows an increase in emissions, it may be due to the improvements gained in reporting mechanisms and not reflect an increase in actual emissions from point sources. (This observation is based on point and areal source emissions inventory only and does not include emissions from mobile sources, a major contributor to NO_x.)

- Additional ambient data from the Ontario MOE indicates a reduction in NO_x concentrations. Based on Ministry data, the annual mean for NO_x has declined between the years 1991 (annual mean - 42.0ppb) and 2000 (annual mean - 36.0).

Total Reduced Sulphur (TRS)

The annual mean concentrations of TRS at the Windsor West (College St. site) were variable during the 1990s, ranging from 0.7 to 1.6 ppb. The variability was more pronounced in the second half of the review period.

Exceedances of the 1-hour AAQC at the Windsor West (College St.) appear to be increasing over time. Averages exceeded the provincial objective of 27 ppb over one hour for 102 hours between 1991-2000. Maximum hourly readings during that time were four to five times the objective as shown in the following summary chart.

TABLE 16 A 3-Year Summary of Number of Exceedances and Maximum 1-hour and 24-hour concentrations for Total Reduced Sulphur
 TRS 1-hour AAQC is 27 ppb

Station	1998			1999			2000		
	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)
Wright/ Water	1	346.5	12	54	13.5	12	43	11.3	
Windsor West (College)	28	132	14.2	1	305.0	26	101	19.3	

(A) Number of hours above AAQC (B) 1-hour max (ppb) (C) 24-hour max (ppb)

The influence of TRS on the number of hours the air quality was in the moderate to poor category, as determined by the AQI, was the greatest in 1997, 1998, and 2000. TRS measurements at Windsor West (College St. Site) reflect the presence of a significant point source nearby; the industrial complex on nearby Zug Island off Detroit and the sewage treatment/sludge composting facility in West Windsor are deemed to be the most likely source.

At the Wright/Water St. site, the annual mean TRS levels were also variable and similar in magnitude to those reported for the Windsor West (College St. site). There was a discernible upward trend during the 1990s. During the review period (1990-2001), a total of 87 hourly averages exceeded the provincial objective; the majority were recorded during the second half of this period. The close proximity of the site to Windsor West suggests that it is also influenced by the industries on Zug Island and the sewage treatment/sludge composting facility in West Windsor.

Ground Level Ozone (O₃)

At the Windsor West site (College St.), the number of hours measured above the provincial hourly AAQC in the reporting period between 1990-2001 was quite variable, ranging from 168 hours in 1991 to 13 hours in 2000. The 1-hour AAQC of 80 ppb was exceeded on 765 hours during the reporting period. The frequency of exceedance of the AAQC peaked in 1991, 1996 and 1999. The highest hourly average was recorded in 1991 (127 ppb). For this site, the annual means ranged from 16 to 21 ppb, with no discernable trend throughout the years 1991-2000.

At the Windsor Downtown site (University St.), the 1-hour AAQC was exceeded for 662 hours during the reporting period. The highest hourly average (139 ppb) was recorded in 1994. As also seen at the Windsor West site, the number of hours recorded above the provincial 1-hour AAQC of 80 ppb was highest in 1996, 1998 and 1999, which supports the observation of generally higher ozone concentrations in the second half of the review period as well as the variability of concentrations with varying meteorological conditions. During this period, the increased influence of ozone in the determination of moderate to poor air quality, as calculated by the AQI, was observed.

More recent partial data indicate that the 1-hour AAQC (80 ppb) was exceeded for 63 hours in 2001 and 153 hours in 2002 at the downtown station.

TABLE 17 Trend for Ozone (O₃) Annual Mean (ppb)
(No Annual AAQC)

Year	Station Windsor-Downtown
1991	17.6
1992	15.1
1993	17.1
1994	18.0
1995	18.3
1996	20.4
1997	20.7
1998	21.4
1999	21.7
2000	18.6

(OMOE-Air Quality Report-2000)

The annual means recorded at the Windsor Downtown site (University Ave.) reveal a slight and gradual increase over the reporting period. The mean for the period 1995 to 1999 was about three ppb higher than during the period 1990 to 1994. This is reported to be similar to the composite 10 year trend for 22 sites across the province, which shows an increase of one ppb in the second half of the decade. The exceptionally cool temperatures during the summer months of year 2000 decreases the occurrence of ozone, thus, this year has a lower annual mean.

As ozone tends to be a regional issue, it is not inherently clear what accounts for the difference in the trend between the Windsor West and Windsor Downtown sites, with Windsor West having no discernable trend and Windsor Downtown have a slight trend upwards. The differences may be attributed to traffic trends; further investigation would be required to make an accurate conclusion. Ozone formation is also heavily dependent on meteorological conditions, which would account, to some extent, for the year-to-year variability.

TABLE 18 A 3-Year Summary of 1-hour and 24-hour Maximum Ozone Concentration and Number of Exceedances Above the 1-hour AAQC

O₃ 1-hour AAQC is 80 ppb

Station	1998			1999			2000		
	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)
Windsor Downtown (University)	87	123	81.9	106	112	76.9	22	103	61.4
Windsor West (College)	51	113	64.9	79	129	66.8	13	106	59.3

(A) Number of hours above AAQC

(B) 1-hour max (ppb)

(C) 24-hour max (ppb)

Carbon Monoxide (CO)

A significant decrease in annual concentrations at the Windsor Downtown site (University Ave) is evident; a similar trend is evident across the province. These reductions are attributed to reduced emissions from the transportation sector which account for about 66 percent of the provincial CO emissions. Annual mean carbon monoxide concentrations at this site appear to be stabilizing at just over 0.2 ppm in the last few years of the review period. The 1-hour and 8-hour objectives were not exceeded during this period.

TABLE 19 10-year Annual Trend for CO Annual Mean (ppm) for Windsor-Downtown

Year	Station Windsor-Downtown
1991	1.0
1992	0.9
1993	0.8
1994	1.0
1995	0.9
1996	0.8
1997	0.6
1998	0.7
1999	0.6
2000	0.3

Coarse/Inhalable Particulate Matter (PM₁₀)

Three sites in Windsor monitored PM₁₀. The annual means varied from 20 to 32 µg/m³ which is in the upper range of the measurements recorded in the province. Overall, the levels were higher at the Wyandotte St., (an industrial site,) by about 2 µg/m³. The means at that site peaked in 1994 and showed a decreasing trend for the remainder of the decade. The other sites show more variability and no obvious temporal pattern.

The interim 24 hour objective of 50 µg/m³, adopted by the Ontario MOE in 1997, was exceeded for 14 percent of the samples collected at the Wyandotte St. site, whereas 7.5 percent of the samples were in non-conformance at the University Ave. and Wright Ave. sites.

In mid-1996, measurements of PM₁₀ were taken at the Windsor West (College St. site) with a TEOM analyzer. The annual means of the 24-hour measurement varied from about 24 to over 28 µg/m³. Both the annual means and the number of daily averages greater than the interim objective of 50 µg/m³ were higher in 1997 and 1998. Observed maximum hourly averages and 24-hour averages were as high as 349 µg/m³ and 127 µg/m³, respectively.

Long range transport of NO_x and SO₂ (precursors to PM₁₀) from the mid-western U.S. contributes to the PM₁₀ levels in southwestern Ontario (Ref. 29).

TABLE 20 A 3-Year Summary of PM₁₀ (µg/m³) for Windsor-West
 PM₁₀ 24-hour interim AAQC is 50 µg/m³

Station	1998			1999			2000		
	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)
Windsor West (College)	36	302	83	15	247	79	9	307	78.2

(A) Number of hours above AAQC (B) 1-hour max (C) 24-hour max

Fine/Respirable Particulate Matter (PM_{2.5})

In 1999, a real-time respirable particulate (PM_{2.5}) monitoring program was initiated at the Riverside Dr. (Tecumseh Water Treatment Plant) site with a TEOM analyzer. The annual mean of the 24-hour measurement for 1999 was 13.8 µg/m³; in 2000, it was 9.8 µg/m³.

During 1999, the highest 1-hour average recorded was 140 µg/m³, and the highest 24-hour average was 68 µg/m³. In 2000, the highest 1-hour average concentration was 83 µg/m³ and the highest 24-hour average was 42 µg/m³.

In 1999 and 2000, the 24-hour benchmark of 30 µg/m³ would have been exceeded on 22 days and three days respectively. Partial, unconfirmed data from the Windsor Downtown site indicate that there were seven days in 2001 and 10 days in 2002, that exceed 30 µg/m³ from a 24-hour averaging period.

2.1.3 Additional Ambient Monitoring Station Targeting the Air Quality Issues linked with Transportation

Ambient air monitoring near the Ambassador Bridge in Windsor is being undertaken by the Air Quality Group at the Ontario Ministry of Environment Southwestern Regional Office. Using a portable monitor at three locations near the bridge, measurements of the levels of particulate matter (PM₁₀, PM_{2.5} and PM₁) and benzene are obtained. Measurements will be incorporated into a model developed to predict local air quality based on traffic conditions.

TABLE 21 A 2-Year Summary of Respirable Particles (PM_{2.5})
 PM_{2.5} 24-hour proposed (2010) Canada-Wide Standard is 30 µg/m³

Station	1999			2000			2001	2002
	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(A)
Windsor (Riverside) - Tecumseh Water Treatment Facility	22	140	68	3	83	42	7	10

(A) Number of days above 24h CWS - applied as a benchmark (B) 1 hour - max µg/m³ (C) 24 hour - max µg/m³

2.1.4 Data from Joint Ontario Ministry of the Environment/Environment Canada Air Toxics Monitoring Program

The air toxics monitoring program in Windsor is undertaken cooperatively by Environment Canada and the Ontario Ministry of the Environment.

Trace Metals (in PM₁₀)

The 1990 IJC's Board's report -*Air Quality on the Detroit-Windsor/Port Huron-Sarnia Region*- identified fifteen contaminants with the highest levels of concern relative to direct inhalation included the following metals: arsenic; beryllium; cadmium; chromium; and nickel. From a collaborative study between Environment Canada and the Ontario MOE, the levels of some of these trace metals, including arsenic, cadmium, and chromium, were determined on PM₁₀ filters at the Windsor Downtown (University Ave.) site from 1990 to 1994 and at the Windsor West (College St.) site from 1990 to 2000. Lead concentrations were also determined from PM₁₀ filters at the same sites. Data on beryllium and nickel are not available.

Arsenic

24-hour Provincial AAQC of 0.3 µg/m³

The levels of arsenic were observed to be rather constant at about 0.001 to 0.002 µg/m³. The maximum 24-hour values ranged from 0.003 to 0.016 µg/m³ and were much lower than the provincial objective of 0.3 µg/m³.

Cadmium

24-hour Provincial AAQC of 2.0 µg/m³

The annual means for cadmium were very low, varying from 0.003 to 0.006 µg/m³. The annual means at the College St site showed a small downward trend in the second half of the 10-year (1990-2000) review period. The maximum 24-hour values varied from 0.003 to 0.027 µg/m³. These seem to have reached a plateau at 0.003 µg/m³. The provincial objective for cadmium and its compounds is 2.0 µg/m³.

Chromium

24-hour Provincial AAQC of 1.5 µg/m³ (sum of di-, tri- and hexavalent forms)

The annual means ranged from 0.004 to 0.010 µg/m³, with variability from year to year with no discernible trend. The maximum 24-hour average concentrations varied from 0.007 to 0.296 µg/m³ but most were the order of 0.01 to 0.02 µg/m³. These values are considerably lower than the provincial objective of 1.5 µg/m³ for the sum of the di-, tri- and hexavalent forms of chromium.

Lead

24-hour Provincial AAQC of 2.0 µg/m³

As observed elsewhere, the measures taken to reduce airborne emissions from vehicle exhaust and industrial processes have resulted in a substantial decrease in the levels of lead in urban air. At the Windsor West (College St.) site, the annual means and the maximum concentrations measured in the second half of the review period (1990-2001) were considerably lower (60 percent lower for the means) than in the first half. Annual mean lead levels at that site appear to have stabilized at about 0.007 µg/m³. The maximum daily values in any year were well below the 24-hour objective.

Lead is considered a criteria pollutant in the United States.

2.1.5 Hazardous Air Pollutants: Selected Volatile Organic Compounds (VOCs)

The VOCs identified by the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region in their 1989 report to the Commission as having the highest level of concern relative to direct inhalation are shown in **Table 22**. Also included in this table are available Ontario MOE AAQC and the U.S. EPA carcinogenic health benchmarks. The U.S. EPA carcinogenic health benchmark is established at a protective level based on the estimated risk of one individual in one million possibly developing cancer after a lifetime of exposure.

TABLE 22 Volatile Organic Compounds (VOCs)

Pollutant	Ontario MOE AAQC	U.S. EPA Benchmark (for continuous lifetime exposure)
1,2-dichloroethane (ethylene dichloride)	24h AAQC is 2 µg/m ³	0.038 µg/m ³
1,3 butadiene	No AAQC	0.0036 µg/m ³
1,4 dichlorobenzene	24h AAQC is 95 µg/m ³	further review required
Benzene	No AAQC	0.12 µg/m ³
Carbon tetrachloride	24h AAQC is 65 µg/m ³	0.07 µg/m ³
Chloroform	Interim AAQC Annual is 0.2 µg/m ³ . 24h is 1 µg/m ³	0.043 µg/m ³
Formaldehyde	24h is 2.4 µg/m ³	0.077 µg/m ³
Perchloroethylene (tetrachloroethylene)	Interim AAQC 24h is	.0000059 µg/m ³ 360 µg/m ³
Trichloroethylene	Interim AAQC 24h is 115 µg/m ³	under review

As noted above the Ontario MOE recently adopted a more stringent objective for carbon tetrachloride, which was decreased from 600 µg/m³ to 2.4 µg/m³.

