POLLUTION STUDIES OF THE PROPOSED VANCOUVER INTERNATIONAL AIRPORT EXPANSION

Volume III - Effects of Airport Activities on Air Quality

Prepared for

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SUMMARY

The Ministry of Transport projects an expansion of Vancouver's International Airport activities from the present 3.5 million passengers per year to approximately 25 million passengers per year by the year 2000. This report presents an assessment of the air emission impact from the airport on the ambient air quality in the region. The emissions from the proposed ferry terminal on Iona Island are also considered.

The report contains sections on the following: background information and state-of-the-art review, identification of airport sources, activity of various sources, source emission factors, source emission rates, regional meteorology, dispersion model description, dispersion modeling results, discussion and recommendations, and conclusions.

The following activities which are associated with air pollutant emissions have been considered: aircraft movements, ground service vehicle movements, fuel storage and distribution, engine tests and maintenance, heating plant operations, airport access traffic and ferry terminal access traffic.

Peak hour emissions, peak day emissions and average daily emissions of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates due to various activities have been assessed for the year 1973 through the year 2000.

The biggest source of pollution is aircraft, followed by access traffic and heating plants. Emissions resulting from ground service vehicles, fuel storage and distribution, and engine tests are less significant.

Regional meteorology including wind conditions and atmospheric stability have been described. These data are necessary for mathematical atmospheric diffusion modeling.

A modified Pasquill-Gifford Gaussian plume model has been used in the dispersion calculations. Pollutant sources are divided into point, line and area sources, and receptors are defined as geographic locations where it is desired to know the ambient pollutant concentration. The geographic locations of sources and receptors are specified relative to a Cartesian

coordinate system. Ambient pollutant concentrations were calculated for various atmospheric conditions and wind velocities.

The concentrations of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates were estimated at four representative locations and the results were compared with federal air quality standards. This was done for the year 1975 through the year 2000. Maximum 1-hour, typical 24-hour and expected average concentrations were estimated.

It is shown that under adverse weather conditions the peak concentration of sulfur dioxide, oxides of nitrogen, and hydrocarbons will reach high values by the year 1985. Although these estimated maximums are high relative to air quality criteria, they should not result in environmental stress. They will probably occur less than ten hours per year.

While the estimates of maximum one-hour concentration serve to place an upper bound on airport-derived pollutant levels, more probable values are obtained by examining typical 24-hour average concentrations and expected annual average concentrations. It is shown that under these conditions no pollutant concentration will exceed the pertinent federal air quality objectives before the year 2000.

Of concern is the build-up of pollutants in the Lower Mainland which is a natural basin surrounded by mountains in which frequent stable atmospheric conditions occur. Temperature inversions prevent polluted air from diffusing upwards and low land breeze/sea breeze winds transport pollutants backwards and forwards through the valley. Under such conditions accumulation of pollutants in the atmosphere takes place leading to high concentrations. The large majority of these pollutants derive from vehicular activity and domestic fuel consumption in the GVRD area. The contribution of airport-derived pollutants during such an episode is minor.

To put things in perspective ambient pollutant values measured in the Central Vancouver area are compared with those calculated for the airport. It is shown that by the year 2000 the airport-derived pollutants will result in associated maximum ambient concentrations similar to the peak levels measured in urban Vancouver during 1969 - 1970. But even by year 2000 the long-term average concentrations at the airport will generally be considerably less than the equivalent 1969 - 1970 averages measured in urban Vancouver.

For more reliable forecasting of the air quality in the Lower Mainland an air quality model should be developed for the whole air basin. This model should be tuned by conducting the appropriate meteorological and air quality surveys. A realistic model for the whole area would facilitate studying the ramifications of future urban and industrial growth, and enable the assessment of the effects of evolving air pollution regulations.

1. INTRODUCTION

1.1 Background

The Ministry of Transport projects an expansion of Vancouver's International Airport activities from the present 3.5 million passengers per year to approximately 25 million passengers per year by the year 2000. Such large commercial airports have a significant direct environmental impact as a result of activities related to their operations. Also, large airports may cause indirect impact due to the stimulated urban and industrial growth around them. The environmental considerations associated with the airport expansion are manifold; here only the direct ambient air quality effects will be considered. Such information is one of many embodied in the Environmental Impact Statement (EIS) which should contain information of all known possible environmental consequences and should enable the airport planners to incorporate environmental considerations into design of airport and its associated facilities.

In the U.S.A. the National Environmental Policy Act (NEPA) has been the law since January 1, 1970. The Act requires a report to be filed assessing the environmental impact of proposed major federal actions. In the first 3 years of the existence of the law more than 3600 EIS's were filed of which more than 2000 by Department of Transport (1). The exact number of EIS related to airport developments is not known to us, but it must be substantial. During the first two months of 1974 29 airport related EIS's were filed in the U.S. (2).

The next section is aimed at assessing the state-of-the-art for estimating the airport related air pollution impact on the environment.

1.2 State-of-the-Art Review

Typically, the EIS contains an elaborate description of the proposed development program and its purpose, but the environmental considerations are far from being exhaustive. Environmental insults are often described in qualitative terms such as "not significant, minor, not appreciable, minimal, certain amount, temporal, etc." (3,4,5,6). Most of the airport EIS's published to date therefore do not analyze environmental problem areas comprehensively in a satisfactory manner, reflecting the lack of understanding of environmental problems and inadequacy of analytical techniques.

Deficiencies in current procedures for environmental impact evaluation of airport activities and the need for methods which would enable a comprehensive environmental evaluation prompted studies on air pollution impact methodology for airports (7,8,9). The following discussion is mainly based on the EPA publication by Norco _et al_ (7).

The general approach to assess the air pollution impact of an airport and its associated surrounding activities is based on a general protocol which consists of: (a) identification and isolation of air pollution producing activities, (b) quantification of these activities, (c) transformation of the activities into emission rate estimates by using source emission factors, (d) description of regional meteorology and (e) transformation of computed emission rates and meteorological data into an air quality forecast via dispersion modeling or some other technique. In cases where the present ambient pollutant levels are known and related to the emission rates via an appropriate dispersion model such a model can be "tuned" to predict future ambient air quality from predicted future spatial and temporal increased source activities. The predicted ambient pollutant levels are related to the ambient air quality standards and, if necessary recommendations are made on how to minimize the environmental impact of these pollutants.

(a) Identification and Isolation of Air Pollution-producing Activities.

The airport-related activities producing air pollution are usually separated into two broad categories; those which take place within the airport boundaries and those which occur outside the boundaries but are induced by the presence of the airport. The activities within the airport are comprised of those related to:

1) aircraft
2) ground service vehicles
3) fuel storage and distribution
4) engine tests and maintenance
5) heating and air conditioning plants
6) access traffic

These activities may be grouped into point, line and area sources according to their emission characteristics.

The activities corresponding to the areas outside the airport boundaries are associated with the various categories of land use, to mention only a few:

1) residential
2) commercial and institutional
3) manufacturing and warehousing
4) transportation and communication
5) vacant and agricultural
6) recreational and water

In our further endeavour we will be concerned only with the activities within the airport boundaries.

(b) Quantification of Air Pollution-producing Activities.

The basis for an analysis of a proposed airport facility and the estimate of various activities are the engineering and planning studies drawn up to satisfy the technical needs of the decision makers. These studies project various airport activity levels and usually contain enough information to enable reasonable estimate of emission sources. Figure 1.1 schematically presents functional dependence of various activities of a commercial airport which are likely to result in emission of air pollutants. The actual emission sources are shown as circular figures on the diagram. The primary independently variable activities (octagons with no input arrows) are the projected passenger demand and projected cargo demand. All other activity levels can presumably be estimated from this information.

