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AMBIENT AIR QUALITY 1970–74
A STATISTICAL ANALYSIS

by
C S Nicholl and P J Choquette

Pollution Data Analysis Division
Air Pollution Programs Branch
Air Pollution Control Directorate

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ABSTRACT

In this report, the air quality data appearing in the 1970-74 annual publications of the National Air Pollution Surveillance (NAPS) Network are summarized and, based on statistical analysis, the significant changes in air pollution levels are outlined

To overcome the difficulties resulting from a continual increase in the number of stations measuring each pollutant, and to avoid the problems associated with making equitable comparisons among stations, the Wilcoxon statistical test was used (Appendix I) This test determines whether there was a statistically significant decrease or increase in the annual averages of a pollutant at all monitoring stations across Canada The annual mean levels of a pollutant for two consecutive years are compared at each station There is no interstation comparison Data for two consecutive years are required and the size of the increase or decrease is noted If a high proportion of stations experienced an increase, the test will show if the increase was statistically significant for those two years A 95% confidence level is used

No attempt is made to establish the cause of any statistically significant changes observed in air quality

RÉSUMÉ

Le présent rapport résume les donnees figurant dans les publications annuelles du réseau de surveillance nationale de la pollution atmosphérique, de 1970 à 1974, il s'appuie sur l'analyse statistique pour exposer les modifications significatives touchant le taux des polluants atmosphériques

Vu les difficultés liées à l'augmentation continue du nombre de stations mesurant chaque polluant et étant donné les problèmes que pose la comparaison équitable des données obtenues à chaque station, on a eu recours au test statistique Wilcoxon (l'annexe I) Ce test permet de déterminer toute augmentation ou diminution significative dans les taux moyens annuels d'un polluant, mesurés à tous les postes de contrôle du Canada Les données d'une station ne sont pas comparées à celles d'une autre L'ampleur de la marge séparant les données de deux années consécutives est enregistrée Si un grand nombre de stations ont observé une augmentation, le test révelera si celle-ci a été significative, du point de vue statistique, pour les années considérées Un niveau de confiance de 95% est utilisé

L'étude ne tente aucunement de déterminer la cause des changements significatifs de la qualité de l'air révélés par les statistiques

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

There appeared to be a general decreasing trend in air pollution levels during the 1970-74 period, shown graphically in Table 1 However, only sulphur dioxide and lead levels exhibited a consistent decrease from year to year In 1974 air quality at most stations met the acceptable levels of the National Ambient Air Quality Objectives for sulphur dioxide, nitrogen dioxide, and carbon monoxide and, even at those stations where it did not, the acceptable levels for the shorter time periods were seldom exceeded There was a significant decrease in levels of suspended particulates during 1970-72, followed by a significant increase during 1972-73 and a period of no significant change during 1973-74 Soiling index values were reduced at most stations from 1971 to 1972 and remained relatively stable in other years Ozone, carbon monoxide and nitrogen dioxide were measured in 1973 and 1974 Carbon monoxide levels showed a statistically significant downward trend Although there were no statistically significant increases in the levels of any pollutant from 1973 to 1974, the overall downward trend in pollution levels was reduced over that period

The number of monitoring stations where, in 1974, air quality met the acceptable levels set for sulphur dioxide, suspended particulates, oxidants (ozone), carbon monoxide, and nitrogen dioxide are listed in Table 2 The maximum 24-h acceptable levels for ozone and suspended particulates were the objectives most frequently exceeded in 1974 In fact, meeting the latter objective would have required a considerable reduction in particulate levels, because many stations had over 25% of their readings above the 24-h acceptable level of 120 $\mu g/m^3$

On a regional basis, monitoring stations in the Prairie Provinces tended to show low annual pollutant levels whereas large cities in Ontario and Quebec indicated relatively high levels For each pollutant a ranking of stations has been made for the year 1974 (Appendix II) ***It should be emphasized that this is a ranking of stations and should not be extrapolated to a ranking of cities.*** The commercial monitoring station on Drummond Street in Montreal is shown to have had a high ranking in 1974 for each pollutant measured, indicating high annual averages Other stations receiving relatively high ranks were the other Montreal stations, the Quebec and Hamilton stations, the commercial and industrial stations located in Windsor and Toronto, and the Ottawa commercial station The Sudbury residential station had a high ranking for sulphur dioxide only, with all other ranks being very low Low ranks, indicating low annual pollutant levels, were received by all Edmonton stations for 1974 and by residential stations in Regina, Saskatoon and Calgary

TABLE 1 STATISTICALLY SIGNIFICANT CHANGES IN AIR POLLUTION LEVELS, BASED ON ANNUAL MEANS FOR NAPS STATIONS ACROSS CANADA DURING 1970-74

Pollutant	Period			
	1970-71	1971-72	1972-73	1973-74
Sulphur dioxide	↘	→	↘	→
Suspended particulates	↘	↘	↗	→
Lead	↘	→	→	↘
Ozone	N/A	N/A	N/A	→
Nitrogen dioxide	N/A	N/A	N/A	→
Carbon monoxide	N/A	N/A	N/A	↘
Soiling index	→	→	→	→

↗ = statistically significant *increase*

↘ = statistically significant *decrease*

→ = statistically *no* significant *change*

N/A = not applicable, pollutant not monitored prior to 1973

TABLE 2 NUMBER OF NAPS STATIONS MEETING ACCEPTABLE LEVELS OF AIR QUALITY AND NUMBER OF TIMES LEVELS EXCEEDED 1974*

Pollutant	Type of station			Total	(%)	# Times acceptable level exceeded
	Commercial	Residential	Industrial			
SULPHUR DIOXIDE						
# meeting 1-h level	17/19**	11/13	5/7	33/39	85	34
# meeting 24-h level	14/19	11/13	6/7	31/39	80	42
# meeting annual level	9/12	5/7	3/4	17/23	74	N/A***
SUSPENDED PARTICULATES						
# meeting 24-h level	0/30	2/17	0/8	2/55	4	598
# meeting annual level	9/24	10/14	2/8	21/46	46	N/A
OXIDANTS (OZONE)						
# meeting 1-h level	2/8	0/4	1/1	3/13	23	147
# meeting 24-h level	1/8	0/4	0/1	1/13	8	622
# meeting annual level	5/8	2/4	1/1	8/13	62	N/A
NITROGEN DIOXIDE						
# meeting 1-h level	3/4	3/3	1/1	7/8	88	1
# meeting 24-h level	4/4	3/3	1/1	8/8	100	-
# meeting annual level	3/3	1/1	1/1	5/5	100	N/A
CARBON MONOXIDE						
# meeting 1-h level	10/11	7/7	2/2	19/20	95	1
# meeting 8-h level	6/11	5/7	2/2	13/20	65	34

* For stations included in this report only

** 17 stations out of 19 commercial stations measuring sulphur dioxide met the 1-h acceptable level

*** N/A - Not applicable

1 INTRODUCTION

1.1 Purpose

The purpose of this report is to summarize the air quality data appearing in the 1970-74 annual publications of the National Air Pollution Surveillance (NAPS) network and to outline the significant changes in air pollutant levels based on statistical analysis

As rising levels of pollution became a concern of many Canadians, a need developed to determine the extent of pollution in Canada and the trends that could occur with changing industrial activity, population density, expanding use of pollution abatement equipment, and other factors To study air pollution, a national surveillance program was initiated in January 1970 The program involves a network of air monitoring instruments, located in the large cities across Canada, which is gradually being expanded to measure air pollutants in all cities with populations over 50 000 Monitoring instruments are usually located at sites where air pollution could present a problem and where a large number of people could be affected

The site of air monitoring instruments is referred to as a 'monitoring station' and each station is classified according to its immediate location within a city, as

C – Commercial (downtown business)
R – Residential
I – Industrial

Any comparison of stations should consider this classification Even when comparing pollutant levels in different cities for a certain type of station, such as commercial, extreme caution must be exercised because of

(a) Varying climatic conditions Although climatic conditions vary little within a city, there may be great variations from one region (or city) to another
(b) Different sampling equipment, procedures and measuring techniques For example, the height of monitoring instruments above ground level varies considerably from site to site
(c) Interference from nearby emission sources This can result in instrument readings that are not representative of pollutant levels in the area

The pollutants monitored are sulphur dioxide, suspended particulates, nitrogen dioxide, carbon monoxide, oxidants and lead The soiling index provides an indication of the soiling or darkening potential of pollutants in the atmosphere Measurements are also made of dustfall and sulphation rate, other indicators of air pollution, but these are not dealt with in the present analysis

It is emphasized that the statistical method used to determine significant changes in air pollutant levels takes into account potential monitoring instrument inaccuracies and other errors

It is also noted that, starting in 1974, the NAPS annual summaries do not report annual means of a pollutant for stations that do not meet a set of criteria, because this could result in values of uncertain accuracy For sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide, and the soiling index, monthly or annual means are not calculated unless at least 50% of the hourly observations are available for the corresponding period Furthermore, the annual mean is not calculated unless monthly means are reported for at least two months in each quarter For suspended particulates and lead, a monthly mean is not reported in the NAPS annual summaries unless a minimum of 3 samples are available for that month The conditions for reporting the annual geometric mean are a minimum of 40 samples in the year with at least 8 valid samples from each quarter

It is the intent of the Air Pollution Control Directorate to update this report as new data become available

1.2 Air Monitoring Program

The National Air Pollution Surveillance (NAPS) Network was established in January 1970 and had 43 monitoring instruments, in 14 cities, measuring sulphur dioxide (SO_2), suspended particulates, lead and soiling index The network expanded rapidly, and by December 1974, the number of instruments had increased to 239 in 40 different cities and the list of pollutants monitored had also expanded to include carbon monoxide (CO), nitrogen dioxide (NO_2), and oxidants (O_3)* The growth of the network is illustrated in Figure 1 Figure 2 is a map of Canada showing all cities in which monitoring instruments are located

1 3 National Ambient Air Quality Objectives

Levels of air quality are established to act as a guide in developing programs to reduce the damaging effects of air pollution These national objectives

- assist in establishing priorities for reducing pollutant levels and the extent of pollution control needed
- provide a uniform yardstick for assessing air quality in all parts of Canada
- indicate the need for and extent of monitoring programs

The *maximum acceptable level* is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being It represents the realistic objective today for all parts of Canada The *maximum desirable level* defines the long-term goal for air quality and provides a basis for an anti-degradation policy in unpolluted parts of the country Table 3 presents both the acceptable and desirable levels for the pollutants and conditions of interest in the present analysis

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* Throughout this period there were another 75 to 125 instruments used to measure dustfall and sulphation rate, but these two indicators of air pollution are not dealt with in this report Stations located in cities with populations less than 25 000 are not included in this analysis nor are most stations with only 1974 readings

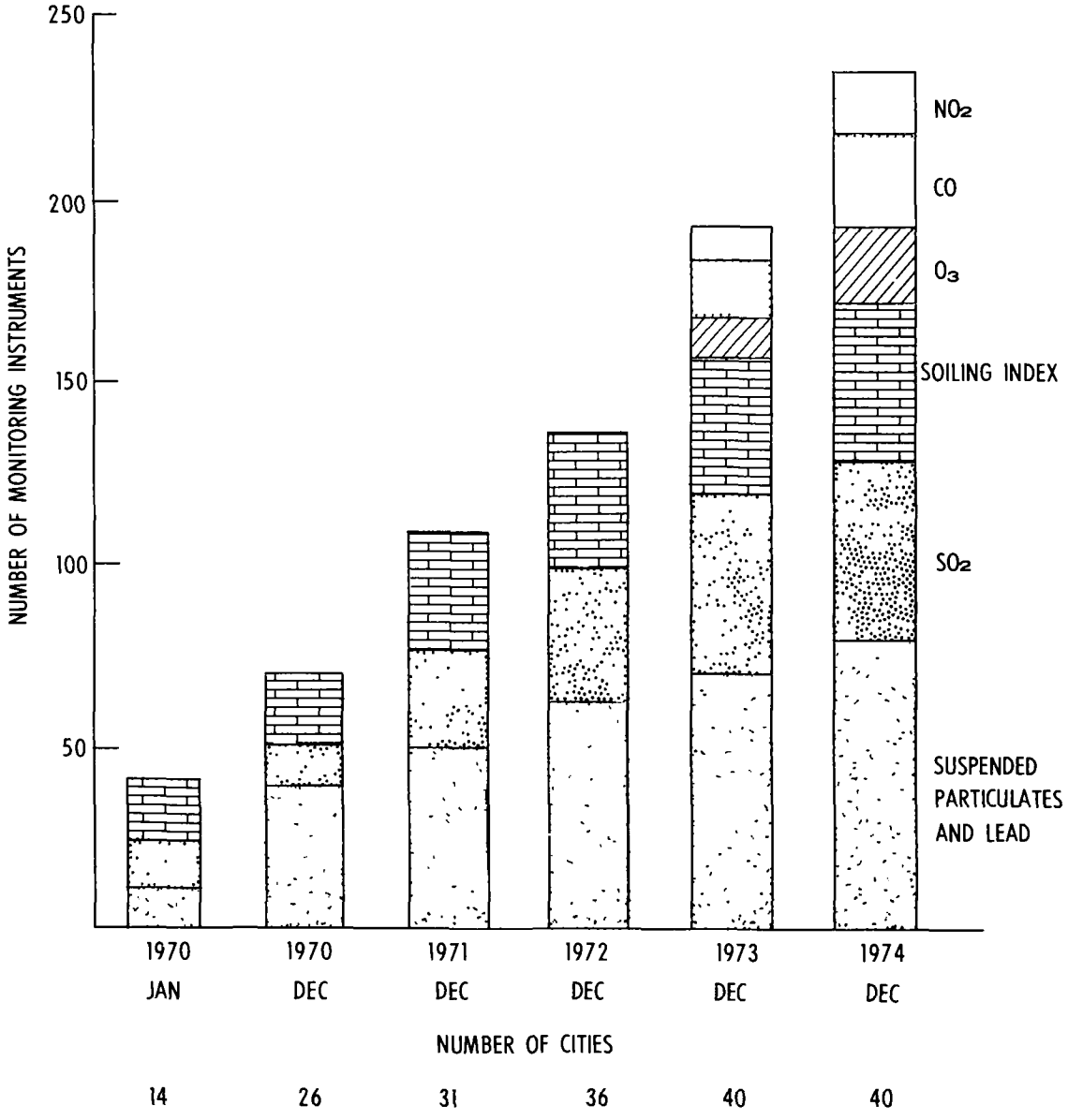


FIGURE 1 GROWTH OF NAPS NETWORK 1970-74

FIGURE 2 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK (January,1974)

TABLE 3 NATIONAL AMBIENT AIR QUALITY OBJECTIVES[a]

Pollutant	Maximum acceptable concentration	Maximum desirable concentration	Averaging time
Sulphur dioxide	2 3 pphm*	1 1 pphm	annual
	11 pphm	6 pphm	24-h
	34 pphm	17 pphm	1-h
Suspended particulates	70 $\mu g/m^3$**	60 $\mu g/m^3$	annual
	120 $\mu g/m^3$	-	24-h
Oxidants (ozone)	1 5 pphm	-	annual
	3 pphm	2 pphm	24-h
	8 pphm	5 pphm	1-h
Carbon monoxide	13 ppm***	5 ppm	8-h
	31 ppm	13 ppm	1-h
Nitrogen dioxide	5 3 pphm	3 2 pphm	annual
	11 pphm	-	24-h
	21 pphm	-	1-h