1,3-butadiene

At present, there is no Provincial AAQC

The annual means were rather constant at 0.1 and 0.2 µg/m³. The maximum 24-hour concentrations peaked in the early 1990s between 2 and 3 µg/m³, and seem to have stabilized at 0.4 µg/m³. Mobile and industrial sources are responsible for about 98 percent of the airborne concentrations of 1,3-butadiene in Windsor (Ref. 30). These concentrations are in excess of the lifetime exposure benchmark of 0.0036 µg/m³ for this contaminant under the Clean Air Act.

Benzene

At present, there is no Provincial AAQC

Although the lowest annual means were recorded in the last three years of the reporting period, it is difficult to conclude from this data set that the benzene levels are decreasing with time. More data are required before any such conclusion can be drawn. The annual means varied from 1.7 to 2.8 µg/m³, which is typical for an urban environment with a myriad of vehicular and fuel combustion sources. These concentrations are in excess of the lifetime exposure benchmark of 0.12 µg/m³ for this contaminant under the Clean Air Act. The Windsor Air Quality Study (1991-1993) determined that sources in

the Greater Detroit-Windsor area contributed 84 percent of the airborne concentrations of benzene in Windsor.

Carbon tetrachloride

24-hour Provincial AAQC is 2.4 µg/m³

The annual means for data obtained in 1999 and 2000 ranged from 0.65 to 0.73 µg/m³ and the maximum values recorded were 0.78 and 0.96 µg/m³. The provincial objective was lowered in 2001 from 600 µg/m³ to 2.4 µg/m³. Carbon tetrachloride is the VOC compound on this list that most closely approaches any of the 24-hour VOC objectives of the Ministry.

Formaldehyde

24-hour Provincial AAQC is 65 µg/m³

The annual means and the magnitude of the maximum 24-hour values were observed to have decreased over the review period, 1990-2001. In the first half of the period, the means were in the range of 3.1 to 8.8 µg/m³, falling to the range of 2.6 to 3.3 µg/m³ during the second half. Likewise the maximum values in the first half of the monitoring period ranged from 12 to 31 µg/m³ and from 4.5 to 9.9 µg/m³ in the second half. These maximum values are well below the provincial objective

of 65 µg/m³. However, the annual averages are in excess of the lifetime exposure benchmark (0.077 µg/m³) for this contaminant under the Clean Air Act.

The 1994 Windsor Air Quality Study contained an estimate that Windsor contributed only four percent of the total formaldehyde emissions in the Detroit-Windsor airshed. The presence of petroleum refineries and Detroit's larger emissions from industrial sources of fuel combustion are considered to be responsible for this difference.

Trichloroethylene

24-hour Provincial AAQC is 115 µg/m³

The provincial objective is 115 µg/m³, well above the maximum values of 0.36 and 0.54 µg/m³ recorded in 1999 and 2000 respectively. The annual means were 0.15 and 0.17 µg/m³.

2.1.6 Hazardous Air Pollutants: Semi-volatile Organic Compounds (SVOCs)

Benzo(a)pyrene (BaP)

Benzo(a)pyrene (BaP), a Polycyclic Aromatic Hydrocarbon (PAH), is one of the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region chemicals of highest concern relative to direct inhalation. Measurements were undertaken between 1990 and 1994 at the Windsor Downtown Site (University Ave.) and between 1990 and 2001 at the Windsor West Site (College St.). The annual means for BaP were typically between 0.3 and 0.5 ng/m³. Presently, no data are available for 24-hour concentration levels. The Provincial Annual Mean AAQC for benzo(a)pyrene from a single source is 0.22 ng/m³ (0.00022 µg/m³); the 24-hour AAQC for a single source is 1.1 ng/m³ (0.0011 µg/m³). There is a Provincial Annual mean AAQC for Benzo(a)pyrene from all sources, which is 0.0003 µg/m³. There is no 24-hour AAQC for all sources.

The larger data set from the Windsor West Site (College St.) suggests a downward trend in concentrations over time, with annual means less than or equal to 0.3 ng/m³ in the latter part of the monitoring period. In the first

half of this period, the annual means at both sites were usually greater than or equal to the objective of 0.3 ng/m³ (or 0.0003 µg/m³) for all area sources and greater than the objective of 0.22 ng/m³ (0.00022 µg/m³) for single sources. In most years, the 24-hour objective of 1.1 ng/m³ was exceeded, with the exception of the last two years during the reporting period.

The 1990 Detroit-Windsor/Port Huron -Sarnia Air Pollution Advisory Board's report to the International Joint Commission suggested that approximately 60 percent of B(a)P emissions for the entire region are attributed to mobile sources while in the vicinity of 39 percent are attributed to utilities and fuel combustion.

Dioxins and Furans (PCDDs/PCDFs)

Annual mean concentrations of total PCDF (furans) and total PCDD (dioxins) varied from about one pg/m³ to 4.9 pg/m³ and from about 1.4 pg/m³ to 3.8 pg/m³ respectively. For both substances, the annual means in the second half of the reporting period were considerably lower than in the first half (a 66 percent decrease in total PCDF and a 46 percent decrease in total PCDD). Data were not available for 1997.

The results were converted to a toxicity equivalent (TEQ). It is evident that the TEQs were considerably lower in the second half of the reporting period, (1995-2001). The annual maximum 24-hour concentrations varied from 0.10 to 0.83 pg/m³; the Ontario 24-hour guideline (5 pg TEQ/m³) was not exceeded in any year of the review period (1990-2001). This trend in ambient concentrations of dioxins and furans has been observed at a number of other sites that are part of the National Air Toxics Monitoring Program; however it appears to be more pronounced in Windsor. The addition of new control technology at the Greater Detroit Resource Recovery Facility in the mid-1990s may have contributed to the decrease in the ambient levels of these substances in the west end of Windsor.

2.1.7 Windsor Air Quality Study -1994

In the fall of 1994, the Ontario Ministry of Environment (MOE) published the Windsor Air Quality Study (Ref. 31). The ultimate aim of the study was to "de-

crease the exposure of Windsor residents to airborne toxic chemicals, involving the community in the decision-making process from their airshed, in a cost-effective way?”

There were two proposed components of this Study:

- Scientific investigative studies, for which the Ontario MOE was responsible, and
- Remedial actions, for which the Windsor Air Quality Committee (a local, multi-stakeholder group) was to accept responsibility.

The Windsor Air Quality Study was designed to answer the following questions:

- What are the airborne toxics which might cause concerns?
- What are the levels of airborne toxics in the airshed?
- What are the major contributing sources for the chemicals of concern?
- What are the most significant exposure pathways for the chemicals of concern?
- What are the relative health risks of Windsor citizens resulting from exposure to airborne toxics?

Primary interest was placed answering the first three questions.

From June 1991 through March 1993, extensive field investigations were undertaken to answer the above questions. The investigations included a detailed compilation of pollutant emission rates in the Detroit/Windsor airshed, an intensified monitoring program and data analysis using mathematical models and an assessment between levels known to be associated with health effects in humans and existing levels found in Windsor.

The intense monitoring program involved data collection based on emissions inventory, fixed site ambient air monitoring, mobile air monitoring, personal exposure measurements, and soil and crop produce survey. The data collected from the monitoring program was utilized in a mathematical model and to complete a health effect assessment.

Ten compounds were selected for an in-depth modeling and health effects investigation. These included metals

(cadmium, chromium (VI) and mercury); volatile organic compounds (VOCs-benzene, 1,3-butadiene, carbon tetrachloride, 1,4-dichlorobenzene, and formaldehyde); polynuclear aromatic hydrocarbons (PAHs, including benzo(a)pyrene); and semi-volatile organic compounds (SVOCs – specifically dioxins and furans).

Of these ten chemicals, six were pollutants were selected due to their higher potential risks in Windsor. These chemicals include: cadmium, chromium, benzo(a)pyrene, benzene, 1, 3-butadiene, and formaldehyde.

The findings of this study pertinent to this report include:

- risks from direct outdoor air exposure are appreciably less than those from indoor air exposure.
- the range of additive cancer risks (calculated by adding the risk for each compound) from all pollutants associated with outdoor air quality is between 5×10^{-5} and 9.4×10^{-4} .

Pollutants of Concern

- In outdoor environments, the following pollutants were of concern: chromium (VI), benzene, 1,3-butadiene, polynuclear aromatic hydrocarbons (PAHs which include benzo(a)pyrene (B(a)P)), carbon tetrachloride, cadmium, and 1,4-dichlorobenzene.

Source of Pollutants

- 74 percent of Windsor’s emissions are from area sources (e.g. traffic, residential/commercial fuel combustion, and small industrial operations). Area sources, particularly vehicular and fuel combustion sources, in Windsor-Detroit, dominate the contribution to ground level concentrations of benzene (84 percent), 1,3-butadiene (96 percent), and benzo(a)pyrene (99 percent) in Windsor.
- Detroit and surrounding sources contribute about 58 percent for cadmium, 65 percent for chromium, 67 percent for benzo(a)pyrene, 67 percent for benzene, and 76 percent for 1,3-butadiene.
- Benzo(a)pyrene, was the only compound measured in Windsor that exceeded the existing Ontario’s air quality criterion. Sixty-seven percent of its concen-

tration is attributed to US sources. The remainder from Windsor and vicinity were attributed to vehicles (12 percent) and wood burning stoves (21 percent)

- Prior to this study, benzo(a)pyrene levels were considered to be higher, as the coke ovens in the Detroit area were shut down for most of this study period, although dispersion modelling suggested a very minimal contribution to ambient levels of B(a)P in Windsor from the retrofitted coke ovens in Detroit, which resumed operation in 1992.
- chromium concentrations are mainly attributed to point sources (i.e. 50 percent from the steel industry in Detroit and 16 percent from the automobile manufacturing sector in Windsor)
- sources of cadmium include road dust from Windsor and Detroit (35 percent), the motor vehicle manufacturing sector in Windsor (27 percent), and the steel industry in Detroit (13 percent).
- most of the formaldehyde in Windsor is attributed to photochemical reactions and long range transport of air pollutants.
- carbon tetrachloride was found to originate primarily from long range transport.
- the highest concentrations of 1,3-butadiene and benzo(a)pyrene were found in northwest Windsor. North-central Windsor has the highest concentrations of benzene, chromium, and cadmium, mostly attributable to local source contributions from the automobile manufacturing sector.

2.2 Detroit

In Michigan, the Air Quality Division of Michigan Department of Environmental Quality (MDEQ) is responsible for the Michigan Air Sampling Network. This program consists of the operation of federally mandated National Air Monitoring Stations (NAMS) and State and Local Air Monitoring Sites (SLAMS) as well as the Special Purpose Monitoring Stations (SPMS) network in Michigan. Air quality measurements from this network are used to demonstrate attainment status with regard to National Ambient Air Quality Standards (NAAQS). Ambient air monitoring is also a requirement under various State Implementation Plans (SIPS).

Michigan is divided into a number of Metropolitan Statistical Areas (MSA). These are areas which have a large population nucleus and are highly integrated economically and socially with adjacent communities. Primary Metropolitan Statistical Areas (PMSAs) are

single counties or groups of counties that make up mega-metropolitan areas. A PSMA is the combination of a MSA with the surrounding metropolitan area. Currently, there are three PMSAs in Michigan; the Detroit PMSA is one of them. While St. Clair county is included in the Detroit MSA (and therefore in the Detroit PMSA), separate measurements from this county will be discussed under Port Huron.

For the purpose of this study, information from monitoring stations located in the counties of Wayne, Oakland and Macomb was considered as representative of a summation for the Greater Detroit Area. The pollutants measured at these stations are described in Table 23 and their distribution is illustrated in Appendix A, Figure 2.

Stations described as having PM_{2.5} chemical speciation monitoring collect data on the levels and composition of fine particulate matter.

TABLE 23 Detroit Ambient Monitoring Stations and Pollutants Measured

Station	Pollutants Measured	Station	Pollutants Measured
New Haven (Macomb)	Ozone, Fine Particulate (PM _{2.5})	Detroit-E. Seven Mile (Wayne)	Lead, Nitrogen Dioxide, Ozone, Fine particulate Matter (PM _{2.5} chemical speciation monitor at this site), Sulphur Dioxide
Warren (Macomb)	Carbon Monoxide, Ozone, Sulphur Dioxide	Livonia (Wayne)	Carbon Monoxide, Coarse Particulate Matter, Fine Particulate Matter
Oak Park (Oakland)	Carbon Monoxide, Ozone, Particulate Matter (PM _{2.5})	Detroit-Joy Road- (Wayne)	Carbon Monoxide
Southfield (Oakland)	PM _{2.5} , chemical speciation at site	Detroit - W. Jefferson (Wayne)	Sulphur Dioxide
Allen Park (Wayne)	Carbon Monoxide, Lead, Ozone, Coarse Particulate Matter (PM ₁₀), Fine Particulate Matter (PM _{2.5}) (PM _{2.5} chemical speciation monitor at site)	Dearborn (Wayne)	Lead, Coarse Particulate Matter, Fine Particulate Matter, Sulphur Dioxide
River Rouge (Wayne)	Lead, Coarse Particulate Matter (PM ₁₀), Sulphur Dioxide, Toxic Organics, Carbonyl Aldehydes/Ketones, Trace Metals	Wyandotte (Wayne)	Fine Particulate Matter (PM _{2.5})
Detroit-W. Fort (Wayne)	Lead, Coarse Particulate Matter (PM ₁₀), Fine Particulate Matter (PM _{2.5}), Carbonyl Aldehydes/Ketones, Trace Metals	Detroit - Penobscot Bldg. Downtown (Wayne)	Carbon Monoxide (discontinued operation)
Detroit-Linwood (Wayne)	Carbon Monoxide, lead, Nitrogen Dioxide, Ozone, Fine Particulate Matter (PM _{2.5}), Sulphur Dioxide	Detroit - National Chemical Services	Coarse Particulate Matter (PM ₁₀)

2.2.1 Criteria Air pollutants

Sulphur Dioxide (SO₂)

There are seven monitoring stations for SO₂ within the Primary Metropolitan Statistical Area (PMSA). During the year 2000, Detroit's W. Fort Street site shared (with the Port Huron monitoring station) the highest annual average for SO₂ in the state, with an annual average of 0.007 ppm. This remains below the annual NAAQS of 0.03 ppm.