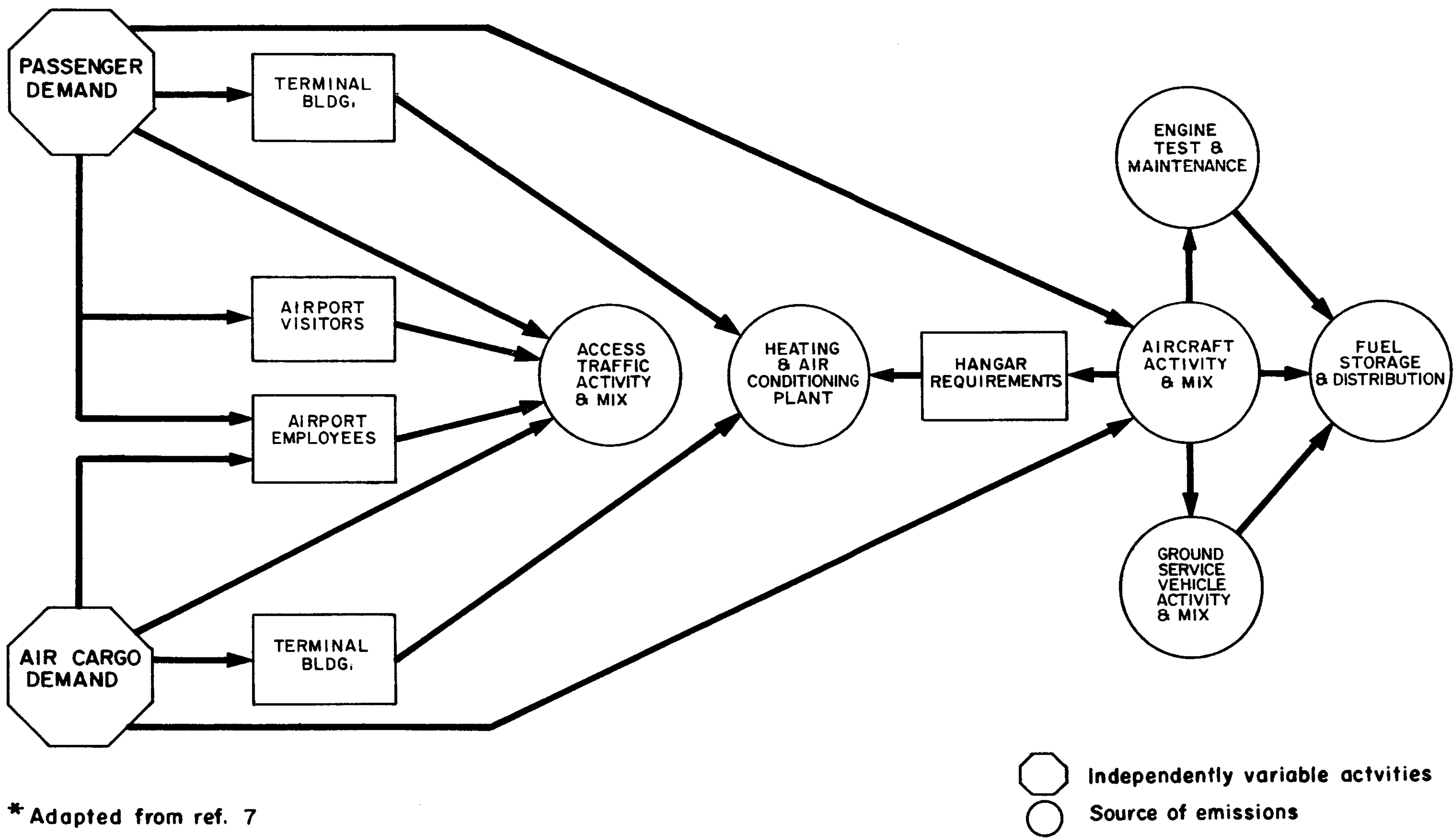
(c) Estimation of Air Pollutant Emissions.

After the various airport activity levels leading to air pollutant emissions have been estimated the emission rates can be computed by applying proper emission factors for each activity. Emission factors are compiled in literature (7,10) and are presented for aircraft, ground service vehicles, fuel storage and distribution, engine test and maintenance, heating and air conditioning plant, and access traffic. Pollutants of primary consideration are carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates.

In most cases the calculation procedure is straightforward and requires only simple arithmetic. Computer programs have been written to handle the large volume of data and to enable the investigator to conduct "numerical experiments" and analysis of specific variables of interests.

Figure I.1

SCHEMATIC OF AIRPORT ACTIVITIES *



* Adapted from ref. 7

Emission rates are presented for each activity separately indicating spatial and temporal patterns and trends with respect to mix and modes of operation. Finally the total emission rate is presented as a summation of individual contributions.

(d) Regional Meteorology.

Once the air pollutants are emitted to the atmosphere they undergo a number of different processes. The most important meteorological processes for air pollution which take place while waste substances are airborne are dilution of waste substances by diffusion and stirring, their removal by fallout, washout and atmospheric reactions, and photochemical processes promoted by solar radiation (11). Regional temperature and wind structure form the background of atmospheric pollutant dispersion and are of prime importance in estimating the air quality of the region.

Meteorological analysis includes the data on atmospheric stability and wind speed, direction and persistance. The most important parameters governing the dispersion of air pollutants in the lower atmosphere are the mixing height and the transport wind speed. Another derived parameter is the ventilation factor. The ventilation factor is obtained as a product of mixing height and the transport wind speed and is a measure of the volume rate of horizontal transport of air within the mixed layer per unit width (normal to the wind vector). Monthly statistics, mean values and directional frequency distributions are derived which are fed into a dispersion model.

(e) Air Quality Estimates. Dispersion Modeling.

The complexity of airport pollutant dispersion modeling resembles that for urban air pollution. A large number of diverse sources emit a variety of waste materials at different rates varying with time and location. The receiving atmosphere is, in turn, continually undergoing changes in temperature and wind structure, thermal and mechanical turbulance, and solar radiation. The kinetics of atmospheric reactions also vary depending on the types of pollutants, moisture content, presence of reactive and/or catalytic particulate matter and solar radiation. The topography of the region modifies the temperature and wind profiles and strongly effects the nature of the turbulent planetary boundary layer as well as the importance of this layer as a pollutant sink.

The accuracy of a pollutant dispersion model will reflect the degree to which the above phenomena are comprehended. The simplest model of diffusion from an area source is a "box" model based on a mean mixing height and transport wind velocity. This model is crude and unreliable unless limited to the order of magnitude assessment and gross pollutant trends. The very complex models, on the other hand take into account and process a large amount of information, and give fairly reliable preductions of ambient pollutant concentrations both temporally and spatially. The use of such models is restricted by the computer capacity and speed, and the available meteorological and analytical data. It is of little use to incur the high expense of developing and running a sophisticated model unless the supply of data is adequate.

At present, there are three fairly complex dispersion models available for use in computing the quality of ambient air as a result of airport activity: the FAA/Argonne Airport Air Pollution Model, the Northern Research and Engineering Corp. (NREC) Model, and the Systems Science and Software (S^3) Photochemical Model. The following brief description of these models is taken directly from reference (7).

"<u>The FAA/Argonne Airport Air Pollution Model</u> is made up of two sub-models. The first deals with the simulation of airport activity and generates an emission enventory that is diurnally and spatially distributed. The second uses the emission inventory as a data base for computing air quality, using a modified steady-state guassian plume algorithm.

The activity sub-model further classifies the emissions by the type of source producing them. Emissions which are generated over a large area (e.g., ground service activity in the terminal area, automobile movement in the parking lots, fuel evaporation from the filling of vehicle tanks, etc.) are classified as area sources. Emissions generated in a long and narrow strip (e.g., roadways, runways) are classified as line sources. Emissions emanating from a very small area (e.g., heating plant, engine test cells) are classified as point sources.

The Gaussian plume air quality sub-model utilizes the point, area, and line source parameters calculated by the activity sub-model, and combines them with meteorological information that is relevant to the area to compute air quality. Since the input emission inventory is both spatially and diurnally distributed, the resulting air quality is also spatially and diurnally distributed.

The sub-model uses a one-hour averaging time to compute pollutant concentrations and makes use of time- and distance-dependent dispersion coefficients. These give better results at the high and low ends of the wind speed range than the coefficients that are distance-dependent only. In addition, a diurnal variation of important meteorological parameters, such as wind speed, mixing depth, etc., is used instead of a seasonal average to improve the model's accuracy.

In making the computations the model extrapolates the point, area, and line sources back to a virtual origin. This eliminates some of the wide fluctuations in calculated concentrations resulting from changes in the wind direction-receptor location, referred to as the beacon effect.

To summarize, the projected emission rates can readily be translated into air quality via the FAA/Argonne Air Pollution Model. The data as presented need only to be modified to show spatial distribution in order to serve as direct input into the air quality sub-model. Experience with this model on Chicago's O'Hare Airport shows the calculated air quality to be underestimated, as compared to observed air quality, particularly for hydrocarbon concentrations.

The NREC model is fundamentally similar to the FAA/Argonne model. An activity sub-model and an air quality sub-model are used.

The basic differences between the Argonne and the NREC air quality sub-models are the type of mathematical simplifications used to compute dispersion. The NREC model uses a one-hour averaging time and a Gaussian plume algorithm, as does the Argonne model. NREC, however, uses only point sources that are located at ground level, instead of the virtual origin point, area, and line sources. It therefore suffers from the large fluctuations in concentration resulting from the "beacon" effect. Also, the NREC model uses dispersion coefficients that are distance-dependent only.