* Parts per hundred million

** Micrograms per cubic metre

*** Parts per million

a Conditions of 25°C (77°F) and 1013 2 mb (760 mm Hg) are used as basis for conversion from $\mu g/m^3$ to ppm or pphm

2 SULPHUR DIOXIDE

Sulphur dioxide is a colourless gas and normally does not occur in urban air at concentrations high enough for its odour to be detected It is emitted into the atmosphere primarily from the production of primary copper and nickel, from natural gas processing, and from the combustion of sulphur-containing fuels

2 1 Annual Arithmetic Means

Throughout the 1970-73 period there was a decreasing trend in sulphur dioxide levels with most stations showing a decrease in their annual arithmetic average from year to year There was no change from 1973 to 1974 at most stations across Canada The number of stations indicating changes in the annual arithmetic means of sulphur dioxide during 1970-74 are listed in Table 4

TABLE 4 SULPHUR DIOXIDE - NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL ARITHMETIC MEAN

Period	Number of stations			
	Decrease	Increase	No change**	Total
1970-71*	10	1	-	11
1971-72	11	6	1	18
1972-73*	15	0	14	29
1973-74	6	5	12	23

* Statistically, there was a significant decrease in sulphur dioxide levels for 1970-71 and 1972-73

** Includes differences of less than 0 1 pphm to ensure changes are not due to monitoring instrument inaccuracies or other errors

In 1974, 5 of 23 stations indicated an annual average sulphur dioxide level higher than the maximum acceptable level This is an improvement over 1972 when 11 of 30 stations were above the acceptable level The highest levels in 1974 occurred at the Windsor commercial and Sudbury residential stations (3 3 pphm) All stations located west of the Province of Ontario had annual levels which met the acceptable level A graphical display of the annual arithmetic means for each station is presented in Appendix III along with information in tabular form

2 2 Maximum Values

When the 1-h and 24-h yearly maximum values are analyzed as a function of time, a downward trend is again generally indicated In 1974, 33 of 39 stations had readings which met the 1-h maximum acceptable level and 31 of 39 stations had readings meeting the 24-h maximum acceptable level These levels are seldom exceeded and when they are, it is usually by a small amount One exception is the Sudbury station where high 1-h readings have been recorded, the maximum being 184 pphm in 1971 (the acceptable level is 34 pphm) A graphical display of the maximum values for a limited number of stations is presented in Appendix III, along with information in tabular form for all stations included in this report

3 SUSPENDED PARTICULATES

Suspended particulate matter consists of fine particles which travel with air currents and do not settle in the vicinity of the emission source Emission sources of importance include iron ore mining and beneficiation plants, forest fires, power generation by utilities, cement manufacturing plants, asbestos producing plants, grain handling and stone quarrying and processing

3.1 Annual Geometric Means

There was a significant decrease in the annual average levels of suspended particulates from 1970 to 1972 From 1972 to 1973 there was a significant increase in levels followed by a period of no change from 1973 to 1974 In 1974, 21 of 46 stations met the acceptable level of 70 $\mu g/m^3$ for the annual geometric mean The Sydney residential station had the highest annual average, 148 $\mu g/m^3$, and the Halifax residential station had the lowest, 32 $\mu g/m^3$ The number of stations indicating changes in the annual means of suspended particulates during 1970-74 are listed in Table 5 The annual geometric means for each station are presented graphically and in tabular form in Appendix IV

TABLE 5 SUSPENDED PARTICULATES–NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL GEOMETRIC MEAN

	Number of stations			
Period	Decrease	Increase	No change**	Total
1970–71*	19	3	5	27
1971–72*	21	4	10	35
1972–73*	8	19	19	46
1973–74	12	12	21	45

* Statistically, there was a significant decrease in the annual geometric means for 1970-71 and 1971-72 For 1972-73, the increase in levels was also consistent enough to be termed statistically significant

** Includes stations where differences were less than 4 $\mu g/m^3$ to ensure changes are not due to monitoring instrument inaccuracies or other errors

3 2 Maximum Values

In 1974, all but two stations had readings of suspended particulates which exceeded the maximum 24-h acceptable level of 120 $\mu g/m^3$ Approximately 40% of the stations had more than one-quarter of their readings above the acceptable level with most of these over 150 $\mu g/m^3$ The Sydney residential station recorded the highest maximum 24-h level, 583 $\mu g/m^3$, and 61% of its readings were above 120 $\mu g/m^3$ In Appendix IV the 1972-74 maximum 24-h values are presented together with the distribution of 1974 readings above the acceptable level, on a station-by-station basis

4 LEAD

Lead levels in ambient air are established by analyzing the samples used for the determination of suspended particulate matter concentrations Therefore lead and suspended particulate readings are taken by the same air monitoring stations

Gasoline-powered motor vehicles are the most important source of lead emissions to the atmosphere This source accounts for more than 70% of total airborne lead emissions in Canada Other sources of relative importance include the production of primary copper and nickel, and the operations involved in lead mining, milling, smelting and refining

4 1 Annual Geometric Means

There are no ambient air quality objectives for lead There was a significant decrease in the annual geometric means for lead from 1970 to 1971 and from 1973 to 1974 For 1971-72 and 1972-73, lead levels at monitoring stations underwent more of a decrease than an increase but the change was not consistent enough to be termed significant Geographically, levels at stations in the Maritime Provinces showed the largest reversal in trends From 1972 to 1973 lead levels at all these stations increased The next year, 1973 to 1974, all stations indicated a decrease This occurrence, combined with the fact that levels at almost all Ontario stations decreased in 1973-74, resulted in a statistically significant decrease for that period Lead levels at stations in Quebec and the Prairie Provinces did not change discernibly during 1972-73 and 1973-74 In 1974, the Toronto industrial station had the highest annual mean (1 72 $\mu g/m^3$), and the Saskatoon residential station had the lowest (0 12 $\mu g/m^3$)

The number of monitoring stations indicating changes in annual geometric means for lead during 1970-74 are listed in Table 6 Annual geometric means for each station are presented in Appendix V

4 2 Maximum Values

Maximum 24-h values for lead did not show any substantial change Comparing 1972 and 1974 data, the maximum value in 1974 was higher for 24 stations, lower for 17 stations and no change occurred for 4 stations The maximum 24-h levels on a station-by-station basis are presented in Appendix V

TABLE 6 LEAD - NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL GEOMETRIC MEAN

Period	Number of stations			
	Decrease	Increase	No change**	Total
1970-71*	17	2	2	21
1971-72	11	7	8	26
1972-73	17	14	13	44
1973-74*	21	5	18	44

* The Wilcoxon test indicates that lead levels decreased significantly during 1970-71 and 1973-74

** Includes stations where differences were less than 0 04 $\mu g/m^3$ to ensure changes are not due to monitoring instrument inaccuracies or other errors

5 OZONE

Ozone (O_3) is the principal gas of several oxidizing gases known collectively as total oxidants Under conditions of strong sunlight and high levels of hydrocarbons and nitrogen oxides, photochemical reactions can occur which cause the ozone concentration to rise Hydrocarbons and nitrogen oxides are emitted primarily from gasoline-powered motor vehicles

5 1 Annual Arithmetic Means

In 1974, ozone levels at 8 of 13 stations met the 1 5 pphm acceptable level for the annual mean Of the 9 stations with 1973 and 1974 measurements, 5 experienced increasing levels in 1974 In 1974, the Toronto commercial station recorded the highest annual mean (2 0 pphm), and the Vancouver commercial station recorded the lowest (0 5 pphm) The number of stations indicating changes in annual arithmetic means for ozone during 1973-74 are listed in Table 7 Appendix VI gives a graphical display of ozone annual means for each station

5 2 Maximum Values

The maximum 1-h and 24-h values at each station for 1973-74 are displayed graphically in Appendix VI In 1974, only the Vancouver commercial station had readings meeting the maximum

TABLE 7 OZONE - NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL ARITHMETIC MEAN

Period	Number of stations			
	Decrease	Increase	No change**	Total
1973-74*	3	5	1	9

* Statistically, the increase in levels was not consistent enough to be termed significant

** Includes stations where differences were less than 0 1 pphm to ensure changes are not due to monitoring instrument inaccuracies or other errors

24-h acceptable level of 3 pphm The maximum 1-h acceptable level of 8 pphm for ozone was met by 3 of the 13 stations

6 NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) is formed when fuels are combusted at high temperatures in engines and furnaces, Therefore, an important source of nitrogen dioxide is the gasoline-powered motor vehicle Other sources include diesel (internal combustion) engines, power generation by utilities, and industrial fuel combustion

In 1974, 5 of 5 stations had nitrogen dioxide levels meeting the annual acceptable level of 5 3 pphm The maximum 24-h acceptable level of 11 pphm was met at 8 of 8 stations and the maximum 1-h acceptable level of 21 pphm was met at 7 of 8 stations The number of stations indicating changes in annual arithmetic means for nitrogen dioxide during 1973-74 are listed in Table 8 It is noted that only three stations had data for both years and that this was insufficient to enable the statistical method to be applied However, by a general analysis of the situation, it appears that no change occurred over the period considered A graphical display of the annual mean, maximum 1-h and 24-h values for the stations involved is given in Appendix VII

7 CARBON MONOXIDE

Carbon monoxide results from the incomplete combustion of fuels The primary source of carbon monoxide emissions is the gasoline-powered motor vehicle Other important sources include forest

TABLE 8 NITROGEN DIOXIDE - NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL ARITHMETIC MEAN

Period	Number of stations			
	Decrease	Increase	No change**	Total
1973-74*	-	1	2	3

* Only three stations had measurements for both 1973 and 1974

** Includes stations indicating differences of less than 0 1 pphm to ensure changes are not due to monitoring instrument inaccuracies or other errors

fires, the non-highway use of gasoline, and the petroleum refining process per se, and wigwam burners

Maximum acceptable 8-h and 1-h levels for carbon monoxide have been established In 1974, 13 of 20 stations had averages meeting the 8-h acceptable level of 13 ppm, and 19 of 20 stations gave readings which met the 1-h acceptable level of 31 ppm The highest 8-h average occurred at the Windsor commercial station (20 ppm) and the highest 1-h average occurred at the Ottawa commercial station (38 ppm) The number of stations indicating changes in annual arithmetic means for carbon monoxide during 1973-74 are listed in Table 9 As with ozone and nitrogen dioxide, carbon monoxide has been included in the NAPS Network only since 1973 Levels at most stations decreased from 1973 to 1974, and the change was consistent enough to be termed statistically significant Appendix VIII presents the annual, maximum 8-h and 1-h averages for each of the stations where carbon monoxide was monitored

8 SOILING INDEX

The soiling index is an indication of the soiling or darkening potential of the pollutants in the atmosphere, measured in 'coefficient of haze' (COH) units The annual mean and 24-h maximum values from 1970 to 1974 are graphically displayed in Appendix IX, along with information in tabular form Although most annual averages declined during the 1971-72 period, the decrease could not be termed significant In other years there was also no change as the trend was not consistent enough to be termed significant

The soiling index has been used in other studies to estimate suspended particulate levels in the calculation of city air quality indices, even though the soiling index is neither an accurate nor precise indicator A comparison of the annual means at commercial stations for both the soiling index and

TABLE 9 CARBON MONOXIDE-NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL ARITHMETIC MEAN

Period	Number of stations			
	Decrease	Increase	No change[*,**]	Total
1973-74[*]	7	1	1	9

[*] Statistically, the decrease in levels was consistent enough to be termed significant

[**] Includes stations indicating differences less than 0 1 ppm to ensure changes are not due to monitoring instrument inaccuracies or other errors

suspended particulates makes the validity of this method of estimation suspect Not only does the magnitude of the year-to-year change differ, but, over 60% of the time, when one decreases the other increases or remains unchanged Even by chance better agreement would be expected The number of monitoring stations indicating changes in annual means for the soiling index during 1970-74 are listed in Table 10

TABLE 10 SOILING INDEX - NUMBER OF STATIONS INDICATING CHANGES IN ANNUAL ARITHMETIC MEAN

Period	Number of stations			
	Decrease	Increase	No change*	Total
1970-71	3	4	2	9
1971-72	12	3	3	18
1972-73	7	7	6	20
1973-74	9	12	5	26

[*] Includes stations indicating differences of less than 0 01 COH units to ensure changes are not due to monitoring instrument inaccuracies or other errors

APPENDIX I - THE WILCOXON MATCHED-PAIRS, SIGNED-RANKS TEST

The Wilcoxon Matched-Pairs, Signed-Ranks Test is a nonparametric test of high power and efficiency The test is carried out as follows

1 List the extreme values (maximum) for each station for the two years considered

2 For each matched pair, determine the signed difference (d_i) between the two values

3 Rank these d_i's without respect to sign Omit zero differences and any other differences below a prefixed value (level above which changes should not be due to monitoring instrument inaccuracies This level varies with the pollutant measured) With tied d_i's, assign the average of the tied ranks

4 Assign to each rank the sign (+ or -) of the d which it represents

5 Determine T, the smaller of the sums of the like-signed ranks

6 By counting, determine N, the total number of d's having a sign

7 The procedure for determining the significance of the observed value of T depends on the size of N

(a) If $N \leq 25$, Table I-1 shows critical values of T for various sizes of N If the observed value of T is equal to or less than that given in the table for a particular significance level (5% used in this study) and a particular N, then it can be said that a statistically significant change occurred at a 95% confidence level

(b) If N>25, Table I-1 cannot be used, however, it can be shown that in such cases the sum of the ranks, T, is almost normally distributed with

$$\text{Mean} = \mu_T = \frac{N(N+1)}{4}$$

$$\text{and Standard Deviation} = \sigma_T = \sqrt{\frac{N(N+1)(2N+1)}{24}}$$

$$\text{Therefore } z = \frac{T - \mu T}{\sigma_T} = \frac{T - \frac{N(N+1)}{4}}{\sqrt{\frac{N(N+1)(2N+1)}{24}}}$$

Siegel, S , *Nonparametric Statistics for the Behavioral Sciences,* McGraw-Hill (1956)

is approximately normally distributed with zero mean and unit variance Thus the probabilities associated with the occurrence of various values as extreme as an observed z computed from the above formula can be found using a table of the cumulative normal distribution (Table I-2) Table I-2 gives one-tailed probabilities of z For a two-tailed test (used in this study), double the p shown If the p thus obtained is equal to or less than $\chi = 05$ (the significance level chosen for this study) then it can be said that a statistically significant change occurred at a 95% confidence level

EXAMPLE - LEAD, 1971-72

Annual geometric means for lead for 1971-72 are given in Table I-3 Although the total number of stations having annual means for both 1971 and 1972 is 26, only 18 of these stations had levels which increased or decreased by more than 0 04 $\mu g/m^3$ (the level above which changes should not be due to monitoring instrument inaccuracies or other errors) For the purposes of the statistical test, therefore, N in this case is 18 There were 7 stations where levels increased and 11 stations where levels decreased

Because N in this case is smaller than 25, the procedure described in 7(a) on the previous page is followed According to Table I-1 when N = 18 the critical value of T is 40 Because the observed value of T (62 5) is greater than the critical value (40), it cannot be said that the downward trend was significant at a 95% confidence level

TABLE I-1 CRITICAL VALUES OF T IN THE WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST

	Level of significance for two-tailed test		
N	05	02	01
6	0	-	-
7	2	0	-
8	4	2	0
9	6	3	2
10	8	5	3
11	11	7	5
12	14	10	7
13	17	13	10
14	21	16	13
15	25	20	16
16	30	24	20
17	35	28	23
18	40	33	28
19	46	38	32
20	52	43	38
21	59	49	43
22	66	56	49
23	73	62	55
24	81	69	61
25	89	77	68

TABLE I-2 PROBABILITIES ASSOCIATED WITH VALUES AS EXTREME AS OBSERVED VALUES OF z IN THE NORMAL DISTRIBUTION

The body of the table gives one-tailed probabilities of z

The left-hand marginal column gives various values of z to one decimal place

The top row gives various values to the second decimal place

Thus for example the one-tailed p of $z \geq 11$ or $z \leq -11$ is $p = .4562$ [a]

z	00	01	02	03	04	05	06	07	08	09
0	5000	4960	4920	4880	4840	4801	4761	4721	4681	4641
1	4602	4562	4522	4483	4443	4404	4364	4325	4286	4247
2	4207	4168	4129	4090	4052	4013	3974	3936	3897	3859
3	3821	3783	3745	3707	3669	3632	3594	3557	3520	3483
4	3446	3409	3372	3336	3300	3264	3228	3192	3156	3121
5	3085	3050	3015	2981	2946	2912	2877	2843	2810	2776
6	2743	2709	2676	2643	2611	2578	2546	2514	2483	2451
7	2420	2389	2358	2327	2296	2266	2236	2206	2177	2148
8	2119	2090	2061	2033	2005	1977	1949	1922	1894	1867
9	1841	1814	1788	1762	1736	1711	1685	1660	1635	1611
1 0	1587	1562	1539	1515	1492	1469	1446	1423	1401	1379
1 1	1357	1335	1314	1292	1271	1251	1230	1210	1190	1170
1 2	1151	1131	1112	1093	1075	1056	1038	1020	1003	0985
1 3	0968	0951	0934	0918	0901	0885	0869	0853	0838	0823
1 4	0808	0793	0778	0764	0749	0735	0721	0708	0694	0681
1 5	0668	0655	0643	0630	0618	0606	0594	0582	0571	0559
1 6	0548	0537	0526	0516	0505	0495	0485	0475	0465	0455
1 7	0446	0436	0427	0418	0409	0401	0392	0384	0375	0367
1 8	0359	0351	0344	0336	0329	0322	0314	0307	0301	0294
1 9	0287	0281	0274	0268	0262	0256	0250	0244	0239	0233
2 0	0228	0222	0217	0212	0207	0202	0197	0192	0188	0183
2 1	0179	0174	0170	0166	0162	0158	0154	0150	0146	0143
2 2	0139	0136	0132	0129	0125	0122	0119	0116	0113	0110
2 3	0107	0104	0102	0099	0096	0094	0091	0089	0087	0084
2 4	0082	0080	0078	0075	0073	0071	0069	0068	0066	0064
2 5	0062	0060	0059	0057	0055	0054	0052	0051	0049	0048
2 6	0047	0045	0044	0043	0041	0040	0039	0038	0037	0036
2 7	0035	0034	0033	0032	0031	0030	0029	0028	0027	0026
2 8	0026	0025	0024	0023	0023	0022	0021	0021	0020	0019
2 9	0019	0018	0018	0017	0016	0016	0015	0015	0014	0014
3 0	0013	0013	0013	0012	0012	0011	0011	0011	0010	0010
3 1	0010	0009	0009	0009	0008	0008	0008	0008	0007	0007
3 2	0007									
3 3	0005									
3 4	0003									
3 5	00023									
3 6	00016									
3 7	00011									
3 8	00007									
3 9	00005									
4 0	00003									

[a] The p value found in the body of the table must be doubled for a two-tailed test

TABLE I-3 EXAMPLE
- ANNUAL GEOMETRIC MEANS FOR LEAD 1971-72

Station	Annual geometric mean ($\mu g/m^3$) 1971	1972	Difference Increase (+)	Rank	Decrease (-)	Rank	No change ($\leq$0 04 mg/m^3)
COMMERCIAL							
Saint John	43	31			0 12	8	
Moncton	48	45					0 03
Montreal-DR	1 18	1 70	0 52	17 5			
Hull	89	1 00	0 11	6 5			
Ottawa	1 13	1 17					0 04
Windsor	1 10	88			0 22	15	
Winnipeg	82	82					0 00
Saskatoon	58	36			0 22	15	
Calgary	1 35	83			0 52	17 5	
Red Deer	39	39					0 00
Medicine Hat	45	29			0 16	10 5	
Vancouver	89	1 00	0 11	6 5			
Victoria	82	69			0 13	9	
RESIDENTIAL							
Halifax	39	23			0 16	10 5	
Montreal-BG	1 26	1 44	0 18	12 5			
Montreal-PAT	73	95	0 22	15			
Windsor	55	53					0 02
Kingston	39	36					0 03
Winnipeg	71	77	0 06	3			
Regina	29	19			0 10	5	
Saskatoon	25	16			0 09	4	
Edmonton	32	30					0 02
Calgary	63	45			0 18	12 5	
Vancouver	1 00	1 05	0 05	1 5			
INDUSTRIAL							
Winnipeg	48	43			0 05	1 5	
Windsor	62	65					0 03
				T = 62 5			

APPENDIX II – RANKING OF STATIONS BY POLLUTANT, 1974

Table II-1 lists all stations included in this report for the year 1974 and provides their ranking for each pollutant, where applicable For example, the station(s) with the lowest annual mean(s) for sulphur dioxide would receive a '1' in the SO_2 column, the station(s) with the second lowest mean(s) would have a '2' and so on with the station(s) having the highest annual man(s) receiving the highest rank Stations having identical values are given the same ranking For sulphur dioxide, the lowest rank (1) was received by 10 stations and the highest rank (11) was given to the Windsor, University Ave , commercial station and to the Sudbury, Ash Street, residential station

When a station is ranked for a particular pollutant, it is because a valid annual mean was calculated for that pollutant When a dash is present instead of a rank, this means that the station did not monitor that pollutant, or that insufficient data were available to calculate a valid annual mean

It should be emphasized that a ranking of stations is strictly that and therefore should not be extrapolated to a ranking of cities.

TABLE II-1 RANKING OF STATIONS BY POLLUTANT 1974[1 2]

Station		SO_2	SP°	COH°°	Pb°°°	CO	NO_2	O_3
		Number of stations monitored						
		23	46	30	44	18	5	13
		Highest rank possible						
		11	38	20	38	15	4	8
		Rank						
COMMERCIAL								
St John s	Duckworth & Ordinance	-	-	-	-	-	-	-
Halifax	N S Tech College	-	6	-	11	-	-	-
Sydney	County Jail	-	17	20	15	-	-	-
Fredericton	Woodstock Rd	-	-	-	-	-	-	-
Saint John	Post Office	-	-	-	-	-	-	-
Saint John-CHAR	110 Charlotte St	-	14	-	16	-	-	-
Montreal-DR	1212 Drummond	-	35	19	36	-	-	-
Montreal-Ont	1125 Ontario E	8	-	16	-	8	3	2
Quebec	Parc-Auto Paquet-Lal	-	30	-	32	-	-	-
Chicoutimi	City Hall	-	-	-	-	-	-	-
Hull	Rue Principale	1	22	5	31	-	-	-
Ottawa	Slater & Elgin	7	26	9	33	12	-	-
Toronto	67 College St	2	23	14	34	7	4	8
Hamilton	Barton & Sanford	6	31	17	30	6	-	6
Windsor	471 University Ave	11	-	13	-	14	2	3
Windsor	City Hall	-	36	-	29	-	-	-
London	King & Rectory	1	27	6	24	-	-	-
Sarnia	156 Victoria St	9	24	8	25	-	-	7
Sudbury	19 Lisgar St	-	11	-	23	-	-	-
S S Marie	Prov Ont Bldg	-	-	-	-	-	-	-
Thunder Bay	14 Algoma St	-	-	-	-	-	-	-
Winnipeg	270 Osborne St	-	21	14	26	7	-	-
Regina	12th & Smith	1	16	-	13	-	-	-
Saskatoon	City Library	1	19	-	12	-	-	-
Moose Jaw	Telephone Bldg	-	18	-	8	-	-	-
Prince Albert	49-12th St E	-	21	-	9	-	-	-
Edmonton	109th St & 98th Ave	1	-	-	-	5	-	2
Edmonton	100th St & 102nd Ave	-	19	1	10	-	-	-
Calgary	620-7th Ave SW	1	-	8	-	11	-	3
Calgary	316-7th Ave	-	37	-	11	-	-	-
Red Deer	4747-50th St	-	15	-	6	-	-	-
Medicine Hat	770 First St SE	-	25	-	3	-	-	-
Vancouver	739 W Hastings St	-	10	15	21	15	-	1
Victoria	Police Station Fisguard	-	4	11	22	-	-	-

(CONT D)

TABLE II-1 RANKING OF STATIONS BY POLLUTANT 1974[1] [2] (CONT D)

Station		SO_2	SP*	COH**	Pb***	CO	NO_2	O_3
		Number of stations monitored						
		23	46	30	44	18	5	13
		Highest rank possible						
		11	38	20	38	15	4	8
		Rank						
RESIDENTIAL								
Halifax	Dalhousie Univ	-	1	-	7	-	-	-
Sydney	Whitney Pier Fire Stn	-	38	-	-	-	-	-
Montreal-BG	Botanical Gardens	3	32	17	37	-	-	7
Montreal-PAT	Pointe Aux Trembles	10	29	2	27	2	-	6
Montreal-JP	Jarry Park	2	-	-	-	-	-	-
Quebec	Parc Bardy	-	-	-	-	-	-	-
Chicoutimi	Filtration Works	-	-	-	-	-	-	-
Kingston	Queen s University	-	-	-	-	-	-	-
Toronto-DM	Don Mills Science Ctr	5	-	12	-	10	-	-
Toronto-RED	Redlands Cres	-	9	-	11	-	-	-
Toronto-L&K	Lawrence & Kennedy	-	-	5	-	13	2	5
Toronto-401	Pharmacy & 401	-	-	-	-	9	-	-
Hamilton	North Park	4	34	9	35	-	-	-
Windsor	Tecumseh Water Works	-	18	-	17	-	-	-
Sudbury	Ash Street	11	2	1	11	1	-	-
Winnipeg	Portage & Woodlawn	-	12	-	19	2	-	-
Regina	3211 Albert St	-	3	-	5	-	-	-
Saskatoon	Mount Royal Lodge	-	7	-	1	-	-	-
Edmonton	127th St & 133rd Ave	1	-	-	-	-	-	-
Edmonton	146th St & 92nd Ave	-	5	-	5	-	-	-
Edmonton	73rd Ave & 95th St	-	-	8	-	-	-	-
Calgary	407-31st Ave NW	-	10	-	4	-	-	-
Calgary	39th St & 29 Ave NW	-	-	-	-	-	-	-
Calgary	Waterworks Plant	-	-	4	-	-	-	-
Vancouver	2294 W 10th Ave	-	-	12	-	9	-	4
Vancouver	27th & Ontario	-	8	-	29	-	-	-
INDUSTRIAL								
Halifax	CFB Shearwater	-	-	-	-	-	1	-
Quebec	Ctr Lois Limoilou	-	35	-	-	-	-	-
Toronto	Evans & Arnold	4	22	16	38	-	-	-
Hamilton	Chatham & Frid	-	33	-	20	-	-	-
Windsor	Morton Terminal Dock	-	31	5	18	-	-	-
Winnipeg	Union Stock Yards	-	20	18	14	-	-	-
Edmonton	11th St & 105th Ave	1	14	-	2	3	-	-
Edmonton	149th St & 115th Ave	-	-	3	-	-	-	-
Calgary	Bonny Brk & 18 A St SE	1	28	7	5	-	-	-
Vancouver	250 W 70th Ave	1	13	10	28	4	-	3

* Suspended particulates

** Coefficient of haze (soiling index)

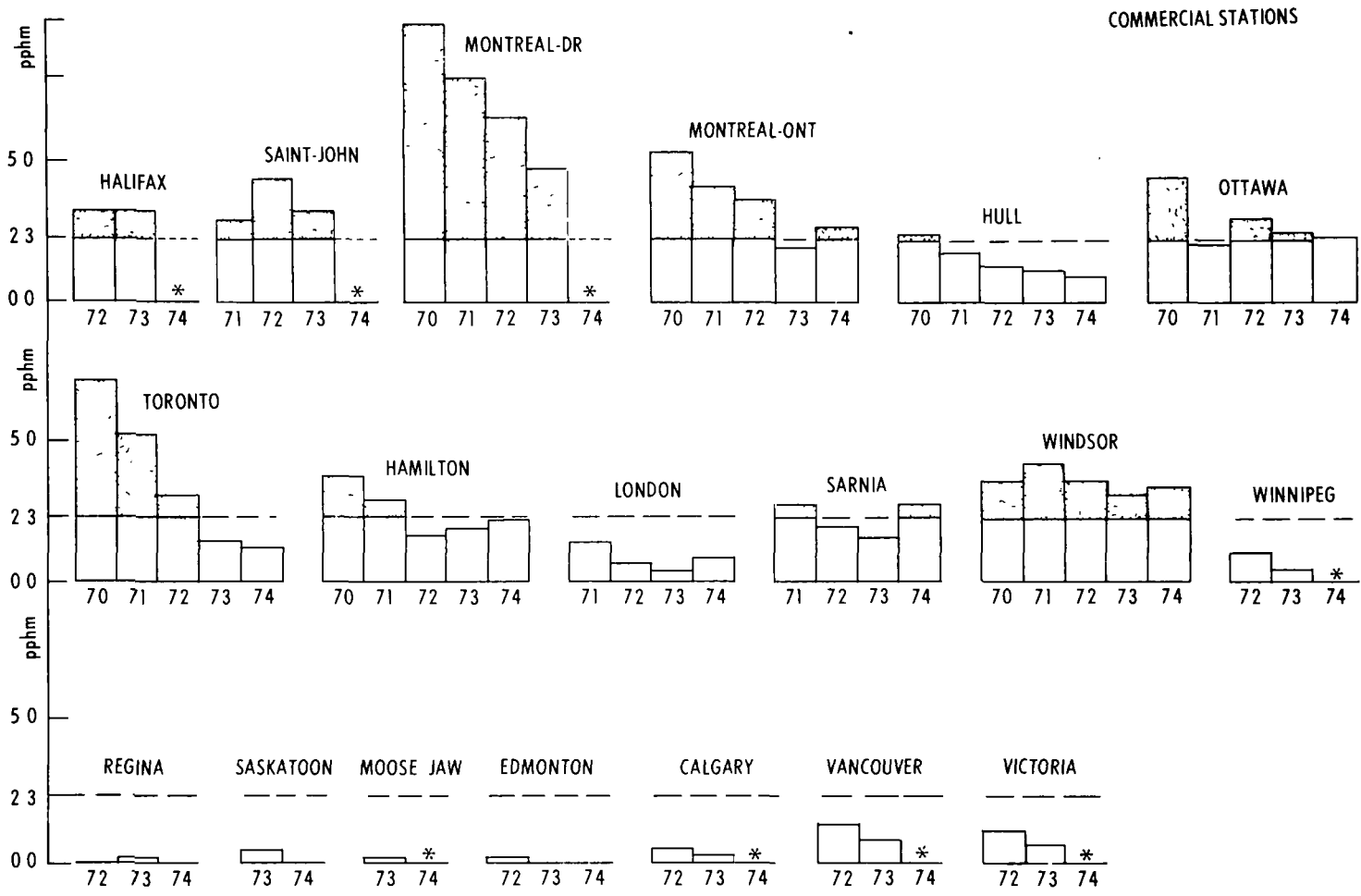
*** Lead

1 A dash (-) means either that the pollutant was not monitored or that insufficient data were available to calculate a valid annual mean