In 2000 and 2001, the highest 24-hour concentration of SO₂ within the state of Michigan occurred at the Detroit W. Fort monitoring site (**Ref. 32**). The W.Fort Site is a National Air Monitoring Station (NAMS) site situated to monitor maximum SO₂ levels (**Ref. 33**). The W. Jefferson site also measured high concentrations, although both sites were still below the 24-hour NAAQS (0.14 ppm or 365 µg/m³). For both years, the Linwood site had high 3-hour concentration measurements; again these concentrations were well below the 3-hour secondary NAAQS (0.50 ppm).

Total Reduced Sulphur (TRS)

Unlike Ontario, TRS is not routinely measured in Michigan.

Nitrogen Dioxide (NO₂)

During 2001, Detroit's NO₂ monitoring sites at Linwood and E. Seven Mile Road measured annual mean concentrations of 0.023 ppm and 0.019 ppm, respectively. The annual mean NAAQS for NO₂ is 0.053 ppm. The highest annual mean value occurred at Detroit's Linwood site in both 2000 and 2001; the annual arithmetic means were 0.025 ppm and 0.023 ppm, respectively. Although there is no hourly NAAQS, the maximum 1-hour concentrations also occurred at Linwood during 2000 and 2001; the maximum hourly concentrations were 0.128 ppm and 0.194 ppm, respectively. Trends (1992-2001) show the Detroit PMSA average annual NO₂ level at about 0.02 ppm, which is comparable to the historical nationwide average.

Ozone (O₃)

Monitoring of ozone levels occurs at six sites within the Detroit PMSA; three located in Wayne County (E. Seven Mile Rd., Linwood, Allen Park); two located within Macomb County (New Haven and Warren); and one located within Oakland County (Oak Park).

Maximum O₃ concentrations typically occur downwind from metropolitan areas that produce the precursor emissions (**Ref. 34**). Monitoring sites meant to detect maximum O₃ concentration(s) are typically located 10-30 miles downwind from an urban area. For this reason, rural areas can, on occasion, detect higher O₃ concentrations when compared to urban or suburban sites.

TABLE 24 Year 2000 and 2001 Summary of SO₂ Data for Greater Detroit Area

Primary NAAQS	Annual Arithmetic Mean	0.03 ppm (80 µg/m ³)
	24-hour	0.14 ppm (365 µg/m ³)
Secondary NAAQS	3-hour	0.50 ppm (1300 µg/m ³)

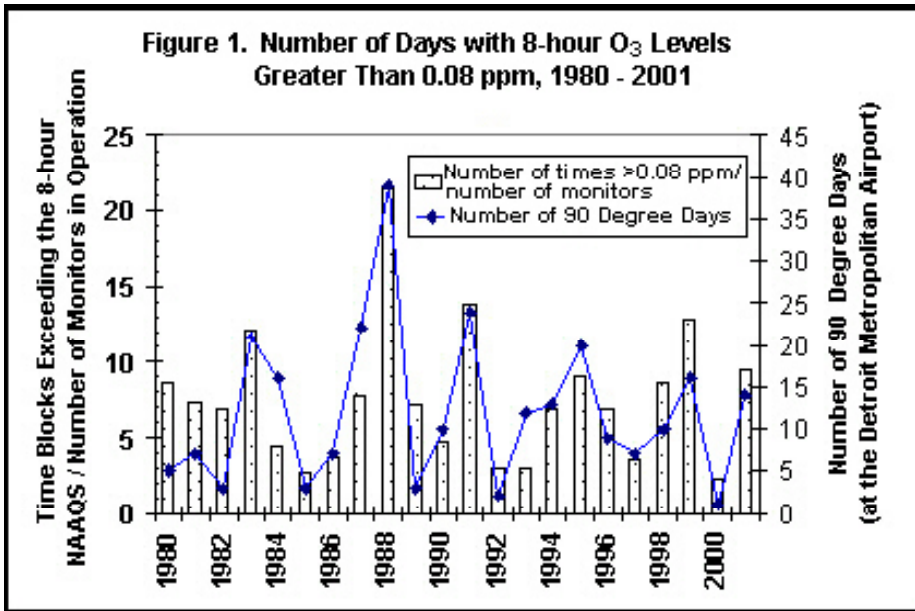
Station	2000 (all values in ppm)				2001 (all values in ppm)			
	Annual Mean	Max. 1hr Values	Max 24hr Values	Max 3hr Values	Annual Mean	Max. 1hr Values	Max 24hr Values	Max 3hr Values
Warren	0.003	0.078	0.017	0.058	0.002	0.068	0.130	0.042
River Rouge	0.005	0.094	0.019	0.050	0.005	0.075	0.016	0.055
W. Fort	0.007	0.126	0.058	0.088	0.007	0.224	0.045	0.115
Linwood	0.006	0.149	0.030	0.098	0.005	0.209	0.028	0.129
E. Seven Mile	0.005	0.083	0.018	0.052	0.004	0.160	0.020	0.073
W. Jefferson	0.008	0.163	0.046	0.103	0.007	0.126	0.044	0.098
Dearborn	0.007	0.118	0.041	0.078	0.008	0.079	0.032	0.045

TABLE 25 Maximum 1-hour and 8-hour Ozone Concentrations for the Greater Detroit Area

Site Location	2000		2001	
	Maximum 1-hour value (ppm)	Maximum 8-hour value (*data not available for 8-hour concentration)	Maximum 1-hour value (ppm)	Maximum 8-hour value
New Haven	0.111		0.127	0.105
Warren	0.1		0.117	0.103
Oak Park	0.09		0.114	0.094
Allen Park	0.082		0.114	0.094
Detroit-Linwood	0.092		0.111	0.092
Detroit- E. Seven Mile	0.103		0.111	0.097

TABLE 26 Ozone Values Compared to Pending U.S. Standard
80 ppm/8hrs. (4th highest recorded value)

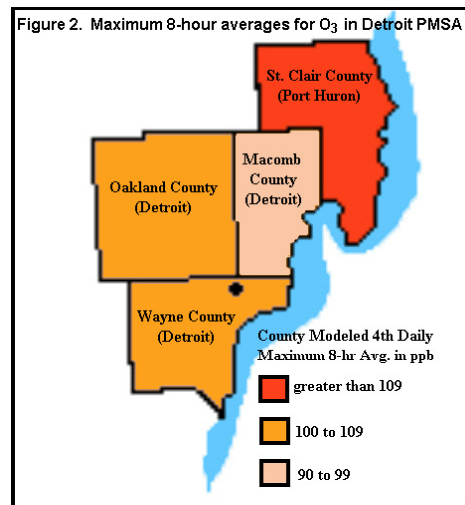
Station	Values in ppm	1995	1996	1997	1998	1999	2000	2001
New Haven	4 th highest 8-hr Value	0.092	0.091	0.090	0.098	0.096	0.075	0.095
	3-yr average	0.091	0.093	0.091	0.093	0.094	0.089	0.088
	Rounded to 0.01 ppm	0.090	0.09	0.09	0.09	0.09	0.09	0.09
Oak Park	4 th highest 8-hr Value	0.084	0.074	0.076	0.089	0.088	0.075	0.090
	3-yr average	0.082	0.081	0.078	0.079	0.084	0.084	0.084
	Rounded to 0.01 ppm	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Allen Park	4 th highest 8-hr Value	0.078	0.082	0.075	0.079	0.087	0.067	0.080
	3-yr average	0.073	0.078	0.078	0.078	0.080	0.077	0.078
	Rounded to 0.01 ppm	0.07	0.08	0.08	0.08	0.08	0.08	0.08
Detroit - Linwood	4 th highest 8-hr Value	0.077	0.079	0.079	0.086	0.084	0.077	0.087
	3-yr average	0.078	0.082	0.078	0.081	0.083	0.082	0.082
	Rounded to 0.01 ppm	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Detroit - E. Seven Mile	4 th highest 8-hr Value	0.091	0.086	0.088	0.093	0.092	0.080	0.092
	3-yr average	0.089	0.090	0.088	0.089	0.091	0.088	0.088
	Rounded to 0.01 ppm	0.09	0.09	0.09	0.09	0.09	0.09	0.09



In February 2001, the U.S. Supreme Court upheld the EPA's designation of 0.08 ppm measured as the maximum daily 8-hour average concentrations as the primary and secondary standard; the State of Michigan will be required to comply with this standard. Designation of nonattainment of the standard is scheduled to begin in April 2004. State Implementation Plans (SIPs) required by the U.S. EPA from all states with nonattainment areas describing how the state will achieve and remain in attainment of the NAAQS will be due three years after designation occurs. The MDEQ analyzed three years of recent data to project the impact of this standard. Results show that counties in and downwind of Detroit typically record values greater than 0.08 ppm (as recorded for the fourth highest 8-hour O₃ concentration) (Ref. 35). Thus, it is anticipated that the Greater Detroit region may be found in nonattainment for ozone in the near future.

Figure 1, produced by MDEQ shows the influence of meteorological conditions, specifically the link between elevated ambient temperatures and number of days with 8-hour O₃ levels greater than 0.08 ppm (1980-2001). As high levels of ozone are often associated with higher temperatures, the impacts of ozone, particularly health impacts, would typically be greatest during the summer months.

Figure 2, a map of Michigan counties, illustrates the maximum 8-hour averages for ozone based on 1995 data. Macomb, Wayne, and Oakland would all exceed the NAAQS of 0.080 ppm. St. Clair County, which represents Port Huron, would also be well above the pending standard.



Carbon Monoxide (CO)

There are seven stations monitoring CO in the Greater Detroit Area; Warren, Oak Park, Allen Park, Linwood, Livonia, Joy Road, Penobscot Bldg-Downtown (monitoring at this latter site ceased after 2000).

Under the National Air Quality Monitoring requirements, all MSAs with populations greater than 500,000 are required to maintain two stations for CO monitoring; one to monitor peak concentrations in major traffic locations (the W. Fort site; however, no data available from MDEQ); the other located in a highly populated area to measure the community's exposure (the Joy Road site).

TABLE 27 Greater Detroit Carbon Monoxide Measurements Compared to Applicable Standards

Site Location	Year 2000		Year 2001	
	Max. 1-hr Values 35 ppm (40 mg/m ³)	Max. 8-hr Values 9 ppm (10 mg/m ³)	Max. 1-hr Values 35 ppm (40 mg/m ³)	Max. 8-hr Values 9 ppm (10 mg/m ³)
Warren	5.1	1.8	4.7	3.3
Oak Park	9.8	3.6	4.6	3.9
Allen Park	6.6	5.1	5.6	1.7
Detroit - W. Fort	No data provided, recently proposed as a NAMs			
Detroit - Linwood	8.2	4.7	5.9	3.7
Livonia	2.5	1.4	4.5	2.3
Detroit - Joy Rd.	7.5	3.6	4.8	3.8
Detroit - Penobscot Bldg. *	7.2	4.1		

*No longer operational

Prior to 1999, portions of Wayne, Oakland and Macomb Counties were designated as nonattainment or unclassified for carbon monoxide. The primary 8-hour NAAQS is 9 ppm (10 mg/m³) and the primary 1-hour NAAQS is 35 ppm (40 mg/m³). Data collected since 1995 indicate these areas are currently in attainment of the standards, and were designated as such in August, 1999 (Ref. 36).

A comparison of monitoring sites between the years 1992-2001 provides a range of 8-hour readings from 10.7 ppm to 3.9 ppm in 2001. In 2001, the highest 8-hour concentration occurred at Oak Park in Oakland County.

Coarse/Inhalable Particulate Matter (PM₁₀)

Currently, there are six monitoring stations for PM₁₀ in the Detroit PMSA. Population exposure to neighborhood scale PM₁₀ air masses is determined at Allen Park and E. Seven Mile Road. Additional neighborhood scale monitoring is performed at River Rouge, W. Fort St., Dearborn and Detroit-West End (formerly National Chemical Service).

During 2001, the highest annual mean of PM₁₀ concentrations occurred at the Detroit - West End site, with the maximum measurement reaching 131 µg/m³. That

TABLE 28 PM₁₀ Determinations - Greater Detroit Locations

Site Location	Year 2000		Year 2001	
	Annual Arithmetic Mean (NAAQS - 50 µg/m ³)	Max. 24-hr Value (NAAQS - 150 µg/m ³)	Annual Arithmetic Mean (NAAQS - 50 µg/m ³)	Max. 24-hr Value (NAAQS - 150 µg/m ³)
Allen Park	27	70	27	59
River Rouge	24	45	28	71
Detroit - W. Fort	38	108	40	97
Livonia	22	49	23	52
Dearborn	41	115	38	89
	35	112	35	131
Detroit - West End **	43	146	46	133

**Formerly known as Detroit-National Chemical

same year (2001) Detroit's annual PM_{10} average for the PSMA was $34 \mu\text{g}/\text{m}^3$; the annual average for the West End Monitoring site was $46 \mu\text{g}/\text{m}^3$. During 2000, the monitoring station at W.End approached the 24-hour standard with a value of $146 \mu\text{g}/\text{m}^3$ (Ref. 37)

In October 1999, the Wayne County Dearborn monitor site had a 24-hour concentration of $156 \mu\text{g}/\text{m}^3$, which is above the $150 \mu\text{g}/\text{m}^3$ standard (Ref. 38).