As with the Argonne model, the emission calculations can be readily adapted for input into the NREC model once some spatial resolution is available. Experience with this model at Argonne has shown that it also underestimates air quality as compared to observations. In most cases, the discrepancies are larger than that of the Argonne model.

The S^3 photochemical model consists of two computer codes; the first, SETUP, uses meteorological and source data to create an input for the second, NEXUS/P (Numerical EXamination of Urban Smog with Photochemistry). NEXUS/P then moves and diffuses the pollutants, changes the pollutant concentrations as a result of photochemical reactions, adds pollutants due to sources, and stores or retrieves pollutants advected into or out of the borders of the computational grid.

The program was originally written to stimulate the photochemical reactions taking place in the Los Angeles smog. It is, therefore, necessary to tailor SETUP to the conditions found around the airport under study.

The data read in at execution time includes wind measurements and initial concentrations of hydrocarbons, NO, NO_2, and CO if desired. NEXUS/P considers reactions occurring between and producing NO, NO_2, HC, O_3, and HNO_2. HNO_2 and O_3 are the results of photochemical reactions, while CO is not explicitly considered. Briefly, the S^3 model treats the transport of pollutants by assigning mathematical points to given amounts of pollutant. The movements of each of these points are then traced through time so that at any point in time and in any cell of the three-dimensional grid system the concentration can be determined by simply counting the number of points residing in that cell at that time. The mechanism for moving the points which takes into account both advection and diffusion is completely independent from the photochemical reactions. Consequently, it is possible to employ several alternative photochemical reaction mechanisms, if so desired. The dispersion and chemical reactions are treated in an alternating step fashion. First, the pollutants are allowed to disperse through the grid system for a time interval, then the dispersion is frozen and a chemical reaction step occurs, etc. In the limit of very small time steps, this alternating procedure approaches the simultaneous operation of dispersion and chemical reactions.

The mathematical point method provides a very convenient means for merging a distribution of airborne and ground-based sources into a cell or grid type model which is essential for the treatment of photochemical reactions. However, because of the limitations of computer core storage and run time, the individual cells cannot be too small so that one tends to lose a certain amount of spatial and temporal resolution. This is the sacrifice which must be made if the photochemistry is to be treated without an intolerable consumption of computer time."

2. IDENTIFICATION OF AIRPORT EMISSION SOURCES

Among the activities which are associated with air pollutant emissions within the airport and which will be considered in this report are included:

1) Aircraft movements
2) Ground service vehicle movements
3) Fuel storage and distribution
4) Engine tests and maintenance
5) Heating plants operation
6) Access traffic activity

These sources may be classified by the type into three groups:

A. Area sources: aircraft movements outside runways, ground service vehicels, fuel distribution, traffic on parking lots.

B. Line sources: aircraft movements on runways, access traffic on roadways.

C. Point sources: engine tests, heating plants.

3. AIRPORT ACTIVITY LEVELS

Various airport activities and their functional dependence have been described in Section 1.2 and schematically presented in Figure 1.1. Independently variable activities are the projected passenger demand and projected air cargo demand. All other activities can presumably be determined from this information.

3.1 Passenger Demand

The passenger demand level is measured by the enplaning passenger rate. Enplaning passengers include originating and connecting passengers. The deplaning passenger rate which includes terminating and connecting passengers is approximately equal to the enplaning passenger rate. The through passengers are those arriving and departing the airport aboard the same aircraft.

Annual enplaning passenger rates are presented in Table 3.1 up to the year 2000 (12). The passenger enplaning rate will increase from 2.2 million in 1975 to over 13 million in the year 2000. The peak enplaning rate will increase from close to 9 thousand passengers per day in 1975 to about 49 thousand passengers per day in the year 2000, and from 1400 passengers per hour in 1975 to 5600 passengers per hour by the year 2000.

TABLE 3.1

PASSENGER DEMAND FORECAST*

VANCOUVER INTERNATIONAL AIRPORT

	1973	1975	1980	1985	1990	1995	2000
Enplaned passengers							
- annual (millions)	1.76	2.16	3.31	4.85	6.98	9.83	13.45
- peak day	7136	8615	12903	18537	26132	36150	48656
- peak hour	1208	1401	1902	2527	3336	4356	5599

Passenger distribution	
- originating	35%
- terminating	35%
- connecting	30%
- through	negligible

* Data obtained from ref 12.

3.2 Air Cargo Demand

The air cargo is functionally divided among freight, express and mail. As with passenger forecasts distinction must be made between originating air cargo, transfer air cargo and terminating air cargo. Table 3.2 presents air cargo forecasts up to year 2000 (12).

TABLE 3.2

AIR CARGO FORECAST*

VANCOUVER INTERNATIONAL AIRPORT

Year	Enplaning and Deplaning (thousands of metric tons)
1972	52.7
1975	108.9
1980	261.8
1985	554.0
1990	1032
1995	1750
2000	2570

* Data obtained from ref (12).

3.3 Aircraft Activity

Aircraft activity and mix is perhaps the single most important information necessary for evaluation of air pollution arrising from the operation of an airport (see Figure 1.1). The activity level is measured by the number of aircraft movements or by the number of aircraft landing-takeoff (LTO) cycles. An aircraft movement or operation is either landing or a takeoff. An LTO cycle includes operations of approach, landing, taxi-in, taxi-out, take-off and climbout; it consists of two movements and LTO cycle activity level equals one-half the number of movements. The mix is measured by the fraction that each aircraft type makes of the total activity. The classification of aircrafts into different classes is summarized in Table 3.3.

Table 3.4 presents data on projected aircraft activity and mix for Vancouver International Airport up to the year 2000 (12). The total aircraft activity is divided into activities corresponding to air carriers, cargo crafts and general aviation. The aircraft percent activity mix is graphically presented in Figure 3.1. The forecast predicts an increase of jumbo and long range aircraft activity from about 1 and 8% in 1973 to about 22 and 13% in the year 2000, respectively. The medium and short range aircraft activity will decrease from about 19 and 6% in 1973 to about 2 and 0.1% in the year 2000, respectively. The general aviation will remain approximately constant at about 65%, as will the cargo aircraft activity at about 1% of the total.

It should be pointed out that aircraft activity and mix are as much dependent on the influence of developing technology as on the patterns of the air passenger and cargo demand and their estimates present an exceedingly difficult task. The projected activities are therefore only approximate figures.

TABLE 3.3

AIRCRAFT TYPE BY CLASS*

CLASS	TYPE	CODE	PAS. CAP.	WEIGHT (m. tons)	COMMON NUMBER OF ENGINES	ENGINE COMMONLY USED
Jumbo						
350	Boeing 747	B747	365	352	4	JT-9D
250	Lockheed 1011	L101	260	186	3	JT-9D
	Douglas DC10	DC10	250	186	3	JT-9D
Long Range						
200	Douglas DC8-60	DC86	180-210	159	4	JT-3D
150	Boeing 707	B707	140-150	148	4	JT-3D
	Douglas DC8-40	DC84	135-140	143	4	JT-3D
Medium Range						
100	Boeing 727	B727	97-122	77	3	JT-8D
	Boeing 737	B737	92-117	52	2	JT-8D
	Boeing 720	B720	115-120	106	4	
	Douglas	DC9	94	44	2	JT-8D
Short Range						
50	Viscount	VC7	48	33	4	
	Convair 640	CV64	50	25	2	501-D13
	Commando CV20	C46	50	22	2	
	Douglas DC3	DC3	21-28	12	2	R-1830
	Nord 262	ND62	24	11		

* Data from references 7, 10 and 12.