2 For stations included in this report

APPENDIX III - SULPHUR DIOXIDE DATA

- Annual arithmetic means, 1970-74
- Maximum hourly and daily values, 1970-74



* INSUFFICIENT DATA TO CALCULATE A VALID MEAN NOTE 2 3 pphm IS THE MAXIMUM ACCEPTABLE LEVEL

FIGURE III-1A SULPHUR DIOXIDE- ANNUAL ARITHMETIC MEANS 1970-74 COMMERCIAL STATIONS
(FOR SELECTED STATIONS ONLY
SEE TABLE III-1 FOR FULL LIST OF STATIONS AND ACTUAL LEVELS)

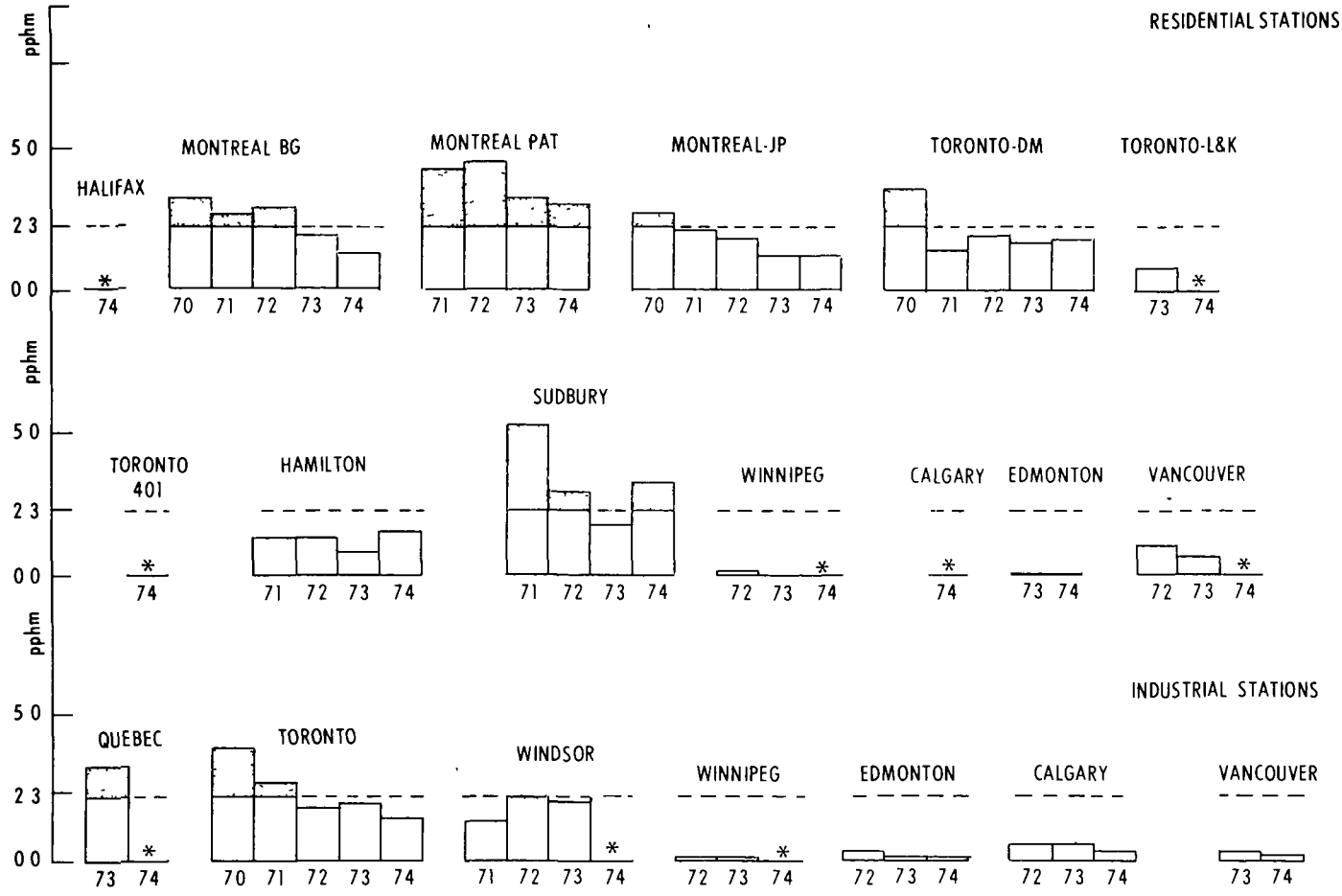


FIGURE III-1B SULPHUR DIOXIDE- ANNUAL ARITHMETIC MEANS 1970-74 ,RESIDENTIAL AND INDUSTRIAL STATIONS
(FOR SELECTED STATIONS ONLY
SEE TABLE III-1 FOR FULL LIST OF STATIONS AND ACTUAL LEVELS)

TABLE III-1 SULPHUR DIOXIDE - ANNUAL ARITHMETIC MEANS, 1970-74

Station	Annual arithmetic mean[2] (pphm[3])				
	1970	1971	1972	1973	1974
COMMERCIAL					
Halifax	-***	-	3 3	3 2	-
Saint John-CHAR	-	2 9	4 4	3 2	-
Montreal-DR	9 9	8 0	6 6	4 7	-
Montreal-ONT	5 4	4 1	3 7	2 0	2 6
Hull	2 4	1 7	1 3	1 2	<1 0
Ottawa	4 5	2 2	3 0	2 5	2 3
Toronto	7 1	5 2	3 0	1 4	1 2
Hamilton	3 7	2 9	1 7	1 8	2 2
London	-	1 4	<1 0	<1 0	<1 0
Sarnia	-	2 7	1 9	1 7	2 7
Windsor	3 6	4 3	3 6	3 2	3 3
Winnipeg[1]	-	-	1 0	<1 0	-
Regina	-	-	<1 0	<1 0	<1 0
Saskatoon	-	-	-	<1 0	<1 0
Moose Jaw	-	-	-	<1 0	-
Edmonton	-	-	<1 0	<1 0	<1 0
Calgary	-	-	<1 0	<1 0	<1 0
Vancouver	-	-	1 4	<1 0	-
Victoria	-	-	1 1	0 6	-
RESIDENTIAL					
Halifax	-	-	-	-	-
Montreal-BG	3 2	2 6	2 9	1 9	1 3
Montreal-PAT	-	4 2	4 5	3 3	3 0
Montreal-JP	2 7	2 1	1 9	1 2	1 2
Toronto-DM	3 6	1 4	1 9	1 6	1 7
Toronto-L&K	-	-	-	<1 0	-
Toronto-401	-	-	-	-	-
Hamilton	-	1 3	1 3	<1 0	1 5
Sudbury	-	5 3	2 9	1 7	3 3
Winnipeg	-	-	<1 0	<1 0	-
Calgary	-	-	-	-	-
Edmonton	-	-	-	<1 0	<1 0
Vancouver	-	-	1 0	<1 0	-

TABLE III-1 SULPHUR DIOXIDE - ANNUAL ARITHMETIC MEANS, 1970-74 (CONT'D)

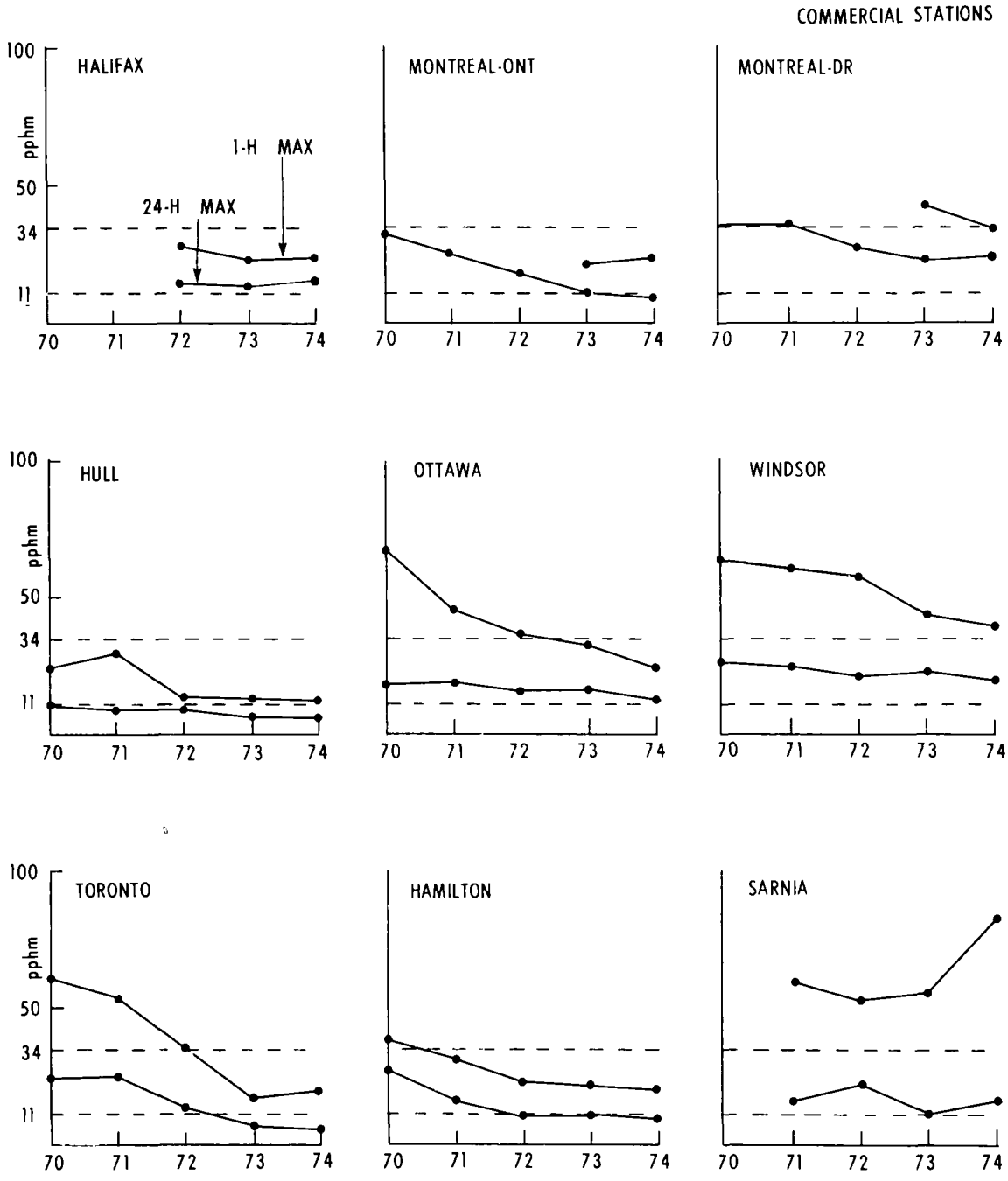
Station	Annual arithmetic mean* (pphm**)				
	1970	1971	1972	1973	1974
INDUSTRIAL					
Quebec	-	-	-	3 3	-
Toronto	3 9	2 7	1 9	2 0	1 5
Windsor	-	1 5	2 5	2 1	-
Winnipeg	-	-	<1 0	<1 0	-
Edmonton	-	-	<1 0	<1 0	<1 0
Calgary	-	-	<1 0	<1 0	<1 0
Vancouver	-	-	-	<1 0	<1 0

* 2 3 pphm is the annual acceptable level

** pphm - parts per hundred million

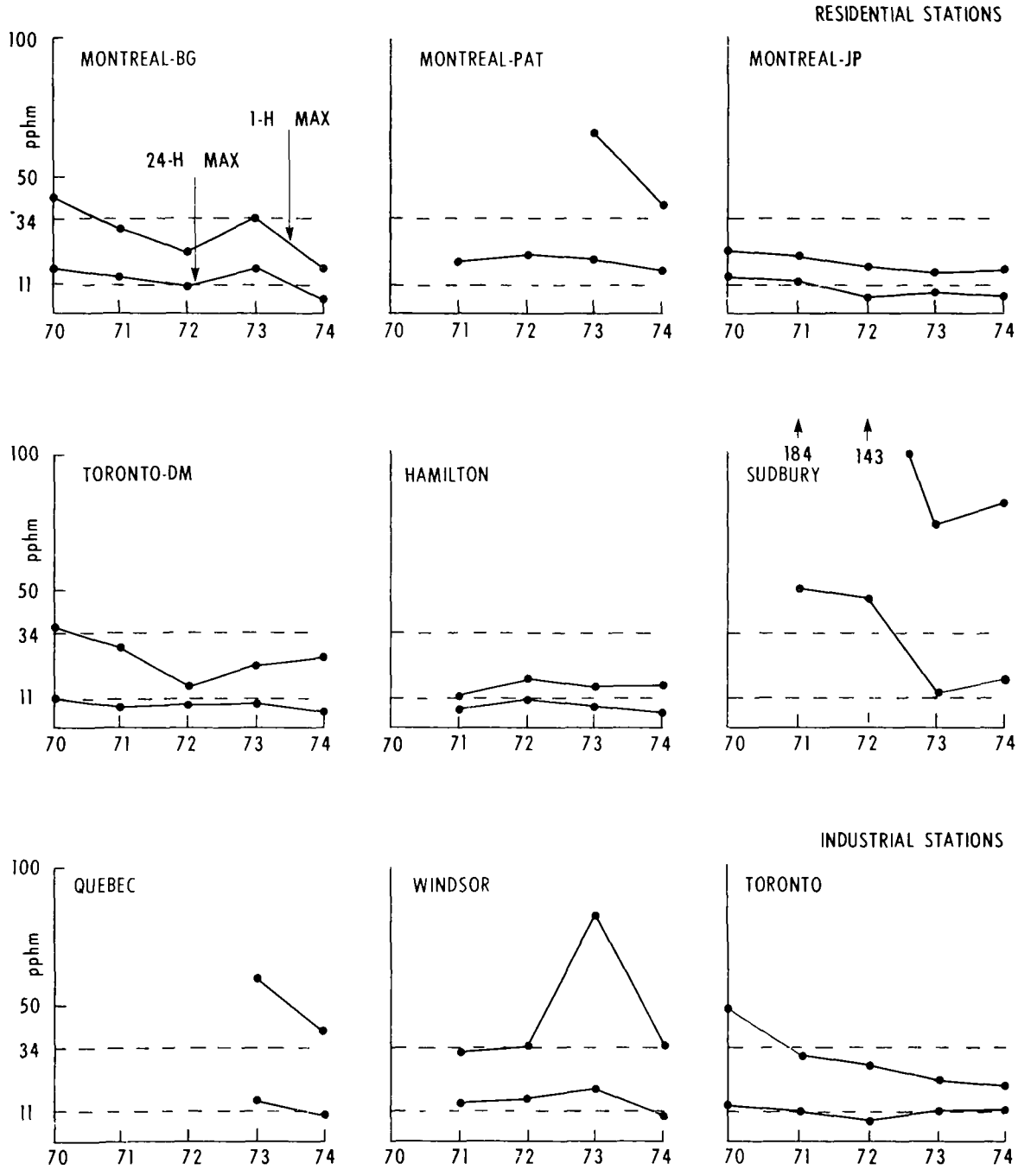
*** A dash (-) means either that the pollutant was not monitored, or that insufficient data were available to calculate a valid annual mean