Fine/Respirable Particulate Matter ($PM_{2.5}$)

The proposed 24-hour $PM_{2.5}$ standard is met when the three-year average at the 98th percentile is less than or equal to $65 \mu\text{g}/\text{m}^3$. Of the 11 monitoring stations, eight were able to provide three years of data. All these stations were below the standard; averages varied from $40 \mu\text{g}/\text{m}^3$ to $47 \mu\text{g}/\text{m}^3$ (at Linwood Site). Wayne County (Linwood site) also experienced the highest annual 24-hour 98th percentile measurement ($51.7 \mu\text{g}/\text{m}^3$) in 1999 (Ref. 39).

TABLE 29 Twenty-four Hour 98th Percentile $PM_{2.5}$ Concentrations by Individual Monitoring Stations, in Greater Detroit, 1999-2001

(98th Percentile, Rounded to Nearest one $\mu\text{g}/\text{m}^3$)
NAAQS is $65 \mu\text{g}/\text{m}^3$

Stations	1999	2000	2001	Mean
New Haven	31.9	33.2	42.0	36
Oak Park	42.8	40.7	39.4	41
Southfield	~	~	44.2	44
Allen Park	49.0	41.8	48.3	46
	44.1	34.6	40.1	40
Detroit - W. Fort	50.2	44.5	42.9	46
Detroit - Linwood	51.7	44.0	46.0	47
Detroit - E. Seven Mile	~	42.0	42.0	42
Livonia	38.4	35.9	44.7	40
Dearborn	45.1	45.1	43.2	44
Wyandotte	45.0	42.7	46.6	45

~No data provided

Based on available, but limited data, the indication is that the annual arithmetic mean would be the more critical standard with respect to future nonattainment designation, when compared to the 24-hour 98th percentile levels (Ref. 40).

Table 30 provides the actual calculated annual arithmetic mean for each $PM_{2.5}$ station as it would be averaged over the three years. For example, the annual arithmetic

mean for Oak Park in 2000 was $15.4 \mu\text{g}/\text{m}^3$, which is above the NAAQS of $15.0 \mu\text{g}/\text{m}^3$. However, as the criteria to determine the annual arithmetic mean states that it is the mean value averaged over three years, Oak Park remains within the standard. However, data from stations at Allen Park (1 & 2), W. Fort St., Linwood, Dearborn and Wyandotte suggest that compliance with the pending standards may prove difficult at these locations.

TABLE 30 Annual Mean PM_{2.5} Concentrations by Individual Monitoring Station for the Detroit PMSA, 1999-2001 (annual mean, rounded to nearest 0.1 µg/m³)

Station	1999	2000	2001	Mean
New Haven	12.7	13.4	13.6	13.2
Oak Park	14.2	15.4	14.7	14.8
Southfield	Not Monitored	Not Monitored	17.1	*
Allen Park #1	16.7	15.6	17.3	16.5
Allen Park #2	19.6	16.0	16.2	17.3
W. Fort St.	17.7	18.1	18.3	18.0
Linwood	17.1	15.5	15.8	16.1
E. Seven Mile	Not Monitored	14.5	14.5	*
Livonia	13.1	14.6	14.6	14.1
Dearborn	17.0	20.1	19.6	18.9
Wyandotte	16.3	17.6	18.2	17.4

* need 3 years of data prior to calculating the mean Source: MDEQ, 2003

2.2.2 Hazardous Air Pollutants

Monitoring for PM_{2.5} Chemical Speciation

Three chemical speciation monitors have been established in the Detroit area. One of these is a National Air Monitoring Station (NAMS) trend chemical speciation monitor site and the other two are chemical speciation SPM, which will remain in operation for the duration of the Detroit Air Toxic Pilot Project.

These monitors provide PM_{2.5} chemical constituent concentrations of: ammonium ion, antimony, arsenic, aluminum, beryllium, barium, bromine, cadmium, calcium, chromium, cobalt, copper, chlorine, cerium, cesium, europium, gallium, gold, hafnium, indium, iridium, iron, lanthanum, lead, manganese, magnesium, mercury, molybdenum, niobium, nitrate, organic and elemental carbon, phosphorus, potassium, rubidium, samarium, scandium, selenium, silicon, silver, sodium, strontium, sulfate, sulfur, tin, tantalum, terbium, titanium, vanadium, yttrium, wolfram, zinc, and zirconium.

2.2.3 Detroit Air Toxics Pilot Project

This project is part of a larger ten city national air toxic data analysis project developed by the EPA to gather information regarding the spatial and temporal variability of hazardous air pollutants concentration in ambient

air as well as general characteristics of air toxics in large urban areas and small urban/rural areas throughout the United States. Many of the air toxics monitored as part of this study are the same as those identified by the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region as having high levels of concern due to their carcinogenic potential.

Monitoring began in 2001 and was to continue for 10 to 12 months. The data collected from the Detroit monitoring stations as well as the other nine cities involved in the study are currently being analyzed and the results should be available in late 2003.

2.2.4 Comparison of Detroit-Windsor Selected Air Toxic Emissions (from Great Lakes Regional Air Toxic Emissions Inventory-1998)

The Great Lakes Regional Air Toxics Emissions Inventory (GLRATEI) tracks the release of selected hazardous toxic contaminants from point sources, area sources and mobile sources and makes it publically available at a county level. The GLRATEI for the 1998 calendar year was compiled for Essex County, Ontario, which was taken as reasonably representative of the Greater Windsor region, and for the sum of the Michigan counties of Macomb, Oakland, and Wayne. The summation of the three Michigan counties has been taken as

representative of the Greater Detroit Area (GDA). However, it should be noted that the boundary of Essex County exceeds the Windsor region, while the three Michigan counties cover most, but not all, of the Greater Detroit Area.

For the majority of the contaminants, based on compilations available in the GLRATEI, emissions from the three counties in the GDA significantly exceed those

from Essex County, which is to be expected given the difference in population of approximately a factor of 10.

Table 31 indicates this difference is not proportionally consistent for some specific contaminants. For example, arsenic emissions from the GDA are a factor of 50 greater than Essex County, while 1,3 butadiene emissions on a per capita basis would nearly be equivalent (a factor of 14.6).

TABLE 31 Comparison of Greater Detroit Area (GDA) and Windsor Emission Data (data from 1998 Great Lakes Regional Air Toxic Emissions Inventory)

Contaminant	Total Essex County (lb/yr)	Total Macomb, Oakland, and Wayne County (lb/yr)	Relative Fraction (Total Macomb, Oakland and Wayne/Essex)
Arsenic	16.35	819.85	50.14
Benzene	367049.07	5753406.69	15.67
Benzo(a)pyrene	27.39	4968.16	181.39
Beryllium	2.92	3.59	1.23
Butadiene 1,3	45238.21	660377.3	14.6
Cadmium	39.07	87.82	2.25
Carbon Tetrachloride	200.05	0.78	0
Chloroform	761.03	4046.44	5.32
Chromium Compounds	406.33	1175.45	2.89
Dichloroethane, 1,2	20.41	516.11	25.29
Formaldehyde	260480.4	2376348.47	9.12
Nickel	2712.19	379.62	0.14
Perchloroethylene	166218.17	4228249.99	25.44
Styrene	46678.06	1147543.78	24.58
Trichloroethylene	723.51	4317460.3	5967.38
Xylene compounds	2463964.72	20103937.21	8.16
<i>Total Emissions</i>	3354537.88	38599321.56	11.51

The total emissions values for Essex County and the GDA are a factor of approximately 12 different, consistent with the population size difference.

- For GDA, arsenic data indicate the significant difference is as a result of the point source sector contribution (814.21 lb/yr) compared to the 2.88 lb/yr from point sources in Essex County, suggesting one or more discrete and significant point sources of arsenic in the GDA.
- A large difference was also observed for benzo(a)pyrene (GDA emits an approximate factor of 182 greater than Essex County), the result of greater point and area source emissions in the GDA. (Emission data from mobile and non road sources was not provided in the GLRATEI.)
- The data for trichloroethylene indicate significantly greater emissions from the GDA (an approximate factor of 6,000). This difference is attributed to both the point and area source categories.

- In addition, the observations from the GLRATEI indicate Essex County emits more carbon tetrachloride and nickel than the GDA; no rationale can be advanced for this finding. The carbon tetrachloride data for Essex County indicate the major source category is area sources (200 lb/yr) while in the GDA, a zero value is reported. Before taking this comparison further, it should be determined if a zero value is representative of the GDA emissions.
- The data indicate that, in Essex County, nickel is emitted largely through point sources (2,040 lb/yr) whereas in the three GDA counties, area sources (20,523 lb/yr) account for the bulk of these emissions.
- Essex County trichloroethylene emissions are considerably below the anticipated proportional comparison to emissions in Greater Detroit; the Essex County estimates should be further verified.

2.3 Sarnia

2.3.1 Common Air Pollutants

In Sarnia, the Sarnia-Lambton Environmental Association (SLEA) has operated an ambient air monitoring network on a voluntary basis for more than 40 years; the Ontario MOE operates additional monitoring sites in the area. Membership in SLEA is comprised of various industries located in the Sarnia area. At present, there are five monitoring stations within the area.

Monitoring station locations are provided on the Map of Sarnia and Port Huron Monitoring Stations in Appendix A, Diagram 3. Stations are situated in locations that may be subject to localized influences.

Sulphur Dioxide (SO₂)

The Centennial Park, Front St. and River Bend sites are specifically located where dispersion modeling predicts the highest expected concentrations of SO₂ to occur. These stations are located to trigger the Lambton Industry Meteorological Alert (LIMA) regulation. LIMA is designed to maintain or lower local ambient SO₂ concentrations during periods of poor dispersion by requiring local sources switch to lower sulphur fuels or curtail production activities.

As of 2001, the SLEA accepted responsibility for advising the Ontario MOE that the LIMA trigger value had been reached; the Ontario MOE would then declare a LIMA. Once an advisory LIMA is issued by the Ontario MOE, local industries subject to the regulation reduce their SO₂ emissions by switching to lower sulphur fuels or by curtailing production (**Ref. 41**). Until April 1 2001, it was the discretion of the Ontario MOE to issue LIMA events when the 24-hour rolling average SO₂ concentrations rose above 70 ppb, and adverse weather conditions were expected to continue for at least six hours. Since 2001, SLEA now alerts the Ontario MOE that the LIMA trigger values have been reached as soon as 70ppb is reached. This change may explain the increased frequency of events in 2001 (**Ref. 42**). It remains the Ontario MOE's responsibility to issue the LIMA.

TABLE 32 Sarnia Ambient Monitoring Stations and Pollutants Measured

Station Name	Pollutants Monitored
Grace Church (operated until 1994)	Sulphur Dioxide
LaSalle Road	Sulphur Dioxide
Centennial Park	Fine Particulate Matter (2000-2001)(PM _{2.5}), Carbon Monoxide, Nitrogen Dioxide, Ozone, Sulphur Dioxide, Total Reduced Sulphur
River Bend (Corunna)	Sulphur Dioxide, Nitrogen Dioxide, Ozone, Volatile Organic Compounds
Front St.	Sulphur Dioxide, Nitrogen Dioxide, Ozone, Volatile Organic Compounds
Moore Line	Coarse Particulate Matter (PM ₁₀)(from March 1997-February 2002), (began in 2000), Fine Particulate Matter (PM _{2.5})

List of pollutants measured may not be complete

*Source: SLEA and OMOE

In 2001, concentrations reached an unusually high one-hour peak of 473 ppb at the Corunna monitoring site; concentrations continued to exceed the 1-hour provincial objective of 250 ppb over three consecutive hours on the same day as the peak was recorded.

The Front St. monitoring site in downtown Sarnia showed daily average concentrations to be in excess of the provincial objective of 100 ppb for two days in November, 2001 (**Ref. 43**). These exceedances occurred during two separate LIMA (November 1 and November 13, 2001).

TABLE 33 Summary Table of SO₂ (in ppb) at Monitoring Stations Front Street, River Bend, LaSalle Road, Grace Church, Sarnia