TABLE 3.4

AIRCRAFT ACTIVITY AND MIX*

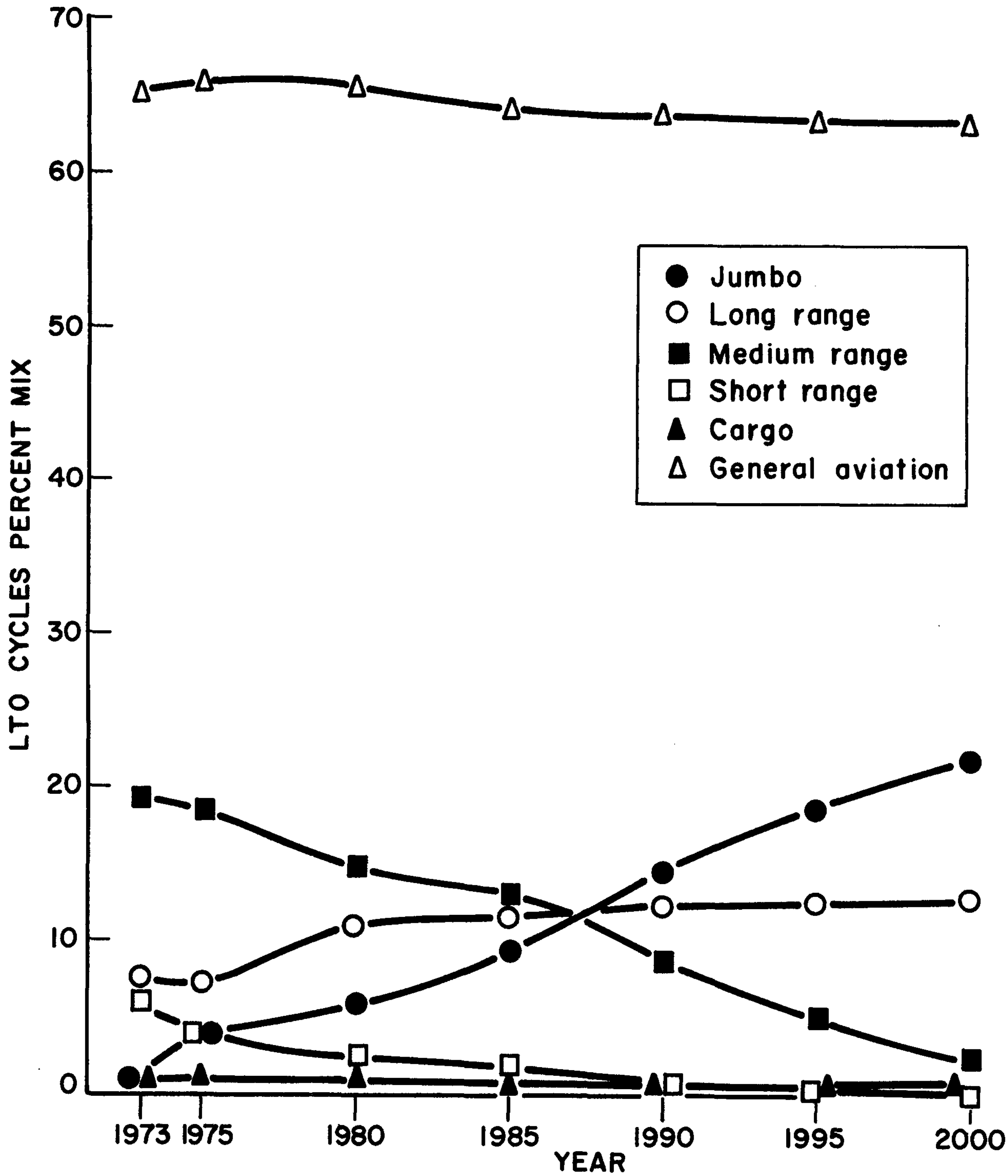
VANCOUVER INTERNATIONAL AIRPORT

LTO Cycles		1973	1975	1980	1985	1990	1995	2000
Total	- annual	84,701	89,288	117,705	149,015	179,025	208,970	238,250
	- average day	230	242	320	405	487	569	650
	- peak day	315	348	460	582	700	817	933
	- peak hour	28	31	41	52	62	72	82
Air Carrier	- annual	28,806	29,738	39,805	52,715	64,325	75,870	87,000
Cargo	- annual	782	900	900	1050	1200	1350	1500
General Aviation	- annual	55,113	58,650	77,000	95,250	113,500	131,750	149,750
Air Carrier	Jumbo							
	- Class 350, % total	0.6	1.5	2.5	4.2	6.4	8.5	9.7
	- Class 250, % total	0.5	2.3	3.3	5.1	8.0	10.0	12.0
	Long Range							
	- Class 200, % total	2.8	1.6	1.2	2.1	2.8	3.1	3.6
	- Class 150, % total	4.9	5.6	9.7	9.4	9.4	9.3	9.0
	Medium Range							
	- Class 100, % total	19.1	18.8	14.7	12.9	8.6	5.0	2.3
	Short Range							
	- Class 50, % total	6.0	4.0	2.5	1.7	0.7	0.3	0.1
Cargo	% total	0.9	1.0	0.8	0.7	0.7	0.6	0.6
General Aviation	% total	65.1	65.7	65.4	63.9	63.4	63.0	62.9

* Data obtained from ref (12).

Figure 3·1

AIRCRAFT ACTIVITY PERCENT MIX
VANCOUVER INTERNATIONAL AIRPORT



3.4 Ground Service Vehicle Activity

The ground service vehicles are the motorized equipment needed to load and unload the aircraft and otherwise prepare the aircraft for the next flight. The activity level and mix of the equipment is measured by the amount of time spent in operation by each vehicle type. The operating time of a particular vehicle type, on the other hand, depends on the type of aircraft being serviced. Table 3.5 lists estimated servicing times of different ground supporting vehicles as a function of aircraft class. These estimates are obtained from data published in reference (7).

The ground supporting vehicle operating times are obtained by multiplying the number of LTO cycles of each aircraft type by the service time of each vehicle type. Table 3.6 gives the projected ground service vehicle operating times for air carriers based upon the aircraft activity and mix forecast of Table 3.4 and the service times of Table 3.5. The ground service vehicle activity related to the cargo and general aviation is not taken into account since it represents only a small fraction of the total activity.

The fuel consumed by ground service vehicles can be estimated using fuel consumption rates listed in Table 3.7 and operating times in Table 3.6. Estimated annual ground service fuel requirements are given in Table 3.8.

TABLE 3.5

SERVICE TIMES OF AIRCRAFT GROUND SERVICE VEHICLES*

Vehicle / Aircraft Class	Jumbo 350	Jumbo 250	Long Range 200	Long Range 150	Medium Range 100	Short Range 50
	Time in Vehicle-Minutes per Aircraft					
1. Tractor	155	148	98	98	66	50
2. Belt Loader	48	40	37	30	28	15
3. Container Loader	92	80	12	10	6	0
4. Cabin Service	24	25	15	15	12	0
5. Lavatory Truck	24	18	18	18	15	10
6. Water Truck	12	10	10	10	10	10
7. Food Truck	55	20	30	30	17	10
8. Fuel Truck	50	45	40	40	20	15
9. Tow Tractor	10	10	10	10	10	5
10. Conditioner	0	0	30	30	0	0
11. Airstart						
Transporting Engine	3	0	10	5	0	0
Diesel Power Unit	2	0	8	4	0	0
12. Ground Power Unit						
Transporting Engine	0	0	9	5	0	0
Gasoline Power Unit	0	0	4	2	0	0
Diesel Power Unit	0	0	4	2	0	0
13. Transporter	19	10	10	5	3	0

* Estimated from data in ref (7).

TABLE 3.6

TOTAL DAILY GROUND SERVICE VEHICLE OPERATING TIME*

VANCOUVER INTERNATIONAL AIRPORT

				Time in Vehicle Hours per Day			
Vehicle	1973	1975	1980	1985	1990	1995	2000
1. Tractor	95.15	108.33	154.39	234.17	322.57	413.25	559.67
2. Belt Loader	35.42	38.90	55.28	77.76	102.59	127.67	153.26
3. Container Loader	11.21	20.45	36.99	66.89	114.28	165.23	258.73
4. Cabin Service	14.24	17.00	25.73	37.51	51.93	66.39	81.19
5. Lavatory Truck	19.49	21.03	29.92	41.18	53.02	64.98	77.04
6. Water Truck	13.04	13.56	18.34	24.47	30.17	35.93	41.86
7. Food Truck	25.25	28.07	42.95	61.72	83.71	106.92	129.40
8. Fuel Truck	31.91	35.99	55.55	79.86	109.61	139.93	170.78
9. Tow Tractor	11.84	12.64	17.41	23.33	28.84	34.18	39.69
10. Conditioner	8.86	8.72	17.44	23.29	29.71	35.28	40.95
11. Airstart							
Transportation Engine	2.08	1.96	3.63	5.34	6.64	9.77	11.92
Diesel Power Unit	1.66	1.54	2.84	4.24	5.91	7.49	9.12
12. Ground Power Unit							
Transportation Engine	1.91	1.71	3.17	4.44	5.86	7.05	8.38
Gasoline Power Unit	0.81	0.71	1.29	1.84	2.52	2.94	3.50
Diesel Power Unit	0.81	0.71	1.29	1.84	2.52	2.94	3.50
13. Transporter	4.84	6.07	9.87	16.03	24.53	33.57	42.49