1 Location changed from Kennedy & York (July 1974) to 270 Osborne St (August 1974)



NOTE 34 pphm IS THE 1-HOUR MAXIMUM ACCEPTABLE LEVEL
11 pphm IS THE 24-HOUR MAXIMUM ACCEPTABLE LEVEL

FIGURE III-2a SULPHUR DIOXIDE - MAXIMUM HOURLY AND DAILY VALUES 1970-74, COMMERCIAL STATIONS (FOR SELECTED STATIONS ONLY SEE TABLE III-2 FOR FULL LIST OF STATIONS AND ACTUAL LEVELS)



NOTE 34 pphm IS THE 1-HOUR MAXIMUM ACCEPTABLE LEVEL
11 pphm IS THE 24-HOUR MAXIMUM ACCEPTABLE LEVEL

FIGURE III-2b SULPHUR DIOXIDE - MAXIMUM HOURLY AND DAILY VALUES 1970-74, RESIDENTIAL & INDUSTRIAL STATIONS (FOR SELECTED STATIONS ONLY SEE TABLE III-2 FOR FULL LIST OF STATIONS AND ACTUAL LEVELS)

TABLE III-2 SULPHUR DIOXIDE - MAXIMUM HOURLY AND DAILY VALUES 1970-74

Station	1-h maximum ** (pphm*)					24-h maximum*** (pphm)				
	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
COMMERCIAL										
Halifax	-	-	28	33	24	-	-	14	13	14
Saint John-CHAR	-	41	49	44	25	-	19	34	25	7
Montreal-DR	-	-	-	42	34	35	36	27	23	23
Montreal-ONT	-	-	-	21	23	33	25	18	11	9
Hull	24	30	13	13	12	11	9	9	6	6
Ottawa	67	45	36	32	24	18	19	16	16	12
Toronto	61	54	36	17	20	24	25	14	7	6
Hamilton	38	31	23	22	20	28	16	10	10	9
London	-	9	10	10	10	-	5	5	5	5
Sarnia	-	59	52	55	83	-	16	22	11	15
Windsor	63	60	57	43	39	26	24	20	22	19
Winnipeg[1]	-	-	24	24	18	-	-	16	14	9
Regina	-	-	9	7	5	-	-	1	1	<1
Saskatoon	-	-	-	5	4	-	-	-	2	<1
Moose Jaw	-	-	-	8	5	-	-	-	2	1
Edmonton	-	-	10	5	2	-	-	<1	1	1
Calgary	-	-	6	6	10	-	-	2	1	2
Vancouver	-	-	12	14	10	-	-	5	8	3
Victoria	-	-	9	9	6	-	-	3	2	3
RESIDENTIAL										
Halifax	-	-	-	-	8	-	-	-	-	3
Montreal-BG	42	31	23	35	17	17	14	10	17	5
Montreal-PAT	-	-	-	66	40	-	19	22	20	17
Montreal-JP	23	21	17	15	16	13	12	6	8	8
Toronto-DM	37	29	16	23	26	11	8	9	9	7
Toronto-L&K	-	-	-	10	10	-	-	-	5	4
Toronto-401	-	-	-	-	13	-	-	-	-	5
Hamilton	-	12	18	15	16	-	7	11	8	7
Sudbury	-	184	143	74	82	-	50	47	13	17
Winnipeg	-	-	4	3	6	-	-	1	2	2
Calgary	-	-	-	-	6	-	-	-	-	1
Edmonton	-	-	-	1	2	-	-	-	<1	1
Vancouver	-	-	9	12	12	-	-	4	9	3
INDUSTRIAL										
Quebec	-	-	-	60	40	-	-	-	15	10
Toronto	48	31	28	22	21	13	11	8	12	12
Windsor	-	33	35	83	36	-	14	16	20	10
Winnipeg	-	-	9	9	7	-	-	2	4	1
Edmonton	-	-	14	26	12	-	-	2	4	1
Calgary	-	-	20	15	17	-	-	3	3	4
Vancouver	-	-	-	9	14	-	-	-	2	2

* pphm - parts per hundred million

** 34 pphm is the 1-h maximum acceptable level

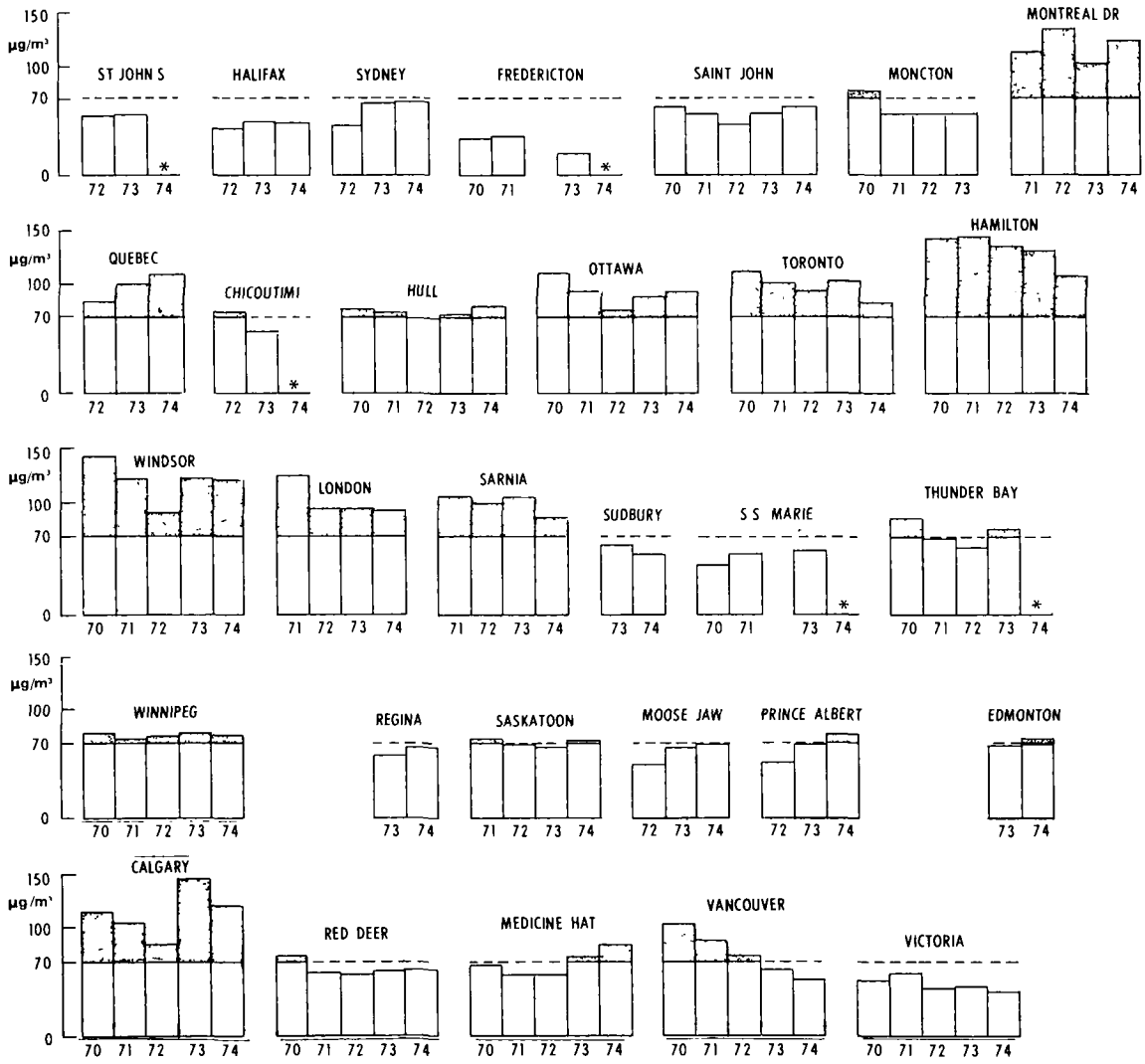
*** 11 pphm is the 24-h maximum acceptable level

1 Location changed from Kennedy & York (July 1974) to 270 Osborne Street (August 1974)

APPENDIX IV - SUSPENDED PARTICULATES DATA

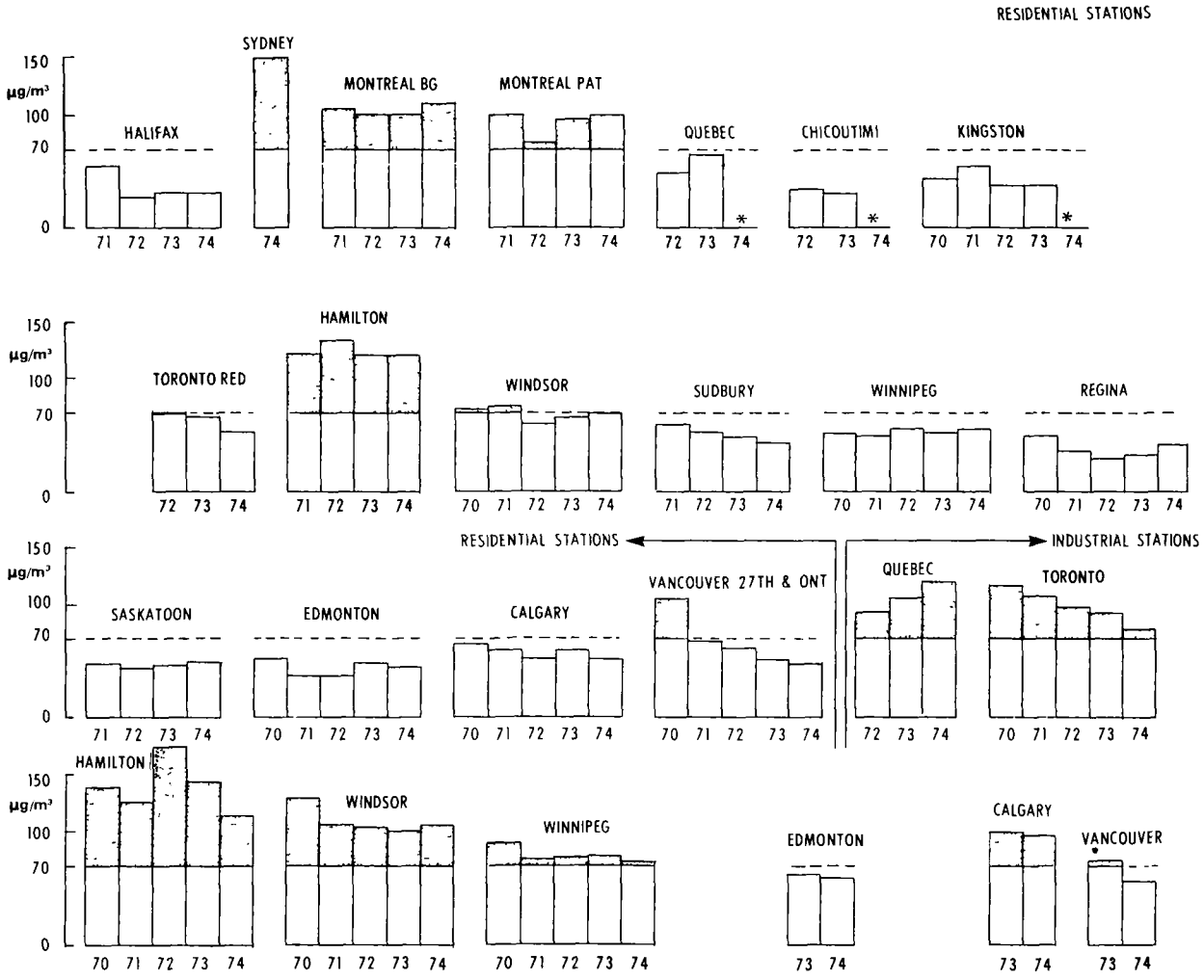
- Annual geometric means, 1970-74
- 24-h maximum values (1972-74) and % of 1974 readings above acceptable level

COMMERCIAL STATIONS



NOTE 70 µg/m³ IS THE MAXIMUM ACCEPTABLE LEVEL * INSUFFICIENT DATA TO CALCULATE A VALID MEAN

FIGURE IV 1A SUSPENDED PARTICULATES ANNUAL GEOMETRIC MEANS 1970 74, COMMERCIAL STATIONS
(SEE TABLE IV1 FOR ACTUAL LEVELS)



NOTE 70 µg/m³ IS THE MAXIMUM ACCEPTABLE LEVEL

* INSUFFICIENT DATA TO CALCULATE A VALID MEAN

FIGURE IV 1B SUSPENDED PARTICULATES ANNUAL GEOMETRIC MEANS 1970 74, RESIDENTIAL & INDUSTRIAL STATIONS
(SEE TABLE IV 1 FOR ACTUAL LEVELS)

TABLE IV-1 SUSPENDED PARTICULATES - ANNUAL GEOMETRIC MEANS, 1970-74

Station	Annual geometric mean[1] ($\mu g/m^3$[2])				
	1970	1971	1972	1973	1974
COMMERCIAL					
St John's	-[3]	-	54	55	-
Sydney	-	-	46	66	67
Halifax	-	-	42	49	47
Fredericton	33	36	-	19	-
Saint John	61	54	46	55	60
Moncton	77	54	54	54	-
Montreal-DR	-	111	132	101	121
Hull	77	73	69	72	79
Quebec	-	-	83	101	103
Chicoutimi	-	-	75	57	-
Ottawa	109	92	75	87	91
Windsor	142	122	91	121	122
Toronto	111	99	92	101	81
Hamilton	140	143	133	128	105
London	-	125	95	94	92
Sarnia	-	105	98	104	85
Sudbury	-	-	-	63	55
S S Marie	44	55	-	58	-
Thunder Bay	84	69	60	76	-
Winnipeg	79	73	75	78	77
Regina	-	-	-	58	66
Saskatoon	-	72	68	65	71
Moose Jaw	-	-	48	65	69
Prince Albert	-	-	51	69	77
Edmonton	-	-	-	65	71
Calgary	117	105	85	147	123
Red Deer	74	59	58	61	62
Medicine Hat	67	57	57	74	88
Vancouver	104	89	77	61	53
Victoria	51	59	44	47	43

(CONT D)

TABLE IV-1 SUSPENDED PARTICULATES - ANNUAL GEOMETRIC MEANS, 1970-74 (CONT'D)

Station	Annual geometric mean* (mg/m³**)				
	1970	1971	1972	1973	1974
RESIDENTIAL					
Halifax	-	55	28	33	32
Sydney	-	-	-	-	148
Montreal-BG	-	104	95	99	111
Montreal-PAT	-	99	77	97	97
Quebec	-	-	50	67	-
Chicoutimi	-	-	36	33	-
Kingston	44	57	38	38	-
Toronto-RED	-	-	70	67	52
Hamilton	-	121	134	120	119
Windsor	72	76	59	66	69
Sudbury	-	59	52	48	41
Winnipeg	53	49	56	52	56
Regina	49	37	29	33	42
Saskatoon	-	48	44	47	48
Edmonton	53	37	37	48	45
Calgary	67	60	53	61	53
Vancouver	106	69	62	53	50
INDUSTRIAL					
Quebec	-	-	95	107	121
Toronto	118	108	99	94	79
Hamilton	138	124	175	143	113
Windsor	129	106	103	98	105
Winnipeg	89	75	76	78	74
Edmonton	-	-	-	62	60
Calgary	-	-	-	98	96
Vancouver	-	-	-	74	57

