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Corrections to the February 1992 International Joint Commission Report on

Air Quality in the Detroit-Windsor/ Port Huron-Sarnia Region

January 1993

International Joint Commission
Commission mixte internationale

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FOREWORD

The February 1992 report of the International Joint Commission on *Air Quality in the Detroit-Windsor/Port Huron-Sarnia Region* contained a number of data entry errors in Appendix E. This report provides the corrected data and revised text related to the trend analyses undertaken on this data.

The corrections relate to the section of the main text of the 1992 report entitled "Air Quality Trends in the Detroit-Windsor/Port Huron-Sarnia Region," (Pages 13 to 16) and the text and tables in "Appendix E" (Pages 28 to 48).

The corrections to the data do not affect the "Executive Summary and Recommendations" of the report as trend data were only available for a very limited number of chemical parameters.

AIR QUALITY TRENDS IN THE DETROIT-WINDSOR/ PORT HURON-SARNIA REGION*

From 1975 to 1983 the Commission reported annually to the Governments of Canada and the United States on specific air pollution concerns and associated activities in the Detroit-Windsor/Port Huron-Sarnia region. The 1975 Reference referred to only three pollutants for which firm commitments had been made by federal, state and provincial authorities to achieve air quality compatible with the air quality objectives proposed by the Commission in its 1972 report to Governments: total suspended particulate (TSP) matter, sulphur oxides and odours. The Board appointed by the Commission under the 1975 Reference also reported, to a limited degree, on ambient levels and control information for carbon monoxide, nitrogen dioxide and photochemical oxidents.

In its final report to Governments in 1983, the Commission reported that from 1976 to 1983 control strategies and technical works had been implemented to bring particulates, sulphur dioxide and odours under control. It reported that more than 90 percent of the geographical region complied with the objective for control of sulphur oxides. The problem of odours was only occasional, and control of particulates in stationary sources had been accomplished.

The ambient air quality in the Detroit River and Saint Clair River Areas was considered satisfactory during this earlier Reference period, if the measured:

1. Sulphur dioxide (SO_2) concentration for:
   a. 1 hour was less than 0.25 ppm (655 $\mu g/m^3$) of air; and for
   b. 24 hours was less than 0.10 ppm (260 $\mu g/m^3$) of air
2. Total Suspended Particulate (TSP) concentration as determined by high volume samplers and at 1 atmosphere and 70°F for:
   a. 24 hours was less than 120 $\mu g/m^3$, and for
   b. 1 year the annual geometric mean was less than 60$\mu g/m^3$.
3. Offensive odours were absent.

Particulate and Sulphur Dioxide

Since 1983, the United States and Canada have amended their particulate matter and sulphur dioxide standards and objectives. The United States particulate standard includes monitoring of and reporting on fine particulates, which are very small particles that can be inhaled and thus reach the lungs. The United States no longer reports on emergency one-hour exceedance for sulphur dioxide, but has retained a 24-hour mean of 365 $\mu g/m^3$ (micrograms per cubic metre), and reports against an annual average limit of 80 $\mu g/m^3$. Ontario reports against an annual average criteria of 0.020 ppm (53 $\mu g/m^3$) as well as 24-hour and 1-hour

* Revision of text contained in February 1992 International Joint Commission report - pages 13-16.

means of 0.10 ppm and 0.250 ppm. Data archiving for sulphur dioxide in the U.S. portion of the region utilizes units of micrograms per cubic metre while in the Canadian portion data is reported in parts per million. In order to ensure consistency in units throughout the region, the Commission reports sulphur dioxide concentrations in micrograms per cubic metre with the Canadian data being converted on the basis of United States standard conditions of 25°C and 1 atmosphere pressure.

Data archiving of air quality information for the region no longer accommodates analysis based on the objectives established for the 1975 Reference. In order to report trend data on sulphur dioxide and total suspended particulates, the Commission seeks clarification from Governments on the regulatory objectives in effect in the region. It is assumed that these replace the earlier bilateral objectives against which the Commission reported until 1983.

Analyses of air quality trends for total suspended particulate and sulphur dioxide from 1983 to 1990 appear in Appendix E. Based on a regional assessment of this data, the total suspended particulate and sulphur dioxide objectives established for the 1975 Reference to the Commission have generally been met but localized exceedances continue to occur. Exceedances of the IJC TSP objective occurred on several occasions from 1983 to 1986, mainly in Wayne County (Detroit area), but data show a clear trend for reduced levels of TSP throughout most of the region since the early 1980s. For sulphur dioxide, a fairly consistent trend of meeting the IJC objectives has emerged.

Improvements in sulphur dioxide emissions in the region are a major success story, but ameliorations in total suspended particulates are less conclusive. As a parameter, TSP alone is not a good indicator of how air quality affects human health because its measurement only considers the number and not the size of particles. Very small particles, or fine particulates measured as PM_{10}, are respirable and can cause adverse health effects. A few monitoring sites in the region no longer report on TSP but only report on PM_{10}. This is a significant change in monitoring protocols, which should be reviewed on a regional basis to ensure that appropriate monitoring is in place to correlate the observed presence of particulate matter with emission sources since some pollutants that correlate with TSP do not always correlate with PM_{10}. The Commission requires both TSP and PM_{10} data to advise Governments on the health and environmental implications of particulate matter.