* Serving air carriers

TABLE 3.7

GROUND SERVICE VEHICLES FUEL CONSUMPTION RATES*

	Vehicle	Rate of Fuel Consumption (l/hr)
1.	Tractor	6.81
2.	Belt Loader	2.65
3.	Container Loader	6.62
4.	Cabin Service	5.68
5.	Lavatory Truck	5.68
6.	Water Truck	5.68
7.	Food Truck	7.57
8.	Fuel Truck	6.43
9.	Tow Tractor	8.89
10.	Conditioner	6.62
11.	Airstart	
	Transporting Engine	5.30
	Diesel Power Unit	31.04
12.	Ground Power Unit	
	Transporting Engine	7.57
	Gasoline Power Unit	18.93
	Diesel Power Unit	26.87
13.	Transporter	5.68
Average 1-10		6.25

* Data from Reference 7

TABLE 3.8

GROUND SERVICE VEHICLE FUEL REQUIREMENTS*
VANCOUVER INTERNATIONAL AIRPORT

	Gasoline		Diesel	
Year	Annual cu.m	Average Daily litres	Annual cu.m	Average Daily litres
1973	733.737	2010	26.751	73
1975	713.383	1954	24.411	67
1980	1072.841	2939	44.828	123
1985	1591.262	4360	66.084	181
1990	2208.503	6051	91.673	251
1995	2845.057	7795	113.613	311
2000	3723.954	10203	137.652	377

* Based on forecast in Table 3.6 and consumption rates in Table 3.7.

3.5 Fuel Storage and Distribution

The amount of emitted pollutants from fuel storage and distribution depends on the total amount of fuel that is handled at the airport for both, aircraft and ground service vehicles. Fuel consumption at Vancouver International Airport is on the order of 350×10^3 cu.m of jet fuel and about 3600 cu.m of gasoline per year. The projected total amount of fuel that is required for operation of aircraft and ground service vehicles will be estimated indirectly by using fuel consumption rates.

The average amount of fuel pumped per carrier LTO cycle is assumed to be approximately 10 cu.m. This is based on the average amount of about 10 cu.m per LTO cycle at the Chicago airport (7).

The ground service vehicles fuel requirements are given in Table 3.8.

The projected total annual fuel requirements based on the aircraft activity forecast (Table 3.4) and ground service vehicles activity (Table 3.6) is presented in Table 3.9. Even though this estimating procedure is crude the projected estimates are probably of the right order of magnitude.

3.6 Engine Tests and Maintenance

To ensure proper performance aircraft engines require regular maintenance and testing. A test consists of measurements of performance while running the engine through a set of typical flight conditions. The air pollutant emissions due to the engine tests may be significant if a substantial number of tests are performed.

The maintenance activity at an airport depends mainly on its character and location. Airlines prefer to locate their maintenance facilities at airports with a large number of originating and terminating flights. Airports which serve mainly as connection points usually are not preferred locations for large-scale maintenance operations. To illustrate: at Los Angeles originating/terminating airport there are about 38 engine run-ups per 1000 aircraft movements (8), while at Chicago connecting airport there are only about one to two engine run-ups per 1000 aircraft movements (7). Based on information obtained from major airlines at Vancouver

TABLE 3.9

AVERAGE DAILY AIRCRAFT AND GROUND SERVICE VEHICLE FUEL REQUIREMENTS

VANCOUVER INTERNATIONAL AIRPORT

	Aircraft Fuel Requirements*		Ground Service Vehicles*** Fuel Requirements		Total		
	Jet Fuel* Litres $x10^{-6}$	Gasoline** Litres $x10^{-3}$	Gasoline Litres	Diesel Litres	Jet Fuel Litres $x10^{-6}$	Gasoline Litres $x10^{-3}$	Diesel Litres
1973	2.30	23.0	2,010	73	2.30	25.01	73
1975	2.42	24.2	1,954	67	2.42	26.15	67
1980	3.20	32.0	2,939	123	3.20	34.94	123
1985	4.05	40.5	4,360	181	4.05	44.86	181
1990	4.87	48.7	6,051	251	4.87	54.75	251
1995	5.69	56.9	7,795	311	5.69	64.70	311
2000	6.50	65.0	10,203	377	6.50	75.20	377

* Based on consumption of 10,000 litres per air carrier LTO cycle

** 1% of jet fuel

*** From Table 3.8

International Airport it appears reasonable to assume about 10 engine run-ups per 1000 air carrier movements. The estimated number of engine tests is given in Table 3.10.

TABLE 3.10

ANNUAL AIR CARRIER ENGINE TESTS

VANCOUVER INTERNATIONAL AIRPORT

Year	Total No. of Engine Tests	No. of Engine Tests in Aircraft Class*						Consumed Fuel** cu.m
		350	250	200	150	100	50	
1973	576	14	9	63	111	325	68	1152
1975	595	34	39	36	128	313	45	1190
1980	796	71	70	34	274	312	35	1592
1985	1054	147	134	74	330	339	30	2108
1990	1287	262	246	115	385	264	14	2574
1995	1517	399	352	146	437	176	7	3034
2000	1740	510	474	187	474	91	4	3480

* Estimated on the basis of the 1973-2000 aircraft mix and the number of engines per aircraft.

** Based on average consumption of 2000 litres per engine test.

3.7 Heating and Air Conditioning Plants

Terminal buildings and hangars are generally heated and air conditioned from one or several plants whose operation is expected to produce some air pollutant emission. The estimated fuel requirements for the heating plants at Vancouver International Airport are summarized in Table 3.11. It is supposed that the new terminal building will be completed in 1985 and that the same amount of fuel will be required in the period 1985-2000.

TABLE 3.11

ANNUAL HEATING PLANTS FUEL REQUIREMENTS

VANCOUVER INTERNATIONAL AIRPORT

Year	Fuel Type	Required Quantity
1973	gas oil coal	5.4×10^6 cu.m/yr 2.1×10^3 cu.m/yr 330 m.ton/yr
1975	gas oil	5.4×10^6 cu.m/yr 2.1×10^3 cu.m/yr
1980	gas oil	8.2×10^6 cu.m/yr 3.3×10^3 cu.m/yr
1985	gas oil	34×10^6 cu.m/yr 13.2×10^3 cu.m/yr
1990-2000		Same as 1985

3.8 Access Traffic

Access traffic is a significant source of air pollution at the airport and must be included in the estimate of total airport emissions. The needed information should contain the following:

number of vehicle trips

mix of vehicles

distance travelled

vehicle operation characteristics

Table 3.12 summarizes the data on access traffic activity and mix at the Vancouver International Airport.

TABLE 3.12

ACCESS TRAFFIC ACTIVITY

VANCOUVER INTERNATIONAL AIRPORT

Year	Distance from* Collection Point to Terminal	Typical 12-hour Day Vehicle Kilometers Travelled	Average* Speed	Typical 12-hour Day Number of Cars with Cold Start (20% Total)*	Typical 24-hour Day Traffic Two-way***	Typical 12-hour Day Traffic Two-way**	Typical Peak Hour Traffic Two-way**
1973	3 km	66,000	40 km/hr	4,400	29,260	22,000	2,600
1975	"	78,000	"	5,200	34,580	26,000	3,100
1980	"	118,500	"	7,900	52,535	39,500	4,500
1985	"	163,500	"	10,900	72,485	54,500	6,300
1990	"	216,000	"	14,400	95,760	72,000	8,500
1995	"	277,500	"	18,500	123,025	92,500	10,900
2000	"	345,000	"	23,000	152,950	115,000	13,500

* Estimated

** Data from ref 12

*** Equals 1.33 typical 12-hour day traffic

4. SOURCE EMISSION FACTORS

The source emission factors will be presented for carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (SO_x), sulfur oxides (SO_x) and particulates (PT).

4.1 Aircraft

The emission factor for aircraft is expressed per LTO cycle which includes ground operations of landing, taxi-in, taxi-out and take-off, and in-flight operations of approach and climb-out below 500 m (1640 feet) (10,13). Typical times-in-mode for an LTO cycle at a metropolitan airport are given in Table 4.1. The modal emission factors are listed in Table 4.2.