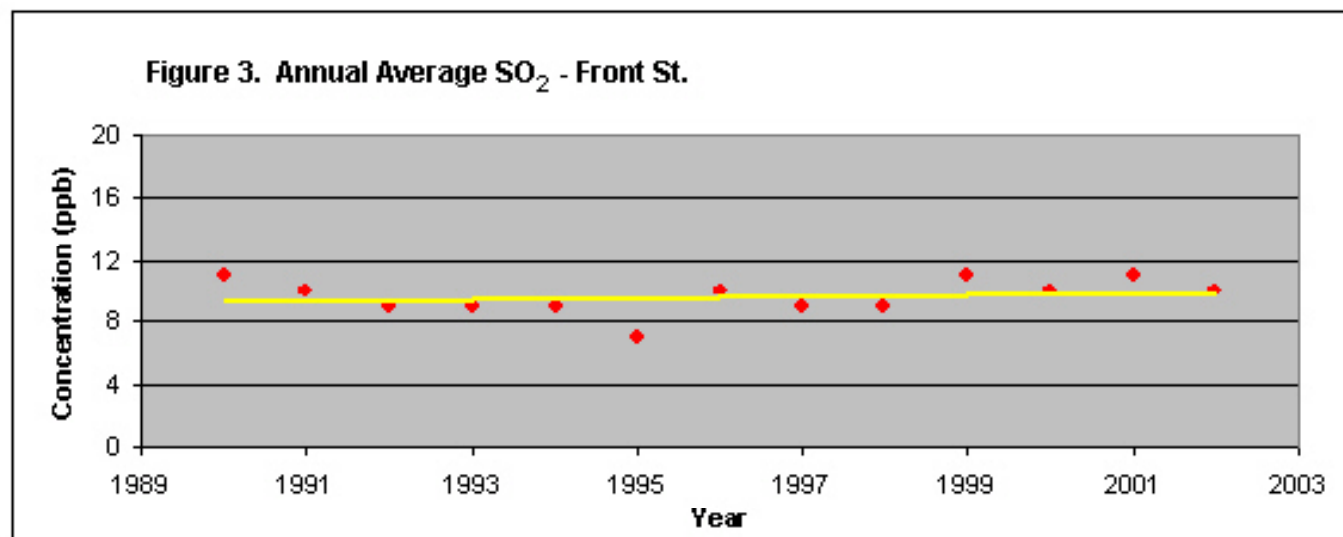
SO₂ 1-hour Ontario MOE AAQC is 250 ppb

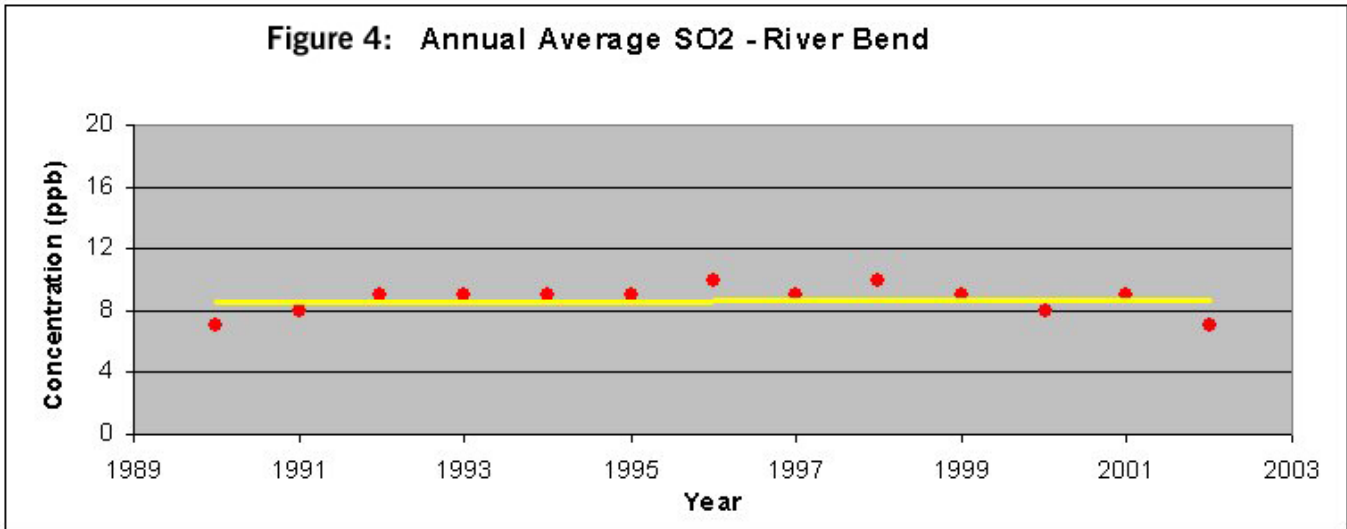
SO₂ 1-year Ontario MOE AAQC is 20 ppb

Location	Front St.		River Bend		LaSalle Road		Grace Church	
Year	Annual Mean	Max 1h	Annual Mean	Max 1h	Annual Mean	Max 1h	Annual Mean	Max 1h
1990	11	270	7	224	6	175	4	120
1991	10	307	8	289	6	125	3	131
1992	9	276	9	310	5	199	3	172
1993	9	226	9	233	5	168	5	177
1994	9	208	9	280	5	129	5	168
1995	7	247	9	343	4	120	Site was closed in 1995	
1996	10	249	10	278	3	314		
1997	9	283	9	233	5	118		
1998	9	262	10	226	6	167		
1999	11	245	9	226	6	171		
2000	10	236	8	231	5	129		
2001	11	237	9	473	5	146		
2002	10	238	7	222	5	131		

Data from monitoring stations in Sarnia and Corunna (Figures 3 and 4) show little change in annual average sulphur dioxide concentrations over the past decade. Concentrations remained approximately one-half of the

annual average objective of 20 ppb. Figures 3 and 4 illustrate the annual level averages for SO₂ at the Front St and River Bend monitoring stations.





Ground Level Ozone

Annual O₃ means appear to be fairly consistent over the past five years. Looking back further, particularly at the Front St site, it appears there has been a slight and gradual increase in the annual means. This is similar to

the composite mean for the rest of the province, which also has seen a gradual increase in the ozone concentration levels.

TABLE 34 Annual Mean and Maximum 1-hour O₃ Concentrations and Number of Times above the 1hour AAQC- Recorded at Two Monitoring Sites in Sarnia
1-hr AAQC 80 ppb

Year	Front St.			River Bend		
	Annual Mean	Max 1h (ppb)	Number of times above 1h AAQC	Annual Mean	Max 1h (ppb)	Number of times above 1h AAQC
1990	17	98	6	23	110	51
1991	19	126	28	23	129	56
1992	21	111	18	24	131	64
1993	22	129	20	23	108	36
1994	23	110	21	25	113	81
1995	23	129	54	23	115	53
1996	22	100	45	24	128	98
1997	22	100	16	24	125	46
1998	22	111	33	26	122	101
1999	21	132	35	28	121	159
2000	20	103	10	24	118	23
2001	20	131	35	26	124	81
2002	21	116	76	26	142	138

Data not available for 8-hour averaging time period

The Front St. monitoring site is located in close proximity to industry and ozone levels are likely influenced by

the scavenging effects of NO_x.

TABLE 35 Summary of Three Years Data for Ozone (O₃) for the MOE Centennial Park Station
1-hr AAQC (80 ppb)

1998			1999			2000		
Number of times above 1h AAQC	1h-Max	24h-Max	Number of times above 1h AAQC	1h-Max	24h-Max	Number of times above 1h AAQC	1h-Max	24h-Max
106	125	75.5	85	145	67.5	15	107	61.3

The number of times the 1-hour AAQC was exceeded was reduced dramatically over the years from 106 incidences during 1998 to only 15 in the year 2000. However, partial data indicate that the one-hour AAQC (80 ppb) was exceeded 93 hours in 2001 and 111 hours in 2002. These results should be compared with meteorological conditions to determine their influence on these outcomes.

Nitrogen Dioxide (NO₂)

In 2001, NO₂ continued a recent and unexplained upward climb in concentration levels; this chart displays the annual average. However, the tabular data summary (Table 36) indicates that neither the 24-hour AAQC (100 ppb) nor the 1hour AAQC (200 ppb) were exceeded in the period from 1990-2002 at the two monitoring sites in the Sarnia region (Front St. and River Bend sites).

TABLE 36 Summary Chart of Annual Mean and 1-hour Maximum NO₂ Concentrations for Two Sites in Sarnia (in ppb)

1-hour AAQC is 200 ppb;

24-hour AAQC is 100 ppb

Location	Front St.		River Bend	
	Mean	Max 1h	Mean	Max 1h
1990	17	86	12	82
1991	20	105	10	58
1992	20	79	12	78
1993	21	109	10	92
1994	17	84	12	72
1995	14	77	11	58
1996	12	100	11	61
1997	10	71	11	64
1998	12	84	11	100
1999	13	92	10	79
2000	15	84	10	56
2001	18	70	10	63
2002	17	14	10	65

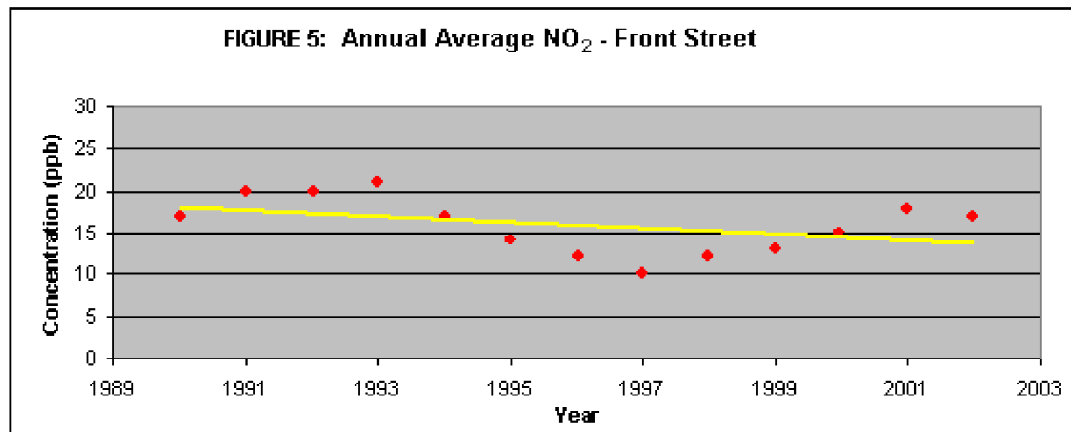


TABLE 37 Three-year Summary of Carbon Monoxide Maximum Values Based on 1-hour and 8-hour Concentrations

8-hour AAQC is 13 ppm

1-hour AAQC is 30 ppm

Site Location	Year 1998		Year 1999		Year 2000	
	Max. 1-hr Values	Max. 8-hr Values	Max. 1-hr Values	Max. 8-hr Values	Max. 1-hr Values	Max. 8-hr Values
Centennial Park	3	1.9	4	1.5	3.86	1.69

Carbon Monoxide levels for both the one hour and eight hour concentrations remain well below the provincial AAQC

Coarse/Inhalable Particulate Matter (PM₁₀)

TABLE 38 Summary of PM₁₀ Mean, Maximum Concentration (1-hour and 24-hour) and Number of Times Above the 24-hour Criterion.

(Information collected by the OMOE at the Centennial Park and SLEA at Moore Line)

PM₁₀ 24-hour Interim AAQC is 50 µg/m³

Year	Centennial Park				Moore Line	
	Arithmetic Mean	Max 1h Value	Max. 24h Value	Number of times above criterion	Max. 24h Value	Number of times above criterion
1997	NA	NA	NA	NA	54	2
1998	20.1	336	66	8	57	4
1999	INS*	185	64	6	78	2
2000	18.1	267	49.3	0	21	0
2001	NA	NA	NA	NA	52	3

*INS - insufficient valid data

NA- data not available

Fine/Respirable Particulate Matter (PM_{2.5})

The 24-hour Canada-Wide Standard (CWS) for PM_{2.5} is 30 µg/m³.

TABLE 39 PM_{2.5} Data from Monitoring Sites within Sarnia Area

Year	Station	Annual Arithmetic Mean	Max 1h Value	Max. 24h Value	Number of days above 30 µg/m ³ benchmark
2000	Moore Line	10	124	32	1
	Centennial Park	9	95	35	3
2001	Moore Line	8	84	35	2
	Centennial Park	9	268	42	8
2002	Moore Line	9	64	42	7

Note: value of the CWS has been applied as a benchmark; the statistical requirements to achieve the standard have not been applied.

Year 2001 levels of PM_{2.5} at the Centennial Park location were similar to 2000, and lower at the Moore Line location. While the data are limited, there are indications that concentrations in excess of the proposed 24-hour CWS of 30 µg/m³ have occurred and will likely continue. PM_{2.5} 24-hour proposed (CWS) Canada-Wide Standard: 30 µg/m³ in year 2010. 2001 levels of PM_{2.5} at the Centennial Park location were similar to year 2000, and lower at the Moore Line location.

Lead

At present, no data for lead monitoring in Sarnia have been located.

2.3.2 Selected Hazardous Air Pollutants

SLEA monitors several VOCs at two stations within the Sarnia area. The IAQAB asked SLEA to provide data for the VOCs which were identified in the earlier IJC report of 1992 for their high levels of concern relative to direct inhalation in the region including: 1,2-Dichloroethane; 1,3-Butadiene; 1,4-Dichlorobenzene; benzene; carbon tetrachloride; chloroform; perchloroethylene; and trichloroethylene. All of these VOCs would be considered to present high levels of concern relative to the risks associated with direct inhalation under both the Clean Air Act benchmark and the criteria used in the earlier IJC report (1991). It should be noted that the calculated mean or average can vary depending on the substitution number used when a sample is below the minimum detention limit of the equipment.