Accordingly,

the Commission recommends that:

16) **the Governments review current air quality objectives for sulphur dioxide and particulate matter in the region and provide the Commission with updated objectives for compliance assessment; and**

17) **consideration be given to modifying the particulate objective to include PM_{10}.**

The United States and Canada have ambient air quality standards or objectives for carbon monoxide, nitrogen dioxide, and ozone. Analysis of the available monitoring data for these parameters in the Reference region is presented in Appendix E.

Carbon Monoxide

Motor vehicles are the main source of carbon monoxide. Current control strategies, by the states and provinces, are aimed at vehicle maintenance and inspection programs to assure that engines and catalytic converters operate to emit less carbon monoxide. Although each new class of vehicles emits less carbon monoxide than its predecessors, the impact of the increased number of vehicles in service has exceeded the impact of emission improvements per vehicle. Ambient air quality standards and objectives for carbon monoxide are:

-United States - concentrations based on a 1-hour mean of 35 ppm (40 mg/m^3) and an 8-hour mean of 9 ppm (10 mg/m^3.)

-Ontario - concentrations based on a 1-hour mean of 30 ppm and an 8-hour mean of 13 ppm.

Available monitoring data for carbon monoxide are difficult to interpret. Very few sites monitor this parameter and most data are too ambiguous to judge compliance as monitoring sites are generally located in heavy traffic areas and thus do not represent regional trends. Based on the data available and analyzed, it was not possible to discern trends or the significance of carbon monoxide as a transboundary air pollutant.

Nitrogen Dioxide

Nitrogen dioxide has received considerable attention in recent years because it is a precursor to ozone and acid precipitation. Since regional authorities rarely monitor nitrogen dioxide, very little monitoring data is available in the Reference region. What limited data are available appear to indicate that the region meets United States and Ontario ambient air quality standards for this pollutant.

Ozone

The United States and Canada have different national standards or objectives for ozone. The United States ozone standard is 120 parts per billion (ppb) based on a one-hour mean and the Ontario criteria is 80 ppb for the same time average. Both countries had used 80 ppb as an analysis tool and requirement during the late 1970s and early 1980s, until the United States increased its ozone standard to 120 ppb.

The warmer summers of recent years have increased the number of ozone-related air pollution incidents in the Reference region and across the entire Canada-United States transboundary region. Neither country has consistently achieved even the more lenient United States ozone standard in the Reference region and it can only be assumed that neither country will consistently achieve its own respective ozone standard or objective within the next few years. Ozone data are presented in Table 6 of Appendix E.

Since 1980, several studies have shown relationships between ozone and acid rain and ozone and toxic air pollution. Governments have not articulated persuasive arguments that

current ozone control programs have a technical, philosophical and legal basis to retain different standards on each side of the international boundary.

As the Reference region is classed as a major non-attainment area for ground-level ozone by both Governments, the Commission encourages Governments to develop a binational ozone control strategy for the Reference region. Although initiatives are underway in both countries to deal with the problem, the Commission is concerned that these do not appear to be leading to effective and timely action to alleviate the current ozone exposure.

The United States Clean Air Act Amendments (1990) authorize control measures for ozone according to the severity of a regional ozone problem, and also has separate provisions for coke oven emissions. Coke ovens have historically been the largest single stationary sources of toxic volatile organic compounds in the United States portion of the Reference region. These organics can react with other air pollutants to generate ozone, and also react with ozone to form other toxic air pollutants.

The Commission is aware of recent closures of coking facilities in the region and the anticipated improvements this should have on local air quality. Although the Commission understands that there are currently no active coke oven operations in the region, the United States Environmental Protection Agency, in designating ozone controls required for the region, is encouraged to ensure that emissions from any new or reactivated coke oven facilities are considered.

On the Canadian side, federal and provincial officials have not reached consensus on implementation strategies and time frames for the the Federal NO_x-VOC (Nitrogen Oxide/ Volatile Organic Compound) Management Strategy, and thus the Commission cannot determine its impact and potential effectiveness in the Reference region.

A regional ozone control strategy must address stationary and mobile sources of volatile organics. Since ozone is clearly a transboundary pollutant and not strictly a locally generated domestic pollution problem in the Reference region,

the Commission recommends that:

18) the Governments, in consultation with the State of Michigan and the Province of Ontario, develop a joint regional ozone control strategy that includes emission controls for mobile and stationary sources, including coke ovens, and

19) the Governments, in consultation with the State of Michigan and the Province of Ontario, adopt a common ozone standard for the Reference region.