TABLE 4.1

TYPICAL TIME IN MODE FOR LTO CYCLE AT A METROPOLITAN AIRPORT*

Aircraft Class	Time in Mode, minutes					
	Taxi-idle	Take-off	Climb-out	Approach	Landing**	Taxi-idle
Jumbo 350 & 250	19.00	0.70	2.20	4.00	0.70	7.00
Long range 200 & 150	19.00	0.70	2.20	4.00	0.70	7.00
Medium range, 100	19.00	0.70	2.20	4.00	0.70	7.00
Short range, 50	19.00	0.50	2.50	4.50	0.50	7.00
General aviation turboprop	19.00	0.50	2.50	4.50	0.50	7.00
General aviation piston	12.00	0.30	4.98	6.00	0.30	4.00

* Data from ref 10.
** Taken as equal to Take-off.

TABLE 4.2

MODAL AIRCRAFT EMISSION FACTORS PER LTO CYCLE*

Aircraft Class	Common Number of Engines	Engine Commonly Used	Mode of Operation	CO	HC	NO_x as NO_2	SO_x as SO_2	PT
				kg/hr/ engine	kg/hr/ engine	kg/hr/ engine	kg/hr/ engine	kg/hr/ engine
Jumbo			Taxi-idle	46.3	12.4	2.75	0.788	1.0
			Take-off	3.76	1.34	327.0	7.74	1.7
350	4	JT-9D	Climbout	5.31	1.20	208.0	6.49	1.8
250	3	JT-9D	Approach	14.8	1.36	24.5	2.36	1.0
Long			Taxi-idle	49.4	44.7	0.649	0.396	0.2
Range			Take-off	5.60	2.11	67.1	4.92	3.7
200	4	JT-3D	Climbout	6.94	2.23	43.6	4.06	3.9
150	4	JT-3D	Approach	18.0	3.56	9.89	1.88	3.6
Medium			Taxi-idle	15.2	3.71	1.32	0.435	0.16
Range			Take-off	3.4	0.353	89.8	3.97	1.7
			Climbout	4.03	0.418	59.4	3.33	1.2
100	3	JT-8D	Approach	8.26	0.794	14.0	1.55	0.68
Short			Taxi-idle	3.96	3.35	0.560	0.224	0.73
Range			Take-off	1.71	0.200	12.7	1.09	1.7
			Climbout	1.54	0.181	10.1	0.992	1.4
50	2		Approach	1.58	0.148	3.32	0.520	1.4
General			Taxi-idle	1.60	0.399	0.433	0.0662	0.14
Aviation			Take-off	0.178	0.025	1.65	0.166	0.36
-Turboprop	2		Climbout	0.258	0.024	1.50	0.154	0.27
			Approach	1.17	0.109	0.767	0.0934	0.27
-Piston	2		Taxi-idle	5.03	0.161	0.006	0.0059	NA**
			Take-off	32.2	0.676	0.097	0.0298	NA
			Climbout	29.8	0.594	0.170	0.0288	NA
			Approach	11.0	0.225	0.023	0.0105	NA

* Data from ref. 10

** NA = Not available

4.2 Ground Service Vehicles

The "uncontrolled" emission factors for ground service vehicles are presented in Table 4.3. These factors are based on the assumption that ground service vehicle (off highway vehicles) will not be subject to the same emission controls as are private motor vehicles. Because ground service vehicles have similar engines only one emission factor is presented for all gasoline-powered and only one for diesel-powered ground service vehicles.

TABLE 4.3

GROUND SERVICE VEHICLES UNCONTROLLED EMISSION FACTORS*

YEAR	1975 - 2000				
Engine Type \ Pollutant	CO g/l	HC g/l	NO_x g/l	SO_x g/l	PT g/l
Gasoline	263.9	59.0	15.1	0.36	0.48
Diesel	39.0	7.79	40.8	3.20	3.01

* Data from ref 7 and 10.

4.3 Fuel Storage and Distribution

Emission of hydrocarbons from fuel storage and distribution is a result of evaporation from storage tanks, i.e., the breathing loss, and of displacement of fuel vapors when tanks are filled, i.e., the working loss. Since breathing and working losses from storage tanks and breathing losses from other tanks can be controlled it will be assumed that the emissions result solely from working losses associated with aircraft and ground service vehicle refueling. Table 4.4 lists emission factors in terms of milligrams of hydrocarbons emitted per litre of fuel pumped.

TABLE 4.4

FUEL STORAGE AND DISTRIBUTION EMISSION FACTORS

Hydrocarbon Working Loss Emission		
	Jet Fuel	Gasoline
milligrams per litre of fuel pumped	66	436

4.4 Engine Tests and Maintenance

An engine test lasts approximately 20-25 minutes and consists of running the engine through a set of typical flight conditions while measurements of performance are made. Times-in-mode of an engine test cycle are similar to those of an LTO cycle presented in Table 4.1. Therefore we will assume the emission factors for engine tests to be the same as those for LTO cycle of an engine under consideration. Such emission factors are presented in Table 4.5.

TABLE 4.5

AIRCRAFT EMISSION FACTORS PER LTO CYCLE*

Aircraft Class	Common Number of Engines	Engine Commonly Used	CO kg/ Engine	HC kg/ Engine	NO_x as NO_2 kg/ Engine	SO_x as SO_2 kg/ Engine	PT kg/ Engine
Jumbo							
350	4	JT-9D	21.2	5.5	14.2	0.83	0.59
250	3	JT-9D	21.2	5.5	14.2	0.83	0.59
Long Range							
200	4	JT-3D	21.5	18.7	3.6	0.71	0.55
150	4	JT-3D	21.5	18.7	3.6	0.71	0.55
Medium Range							
100	3	JT-8D	7.71	2.2	4.6	0.46	0.19
Short Range							
50	2		3.0	1.3	1.1	0.18	0.49
General Aviation							
- Turboprop	2		1.4	0.5	0.54	0.08	0.09
- Piston	2		5.5	0.18	0.021	0.006	0.01

* Data from ref 10.

4.5 Heating and Air Conditioning Plant

The most probable fuels for use in Vancouver International Airport heating plants are natural gas and oil. Coal is not used for heating to any significant extent although the supply in the area is ample. Table 4.6 lists the emission factors for all three types of fuel.

TABLE 4.6

HEATING PLANT EMISSION FACTORS*

Fuel Type	Natural Gas	Oil	Coal
	kg/10^6 cu.m	kg/cu.m	kg/m.ton
CO	320	0.5	1.0
HC	128	0.35	0.5
NO_x as NO_2	1600	7.2	7.5
SO_x as SO_2	9.6	36	38
PT	302	2.2	7.0

* Data from ref 10.

4.6 Access Traffic

In this study the average emission factors for highway vehicles listed in Table 4.7 will be used. The emission factors for hot engine operation and for cold start are included. These emission factors diminish with time as more new vehicles with emission controls are brought into the population.

TABLE 4.7

HIGHWAY VEHICLES AVERAGE EMISSION FACTORS

Year	CO		HC		NO_x	SO_x	PT
	Hot* Operation	Cold** Start	Hot* Operation	Cold** Start	Hot* Operation	Hot*** Operation	Hot*** Operation
	g/km	g	g/km	g	g/km	g/km	g/km
1973	52	158	6.5	15	3.2	0.12	0.36
1975	43	158	4.9	15	2.9	0.12	0.36
1980	30	83	3.1	8.1	2.6	0.12	0.36
1985	19	61	1.3	5.8	1.5	0.12	0.36
1990-2000	Same as 1985						

* Data from ref 14
** Data from ref 7
*** Data from ref 10

5. SOURCE EMISSION RATES

The source emission rates of various pollutants will be computed by applying the source emission factors of Section 4 to the activity levels of Section 3.

5.1 Aircraft

The important points considered in aircraft emissions are the total emission rate, the emission by aircraft mix and mode of operation, and the trends in aircraft emissions.

Total emissions of various pollutants and yearly trends are shown in Table 5.1 and Figure 5.1. Average 24-hour day, peak day and peak hour emissions are listed in the Table. Carbon monoxide is emitted in largest quantities followed by hydrocarbons and nitrogen oxides. Sulfur oxides and particulates are emitted in an order of magnitude smaller amounts. The relative increase in emissions of different pollutant is about the same; the quantities of emitted pollutants will about double in the period till the year 1980, quadruple till 1990 and increase 5 to 8 times before the end of the century.

Relative emission rates by mode of operation are summarized in Table 5.2. Average 1973-2000 contributions for various pollutants by different modes of operation are presented. The highest contribution to carbon monoxide, hydrocarbons, sulfur oxides and particulates emissions comes from taxi-idle operation, while the nitrogen oxides contribution is the highest for climbout operation.

More detailed presentation of relative emission rates by aircraft mix and mode of operation is given in Table A.5.2 (Appendix III).