TABLE 40 Ambient Air Monitoring Data for Selected Hazardous Air Pollutants in Sarnia

Chemical	Year	FRONT STREET		RIVER BEND	
		24-hour Max $\mu\text{g}/\text{m}^3$	Mean $\mu\text{g}/\text{m}^3$	24-hour Max $\mu\text{g}/\text{m}^3$	Mean $\mu\text{g}/\text{m}^3$
1,2-Dichloroethane (24h MOE AAQC is $2 \mu\text{g}/\text{m}^3$)	1995	0.5	0.1	0.6	0.0
	1996	0.3	0.0	0.2	0.0
	1997	1.0	0.1	0.2	0.0
	1998	0.6	0.1	3.3	0.2
	1999	1.0	0.0	0.4	0.0
	2000	1.9	0.2	2.3	0.3
	2001	1.9	0.1	8.2	1.0
	2002	6.5	0.5	1.5	0.1
1,3-Butadiene (No MOE AAQC) US Clean Air Act Lifetime Benchmark concentration $0.0036 \mu\text{g}/\text{m}^3$ *	1995	3.0	0.5	0.8	0.2
	1996	6.6	0.9	2.7	0.1
	1997	8.2	1.0	1.3	0.1
	1998	8.0	0.7	2.2	0.2
	1999	4.6	0.5	1.1	0.1
	2000	5.6	0.6	0.5	0.0
	2001	3.0	0.5	0.5	0.0
	2002	9.7	0.5	1.9	0.2
1,4-Dichlorobenzene (24h MOE AAQC is $95 \mu\text{g}/\text{m}^3$)	1995	0.6	0.1	0.1	0.0
	1996	0.2	0.0	0.1	0.0
	1997	0.8	0.1	0.1	0.0
	1998	0.8	0.1	0.0	0.0
	1999	0.2	0.0	< minimum detection limit	0.0
	2000	0.2	0.0	0.2	0.0
	2001	1.9	0.3	0.9	0.1
	2002	0.5	0.0	0.4	0.1
Benzene (NO AAQC) US Clean Air Act Lifetime Benchmark concentration $0.12 \mu\text{g}/\text{m}^3$ *	1995	9.7	2.6	5.4	1.5
	1996	10.0	3.2	7.4	1.8
	1997	17.7	3.2	3.7	1.2
	1998	6.4	2.4	4.9	1.2
	1999	8.0	2.5	22.2	1.7
	2000	10.6	2.2	9.0	1.7
	2001	6.5	1.9	5.1	1.2
	2002	10.9	1.6	6.1	1.3

continued next page

TABLE 40 (cont'd) Ambient Air Monitoring Data for Selected Hazardous Air Pollutants in Sarnia

Chemical	Year	FRONT STREET		RIVER BEND	
		24-hour Max µg/m ³	Mean µg/m ³	24-hour Max µg/m ³	Mean µg/m ³
Carbon tetrachloride (24h MOE AAQC is 65 µg/m ³) US Clean Air Act Lifetime Benchmark concentration 0.07 µg/m ³ *	1995	1.7	0.93	0.9	0.7
	1996	1.6	0.8	1.1	0.7
	1997	2.0	0.9	1.0	0.6
	1998	1.9	0.7	5.0	1.0
	1999	1.8	0.7	1.6	0.6
	2000	3.5	0.99	5.2	0.7
	2001	4.1	0.92	8.9	1.2
	2002	1.5	0.48	1.2	0.6
Chloroform (Interim 24h MOE AAQC is 1 µg/m³)	1995	0.2	0.1	0.2	0.1
	1996	0.3	0.1	0.1	0.1
	1997	0.3	0.1	0.1	0.1
	1998	0.4	0.1	3.7	0.2
	1999	0.2	0.1	0.2	0.1
	2000	0.5	0.2	0.6	0.2
	2001	0.8	0.1	0.9	0.1
	2002	0.2	0.0	0.4	0.0
Perchloroethylene (Interim 24h MOE AAQC is 30 µg/m ³)	1995	1.1	0.3	5.6	0.5
	1996	1.6	0.3	6.9	0.9
	1997	3.0	0.4	7.4	1.0
	1998	2.9	0.4	1.2	0.3
	1999	3.0	0.3	2.1	0.4
	2000	1.2	0.3	4.7	0.8
	2001	1.1	0.2	6.9	1.1
	2002	2.5	0.3	4.3	0.6
Trichloroethylene (Interim 24h MOE AAQC is 115 µg/m ³)	1995	0.2	0.0	0.3	0.0
	1996	0.4	0.1	0.2	0.0
	1997	0.8	0.1	0.4	0.0
	1998	0.4	0.1	5.6	0.2
	1999	0.8	0.0	0.5	0.0
	2000	0.9	0.2	5.2	0.3
	2001	1.1	0.2	1.9	0.3
	2002	0.4	0.1	1.1	0.1

*NOTE: the U.S. Clean Air Act Lifetime Benchmark is the air concentration at which a continuous life-time of exposure could result in a calculated risk of development of cancer in no more than one in one million of the exposed population. As the extent of exposure in the Sarnia setting does not meet these conditions, use of this benchmark as a direct comparison to ambient concentrations is inappropriate. It is included as indicative of one of the more conservative guidelines for exposure to the given contaminant in current legislation.

2.3.3 Great Lakes Regional Air Toxic Emissions Inventory - 1998

As discussed above, the Great Lakes Regional Air Toxic Emission Inventory is reported on a county basis for both Michigan and Ontario. For the purpose of this study, emission data from St. Clair County will be used

to represent Port Huron and data collected from Lambton County will be used as representative of Sarnia. The higher values for several of the contaminants in Sarnia reflect the concentration of petrochemical refining facilities in this region as compared to the Port Huron area.

TABLE 41 Great Lakes Regional Air Toxic Emissions Inventory, 1998 data
St. Clair County is representative of Port Huron, Michigan
Lambton County is representative of Sarnia, Ontario
(lb/yr) for selected contaminants

POLLUTANT NAME	COUNTY	POINT EMISSIONS	AREA EMISSIONS	MOBILE SOURCES (road & non-road)	TOTAL
1,2-Dichloroethane	St. Clair County	0.00	91.74	0.00	91.74
	Lambton County	22.10	6.31	0.00	28.41
	Total for the area	22.10	98.05	0.00	120.15
1,3-Butadiene	St. Clair County	0.00	0.00	24,441.52	24,441.52
	Lambton County	182,728.39	0.00	21,067.43	203,795.82
	Total for the area	182,728.39	0.00	45,508.95	228,237.34
Arsenic	St. Clair County	138.88	0.01	0.25	139.14
	Lambton County	66.18	2.22	12.69	81.09
	Total for the area	205.06	2.23	12.94	220.23
Benzene	St. Clair County	202.96	76,428.67	192,496.47	269,128.10
	Lambton County	364,179.24	15,098.90	165,475.89	544,754.03
	Total for the area	364,382.20	91,527.57	357,972.36	813,882.13
Benzo(a)pyrene	St. Clair County	0.00	81.99	0.00	81.99
	Lambton County	3,678.11	22.88	0.00	3,700.99
	Total for the area	3,678.11	104.87	0.00	3,782.98
Beryllium	St. Clair County	20.59	0.00	0.00	20.59
	Lambton County	35.18	0.97	0.26	36.41
	Total for the area	55.77	0.97	0.26	57.00
Cadmium	St. Clair County	19.91	0.94	0.00	20.85
	Lambton County	26.82	7.85	3.76	38.43
	Total for the area	46.73	8.79	3.76	59.28
Carbon Tetrachloride	St. Clair County	0.00	35.08	0.00	35.08
	Lambton County	0.00	0.00	0.00	0.00
	Total for the area	0.00	35.08	0.00	35.08
Chloroform	St. Clair County	0.00	156.15	0.00	156.15
	Lambton County	0.00	154.60	0.00	154.60
	Total for the area	0.00	310.75	0.00	310.75

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TABLE 41, cont'd Great Lakes Regional Air Toxic Emissions Inventory, 1998 data

Chromium compounds	St. Clair County	492.43	0.03	4.40	496.36
	Lambton County	308.57	29.46	50.88	388.91
	Total for the area	801.00	29.49	55.28	885.27
Formaldehyde	St. Clair County	2,597.77	199.77	79,853.51	82,651.05
	Lambton County	5,674.95	610.04	142,727.07	149,012.06
	Total for the area	8,272.72	809.81	222,580.58	231,663.11
Nickel	St. Clair County	620.26	0.06	5.57	625.89
	Lambton County	62,293.33	69.99	822.81	63,186.13
	Total for the area	62,913.59	70.05	828.38	63,812.02
Tetrachloroethylene (Perchloroethylene)	St. Clair County	20,250.00	176,049.30	0.00	196,299.30
	Lambton County	0.00	59,004.49	0.00	59,004.49
	Total for the area	20,250.00	235,053.79	0.00	255,303.79
Styrene	St. Clair County	100,036.21	0.00	44,319.98	144,356.19
	Lambton County	91,573.65	94.68	21,960.57	113,628.90
	Total for the area	191,609.86	94.68	66,280.55	257,985.09
Trichloroethylene	St. Clair County	251.28	141,279.90	0.00	141,531.18
	Lambton County	0.00	401.32	0.00	401.32
	Total for the area	251.28	141,681.22	0.00	141,932.50
Xylene (mixed isomers)	St. Clair County	84.15	141,681.22	0.00	141,932.50
	Lambton County	363,693.51	112,909.28	450,019.08	935,651.87
	Total for the area	363,777.66	254,590.50	450,019.08	1,077,584.37

2.4 Port Huron

2.4.1 Criteria (Common) Air Pollutants

Air quality monitoring in Port Huron, MI, is limited to one station at Dove Rd. which monitors ozone, fine particulate matter (PM_{2.5}), and sulphur dioxide (SO₂). As mentioned, the Michigan DEQ considers Port Huron as part of the Greater Detroit PMSA.

Sulphur Dioxide

In 2001, Port Huron's monitoring station shared the highest annual SO₂ average of 0.007 ppm in the state with the W. Fort St. site in Detroit. The highest 24-hour concentration of 0.06 ppm, measured at the Port Huron site, while still below the 24-hour NAAQS of 0.14 ppm, is also the highest in the state. Although the secondary NAAQS of 0.50 ppm over three hours was not exceeded, the Port Huron site did measure the highest concentration of the state of Michigan at 0.14 ppm for the three hour period.

TABLE 42 SO₂ Mean, Maximum and Number of Times Above Standard for Port Huron Monitoring Station (year 2000, 2001)

Site Location	Year 2000					Year 2001				
	[a]	[b]	[c]	[d]	[e]	[a]	[b]	[c]	[d]	[e]
Port Huron Dove Rd.	0.006	0.041	0	0.147	0	0.007	0.06	0	0.144	0

[a] Annual Arithmetic mean 80 µg/m³ (0.03 ppm)

[b] 24-hr 365 µg/m³ (0.14 ppm) Max. Value

[c] Number of times above standard

[d] 3-hr 1300 µg/m³ Max. Value

[e] Number of times above standard

TABLE 43 Summary of Annual Mean and 1-hour Maximum Concentration of SO₂ for SLEA's Monitoring Site in Port Huron, MI

Primary NAAQS Annual Arithmetic mean - 0.03 ppm (30 ppb)

The U.S. does not have a 1-hour NAAQS (Ontario's AAQC is 250 ppb)

Year	Mean	Max 1h	Year	Mean	Max 1h
1990	3	300	1995	4	150
1991	4	150	1996	5	210
1992	3	180	1997	5	230
1993	3	160	1998	5	250
1994	5	200			

(SLEA operated an air quality monitoring station in Port Huron until 1998.)

Ground Level Ozone

During the years 1992-2001, the highest detected 1-hour O₃ concentration for all of Michigan was 0.184 ppm,

which occurred at the Port Huron site on May 22, 1996 (MDEQ, 2003).

TABLE 44 Fourth Highest 8-Hr Ozone (O₃) Values Averaged at 3-year Increments, 1995-2001

The proposed USEPA 8-hour standard is met when the 3-year average of the 4th highest concentration is less than or equal to 0.08 ppm.

Station	Values in ppm	1995	1996	1997	1998	1999	2000	2001
Port Huron	4 th highest 8-hr Value	0.094	0.086	0.079	0.091	0.091	0.08	0.084
	3-yr average	0.089	0.088	0.086	0.085	0.087	0.087	0.085
	Rounded to 0.01 ppm	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Source: MDEQ 2003

Although the U.S. EPA has not begun to designate areas as nonattainment; **Table 44** indicates that should recent circumstances persist, Port Huron would be in non-attainment with the new ozone standard.

Carbon Monoxide

Not Monitored.

Nitrogen Dioxide (NO₂)

Not Monitored.

Coarse/Inhalable Particulate Matter (PM₁₀)

Not Monitored.

Fine/Respirable Particulate Matter (PM_{2.5})

TABLE 45 Annual Mean PM_{2.5} Concentrations, 1999-2001 (annual mean, rounded to nearest 0.1 µg/m³) - Annual USEPA PM_{2.5} Pending/Proposed Annual Standard - 15.0 µg/m³

Station Name	1999	2000	2001	Mean
Port Huron	13.2	14.4	14	13.9

NOTE: Calculating the Annual arithmetic mean to determine attainment status, the annual average of the quarterly PM_{2.5} mean concentrations are averaged over three years. This result must be less than or equal to 15 µg/m³. For Port Huron, its calculated annual average is 13.9 µg/m³, which would be in compliance with the new standard.

TABLE 46 Twenty-four Hour 98th Percentile PM_{2.5} Concentrations, 1999-2001
 (annual mean, rounded to nearest 0.1 µg/m³)
 USEPA 24-hour PM_{2.5} standard - 65 µg/m³

Station Name	1999	2000	2001	Mean
Port Huron	44.5	33.1	40.5	39
(at same site)	No data		35.9	Need more data

NOTE: To be in attainment of the NAAQS of 65 µg/m³, the 3-year average of the 98th percentile 24-hour concentration must be less than or equal to the standard, which appears to be the case.

Lead

The Port Huron air quality monitoring station does not monitor for this pollutant.

2.5 Sault Ste. Marie, Ontario

The city of Sault Ste. Marie, Ontario is situated on the north shore of the St. Mary's River, which connects Lake Superior to Lake Huron. Sault Ste. Marie, Ontario is directly linked to Sault Ste. Marie, Michigan by the International Bridge. Sault Ste. Marie, Ontario is more developed, with an industry based largely on the natural resources of the area, including an integrated steel mill with coking operations and a pulp and paper facility.

There are two air quality monitoring stations within Sault Ste. Marie, Ontario.

- Bonney St. Pumphouse
- Patrick St. WM. Merrifield School

2.5.1 Common Air Pollutants

Ambient Concentrations

The Criteria pollutants trends for the review period (1990-2000):

- Annual SO₂ means were within Ministry AAQC and did not noticeably vary with time; the magnitude of the annual maximum concentrations were slightly lower in the second half of the review period, 1990-2000.
- Annual NO₂ means displayed a weak downward trend; this trend was more noticeable for the annual maximum values and these conformed to Ministry objectives during the review period, 1990-2000.
- Mean Total Reduced Sulphur (TRS) levels showed a noticeable downward trend throughout the decade; there were few exceedances of the hourly objective and none during the last three years of the review period
- Annual mean ground level ozone values were slightly higher in the latter part of the reporting period; however the year-to-year variability in ozone levels prevents drawing any conclusion on trends over such a short time frame.

Sulphur Dioxide (SO₂)

Historically, ground level concentrations of sulphur dioxide in Sault Ste. Marie, ON have been well below Ministry AAQC and not of significant concern for local air quality.