APPENDIX E*

Air Quality Trends in the Detroit-Windsor/ Port Huron-Sarnia Region

POST-1983 TRENDS FOR TOTAL SUSPENDED PARTICULATES AND SULFUR DIOXIDE

From 1975 to 1983 the Commission reported to the Governments on trends in total suspended particulates (TSP) and sulfur dioxide (SO_2). The Commission received air quality data suitable to estimate the one-hour and 24-hour means for the two air quality parameters to compare with the established objectives which the Governments had agreed upon and incorporated into the 1975 Reference. The objectives were:

- **a 24-hour average for total suspended particulate of 120 $\mu g/m^3$;**
- **a 1-year annual geometric mean for total suspended particulate of 60 $\mu g/m^3$;**
- **a one-hour objective for sulfur dioxide of 0.25ppm (655 $\mu g/m^3$);**
- **a 24-hour objective for sulphur dioxide of 0.10ppm (260 $\mu g/m^3$).**

In response to the Commission's request for post-1983 data to continue this reporting, the United States Environmental Protection Agency (U.S. EPA) provided the Commission with extensive air quality data for Michigan, summarized by counties, for the years 1965 to 1983. Monitoring data for Canadian stations reported as part of the National Air Pollution Surveillance (NAPS) Program were provided by Environment Canada and the Ontario Ministry of the Environment for the period 1980 to 1990. The analysis was limited to those stations reported under the NAPS program. Generally, information from the Ministry of the Environment's AQUIS data base has been utilized for these stations. Some of the sources showed major changes in air quality monitoring and data activities after 1983. The form and format of archived air quality data no longer suited the specific calculations previously performed by the Commission. Air quality monitoring ceased at some stations in the Reference area. Other stations had name changes or changes in the numerical identifiers in various data banks. Many analytical methods used in air quality monitoring also changed, and data network managers instituted new or additional quality control procedures consistent with the new analytical methods and the need to maintain high quality data reporting and archiving.

*Revision of text contained in the February 1992 International Joint Commission report - Pages 28 to 48.

Because these factors affect the analysis and interpretation of data for air quality trends, data base managers were consulted to determine the best way to ensure consistency with past reporting as well as provide an accurate assessment of new reporting. They suggested the assembly of a subset of data and some changes in statistical methodology to retain the historical continuity of stations and parameters. Some methodologies appear in Table 1.

The data for total suspended particulates (TSP) appear in Table 2. The data for sulfur dioxide appear in Table 3.

The analysis of total suspended particulates trend data from Table 2 shows the following:

1. Based on a regional analysis of the available data, there has been a general downward trend in TSP levels. For the most part, ambient air quality has met the IJC objective for TSP over the past ten years. However, at individual stations, frequent exceedances of the objective continue to be recorded.
2. An overview of TSP monitoring for the seven Michigan counties of the transboundary region (Lapeer, Macomb, Monroe, Oakland, Saint Clair, Washtenaw and Wayne), shows that Wayne County's urban industrialized zone and adjacent Monroe County have the greatest problems with TSP. The stations in Wayne County show a downward trend in ambient air levels of TSP over the period. The slightly inconsistent trend at one Monroe County station and the occurrence of elevated levels, as indicated by the maximum values recorded, implies the need for additional remedial measures for certain sources. The data did not allow, nor was it the intent to identify, the specific sources.

The analysis of data from Table 3 on SO_2 trends shows the following:

1. On a regional basis, SO_2 levels generally meet the IJC ambient air quality objectives. Levels throughout the region have remained fairly consistent since 1983 with the highest levels being recorded in the Sarnia area.
2. On the basis of annual mean concentrations, the Province of Ontario has a criteria of 0.02 ppm (52.4 $\mu g/m^3$) and the United States 0.03 ppm (80 $\mu g/m^3$). All stations analyzed met the annual mean criteria for SO_2. The U.S. stations met the more stringent Ontario criteria.
3. Several statistical anomalies in the data suggest that exceedances of objectives may have occurred, but further examination indicates the need for several statistical tests to resolve the anomalies. The individual exceedances are not sufficient to upset the overall trend where trends are discernable.
4. The Commission questions the reduced level of monitoring SO_2 in the U.S portion of the region. The data sets indicate a reduced level of SO_2 monitoring after 1984 which raises questions about the soundness of the monitoring activity in this portion of the region.

OTHER AIR QUALITY PARAMETERS

The Commission reported periodically on the following air quality parameters in its reports to Governments from 1975 to 1983. Common air quality objectives have not been established by the Governments for the Reference region.

Carbon Monoxide

Ambient air quality standards in the United States for carbon monoxide include a short-term event level of 35ppm or 40,000 $\mu g/m^3$, expressed as one-hour mean, and long term standard of 9ppm or 10,000 $\mu g/m^3$, expressed as an eight-hour mean. The Province of Ontario's air quality criteria for carbon monoxide are 30 ppm for a one-hour mean and 13 ppm for an eight-hour mean.

Table 4 presents carbon monoxide trends for the period 1973 to 1990. As limited carbon monoxide data are available throughout the region, it is not possible to discern trends for this parameter.

Nitrogen Dioxide

The United States ambient air quality standard for nitrogen dioxide is 0.053ppm or 100 $\mu g/m^3$, expressed as an annual arithmetic mean. Ontario has a one-hour event criterion of 0.20 ppm and a 24-hour criterion of 0.10 ppm. Table 5 presents some of the reported but limited nitrogen dioxide data for the Reference region.

Based on the limited data available for the stations analyzed, the air quality in the U.S. portion of the region meets the U.S. annual arithmetic mean criteria. The Canadian stations generally meet the one-hour and 24-hour provincial ambient air quality criteria.