* The maximum acceptable level is 70 $\mu g/m^3$ on an annual basis

** Micrograms per cubic metre

*** A dash (-) means either that the pollutant was not monitored, or that insufficient data were available to calculate a valid annual mean

TABLE IV-2 SUSPENDED PARTICULATES - 24-H MAXIMUM VALUES, 1972-74

Station	24-h maximum* ($\mu g/m^3$**)			Percent (%) of 1974 readings above acceptable level*		
	1972	1973	1974	Between 121-150 $\mu g/m^3$	Between 151-250 $\mu g/m^3$	>250 $\mu g/m^3$
COMMERCIAL						
St John's	135	140	140	5	-	-
Sydney	84	362	186	5	4	-
Halifax	86	121	154	2	2	-
Fredericton	-	127	124	3	-	-
Saint John	140	151	190	-	2	-
Moncton	171	146	480	-	-	33
Montreal-DR	302	279	319	12	25	6
Hull	227	200	198	11	11	-
Quebec	230	470	428	8	17	6
Chicoutimi	170	220	176	-	3	-
Ottawa	232	200	190	11	11	-
Windsor	247	319	282	27	24	4
Toronto	207	250	222	19	8	-
Hamilton	519	316	309	16	23	2
London	307	371	358	17	11	7
Sarnia	290	473	210	15	11	-
Sudbury	-	227	205	2	2	-
S S Marie	-	289	136	8	-	-
Thunder Bay	283	210	280	7	3	3
Winnipeg	193	304	178	12	2	-
Regina	-	179	201	7	7	-
Saskatoon	192	238	289	12	12	2
Moose Jaw	172	174	257	9	16	3
Prince Albert	301	313	375	5	24	4
Edmonton	-	230	294	12	3	2
Calgary	295	363	386	8	37	6
Red Deer	477	288	220	8	14	-
Medicine Hat	123	313	233	13	16	-
Vancouver	146	131	133	7	-	-
Victoria	92	109	144	4	-	-

(CONT D)

TABLE IV-2 SUSPENDED PARTICULATES - 24-H MAXIMUM VALUES, 1972-74 (CONT'D)

Station	24-h maximum ($\mu g/m^3$) 1972	1973	1974	Percent (%) of 1974 readings above acceptable level: Between 121-150 $\mu g/m^3$	Between 151-250 $\mu g/m^3$	>250 $\mu g/m^3$
RESIDENTIAL						
Halifax	66	138	159	4	2	-
Sydney	-	-	583	7	20	34
Montreal-BG	293	314	266	16	16	6
Montreal-PAT	219	221	208	14	11	-
Quebec	165	222	363	5	9	5
Chicoutimi	64	106	106	-	-	-
Kingston	150	108	96	-	-	-
Toronto-RED	316	218	185	3	2	-
Hamilton	382	388	359	18	25	9
Windsor	188	163	201	6	9	-
Sudbury	161	222	164	-	2	-
Winnipeg	172	318	188	6	2	-
Regina	132	118	152	2	2	-
Saskatoon	192	196	179	5	4	-
Edmonton	125	268	174	3	2	-
Calgary	244	180	133	7	-	-
Vancouver	138	105	135	3	-	-
INDUSTRIAL						
Quebec	430	325	362	21	19	7
Toronto	197	201	242	12	7	-
Hamilton	451	328	260	18	26	2
Windsor	212	214	406	23	14	4
Winnipeg	209	457	219	4	13	-
Edmonton	-	163	261	7	17	2
Calgary	-	201	348	4	24	5
Vancouver	-	155	181	10	4	-

The 24-h maximum acceptable level is 120 $\mu g/m^3$

[a] Micrograms per cubic metre

APPENDIX V – LEAD DATA

– Annual geometric means and 24-h maximum values, 1970-74

TABLE V-1 LEAD - ANNUAL GEOMETRIC MEANS AND 24-H MAXIMUM VALUES 1970-74

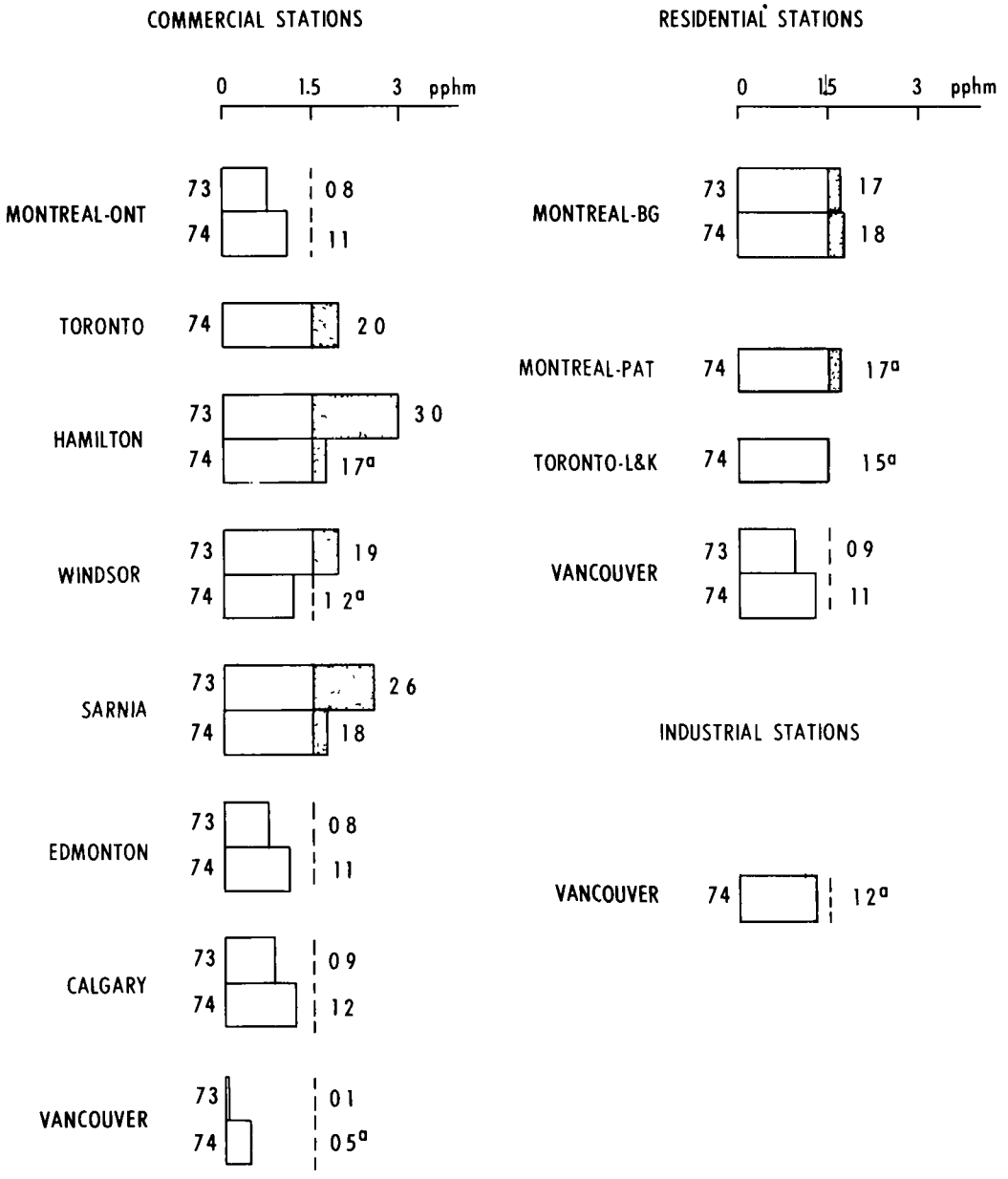
Station	Annual geometric mean ($\mu g/m^3$°)					24-h maximum ($\mu g/m^3$)				
	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
COMMERCIAL										
St John s	-°°	-	0 64	0 75	-	-	-	2 1	1 9	1 6
Halifax	-	-	0 28	0 40	0 32	-	-	0 6	1 1	1 8
Sydney	-	-	0 31	0 47	0 41	-	-	1 3	1 6	2 8
Fredericton	0 32	0 31	-	0 19	-	1 3	1 1	-	1 0	1 5
Saint John	0 48	0 43	0 31	0 58	0 47	1 3	1 1	1 0	2 1	1 6
Moncton	0 65	0 48	0 45	0 54	-	2 8	1 0	0 9	1 4	3 9
Montreal-DR	-	1 18	1 70	1 58	1 38	-	4 1	7 9	6 1	3 9
Hull	1 07	0 89	1 00	0 96	1 02	3 6	2 3	2 2	3 7	2 3
Quebec	-	-	1 07	1 01	1 15	-	-	2 0	2 5	3 4
Chicoutimi	-	-	0 72	0 76	-	-	-	2 1	2 2	2 1
Ottawa	1 34	1 13	1 17	1 18	1 17	4 0	2 6	3 3	4 0	2 9
Windsor	1 57	1 10	0 88	1 06	0 99	4 6	2 1	2 8	3 3	2 2
Toronto	-	-	1 36	1 40	1 22	-	-	3 2	3 6	3 8
Hamilton	-	-	1 40	1 59	1 00	-	-	3 5	4 2	2 6
Sudbury	-	-	-	0 98	0 78	-	-	-	4 1	1 8
S S Marie	-	-	-	0 69	-	-	-	-	5 9	1 3
Thunder Bay	-	-	0 73	0 73	-	-	-	1 8	1 5	1 2
London	-	-	0 93	0 86	0 82	-	-	2 1	2 8	3 8
Sarnia	-	-	0 80	0 73	0 86	-	-	1 9	2 5	2 1
Winnipeg	0 88	0 82	0 82	0 87	0 88	7 1	6 6	6 6	6 3	19 9
Regina	-	-	-	0 43	0 37	-	-	-	1 7	1 9
Saskatoon	-	0 58	0 36	0 31	0 35	-	1 3	2 0	1 1	1 0
Moose Jaw	-	-	0 26	0 25	0 25	-	-	0 6	0 9	1 7
Prince Albert	-	-	0 29	0 22	0 26	-	-	0 7	0 7	0 9
Edmonton	-	-	-	0 20	0 29	-	-	-	1 0	1 0
Calgary	1 15	1 35	0 83	0 26	0 32	2 4	3 2	3 5	1 4	3 0
Red Deer	0 55	0 39	0 39	0 19	0 19	1 1	1 2	1 2	1 3	1 1
Medicine Hat	0 54	0 45	0 29	0 13	0 15	1 6	1 3	0 8	0 5	0 8
Vancouver	1 35	0 89	1 00	0 92	0 68	4 5	2 0	2 4	2 7	1 9
Victoria	0 89	0 82	0 69	0 77	0 76	3 1	2 8	3 1	2 4	3 0
RESIDENTIAL										
Halifax	-	0 39	0 23	0 32	0 21	-	1 2	0 7	1 0	1 0
Montreal-BG	-	1 26	1 44	1 67	1 39	-	5 0	3 4	5 8	4 5
Montreal-PAT	-	0 73	0 95	1 03	0 94	-	2 4	2 1	4 2	4 0
Quebec	-	-	0 76	0 82	-	-	-	2 0	6 9	5 3
Chicoutimi	-	-	0 21	0 13	-	-	-	0 6	1 1	0 9
Windsor	0 82	0 55	0 53	0 48	0 48	2 8	2 6	1 9	2 3	1 5
Kingston	0 51	0 39	0 36	0 33	-	1 2	0 7	0 7	0 9	1 1
Toronto-RED	-	-	0 63	0 56	0 32	-	-	1 9	2 7	1 5
Hamilton	-	-	-	1 45	1 32	-	-	-	3 6	2 9
Sudbury	-	-	0 42	0 44	0 32	-	-	1 6	2 3	1 6
Winnipeg	0 91	0 71	0 77	0 80	0 58	6 2	18 7	5 0	6 7	10 4
Regina	0 44	0 29	0 19	0 22	0 18	1 8	0 7	0 6	0 9	1 8
Saskatoon	-	0 25	0 16	0 16	0 12	-	0 7	0 7	0 6	0 7
Edmonton	0 48	0 32	0 30	0 16	0 18	1 6	1 0	1 3	0 9	0 8
Calgary	0 60	0 63	0 45	0 17	0 16	2 0	1 9	2 8	3 6	1 3
Vancouver	1 28	1 00	1 05	1 02	0 99	4 9	2 1	2 8	3 4	3 1
INDUSTRIAL										
Quebec	-	-	0 94	0 98	-	-	-	2 9	9 0	3 3
Windsor	0 94	0 62	0 65	0 54	0 52	2 8	1 9	2 3	1 3	1 8
Toronto	-	-	2 22	1 81	1 72	-	-	7 5	4 2	5 0
Hamilton	-	-	-	1 25	0 66	-	-	-	5 2	4 2
Winnipeg	0 43	0 48	0 43	0 51	0 39	2 1	2 4	2 9	3 8	5 3
Edmonton	-	-	-	0 13	0 14	-	-	-	1 3	0 9
Calgary	-	-	-	0 19	0 18	-	-	-	1 1	1 2
Vancouver	-	-	-	1 27	0 97	-	-	-	2 6	3 0

° Micrograms per cubic metre

°° A dash (-) means either the pollutant was not monitored or that insufficient data were available to calculate a valid mean