During the 1990s, mean annual concentrations ranged from 1.5 to 2.2 ppb and the annual maximum 1-hour averages varied from 60 to 190 ppb. These values are well within the Ministry's annual mean objective of 20 ppb and maximum 1 hour objective of 250 ppb.

There is no obvious trend in the annual mean concentrations as the year-to-year variability is small and not considered to be significant. From the available Ontario MOE emissions inventory for the major point sources in Sault Ste. Marie, ON, annual SO₂ emissions from Algoma Steel Inc. dominate (> 99 percent) and remained fairly constant at 9,000 to 12,000 tonnes per year (9,900 to 13,228 tons) from 1990 to 1997. Since 1998, these emissions have marginally decreased, ranging from 7,000 to 9,000 tonnes per year (7,716 to 9,900 tons). This reduction may have contributed to the reduced hourly concentrations observed since 1997. However, meteorological dispersion conditions also play a key role in the magnitude and frequency of occurrence of short term elevated concentrations and correlations between emissions and measured concentrations are not always evident.

TABLE 47 Three-year Summary for SO₂ in Sault Ste. Marie, Ontario

SO₂ 1-hour Ontario MOE AAQC is 250 ppb
 SO₂ 24-hour Ontario MOE AAQC is 100 ppb
 SO₂ 1-year Ontario MOE AAQC is 20 ppb

Station	1998				1999				2000			
	[a]	[b]	[c]	[d]	[a]	[b]	[c]	[d]	[a]	[b]	[c]	[d]
Patrick St. Merrifield School	0	1.9	93	25.4	0	1.9	113	25.8	0	2	94	21.2

[a] Number of times above any AAQC
 [b] Annual Mean
 [c] 1-hour max
 [d] 24-hour max

Nitrogen Dioxide (NO₂)

In Sault Ste. Marie, ambient measurements reveal that NO₂ comprises about 60 to 65 percent of the oxides of nitrogen (NO + NO₂). This is about five percent higher than the provincial average. The annual means and the annual maximum concentrations for NO₂ revealed a downward trend during the review period from 1990-2000. This is especially evident for the annual maximum values. Due to instrumentation failures in 1999, there were insufficient data to compute the annual mean. Lower ambient concentrations coincide with reduced

NO_x emissions from the Algoma Steel Inc. facilities in the late 1990s. The influence of traffic emissions on NO₂ concentrations is very site-specific and is not well known at this site. Annual means at this site are slightly more than half of the levels in most other major centers in the province.

The Ontario Ministry of the Environment's 1-hour objective for NO₂ of 200 ppb was never exceeded during the review period; the highest recorded value being 160 ppb in 1991.

TABLE 48 Three-year Summary for NO₂ in Sault Ste. Marie, Ontario

NO₂ 1-hour Ontario MOE AAQC is 200 ppb
 NO₂ 24-hour Ontario MOE AAQC is 100 ppb

Station	1998			1999			2000		
	Mean	1hr-max	24h-max	Mean	1hr-max	24h-max	Mean	1hr-max	24h-max
Patrick St. Merrifield School	10.3	55	29.6	INS*	113	25.8	10.9	58	35.7

*INS - insufficient valid data

Total Reduced Sulphur (TRS)

The annual mean concentrations of TRS show a decline during the 1990s. The number of episodes with hourly averages exceeding the pulp mill objective of 27 ppb has been sporadic with a total of 11 hours during the entire period, 1990-2001. The decline in TRS concentrations is in parallel with a decline in the number of hours of moderate to poor air quality since 1998 indicating the

influence of TRS on the Air Quality Index as shown in Table 49. A TRS emissions inventory for Algoma Steel Inc. is not available at this time for the review period and hence it is difficult to compare air quality improvements with emission reductions. However, one can assume that the process improvements undertaken at that facility in the 1990s to reduce overall air contaminant emissions has resulted in reduced TRS releases.

TABLE 49 Three-year Summary for Total Reduced Sulphur in Sault Ste. Marie, Ontario
TRS 1-hour Ontario MOE AAQC is 27 ppb

Station	1998			1999			2000		
	Number of hours above AAQC	1hr-max	24h-max	Number of hours above AAQC	1hr-max	24h-max	Number of hours above AAQC	1hr-max	24h-max
Patrick St. Merrifield School	3	37	4.1	0	25	4.8	0	13	3.2

Ground Level Ozone

The annual means ranged between 22 to 25 ppb, which is typical for northern Ontario and which is about five ppb greater than in southern Ontario. The four highest annual means of the review period were observed in the last five years, possibly suggesting a trend of increasing ozone levels at that site during this latter period.

The number of recorded hours above the provincial 1-hour objective of 80 ppb was highest in 1996, 1998 and 1999, again supporting the observation of generally higher ozone concentrations in the second half of the decade. During this period, the increased influence of ozone on the occurrence of moderate-to-poor air quality is also evident. This trend moderated in the latter part of the decade, likely largely due to meteorological factors.

TABLE 50 Three-year Summary for Ozone Maximum 1-hour and 24-hour levels in Sault Ste. Marie, Ontario
O₃ 1-hour Ontario MOE AAQC is 80 ppb

Station	1998			1999			2000		
	Number of hours above AAQC	1hr-max	24h-max	Number of hours above AAQC	1hr-max	24h-max	Number of hours above AAQC	1hr-max	24h-max
Patrick St. Merrifield School	10	98	61.5	8	88	68	1	82	65.7

Total Suspended Particulate (TSP)

Monitoring for TSP was undertaken at both the ambient (Patrick St) and the industrial (Bonney St.) sites. Monitoring was suspended at the ambient site in the summer of 1996. At both sites, the levels of TSP are observed to have increased from 1992 to 1995. At the industrial site, the levels continued to rise, peaking during the period 1997 to 1999. The trend in estimated PM emissions for Algoma Steel is very similar to the TSP trends.

Between the years 1990 and 2001, the annual geometric means from the industrial site were nearly double those at the ambient site, and exceeded the Provincial Annual AAQC of $60 \mu\text{g}/\text{m}^3$ in all but one year after 1993. In addition, the frequency of exceedance of the 24 hour objective of $120 \mu\text{g}/\text{m}^3$ was considerably higher at the industrial site and mirrored the trend for the geometric means. At the industrial site, maximum 24-hour values ranged from 249 to over $500 \mu\text{g}/\text{m}^3$. Reductions in the annual means and frequency of exceedance of the objective occurred in 2000 and 2001. With the exception of year 2000, data show the annual levels of TSP in the west end of the city near the industrial site have been in exceedance of the Provincial AAQC since 1994.

TABLE 51 Three-year Summary of Total Suspended Particles (TSP) for Bonney St., Pumphouse Location (at present, data for Patrick St. Site not available)

TSP 24-hour Ontario MOE AAQC is $120 \mu\text{g}/\text{m}^3$
 TSP 1-year Ontario MOE AAQC is $60 \mu\text{g}/\text{m}^3$

Station Name	1998				1999				2000			
	[a]	[b]	[c]	[d]	[a]	[b]	[c]	[d]	[a]	[b]	[c]	[d]
Bonney St., Pumphouse	81.8	1	249	18	91.5	1	424	16	57.6	0	267	9

[a] Annual Geometric Mean

[c] Max 24h Value

[b] # of times above 1 yr. AAQC

[d] # of times above 24h AAQC

Coarse/Inhalable Particulate (PM_{10})

The annual geometric means at the ambient site varied from about 14 to $20 \mu\text{g}/\text{m}^3$, whereas the means at the industrial site varied from 24 to $37 \mu\text{g}/\text{m}^3$. The values followed the same trend at both sites, with peak values recorded in 1994 and 1999. The year-to year values were variable, especially at the industrial site and no clear trend could be ascertained from the data set.

The frequency of exceedance of the Ministry's interim objective of $50 \mu\text{g}/\text{m}^3$ as a 24-hour average was considerably higher at the industrial site, with 10 percent to over 40 percent of the samples in non-conformance. Non-conformance with the interim objective was highest in 1999 at both sites.

In mid-1996, measurements of inhalable particulate were undertaken at the ambient site with a TEOM analyzer. The annual means varied from 17 to $18.5 \mu\text{g}/\text{m}^3$, very close to those obtained from the manual daily sampler. There was no discernible pattern of increasing/decreasing values. Maximum hourly averages as high as $360 \mu\text{g}/\text{m}^3$ were observed. The number of days with 24 hour averages in excess of $50 \mu\text{g}/\text{m}^3$ gradually increased every year, from three exceedances in 1996 to 17 in 2001.

Fine/Respirable Particulate (PM_{2.5})

Respirable particulate levels in the year 2000 at the industrial site had an annual mean of 11.1 µg/m³, a maximum 1-hour measurement of 170 µg/m³, a maximum 24-hour value of 55 µg/m³ and 22 days (24-hour period) above the pending 24-hour Canada-Wide

Standard (CWS) of 30 µg/m³. In 2001, the mean was 13.3 µg/m³, the maximum one hour value was 191 µg/m³, the maximum 24-hour reading was 53 µg/m³ and 24 days were above the proposed CWS. These results were among the highest in the province and show a significant impact on the levels of respirable particulate in that part of the city.

TABLE 52 Three-year Summary of Respirable Particles (PM_{2.5})
PM_{2.5} 24-hour proposed Canada-Wide Standard - 30 µg/m³

Station Name	1999			2000			2001		
	[a]	[b]	[c]	[a]	[b]	[c]	[a]	[b]	[c]
Bonney St., Pumphouse	0	174	25.8	32	178	59.1	24	191	53

[a] Number of times above 24h CWS

[b] 1h-max (µg/m³)

[c] 24h-max (µg/m³)

2.5.2 Selected Hazardous Air Pollutants

Volatile Organic Compounds (VOCs)

Benzene

No Provincial AAQC

At the ambient site (Patrick St. site), the annual mean benzene values were rather constant, varying from about 1.5 to over 3.0 µg/m³. These levels are quite common in urban centers due to the impact from transportation and area sources.

At the industrial site (Bonney St. site), the annual mean benzene values were considerably higher (from 5.6 to over 15 µg/m³) and more variable presumably due to the impact of emissions from the Algoma Steel facilities. Both sites showed higher mean values during the period 1995 to 1997. At the industrial site (Bonney St. Site), 24 hour values over 30 µg/m³ and as high as 60 µg/m³ were measured.

The VOC emissions inventory for the Algoma Steel Inc. facilities show a similar pattern with increasing emissions during the 1995 to 1997 period followed by substantially reduced values as of 1998.

Carbon tetrachloride

24-hour (Provincial) AAQC is 2.4 µg/m³

At both sites, the VOC cartridges were analyzed for this substance starting in 1994. The annual means at the industrial site (Bonney St.) varied from 0.28 to 0.66 µg/m³, whereas those at the ambient site (Patrick St.) were similar and varied from 0.39 to 0.54 µg/m³. There was no discernible upward/downward trend with time. The maximum value at both sites was slightly over 1.0 µg/m³ during the monitoring period reported. This is below the provincial objective of 2.4 µg/m³ which was lowered from 600 µg/m³ in 2001.

Semi Volatile Organic Compounds

Benzo(a)pyrene (BaP), a Polycyclic Aromatic Hydrocarbon (PAH), was one of the IJC Board's chemicals of highest concern relative to direct inhalation.

Ontario MOE Annual Mean AAQC is 0.00022 µg/m³ (for single source) Ontario MOE 24-hour AAQC is 0.0011 µg/m³ (for single source) Ontario MOE Annual Mean AAQC is 0.0003 µg/m³ (for all sources)

Both sites recorded higher annual means in 1993 and 1994, followed by a substantial reduction the following

year. This downward trend was maintained at the industrial site (Bonney St.) until 1998, followed by a reversed trend in the subsequent three years. The annual means at the ambient site (Patrick St.) were variable from 1993 to 1996 and rather constant for the rest of the reporting period at about 0.0003 to 0.0005 µg/m³.

The frequency of exceedance of the 24-hour objective was more pronounced at the industrial site with 20 to 80 percent of the values exceeding it. At the ambient site, usually less than 10 percent of the samples were in non-conformance of the objective. In the latter part of the decade, both sites showed improvements in the degree of non-conformance.

2.5.3 Industries in Sault Ste. Marie, Ontario

St. Marys Paper Ltd. was built in 1900 and produces specialty papers from ground wood pulp and purchased kraft pulp (pulp processed with sulphur solution). Production was estimated to be 198,000 tonnes (218,300 tons) in 1997. By using the National Pollutant Release Inventory (NPRI) Data Search, the 2000 Facility Substance Summary for St. Marys Paper reflected:

- zero on-site releases, transfers for disposal and transfers for recycling for Ammonia and Phosphoric Acid.
- 22.50 kg (49.6 lbs) of Mercury and its compounds (which are classified as toxic/carcinogenic) were transferred for disposal in this year.
- 2000 data was limited and only available for Phosphoric Acid, with no on-site releases, transfers for disposal or transfers for recycling.

The major point in Sault Ste. Marie is Algoma Steel Inc. This company is Canada's third largest integrated steelmaker. It produces two product lines, sheet and plate. During production, several pollutants (some classified as toxic/carcinogenic) are released and/or transferred. The NPRI has collected data on these releases for years 1994-2000.

The NPRI Facility Substance Summary for Algoma Steel Inc. indicates for the year 2000:

- Benzo(s)anthracene as the largest on-site substance released at 914 kg (2015 lbs);
- Benzo(a)pyrene as the second released at 762 kg (1680 lbs); and
- Benzo(k)fluoranthene at 610 kg (1345 lbs).

All three substances are classified as toxic/carcinogenic.

- Hydrochloric Acid is the only substance transferred for recycling for year 2000 at 278.83 tonnes (307.4 tons).
- No substances were transferred for disposal.