Ozone

The ambient air quality ozone standards of the United States and Canada differ. The United States ozone standard is 120 parts per billion (ppb) based on a one-hour mean, and the Canadian national ambient air standard for ozone is 82 ppb, also expressed as a one-hour mean. The Province of Ontario's one-hour criteria is 80 ppb. On some days, the differences in the ozone standards would enable the United States to meet its standard while the Canadian portion of the region would not meet the more stringent Canadian or Ontario criteria. On poor air quality days neither country meets its own ozone standard. This has been a frequent occurrence during the summer months in recent years. Table 6 presents ozone data for the 1973 to 1990 period.

For 1990, the last year reported in the summary herein, all Michigan areas in the transboundary region except Macomb County met the United States ozone standard. Only two sites that met the United States standard also met the Canadian criteria. While Canadian stations met the more lenient U.S. standard during 1990, exceedances of the Canadian criteria were frequent.

TABLE 1

Selected Tests Used to Analyze Air Quality Data for the Period of 1983-1990

1. *Available data*	For air quality monitoring stations, the usual data for a given parameter are the annual arithmetic mean, maximum observed value, monthly means and the number of observations used to calculate the annual mean.
2. *The annual arithmetic mean*	If the annual arithmetic mean estimated from air quality monitoring data numerically exceeds the objective, the objective is not achieved. The converse is not always true, but depends on the time scales associated with the averaging processes.
3. *The maximum observed parameter value*	The objective is achieved if it numerically exceeds this parameter. If no observed datum exceeds the objective, then no mean based on observed data can exceed the objective.
4. *The annual arithmetic mean and maximum observed value for a parameter as an ordered pair*	The objectives place upper limits on post-1983 data. Regional air quality meets the objectives if both the annual arithmetic mean and maximum observed value of a parameter, as an ordered pair, numerically equal or are less than the ordered pair of 1983 data. This test will overcount data pairs in which the maximum observed value is below the 24-hour mean and requires a correction.
5. *Air Quality Index (AQI)*	An air quality index (AQI) widely used in the United States, assigns a value of 100 to the United States ambient air standard of 260 $\mu g/m^3$ for TSP and 80 $\mu g/m^3$ for SO_2 as 24-hour means. Air quality is "good" below AQI of 100 and worsens above an AQI of 100. The AQI values for the Reference objectives are 46 for TSP, 72 for SO_2 for the 24-hour mean and 179 for SO_2 for the one-hour mean. The AQI ignores parameter interaction but helps citizens in relating perceptions of health risk with air quality. Without additional monitoring information, the Commission cannot assess whether a region can achieve an objective if the parameter has an undesirable AQI value.
6. *Air quality network design*	Air quality stations measure different numbers of parameters with different frequencies. A study of the trends in numbers of stations, their geographical distribution, parameters measured, operational life times, and related factors can provide other important information in assessing a region's compliance with objectives for air quality.
7. *Outliers*	When a parameter's maximum observed value far exceeds other observed values, it might imply an outlier. By combining the maximum observed value, the annual arithmetic mean and the number of observations used to calculate the mean, an analyst can estimate a new annual mean that excludes the maximum observed value from the data. Suspicion of an outlier is reinforced when the new mean is much smaller than the original annual mean, and one might argue that the new mean is the appropriate one to use in previously described statistical tests. As this method may cause errors, its use requires great care.

TABLE 2

Air Quality Trends for Total Suspended Particulates (µg/m³)

WAYNE COUNTY (26163) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	83.5	79.0	67.4	61.3	63.7	64.4	61.9	65.6	61.5	68.1	58.0
	max value	247	210	191	134	153	257	198	210	128	136	123
0002	ann. mean	151	129	124	111	118	123	113	104	124	99.6	86.2
	max value	279	287	341	241	307*	341*	248	298*	280*	211	171
0003	ann. mean	54.8	50.3	49.6	50.1	51.3	46.2	43.2	44.3	50.9		
	max value	113	143	129	141	123	391*	128	115	93		
0004	ann. mean	54.2	54.4	46.6	51.5	51.4	50.4	40.8	50.5	54.5	49.6	
	max value	126	132	115	133	203	300*	74**	282*	287*	105	
0014	ann. mean	49.9	49.4	49.4	48.7	48.7	43.6	41.4	45.8	45.1	45.2	42.5
	max value	97	97	134	173	116	110	85	114	126	93	98
0015	ann. mean	121	105	96.1	95.9	106	98.8	86.1	86.8	94.8	87.5	84.8
	max value	272	277	403	266*	334*	289*	165	202	212	221	208
0016	ann. mean	96.5	73.5	74.9	68.7	65.7	60.5	54.8	56.8	54.7	56.4	55.1
	max value	339	204	236	165	140	163	103	145	141	171	119
0019	ann. mean	61.0	64.7	58.8	57.9	57.7	44.5	49.1	50.5	52.2	51.9	48.4
	max value	122	178	153	147	137	149	94	168	152	134	111
0029	ann. mean							74.6	64.0	61.5	60.5	63.8
	max value							133	146	166	134	161
	Average of means	**84.0**	**75.7**	**70.8**	**68.1**	**70.3**	**66.4**	**62.8**	**63.1**	**66.6**	**64.9**	**62.7**
	Average of maximums	**199**	**191**	**213**	**175**	**189**	**250**	**136**	**187**	**176**	**151**	**142**

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (μg/m³)