APPENDIX VI - OZONE DATA

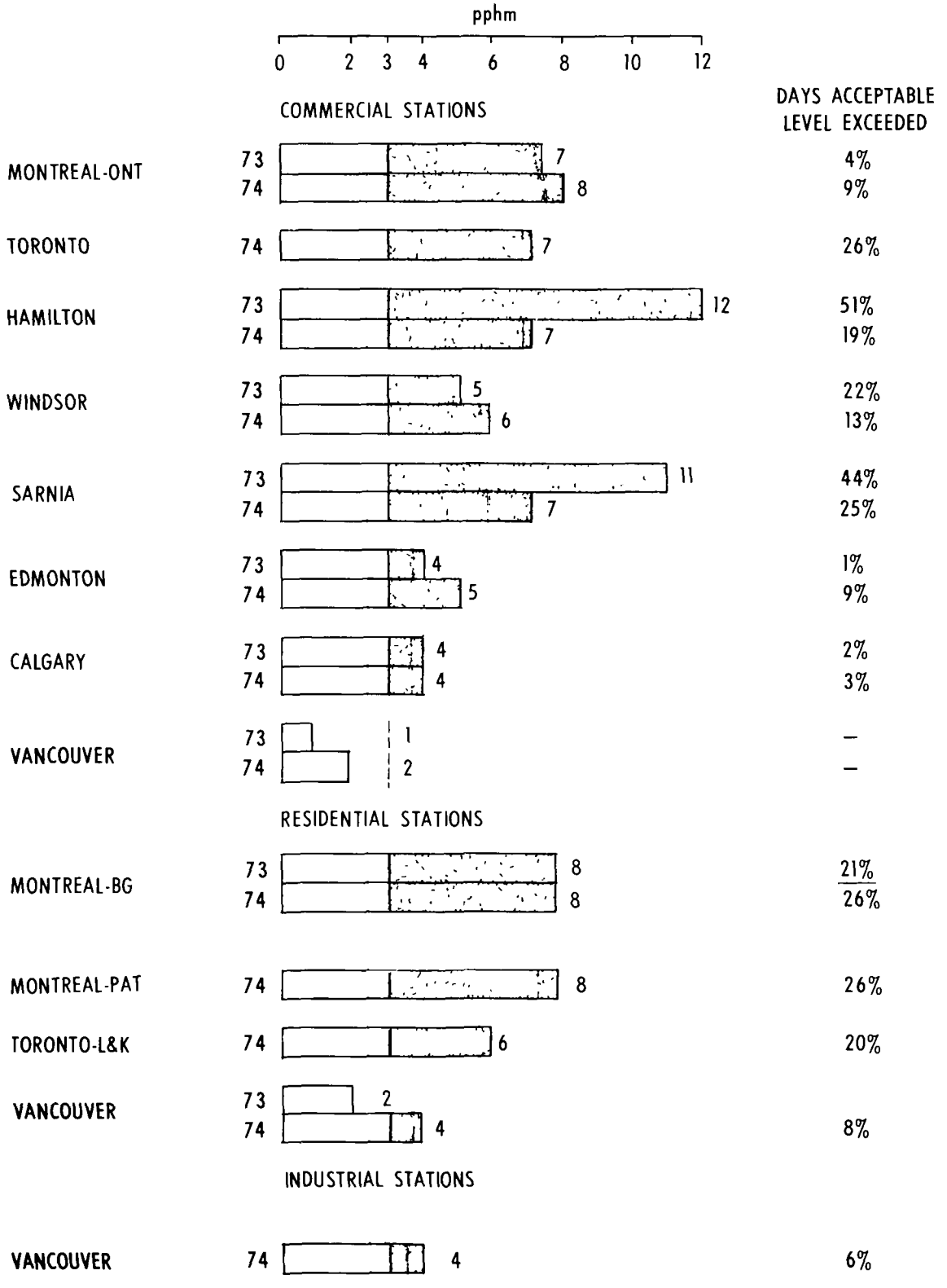
- Annual arithmetic means, 1973-74
- Maximum 24-h averages (1973-74) and % of time acceptable level exceeded
- Maximum 1-h averages (1973-74) and % of time acceptable level exceeded



NOTE 15pphm IS THE MAXIMUM ACCEPTABLE LEVEL

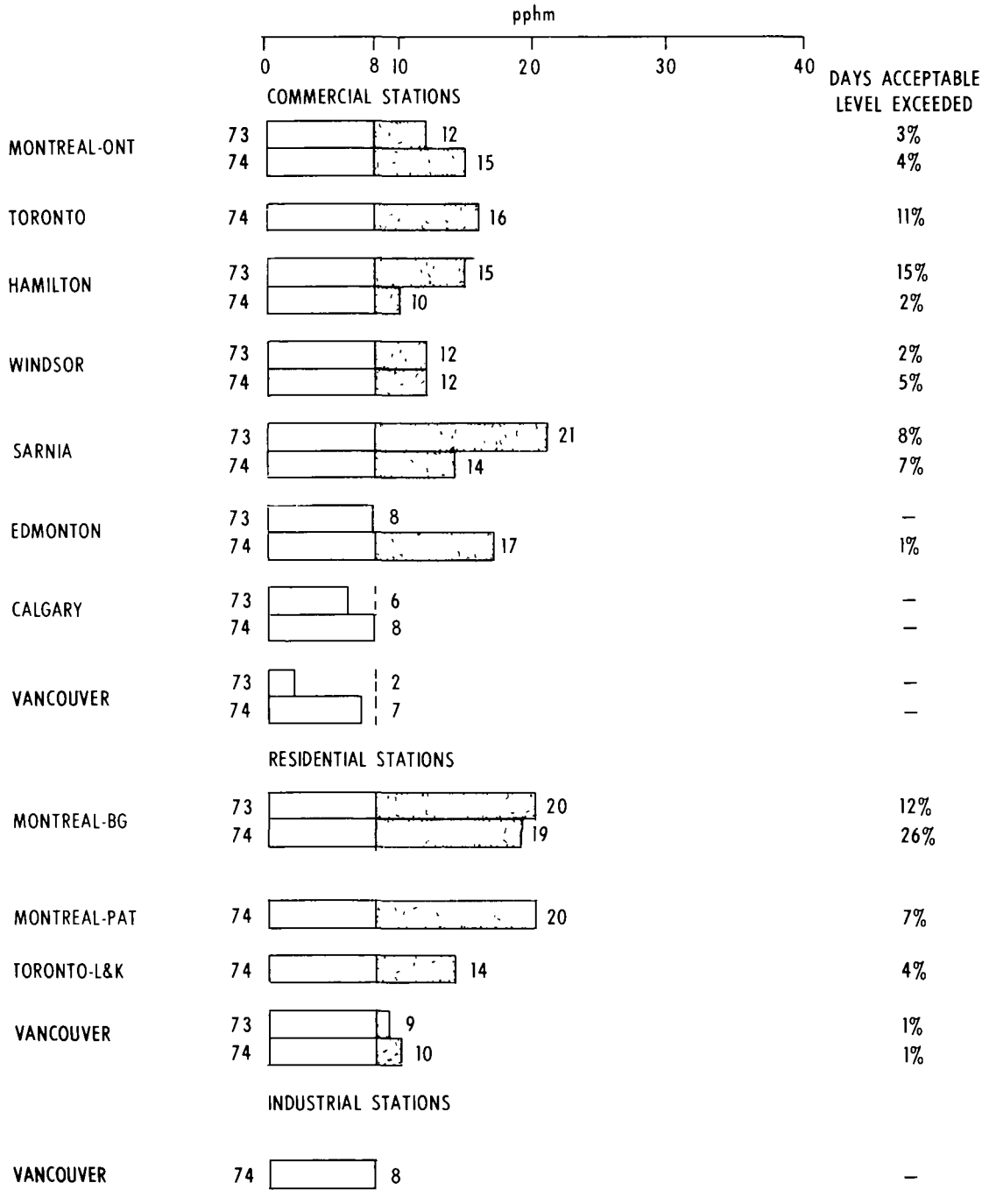
a - ESTIMATED VALUE

FIGURE VI-1 OZONE - ANNUAL ARITHMETIC MEANS 1973-74
(pphm - PARTS PER HUNDRED MILLION)



NOTE: 3 pphm IS THE MAXIMUM ACCEPTABLE LEVEL

FIGURE VI-2 OZONE - MAXIMUM 24-H AVERAGES 1973-74 (pphm - PARTS PER HUNDRED MILLION)

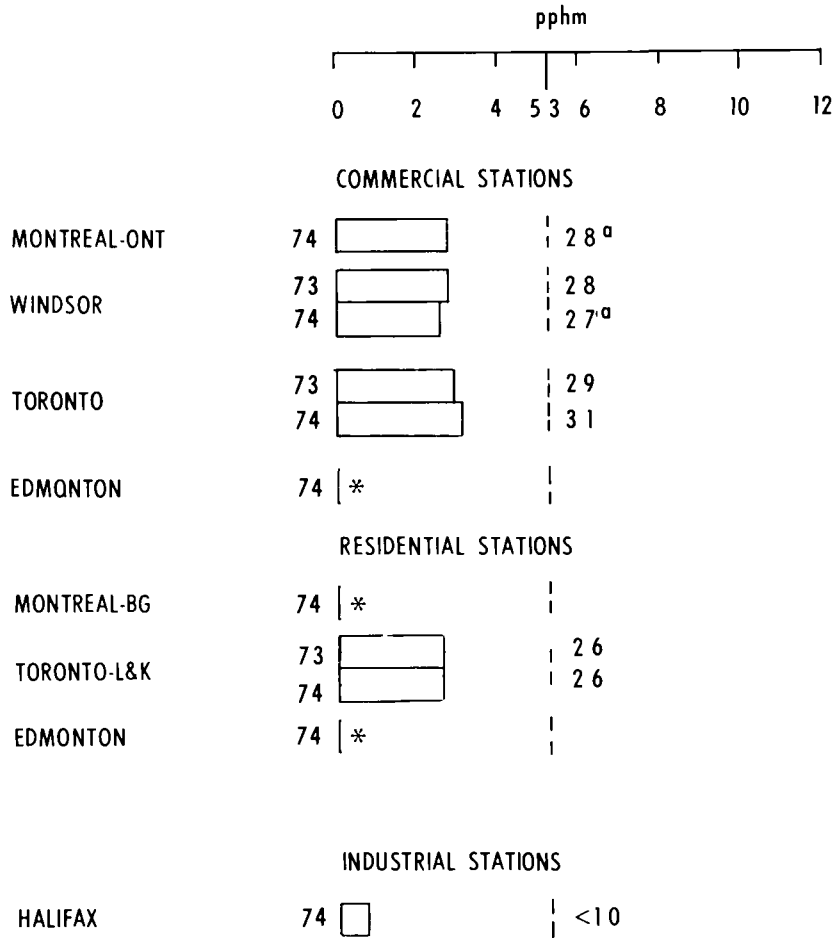


NOTE 8 pphm IS THE MAXIMUM ACCEPTABLE LEVEL

FIGURE VI-3 OZONE - MAXIMUM 1-H AVERAGES 1973-74 (pphm - PARTS PER HUNDRED MILLION)

APPENDIX VII - NITROGEN DIOXIDE DATA

- Annual arithmetic means, 1973-74
- Maximum 24-h averages, 1973-74
- Maximum 1-h averages, 1973-74

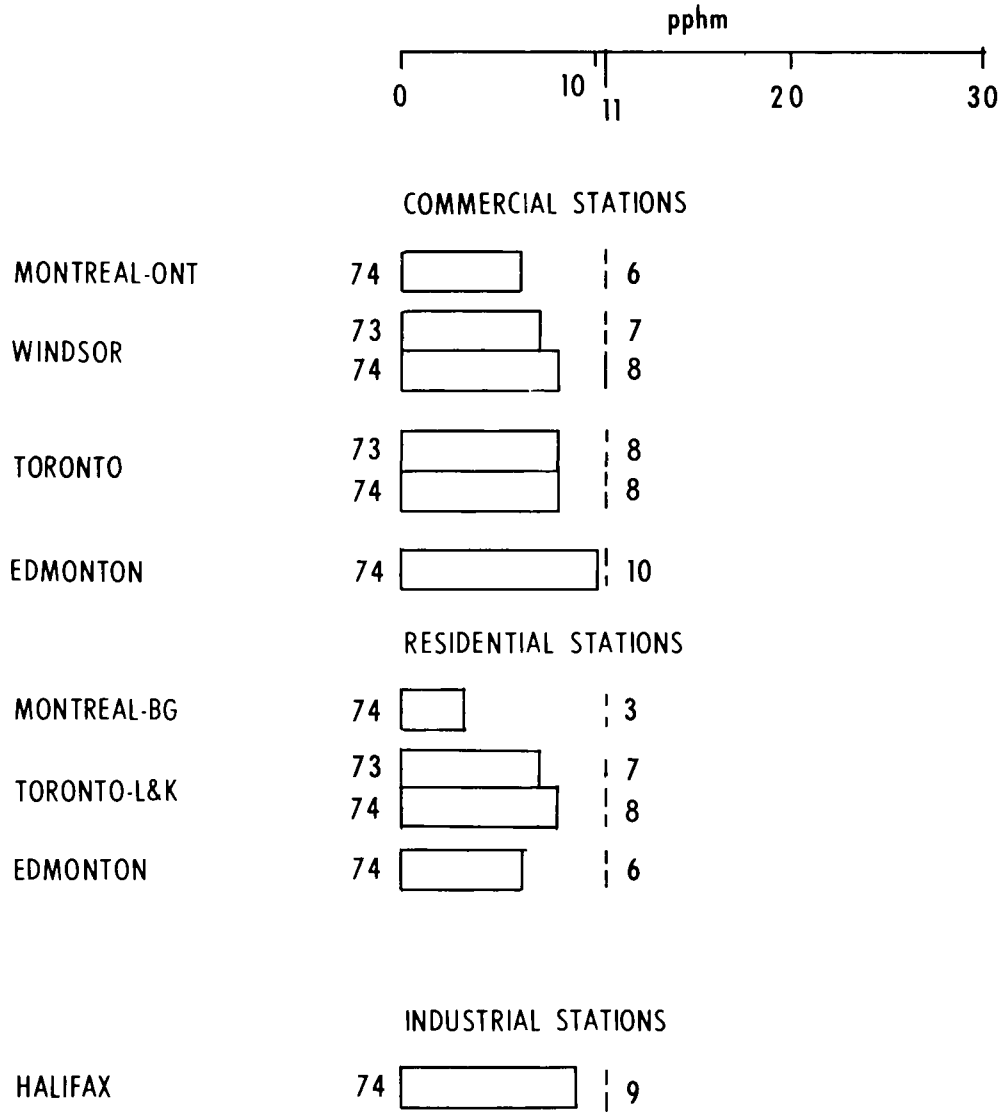


NOTE -5 3pphm IS THE MAXIMUM ACCEPTABLE LEVEL

* INSUFFICIENT DATA TO CALCULATE A VALID MEAN

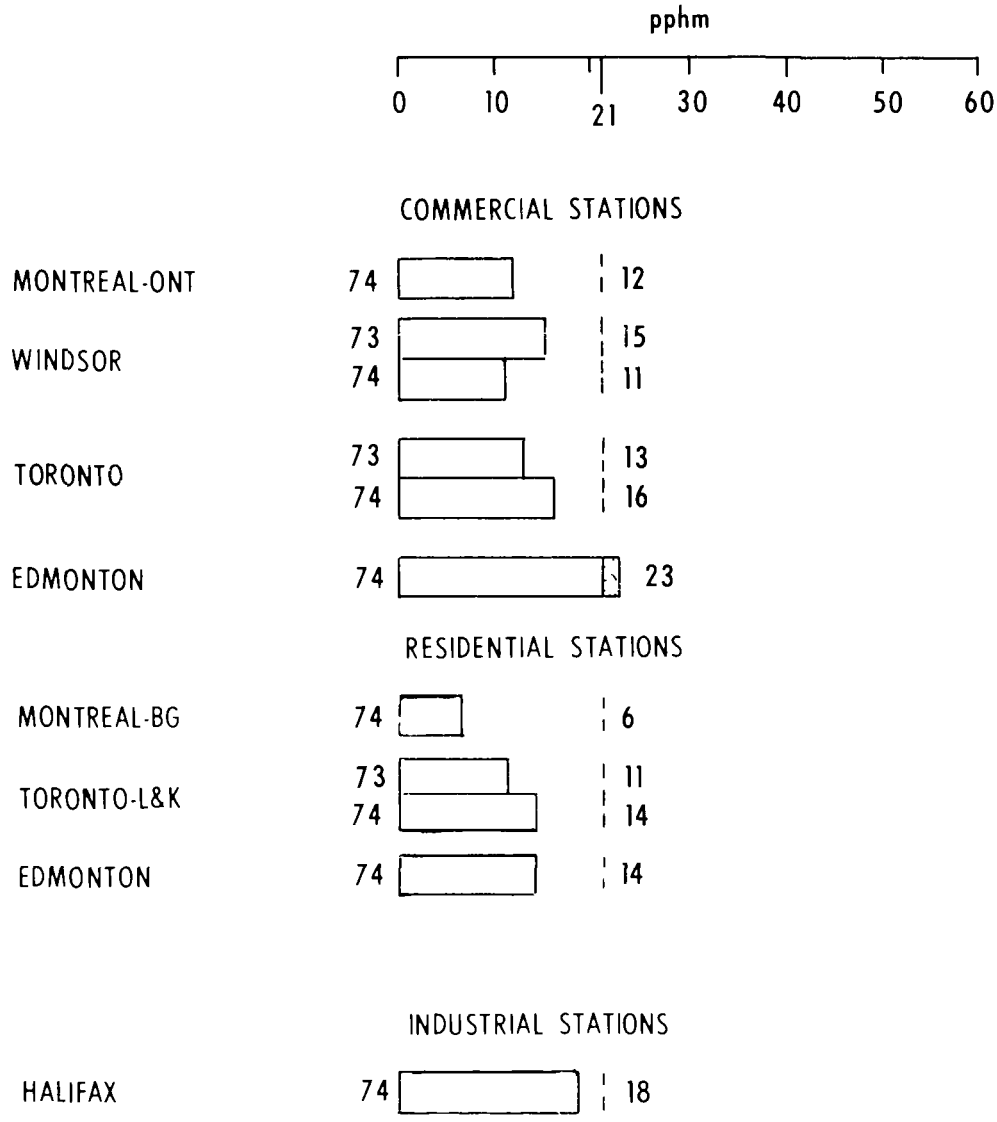
a - ESTIMATED VALUE

FIGURE VII-1 NITROGEN DIOXIDE - ANNUAL ARITHMETIC MEANS 1973-74
(pphm - PARTS PER HUNDRED MILLION)