Over 88% of overall pollutant emissions in 1973, and 93% in the year 2000 comes from air carriers. Although the activity level of general aviation is high (see Table 3.4 and Figure 3.1) the resulting pollutant emissions are comparatively low. Emissions from cargo aircrafts amount to less than 2% of total emissions. The increase in pollutant emissions is mainly due to enlarged activities of jumbo and long range aircrafts, commonly equipped with JT-9D and JT-3D engines, respectively.

TABLE 5.1

TOTAL AIRCRAFT EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

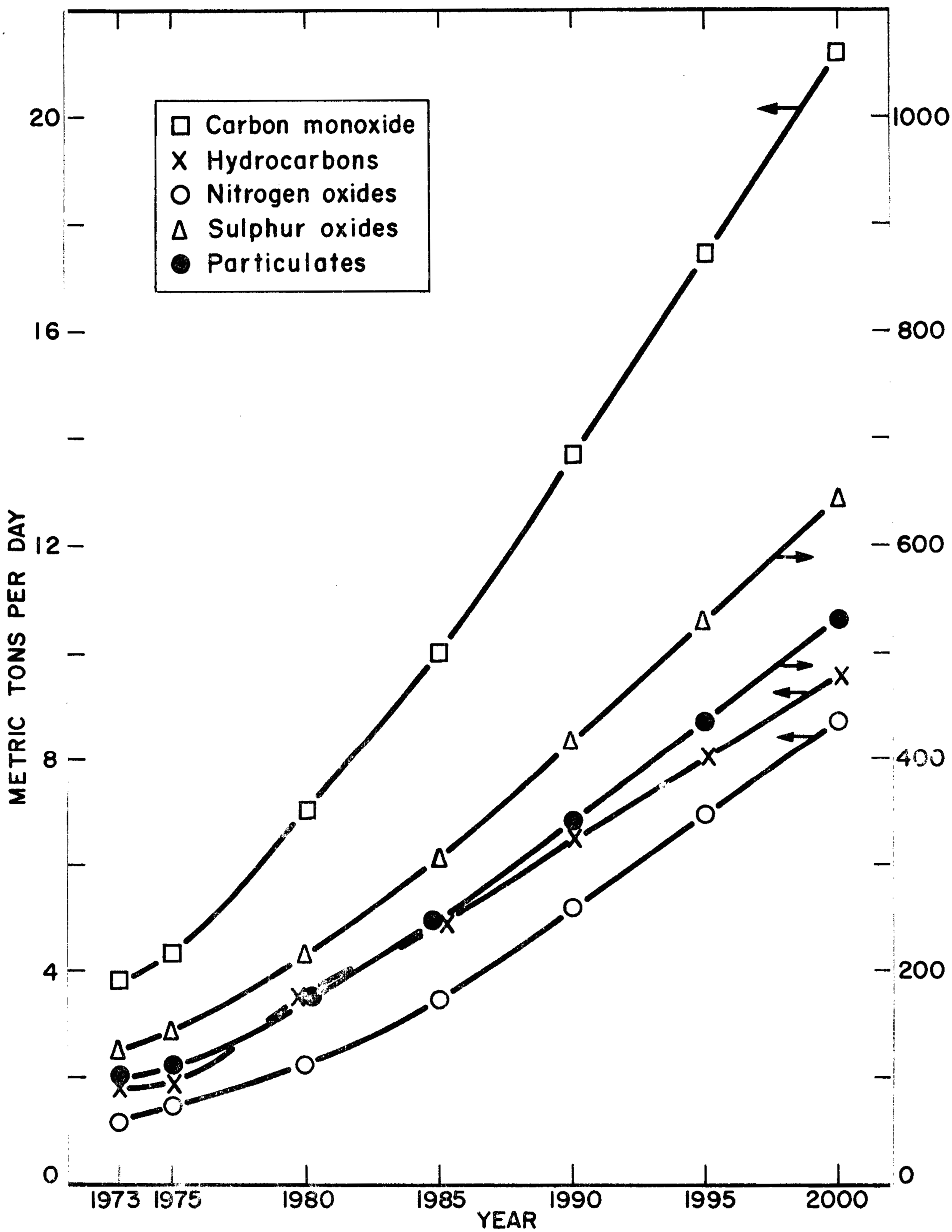
	Average Daily Emissions, kg					Peak Day Emissions, kg					Peak Hour Emissions, kg				
	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT
1973	3,808	1,792	1,121	122.8	99.44	5,216	2,454	1,535	168.2	136.2	463.6	218.2	136.4	14.96	12.11
1975	4,315	1,887	1,447	141.0	109.2	6,205	2,713	2,080	202.8	157.0	552.8	241.7	185.3	18.06	13.99
1980	7,028	3,502	2,228	212.6	173.2	10,103	5,034	3,203	305.6	249.0	900.5	448.7	285.5	27.24	22.20
1985	9,991	4,858	3,470	305.1	246.8	14,358	6,981	4,986	438.4	354.6	1,283	623.7	445.5	39.17	31.69
1990	13,693	6,474	5,160	415.8	339.2	19,682	9,305	7,417	597.6	487.6	1,743	824.2	656.9	52.93	43.18
1995	17,412	8,005	6,949	528.6	434.6	25,001	11,494	9,978	759.1	624.0	2,203	1,013	879.3	66.89	54.99
2000	21,142	9,551	8,732	641.7	530.7	30,347	13,710	12,534	921.0	761.8	2,667	1,205	1,102	80.95	66.96

AVERAGE EMISSION INCREASE FACTORS

	CO	HC	NO_x	SO_x	PT
1973	1.00	1.00	1.00	1.00	1.00
1975	1.1	1.1	1.3	1.1	1.1
1980	1.8	2.0	2.0	1.7	1.7
1985	2.6	2.7	3.1	2.5	2.5
1990	3.6	3.6	4.6	3.4	3.4
1995	4.6	4.5	6.2	4.3	4.4
2000	5.6	5.3	7.8	5.2	5.3

Figure 5·1

AVERAGE DAILY AIRCRAFT EMISSIONS
VANCOUVER INTERNATIONAL AIRPORT



Carbon monoxide emissions from jumbo aircrafts amount to about 5% of total emissions in 1973, about 19% in 1980 and almost 50% in the year 2000. The emissions from long range aircrafts will increase from about 43% in 1973 to 46% in 1980 and then drop to 36% in the year 2000. By the end of the century these two classes together will account for over 85% of all carbon monoxide emissions. Similar trend is observed for all other pollutants. The results in Table A.5.2 thus demonstrate that any attempt to reduce aircraft emissions should concentrate on the jumbo and long range aircraft classes.

TABLE 5.2

AVERAGE RELATIVE EMISSIONS BY MODE OF OPERATION*

VANCOUVER INTERNATIONAL AIRPORT

	CO % Emission	HC % Emission	NO_x % Emission	SO_x % Emission	PT % Emission
Taxi-idle	82	97	11	39	45
Takeoff	1	0.2	23	10	6
Climbout	8	1.0	48	27	18
Approach	8	1.5	16	21	27
Landing	1	0.3	2	3	4

* From data in Table A.5.2

5.2 Ground Service Vehicles

It is assumed that ground service vehicles (off highway vehicles) will not be subject to the emission controls as highway vehicles. The "uncontrolled" emission rates of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates are presented in Table 5.3 for gasoline and diesel type of engines. The combined total emissions are also given in kilograms per day. The emissions amount to 533 kg/day of carbon monoxide, 110 kg/day of hydrocarbons, 33 kg/day of nitrogen oxides, 1.0 kg/day of sulfur oxides and 1.2 kg/day of particulates in the year 1973; for 1980 the corresponding figures are 780, 174, 49, 1.4 and 1.8 kg/day respectively; in the year 2000 the corresponding emissions will be 2708, 606, 170, 4.9 and 6.0 kg/day respectively.

Most of the pollutant emissions come from gasoline type engines; diesel type engines contribute less than 1 percent of carbon monoxide and hydrocarbons emissions, about 10% of nitrogen oxides emissions, about 30% of sulfur oxides emissions and about 20% of particulate emissions. In the event of imposition of emission controls on off highway vehicles the emissions from ground service vehicles will be reduced.