MONROE COUNTY (26115) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0003	ann. mean	67.1	59.8	52.2	50.3	46.2	45.3	44.8	45.4	59.7		
	max value	180	129	158	136	151	90	79	105	115		
0004	ann. mean	82.5	79.1	79.8	68.7	56.1	81.8	70.1	70.4	90.9		
	max value	245	163	216	193	79**	783*	271*	166	236		
0023	ann. mean	87.9	77.6	71.5	78.6	67.4	63.9	77.5	68.3			
	max value	154	141	190	172	175	146	191	157			
0951	ann. mean				67.9	60.6	72.9	48.7	61.0	73.4	60.6	61.6
	max value				339*	398*	1077*	169	1300*	616*	210	304*
	Average of means	**79.2**	**72.1**	**67.8**	**66.4**	**57.6**	**66.0**	**60.3**	**61.3**	**74.7**		
	Average of maximums	**193**	**144**	**188**	**210**	**201**	**524**	**178**	**432**	**322**		

SAINT CLAIR COUNTY (26147) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0005	ann. mean		54.7	47.9	44.0	45.1	41.4	43.8	44.5	46.5	53.7	38.0
	max value		108	135	112	125	158	92	117	127	136	85
0910	ann. mean	62.9	46.5	55.2	50.5	55.2	58.1	54.5	49.6	52.1	56.5	52.1
	max value	179	115	156	125	120	212	110	114	171	235	123
0912	ann. mean	53.5	52.1	50.2	57.3	49.4	54.2	49.8	48.7	46.7	47.9	46.4
	max value	157	169	142	167	115	245	105	125	134	122	142
1001	ann. mean	87.0	72.9	71.3	67.6	63.8	59.9	57.0	60.6	66.3		
	max value	175	180	240	175	139	245	139	157	154		
	Average of means	**67.8**	**56.6**	**56.2**	**54.8**	**53.4**	**53.4**	**51.3**	**50.8**	**52.9**	**52.7**	**45.5**
	Average of maximums	**170**	**143**	**168**	**145**	**125**	**215**	**112**	**128**	**146**	**164**	**117**

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates ($\mu g/m^3$)

LAPEER COUNTY (26087) Station

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	86.0	57.0	59.3	81.3	64.3	59.5	57.5	81.5	54.9		
	max value	271	109	157	197	144	241	117	226	143		

WASHTENAW COUNTY (26161) Station

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0002	ann. mean	49.1	49.5	49.4	46.4	48.5	50.7	49.3	50.3	43.1	43.7	40.9
	max value	88	92	102	95	138	169	91	139	84	75	95

MACOMB COUNTY (26099) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean			66.6	57.6	57.4	53.1	53.8	59.1			
	max value			144	155	120	257	114	131			
0008	ann. mean	77.2	66.9	66.8	57.0	56.1	50.0	53.8	60.2			
	max value	176	157	271	130	118	127	136	168			
6001	ann. mean	63.1	56.0	53.9	52.6	51.6	49.5	46.8	48.8			
	max value	128	115	119	140	117	214	89	107			
8001	ann. mean	69.3	61.8	55.2	53.2	56.5	50.9	51.4	53.8	59.7		
	max value	143	115	123	128	118	105	107	98	134		
	Average of means	**69.9**	**61.6**	**60.6**	**55.1**	**55.4**	**50.9**	**51.4**	**55.5**			
	Average of maximums	**149**	**129**	**164**	**138**	**118**	**176**	**112**	**126**			

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (µg/m³)

OAKLAND COUNTY (26125) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0003	ann. mean	67.0	59.6	57.0	54.5	52.3	51.1	47.4	60.4			
	max value	111	123	153	111	124	260*	92	141			
0005	ann. mean		57.4	51.8	54.8	56.7	59.3	50.5	64.1			
	max value		115	132	130	152	255	129	132			
1001	ann. mean	76.1	63.3	50.1	52.1	55.6	52.1	47.7	57.5			
	max value	209	128	124	129	125	151	84	133			
3001	ann. mean	58.6	50.6	50.7	48.8	50.6	43.8	47.8	57.1			
	max value	105	103	134	126	125	90	89	112			
	Average of means	67.2	57.7	52.4	52.6	53.8	51.6	48.4	59.8			
	Average of maximums	142	117	136	124	132	189	98.5	130			

LAMBTON COUNTY (SARNIA)

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 061004R												
	ann. mean	82	68	66	65	48	51	49	46	49	41	37
	max value	178	223	175	131	94	181	109	158	208	88	121

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (µg/m³)

ESSEX COUNTY (WINDSOR) Stations

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060203R											
ann. mean	66	51	52	41	39	50	49	54	42	52	42
max value	202	104	140	98	83	207	109	144	126	94	109
AES 060204C											
ann. mean	77	65	61	58	64	66	70	76	69	65	65
max value	166	189	182	149	255	200	193	439	189	174	143
AES 060212I											
ann. mean						85	77	73	80	60	60
max value						342	154	154	175	178	152
Average of means						**67**	**65**	**68**	**64**	**59**	**56**
Average of maximums						**250**	**152**	**246**	**163**	**149**	**135**

Notes:

"Ann. mean" is the annual arithmetic average of daily means. (Although preferrable to report annual geometric means, these were not available for many U.S. stations, thus, for consistency, annual arithmetic means are reported). "Max value" is the largest recorded observation. Underlined entries indicate that the IJC 24-hour average objective was not achieved. An asterisk (*) indicates that the maximum value exceeds the United States TSP standard of 260 µg/m³ because at least one datum exceeded the TSP standard that year. Two asterisks (**) indicate that there are quality assurance problems with the entries, but that the numbers are reported for completeness.