NOTE: - 11pphm IS THE MAXIMUM ACCEPTABLE LEVEL

FIGURE VII-2 NITROGEN DIOXIDE - MAXIMUM 24-H AVERAGES 1973-74
(pphm - PARTS PER HUNDRED MILLION)



NOTE 21pphm IS THE MAXIMUM ACCEPTABLE LEVEL

FIGURE VII-3 NITROGEN DIOXIDE - MAXIMUM 1-H AVERAGES 1973 - 74
(pphm - PARTS PER HUNDRED MILLION)

APPENDIX VIII – CARBON MONOXIDE DATA

- Annual arithmetic means, 1973–74
- 8-h and 1-h maximum values, 1974

TABLE VIII-1 CARBON MONOXIDE - 1973-74 ANNUAL ARITHMETIC MEANS AND 1974 8-H AND 1-H MAXIMUM VALUES

Station	Annual arithmetic mean (ppm*)		Max 8-h avg** (ppm)	Max 1-h avg*** (ppm)
	1973	1974	1974	1974
COMMERCIAL				
Montreal-ONT	-****	2 4	11	15
Ottawa	3 1	3 2	16	38
Toronto	3 3	2 0[a]	6	11
Hamilton	2 1	1 9	7	12
Windsor	4 7	5 1	20	25
Winnipeg	2 4	2 0[a]	14	29
Regina	-	-	9	22
Saskatoon	-	-	6	12
Edmonton	2 1	1 8	10	20
Calgary	4 3	3 0	15	23
Vancouver	-	5 4[a]	19	31
RESIDENTIAL				
Montreal-PAT	-	0 7	7	15
Toronto-DM	-	2 9[a]	10	13
Toronto-L&K	-	5 0[a]	15	22
Toronto-401	-	2 6	11	19
Sudbury	-	<0 5[a]	4	10
Winnipeg	1 1	0 7[a]	9	20
Vancouver	-	2 6	14	22
INDUSTRIAL				
Edmonton	1 7	0 9	5	10
Vancouver	-	1 2	10	15

* Parts per million

** The 8-h maximum acceptable level is 13 ppm

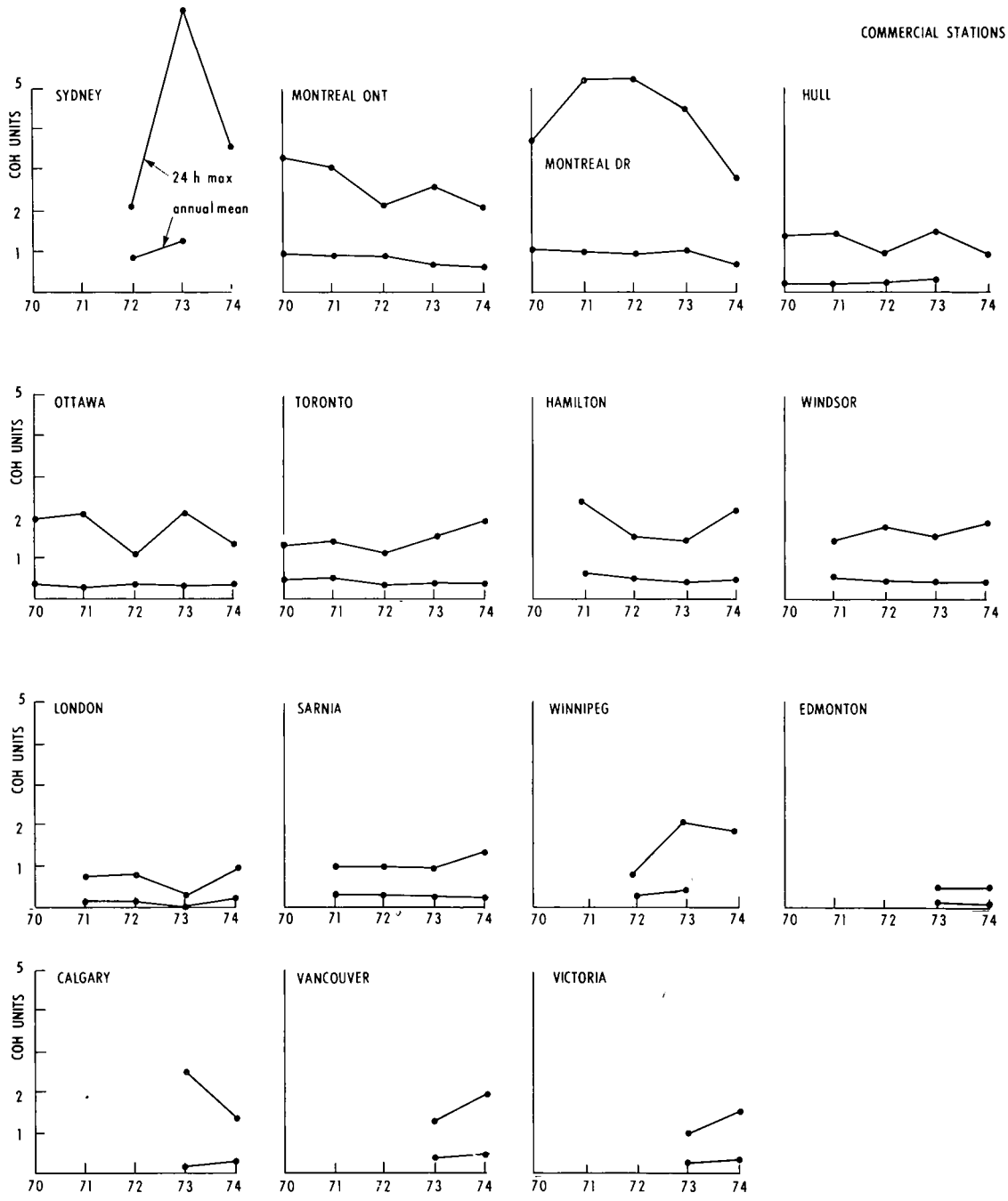
*** The 1-h maximum acceptable level is 31 ppm

**** A dash (-) means either that the pollutant was not monitored, or that insufficient data were available to calculate a valid annual mean,

a Estimated value

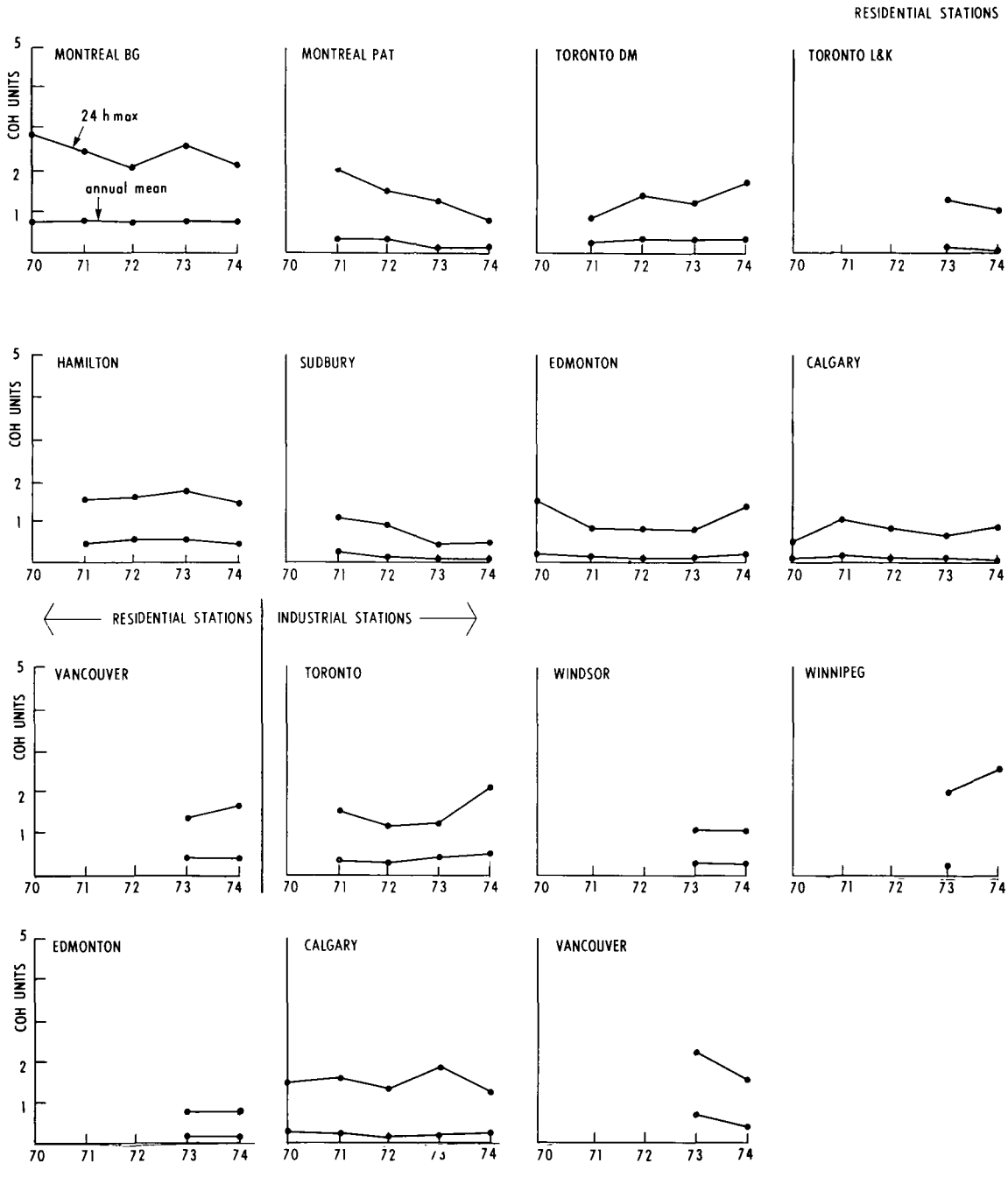
APPENDIX IX – SOILING INDEX DATA

– Annual arithmetic means and 24-h maximum values, 1970-74



Note readings are COH units per 1000 linear feet

FIGURE IX 1A SOILING INDEX ANNUAL ARITHMETIC MEANS AND 24 H MAXIMUM VALUES 1970 74
(SEE TABLE IX 1 FOR ACTUAL LEVELS)



Note readings are COH units per 1000 linear feet

FIGURE IX-1B SOILING INDEX ANNUAL ARITHMETIC MEANS AND 24-H MAXIMUM VALUES 1970-74 (CONT'D)
(SEE TABLE IX 1 FOR ACTUAL LEVELS)

TABLE IX-1 SOILING INDEX - ANNUAL ARITHMETIC MEANS AND 24-HR MAXIMUM VALUES 1970-74

	Annual arithmetic mean (COH units*)					24-h maximum (COH units)				
Station	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
COMMERCIAL										
Sydney	-**	-	0 88	1 27	-	-	-	2 1	7 0	3 5
Montreal-ONT	0 94	0 90	0 90	0 75	0 67	3 3	3 0	2 1	2 6	2 1
Montreal-DR	1 08	1 10	0 97	1 02	0 67	3 7	5 2	5 2	4 5	2 8
Hull	0 28	0 28	0 29	0 34	-	1 5	1 5	1 0	1 6	1 0
Ottawa	0 38	0 26	0 34	0 36	0 37	2 0	2 1	1 1	2 2	1 4
Toronto	0 50	0 57	0 42	0 43	0 46	1 5	1 5	1 2	1 6	1 9
Hamilton	-	0 67	0 55	0 47	0 54	-	2 5	1 6	1 5	2 2
Windsor	-	0 58	0 45	0 45	0 40	-	1 5	1 8	1 6	1 8
London	-	0 21	0 14	<0 10	0 14	-	0 8	0 8	0 3	1 1
Sarnia	-	0 34	0 34	0 28	0 30	-	1 0	1 0	1 0	1 3
Winnipeg	-	-	0 36	0 45	-	-	-	0 9	2 1	1 9
Edmonton	-	-	-	0 12	<0 10	-	-	-	0 5	0 5
Calgary	-	-	-	0 18	0 31	-	-	-	2 5	1 3
Vancouver	-	-	-	0 41	0 49	-	-	-	1 3	2 0
Victoria	-	-	-	0 30	0 40	-	-	-	1 0	1 6
RESIDENTIAL										
Montreal-BG	0 70	0 77	0 73	0 74	0 79	2 9	2 5	2 1	2 6	2 2
Montreal-PAT	-	0 34	0 32	0 18	0 15	-	2 0	1 5	1 3	0 7
Toronto-DM	-	0 27	0 31	0 31	0 38	-	0 9	1 4	1 2	1 7
Toronto-L&K	-	-	-	0 22	0 17	-	-	-	1 3	1 0
Hamilton	-	0 51	0 56	0 54	0 50	-	1 5	1 6	1 7	1 4
Sudbury	-	0 26	0 10	<0 10	<0 10	-	1 1	0 9	0 4	0 5
Edmonton	0 23	0 18	0 14	0 13	0 22	1 5	0 9	0 9	0 9	1 3
Calgary	0 13	0 17	0 13	0 11	0 12	0 5	1 1	0 9	0 7	0 9
Vancouver	-	-	-	0 41	0 40	-	-	-	1 4	1 7
INDUSTRIAL										
Toronto	-	0 36	0 30	0 43	0 54	-	1 6	1 2	1 3	2 1
Windsor	-	-	-	0 32	0 30	-	-	-	1 1	1 0
Winnipeg	-	-	-	0 22	-	-	-	-	2 0	2 6
Edmonton	-	-	-	0 17	0 17	-	-	-	0 8	0 8
Calgary	0 26	0 26	0 14	0 19	0 24	1 5	1 6	1 3	1 9	1 2
Vancouver	-	-	-	0 71	0 34	-	-	-	2 2	1 5

* COH units per 1000 linear feet

** A dash (-) means either the pollutant was not monitored or that insufficient data were available to calculate a valid mean