2.5.4 Great Lakes Regional Air Toxics Emissions Inventory - Sault Ste. Marie

Table 52 provides a summary of emissions data for the Great Lakes Regional Air Toxics Emissions Inventory (GLRATEI). This inventory collects data on county basis. Chippewa county was taken as suggestive of Sault Ste. Marie, MI and Algoma District includes Sault Ste. Marie, ON (in northern Ontario, jurisdictions are defined as Districts, not counties).

Both the Chippewa County and Algoma District represent areas much larger than Sault Ste. Marie, MI and ON. The data are included to provide a general impression of the amount of hazardous air pollutants emitted from these areas. Additionally, caution should be taken not to compare these emission rates between Chippewa County and Algoma District as the latter is significantly larger in size and in population.

In comparing the data sets for Algoma District/Sault Ste. Marie ON, one set from Environment Canada's NPRI and the other from the Great Lakes Regional Air Toxics Emissions Inventory, certain discrepancies are evident. The NPRI estimates annual benzo-a-pyrene emissions from the Algoma Steel facility in Sault, ON at 762 kg (1680 lbs) per year, while the GLRATEI 1998 estimate for point source emissions of this contaminant from the entire Algoma District is 0.36 lbs per year. In this case, given the corroborating ambient measurements in Sault Ste. Marie, ON, the NPRI estimate is the more credible.

Upon further discussion with Ontario MOE staff, it was reported that the arsenic emissions were from Algoma

Steel-Wawa Ore Division, some distance from Sault Ste. Marie, Ontario. The facility was exempted from NPRI reporting. The arsenic emission from this facility was estimated from stack testing emission factors and the production quantity from their sintering operation. This facility ceased operation in 1998.

The GLRATEI also indicates that 1998 annual arsenic emissions in the Algoma District are 41,618 lbs. Per year; however, the NPRI does not identify sources with this level of release within that geographic area. However, communications with provincial staff indicate that the arsenic emissions came from Algoma Steel - Wawa, Ontario.

TABLE 53 Great Lakes Regional Air Toxic Emissions Inventory, 1998 data

Chippewa County represents Sault Ste. Marie, Michigan
 Algoma District represents Sault Ste. Marie, Ontario
 (lb/yr) for selected contaminants

*1998 NPRI data provided for comparative purposes

POLLUTANT NAME	COUNTY	POINT EMISSIONS	AREA EMISSIONS	MOBILE SOURCES (road & non-road)	TOTAL
1,2-Dichloroethane	Chippewa County	0.00	34.44	0.00	34.44
	Algoma District	0.05	6.98	0.00	7.03
	Total for the area	0.05	41.42	0.00	41.47
1,3-Butadiene	Chippewa County	0.00	0.00	4,248.89	4,248.89
	Algoma District	0.47	0.00	24,403.65	24,404.12
	Total for the area	0.47	0.00	28,652.54	28,653.01
Arsenic	Chippewa County	21.14	0.00	0.05	21.19
	Algoma District	41,618.59	2.16	4.59	41,625.34
	Total for the area	41,639.73	2.16	4.64	41,646.53
Benzene	Chippewa County	2.78	41,170.57	40,599.43	81,772.78
	Algoma District (NPRI)	361,178.10	46,083.04	195,087.75	602,348.89 (361,161.3*)
	Total for the area	361,180.88	87,253.61	235,687.18	684,121.67
Benzo(a)pyrene	Chippewa County	0.00	72.67	0.00	72.67
	Algoma District	0.36	90.59	0.00	90.95
	Total for the area	0.36	163.26	0.00	163.62
Beryllium	Chippewa County	0.00	0.00	0.00	0.00
	Algoma District	66.88	0.94	0.00	67.82
	Total for the area	66.88	0.94	0.00	67.82
Cadmium	Chippewa County	1.68	0.82	0.00	2.50
	Algoma District	220.25	8.02	1.31	229.58
	Total for the area	221.93	8.84	1.31	232.08
Carbon Tetrachloride	Chippewa County	0.00	0.00	0.00	0.00
	Algoma District	136.68	66.46	0.00	203.14
	Total for the area	136.68	66.46	0.00	203.14

continued next page

TABLE 53, cont'd Great Lakes Regional Air Toxic Emissions Inventory, 1998 data

POLLUTANT NAME	COUNTY	POINT EMISSIONS	AREA EMISSIONS	MOBILE SOURCES (road & non-road)	TOTAL
Chloroform	Chippewa County	0.00	37.57	0.00	37.57
	Algoma District	3,107.40	244.95	0.00	3,352.35
	Total for the area	3,107.40	282.52	0.00	3,389.92
Chromium compounds	Chippewa County	0.00	0.02	1.04	1.06
	Algoma District (NPRI)	0.01	28.68 (176.37*)	31.77	60.46
	Total for the area	0.01	28.70	32.81	61.52
Formaldehyde	Chippewa County	202.36	48.08	25,408.98	25,659.42
	Algoma District (NPRI)	136.19 (83,775.66*)	637.97	113,367.47	114,141.63
	Total for the area	338.55	686.05	138,776.45	139,801.05
Nickel	Chippewa County	0.00	0.04	1.33	1.37
	Algoma District (NPRI)	285.93 (3,637.63*)	68.32	301.21	655.46
	Total for the area	285.93	68.36	302.54	656.83
Styrene	Chippewa County	0.00	0.00	8,464.56	8,464.56
	Algoma District (NPRI)	0.00 (1,785.74*)	295.25	24,332.12	24,627.37
	Total for the area	0.00	295.25	32,796.68	33,091.93
Tetrachloroethylene	Chippewa County	0.00	42,256.84	0.00	42,256.84
	Algoma District	0.00	57,872.30	0.00	57,872.30
	Total for the area	0.00	100,129.14	0.00	100,129.14
Trichloroethylene	Chippewa County	0.00	33,909.07	0.00	33,909.07
	Algoma District	11.15	530.69	0.00	541.84
	Total for the area	11.15	34,439.76	0.00	34,450.91
Xylene (mixed isomers)	Chippewa County	1.87	48,546.31	109,741.20	158,289.38
	Algoma District (NPRI)	3.99	101,195.30 (881.85*)	596,187.80	697,387.09
	Total for the area	5.86	149,741.61	705,929.00	855,676.47

2.6 Sault Ste. Marie, Michigan

The city of Sault Ste. Marie, Michigan situated on the south side of St. Mary's River, receives winds from a north, slightly west direction and from the east, slightly south direction. Winds from the north direction would carry emissions from the more industrialized areas of Sault Ste. Marie, Ontario.

At present, Sault Ste. Marie Michigan does not have an extensive air quality monitoring network. In fact, only recently the area, as part of a co-operative study involving U.S. EPA, Environment Canada, the State of Michigan and the Sault Michigan Inter-Tribal Council, initiated an air monitoring program to determine any impacts from the industries in Sault Ste. Marie, Ontario, particularly Algoma Steel. Two monitoring sites have been established to collect data on fine particulate matter only (PM_{2.5}).

Air quality monitoring for the following pollutants is not collected in Sault Ste. Marie, Michigan: Sulphur dioxide; Nitrogen dioxide; Total Reduced Sulphur; ground level ozone, and coarse/inhalable particulate matter.

Fine/Respirable Particulate Matter (PM_{2.5})

Monitors have been installed to determine the levels of respirable particulate near the Algoma Steel facilities. One of the monitors provides PM_{2.5} and chemical speciation. Its purpose is to determine PM_{2.5} constituents, allow assessment of trends and develop mitigation approaches to reduce ambient aerosol emissions. Monitoring began recently in February 2001; as a result limited data are available.

TABLE 54 Annual Mean PM_{2.5} Concentrations, 2001 (Annual Mean, rounded to nearest 0.1 µg/m³)

Station Name and Number		2001
260330901*	Sault Ste. Marie Tribal #1	8.2
260330901*	Sault Ste. Marie Tribal #2	7.9
260330902	Sault Ste. Marie Tribal	7.9

*Station 260330901 obtained two measurements

NOTE: Calculating the annual arithmetic mean to determine attainment status, the annual average of the quarterly PM_{2.5} mean concentrations over three years. This result must be less than or equal to 15 µg/m³. More data are necessary to determine PM_{2.5} attainment levels in Sault Ste. Marie, Michigan.

TABLE 55 Twenty-four Hour 98th Percentile PM_{2.5} Concentrations, 2001 (Annual Mean, rounded to nearest 0.1 µg/m³)

Station Name and Number		2001
260330901*	Sault Ste. Marie Tribal #1	28
260330901*	Sault Ste. Marie Tribal #2	25
260330902	Sault Ste. Marie Tribal	28

*Station 260330901 obtained two measurements

NOTE: To be in attainment of the proposed US-NAAQS of 65 µg/m³, the 3-year average of the 98th percentile 24-hour concentration must be less than or equal to the standard. Additional data are required to determine the status of Sault Ste. Marie, Michigan.

3.0 FINDINGS

- i) While the data reviewed were not the most current nor comprehensive, it is clear that, in all three regions, during episodes that occur with some frequency, particularly in the summer months, smog (ozone and fine particulate) achieves levels that would affect the well being of the entire population and have an immediate, pronounced negative impact on the most sensitive elements of the populations – youth and the elderly. Similar conditions are evident in the past few years and appear to persist to this day.
- ii) The two southerly regions are the subject of a greater number of Ontario MOE smog alerts, while the northern locale has a higher annual average ozone concentration. Continued non conformance with the Ontario interim 24 hour PM10 objective and the annual Total Suspended Particulate ambient air quality criterion (AAQC) is evident in Sault Ste Marie Ontario, particularly at the monitoring site adjacent to the Algoma Steel facility. Concentrations of benzo-a-pyrene at this industrial site were also in excess of the provincial AAQC for this contaminant.
- iii) Sources of smog are both regional (Chicago-Quebec City corridor) and local (mobile, point and areal sources). Improvement in local and downwind air quality, particularly in the two southern locales, would require significant reductions from all local source segments, including gasoline and diesel powered vehicles in the mobile sector.
- iv) With regard to hazardous air pollutants (HAPs), of those tracked by the Commission in 1991, there is evidence that emissions of several of these may have declined over the ensuing period. However, emissions of trichloroethylene and xylene compounds appear to be at or above previous estimates. Many organic HAPs are Volatile Organic Compounds (VOCs) and, as such, also contribute to the formation of ozone. There is some evidence of particular HAPs in excess of the levels associated with the one-in-one-million lifetime cancer risk benchmark in the US Clean Air Act.
- v) Concentrations of hazardous air pollutants are more strongly associated with local sources and further regional reductions from both mobile and stationary sources would be required to lower these concentrations.
- vi) Additional assessment of the health impact of these HAPs individually is complicated by the differences among the various guidelines and standards prevailing among the jurisdictions; however, the risk assessment now underway under the US Ten City Study may offer some further guidance on this issue.
- vii) A more comprehensive overview of the current prevailing situation would require a joint coordinated effort by the federal, state and provincial agencies.

4.0 RECOMMENDATIONS

- i) Senior levels of the USEPA and Environment Canada should join with their counterparts in the State of Michigan and the Province of Ontario to provide a more comprehensive, current and joint overview of air quality in these three regions. Sharing of the most current information regarding routine sampling and monitoring results should be a part of this co-operative effort.
- ii) This same body should also commit to the development of an appropriate bilateral control strategy, considering both stationary and mobile sources of common air pollutants and HAPs, to achieve significant reductions in local and regional concentrations of those pollutants adversely affecting regional air quality.
- iii) The Commission should adopt the role of facilitating discussion and communication among the Parties and Jurisdictions in supporting the development of integrated monitoring programs and control strategies in these regions.
- iv) Continued development of a mechanism to compare air quality standards and guidelines for both common and hazardous air pollutants in transboundary airsheds is also recommended.
- v) The IJC should carefully track the US Urban HAPs Study currently underway in ten cities in the United States and assess the outcomes of this study, as these would have relevance could be applied in the three regions, particularly the two southern locales, as well as a vast majority of North American urban settings.

ACRONYMS

AAQC	Ambient Air Quality Criteria
AQI	Air Quality Index
BaP	benzo(a)pyrene
CCME	Canadian Council of the Ministers of the Environment
CO	carbon monoxide
COH	coefficient of haze
GDA	Greater Detroit Area
GLRATEI	Great Lakes Regional Air Toxics Emissions Inventory
HAPs	Hazardous Air Pollutants
IJC	International Joint Commission
LIMA	Lambton Industrial Meteorological Alert - Sarnia
LIMA	Lambton Industry Meteorological Alert - Sarnia
MACT	Maximum Achievable Control Technology
MDEQ	Michigan Department of Environmental Quality
MSA	Metropolitan Statistical Areas
NAAQS	National Ambient Air Quality Standards - US
NAMS	National Air Monitoring Stations - US
NESHAPS	National Emission Standards for Hazardous Air Pollutants - US
NO ₂	nitrogen dioxide
NO _x	nitrogen oxides
O ₃	ozone
OMOE	Ontario Ministry of the Environment
PAH	polycyclic aromatic hydrocarbon
PCDD	polychlorinated dibenzo- <i>p</i> -dioxin
PCDF	polychlorinated dibenzofurans
PEMA	Pollution Emission Management Area
PM ₁₀	Inhalable Particulate Matter
PM _{2.5}	Respirable Particulate Matter
PMSAs	Primary Metropolitan Statistical Areas
ppb	parts per billion
SIP(s)	State Implementation Plan(s)
SLAMS	State and Local Air Monitoring Sites - US
SLEA	Sarnia-Lambton Environmental Association
SO ₂	sulphur dioxide
SOLEC	State of the Lakes Ecosystem Conference
SP	suspended particles
SPMS	Special Purpose Monitoring Stations
TACs	toxic air contaminants
TEOM	Tapered Element Oscillating Microbalance
TEQ	toxicity equivalent
TRS	total reduced sulphur
TSP	total suspended particulates
U.S. EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

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