TABLE 3

Air Quality Trends for Sulfur Dioxide (µg/m³)

WAYNE COUNTY (26163) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	19.6	24.0	26.1	18.2	19.9	13.0	14.5	16.4	22.6	19.4	18.7
	max value	461	461	445	225	320	246	215	241	485	236	280
0002	ann. mean		34.3	40.6	35.6	25.6	28.3	25.1	20.5	28.4	27.1	28.3
	max value		267	694*	608	322	236	309	335	587	312	283
0005	ann. mean	22.4	29.8	25.8	27.3	23.4	23.8	25.0	24.9	25.3	23.7	21.1
	max value	338	477	380	553	359	348	288	629	396	430	246
0015	ann. mean	45.6	45.0	46.1	37.0	31.8	37.4	38.0	39.6	40.2	37.0	32.8
	max value	791*	681*	529	498	461	532	741*	356	458	354	383
0016	ann. mean	25.9	35.2	38.9	15.5	26.1	17.2	21.8	27.6	24.2	25.9	24.8
	max value	456	398	514	427	469	217	270	254	301	390	307
0019	ann. mean	24.5	29.7	24.6	27.0		19.3	18.5	19.0	19.9	18.0	17.3
	max value	524	409	338	618		241	262	385	278	215	197
0029	ann. mean							26.5	21.5	23.7	26.6	21.0
	max value							424	354	238	312	204
	Average of means	**27.6**	**33.0**	**33.7**	**26.8**	**25.4**	**23.2**	**24.2**	**24.2**	**26.3**	**25.4**	**23.4**
	Average of maximums	**514**	**449**	**483**	**488**	**386**	**303**	**358**	**365**	**392**	**321**	**271**

TABLE 3 (continued)

Air Quality Trends for Sulfur Dioxide ($\mu g/m^3$)

MONROE COUNTY (26115) Stations

No reported sulfur dioxide monitoring after 1984 in data base

SAINT CLAIR COUNTY (26147) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0005	ann. mean		24.6	37.7	27.3	28.0	24.0	22.6	21.4	20.3	22.0	19.8
	max value		377	587	1153*	798*	748*	862*	603	783*	493	574

LAPEER COUNTY (26087) Station

No reported sulfur dioxide monitoring after 1984 in data base

WASHTENAW COUNTY (26161) Station

No reported sulfur dioxide monitoring after 1984 in data base

MACOMB COUNTY (26161) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1003	ann. mean	14.7	23.4	36.4	38.8	36.4	20.3	19.5	16.5	16.4	15.9	16.3
	max value	269	446	343	724*	403	582	202	390	278	210	244

OAKLAND COUNTY (26125) Stations

0902	ann. mean	10.8	25.0			10.5	7.8	5.0				
	max value	209	487			236	288	131				

TABLE 3 (continued)

Air Quality Trends for Sulfur Dioxide (µg/m³)

ESSEX COUNTY (WINDSOR) Stations

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C											
ann. mean	28.8	31.4	23.6	21.0	18.3	18.3	21.0	21.0	28.8	21.0	18.3
max value	341	707	393	445	524	262	524	288	341	288	183
AES 060211R											
ann. mean	26.2	23.6	23.6	23.6	26.2	23.6	15.7	13.1	21.0	23.6	21.0
max value	341	367	341	576	445	341	367	288	367	288	236
AES 060212I											
ann. mean						23.6	26.2	18.3	21.0	18.3	21.0
max value						472	341	341	341	367	288
Average of means						21.8	21.0	17.5	23.6	21.0	20.1
Average of maximums						358	411	306	349	314	236

LAMBTON COUNTY (SARNIA) Stations

AES 061004R											
ann. mean	34.1	36.7	31.4	26.2	23.6	28.2	21.0	18.3	23.6	21.0	31.4
max value	917*	629	655	550	838*	498	734*	524	629	629	629

Notes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates a maximum observed value which exceeds the one-hour IJC objective for sulfur dioxide of 655 µg/m³ and thus assures at least one exceedance of the objective within the reporting period.

Data for Canadian stations have been converted from ppm units to µg/m³ on the basis of U.S. standard conditions of 25°C and 1 atmosphere to ensure consistency of units throughout the region.

TABLE 4

Air Quality Trends for Carbon Monoxide (ppm)

WAYNE COUNTY (26163) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0001	ann. mean	1.35	1.38	1.38	1.18	1.38	1.38	1.11	1.03	0.97	0.93
	max value	18.1	12.5	10.8	12.7	17.8	16.3	10.1	8.9	15.0	16.8
0014	ann. mean	1.32	1.31	1.28	1.22	1.31	1.24	1.08	1.02	1.03	0.97
	max value	17.7	18.2	17.8	20.5	15.8	17.2	16.3	10.2	22.3	17.4
0016	ann. mean	1.87	1.84	1.69	1.69	2.05	2.21	1.43	1.09	1.05	1.06
	max value	17.1	12.7	16.5	13.1	17.7	16.3	13.4	10.3	10.9	11.4
2002	ann. mean	1.25	1.04	0.87	0.58	0.92	0.93	0.98	0.78	0.79	0.86
	max value	12.9	12.8	7.6	15.4	8.0	9.2	13.9	9.4	15.3	17.5
	Average of means	**1.45**	**1.39**	**1.30**	**1.17**	**1.42**	**1.44**	**1.15**	**0.98**	**0.96**	**0.96**
	Average of maximums	**16.4**	**14.0**	**13.2**	**15.4**	**14.8**	**14.7**	**13.4**	**9.7**	**15.9**	**15.8**

Year		1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	0.86	0.85	1.14	0.76	0.8	0.84	0.79	0.7
	max value	13.9	14.9	6.1	17.4	12.0	7.8	11.0	7.8
0014	ann. mean	1.07	1.07	1.01	0.99	0.86	0.82	0.82	0.69
	max value	15.7	21.7	14.6	20.6	15.0	12.1	9.5	9.7
0016	ann. mean	0.99	1.02	0.96	1.04	0.86	0.9	0.84	0.74
	max value	9.4	6.5	8.1	12.0	11.6	8.3	11.2	7.8
2002	ann. mean	0.87	0.84	0.75	0.88	0.81	0.7	0.68	0.61
	max value	11.4	14.0	9.7	19.5	23.4	8.1	8.5	7.4
	Average of means	**0.95**	**0.94**	**0.96**	**0.92**	**0.83**	**0.82**	**0.78**	**0.68**
	Average of maximums	**12.6**	**14.3**	**9.6**	**17.4**	**15.5**	**9.1**	**10.0**	**8.2**

TABLE 4 (continued)

Air Quality Trends for Carbon Monoxide (ppm)

MONROE COUNTY (26115) Stations

No reported carbon dioxide monitoring for the 1973-1990 period.

SAINT CLAIR COUNTY (26147) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0003	ann. mean	3.08	10.3*	2.53	2.63	3.73	2.23	1.41	3.21		
	max value	13.5	308*	10.0	14.7	10.8	9.3	14.5	8.3		

No carbon monoxide monitoring reported after 1980.

LAPEER COUNTY (26087) Station

No reported carbon dioxide monitoring for the 1973-1990 period.

WASHTENAW COUNTY (26161) Station

No reported carbon dioxide monitoring for the 1973-1990 period.

MACOMB COUNTY (26099) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1003	ann. mean				1.76	1.09	1.1	1.18	1.23	1.04	1.33
	max value				16.5	24.9	20.1	22.7	23.7	12.3	13.3

Year		1983	1984	1985	1986	1987	1988	1989	1990
1003	ann. mean	0.92	1.08	0.77	0.87	0.8	0.69	0.81	0.63
	max value	13.0	20.7	10.6	25.4	20.7	9.3	11.0	9.5

TABLE 4 (continued)

Air Quality Trends for Carbon Monoxide (ppm)

OAKLAND COUNTY (26125) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0001	ann. mean									0.82	0.85
	max value									19.0	17.0
Year				1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean			0.9	0.83	0.7	0.78	0.76	0.75	0.88	0.39
	max value			14.0	19.0	11.1	15.4	11.7	8.4	10.6	7.1

ESSEX COUNTY (WINDSOR) Stations

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C											
ann. mean	1.7	1.1	0.5	0.8	0.5	0.5	0.5	0.7	0.9	1.0	1.2
max value	13	19	10	9	10	11	8	9	9	12	12

LAMBTON COUNTY (SARNIA) Stations

AES 061004R											
ann. mean	0.3	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
max value	5	9	16	8	6	10	10	9	11	6	9

Notes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates that there are data quality problem notations associated with this reported statistic.

TABLE 5

Air Quality Trends for Nitrogen Dioxide (ppm)

WAYNE COUNTY (26163) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0019	ann. mean								0.022	0.021
	max value								0.082	0.107

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0019	ann. mean	0.019	0.022	0.019	0.021	0.018	0.024	0.021		0.018
	max value	0.132	0.137	0.114	0.114	0.093	0.108	0.090		0.045

WASHTENAW COUNTY (26161) Stations

No nitrogen dioxide monitoring reported for the period 1973-1990.

LAPEER COUNTY (26087) Station

No nitrogen dioxide monitoring reported for the 1973-1990 period.

SAINT CLAIR COUNTY (26147) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0003	ann. mean	0.031	0.031	0.039	0.039	0.051	0.014	0.018			
	max value	0.18	0.4	0.18	0.44	0.28	0.1	0.19			
0904	ann. mean						0.02	0.013	0.011	0.013	0.011
	max value						0.352	0.066	0.122	0.129	0.099

No nitrogen dioxide monitoring reported after 1982.

MACOMB COUNTY (26099) Stations

1003	ann. mean				0.026	0.028				0.021	
	max value				0.04	0.055				0.116	

No nitrogen dioxide monitoring reported after 1981.

TABLE 5 (continued)

Air Quality Trends for Nitrogen Dioxide (ppm)

OAKLAND COUNTY (26125) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0001	ann. mean									0.038
	max value									0.48
0002	ann. mean			0.017	0.007					
	max value			0.032	0.027					
0902	ann. mean								0.01	0.012
	max value								0.064	0.07

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0902	ann. mean			0.009	0.01	0.008				
	max value			0.07	0.1	0.05				

MONROE COUNTY (26115) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0008	ann. mean			0.018	0.017					
	max value			0.036	0.028					
0020	ann. mean	0.039		0.021	0.018					
	max value	0.18		0.057	0.028					

No nitrogen dioxide monitoring reported after 1976.

ESSEX COUNTY (WINDSOR) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C												
	ann. mean	0.031	0.030	.029	.026	.027	.026	.025	.027	.030	.028	.025
	max value	0.16	0.17	.14	.12	.12	.10	.14	.10	.16	.16	.10

LAMBTON COUNTY (SARNIA) Stations

AES 061004R												
	ann. mean	.022	.018	.022	.020	.023	.019	.021	.012	.015	.019	.021
	max value	.14	.12	.25	.17	.12	.13	.12	.08	.09	.09	.10

Notes:"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates that there are data quality problem notations associated with this reported statistic.

Table 6

Air Quality Trends for Ozone (ppb)

WAYNE COUNTY (26163) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0001	ann. mean								51.5	49.2
	max value								133	123
0016	ann. mean								55	50.7
	max value								129	118
0019	ann. mean					56.4	63.2	39.4	56.1	56.7
	max value					137	217	116	139	158
0020	ann. mean	43.7	35.9	48.8	53.5	38.7	44.5	29.5		
	max value	107	86	287	210	149	170	72		
2002	ann. mean						50.5	42.9	57	49
	max value						188	110	122	121
2003	ann. mean					48.7	55.5	36.3		
	max value					127	146	100		

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	48.0	47.2	38.7	37.7	39.3	39.7	52.1	45.4	45.3
	max value	151	117	97	94	118	98	138	110	92
0016	ann. mean	51.4	50.1	44.3	42.5	41.8	49.4	52.8	53.5	46.8
	max value	150	148	98	99	88	117	168	112	95
0019	ann. mean	51.1	54.2	50.3	47.7	50.8	54.7	49.0	50.2	50
	max value	109	155	115	97	112	150	145	144	113
2002	ann. mean	52.2	53.8	51.3	50.3	43.5	50.7	57.2	50.8	44.7
	max value	136	116	109	106	109	110	141	106	93

TABLE 6 (continued)

Air Quality Trends for Ozone (ppb)

WASHTENAW COUNTY (26161) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
1001	ann. mean							57.7	51.6	42
	max value							123	105	99

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
1001	ann. mean	54.7	51.4	49.6	47.2	47.7	50.2	61.6	55.6	48.1
	max value	105	95	95	101	110	120	125	107	89
0005	ann. mean						56.1	58.4	52.5	47.8
	max value						145	135	99	94

SAINT CLAIR COUNTY (26147) Stations

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0005	ann. mean	57	56.6	52.4	52.7	47.2	55.0	54.7	55.2	50
	max value	196	141	127	117	134	130	145	147	123
0030	ann. mean								42.1	52.0
	max value								108	118

MONROE COUNTY (26115) Stations

No ozone monitoring reported for the period 1973-1980.

LAPEER COUNTY (26087) Stations

No ozone monitoring reported for the period 1973-1980.

TABLE 6 (continued)

Air Quality Trends for Ozone (ppb)

OAKLAND COUNTY (26125) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0001	ann. mean									51.4
	max value									122
0902	ann. mean								59.2	43.4
	max value								152	84
1002	ann. mean				56.0	41.3	40.5	33.9	34.0	
	max value				218	162	179	98	82	

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	53.2	55.4	48.9	49	48.4	48	56.9	53.9	44.2
	max value	153	142	143	104	114	124	155	125	109
0902	ann. mean			45.5	30.1	12.3				
	max value			111	70	60				

MACOMB COUNTY (26099) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0009	ann. mean								62	52.9
	max value								151	180
1003	ann. mean					58.6	71.3	50.2	45.7	49.2
	max value					227	195	127	111	155

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0009	ann. mean	53.4	52.3	40.4	47.4	44.9	50.5	55.9	55.7	53.7
	max value	165	170	96	130	150	131	204	171	134
1003	ann. mean	52.3	52.4	50.5	50.5	47.1	50.2	53.8	50.9	47.4
	max value	123	127	111	117	101	148	172	115	128

TABLE 6 (continued)

Air Quality Trends for Ozone (ppb)

ESSEX COUNTY (WINDSOR) Stations											
Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C											
ann. mean	19.9	18.8	18.1	18.7	18.9	19.7	17.4	17.6	21.9	20.6	17.1
max value	131	130	122	135	143	116	104	110	159	136	102
LAMBTON COUNTY (SARNIA) Stations											
AES 061004R											
ann. mean	21.6	21.3	22.7	23.0	23.3	22.9	20.9	21.8	22.6	25.3	21.4
max value	155	169	132	136	125	110	114	170	131	157	107

Footnotes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates a data quality problem associated with the reported statistic.