TABLE 5.3

GROUND SERVICE VEHICLES UNCONTROLLED AVERAGE DAILY EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

Year	CO kg/day			HC kg/day			NO_x kg/day			SO_x kg/day			PT kg/day		
	Gasoline	Diesel	Total	Gasoline	Diesel	Total	Gasoline	Diesel	Total	Gasoline	Diesel	Total	Gasoline	Diesel	Total
1973	530.4	2.847	533.2	118.6	0.5690	119.2	30.35	2.978	33.33	0.7236	0.234	0.958	0.9648	0.2197	1.185
1975	515.7	2.613	518.3	115.3	0.5219	115.8	29.51	2.734	32.24	0.7034	0.214	0.917	0.9379	0.2017	1.140
1980	775.6	4.797	780.4	173.4	0.9582	174.4	44.38	5.018	49.40	1.058	0.394	1.452	1.411	0.3702	1.781
1985	1151	7.059	1158	257.2	1.410	258.6	65.84	7.385	73.23	1.570	0.579	2.149	2.093	0.5448	2.638
1990	1597	9.79	1607	357.0	1.955	359.0	91.37	10.24	101.6	2.178	0.805	2.983	2.904	0.7551	3.659
1995	2057	12.13	2069	459.9	2.423	462.3	117.7	12.69	130.4	2.806	0.995	3.801	3.742	0.9361	4.678
2000	2693	14.70	2708	603.0	2.937	605.9	154.1	15.38	169.5	3.673	1.206	4.879	4.897	1.135	6.032

5.3 Fuel Storage and Distribution

The emissions of hydrocarbons due to working losses associated with aircraft and ground service vehicle refueling are listed in Table 5.4. The hydrocarbon emission range from 163 kg/day in 1973, to 226 kg/day in 1980, to 462 kg/day in the year 2000. These emissions depend on aircraft activity and the emission growth pattern is the same as that for aircraft.

TABLE 5.4

FUEL STORAGE AND DISTRIBUTION AVERAGE DAILY EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

Year	Hydrocarbon Emissions, kg/day		
	Jet Fuel	Gasoline	Total
1973	151.80	10.90	162.70
1975	159.72	11.40	171.12
1980	211.20	15.23	226.43
1985	267.30	19.56	286.86
1990	321.42	23.87	345.29
1995	375.54	28.21	403.75
2000	429.00	32.79	461.79

5.4 Engine Tests and Maintenance

Pollutant emissions due to engine tests and maintenance are listed in Table 5.5. These figures were arrived at by using the number of tests in Table 3.10 and emission factors per LTO cycle in Table 4.5. The number of engine tests depends on aircraft activity and the emission growth pattern is the same as that for aircraft.

TABLE 5.5

ENGINE TESTING AND MAINTENANCE AVERAGE DAILY EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

Year	CO	HC	NO_x	SO_x	PT
	kg/day	kg/day	kg/day	kg/day	kg/day
1973	19.01	11.46	7.81	0.83	0.56
1975	20.88	11.55	8.54	0.90	0.59
1980	33.19	19.91	12.56	1.33	0.90
1985	47.49	27.08	19.28	1.87	1.28
1990	64.65	34.91	28.06	2.47	1.73
1995	81.74	42.27	37.21	3.07	2.19
2000	98.04	49.26	45.96	3.64	2.64

5.5 Heating and Air-Conditioning Plant

It is assumed that only natural gas and oil are used as fuel for heating plants (see Table 3.11). Emissions resulting from gas-fired and oil-fired heating plants are given in Table 5.6.

Carbon monoxide emission is expected to increase from 2.8 metric tons per year in 1975 to 4.3 tons in 1980 and 17.5 tons in the year 1985. Hydrocarbon emissions will increase from 1.4 tons per year in 1975 to 2.2 tons in 1980 and 9.0 tons in 1985. Corresponding emissions of nitrogen oxides are 23.8, 36.9 and 149.4 tons; of sulfur oxides 75.6, 118.9 and 475.5 tons; and of particulates 6.3, 9.7 and 39.3 metric tons per year in the year 1975, 1980 and 1985, respectively.

The average contribution to the emission from gas heating over the period 1973-2000 is 62% CO, 48% HC, 36% NO_x, 0% SO_x and 26% PT.

Fuel consumption by heating plants varies during a year; it is higher in winter and lower in summer. The "average" day's fuel consumption is calculated over the 200-day period.

TABLE 5.6

HEATING PLANT EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

	CO			HC			NO_x			SO_x			PT		
Year	Gas Heating kg/year	Oil Heating kg/year	Total kg/year	Gas Heating kg/year	Oil Heating kg/year	Total kg/year	Gas Heating kg/year	Oil Heating kg/year	Total kg/year	Gas Heating kg/year	Oil Heating kg/year	Total kg/year	Gas Heating kg/year	Oil Heating kg/year	Total kg/year
1973	1,728	1,050	2,778	691	735	1,426	8,640	15,120	23,760	52	75,600	75,652	1,631	4,620	6,251
1975	1,728	1,050	2,778	691	735	1,426	8,640	15,120	23,760	52	75,600	75,652	1,631	4,620	6,251
1980	2,624	1,650	4,274	1,055	1,155	2,205	13,120	23,760	36,880	79	118,800	118,879	2,476	7,260	9,736
1985-2000	10,880	6,600	17,480	4,352	4,620	8,972	54,400	95,040	149,440	326	475,200	475,526	10,268	29,040	39,308
*	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day	kg/day
1973	8.64	5.25	13.89	3.46	3.68	7.13	43.20	75.60	118.8	0.26	378.0	378.3	8.16	23.10	31.26
1975	8.64	5.25	13.89	3.46	3.68	7.13	43.20	75.60	118.8	0.26	378.0	378.3	8.16	23.10	31.26
1980	13.12	8.25	21.37	5.25	5.78	11.03	65.60	118.8	184.4	0.40	594.0	594.4	12.38	36.30	48.68
1985-2000	54.40	33.00	87.40	21.76	23.10	44.86	272.0	475.2	747.2	1.63	2376	2378	51.34	145.2	196.5
Average Contribution, %	62	38		48	52		36	64		0	100		26	74	

* Average over 200 days period

5.6 Access Traffic

Access traffic is the second most significant source of airport emissions, and is exceeded only by the aircraft. Access traffic emissions are displayed in Table 5.7, and 12-hour day emissions are graphically presented in Figure 5.2. A substantial decrease in emissions around the year 1985 is due to the imposition of the 1975 automotive emission standards. The total emissions decrease as pre-1975 cars are gradually phasing out and more controlled vehicles enter the population even though the vehicle traffic increases. After 1985 emissions steadily increase and will about double before the end of the century. If 1975 controls, on the other hand, are not put into effect the total emissions will be 7-8 times the 1973 level.

These emissions are calculated for the average speed of 40 hm/hr. When the average speed is reduced from 40 km/hr to 20 hm/hr the emissions will increase; the correction factors for CO and HC are about 2.1 and 1.7, respectively (7).

The contributions to the emissions of carbon monoxide and hydrocarbons by the cold start is presented in Table 5.8; the emissions from cold start amount to about 20% of emissions from hot operation.

The change of traffic mode from private transportation to mass transit by buses, diesel commuter trains or electric rail transit would substantially effect the pollutant emission. Such considerations, however, are beyond the scope of this study.

TABLE 5.7

ACCESS TRAFFIC EMISSIONS*

VANCOUVER INTERNATIONAL AIRPORT

Year	24-hr day emissions, kg**					12-hr day emissions, kg					Peak hour emissions, kg				
	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT
1973	5,489	658.4	280.9	10.53	31.60	4,127	495.0	211.2	7.92	23.76	487.8	58.50	24.96	0.936	2.808
1975	5,554	612.1	300.8	12.45	37.35	4,176	460.2	226.2	9.36	28.08	497.9	54.87	26.97	1.116	3.348
1980	5,601	573.8	409.8	18.91	56.74	4,211	431.4	308.1	14.22	42.66	479.7	49.14	35.10	1.620	4.860
1985	5,017	366.8	326.2	26.09	78.28	3,772	275.8	245.3	19.62	58.86	436.0	31.88	28.35	2.268	6.804
1990	6,626	484.5	430.9	34.47	103.4	4,982	364.3	324.0	25.92	77.76	588.2	43.01	38.25	3.060	9.180
1995	8,515	622.6	553.7	44.29	132.9	6,402	468.1	416.3	33.30	99.90	754.3	55.15	49.05	3.924	11.77
2000	10,584	773.9	688.3	55.06	165.2	7,958	581.9	517.5	41.40	124.2	934.2	68.31	60.75	4.860	14.58

* Distance from collection point to terminal = 3 km

** Equals 1.33 12-hr day emissions

Figure 5·2

TWELVE-HOUR DAY ACCESS TRAFFIC EMISSIONS
VANCOUVER INTERNATIONAL AIRPORT

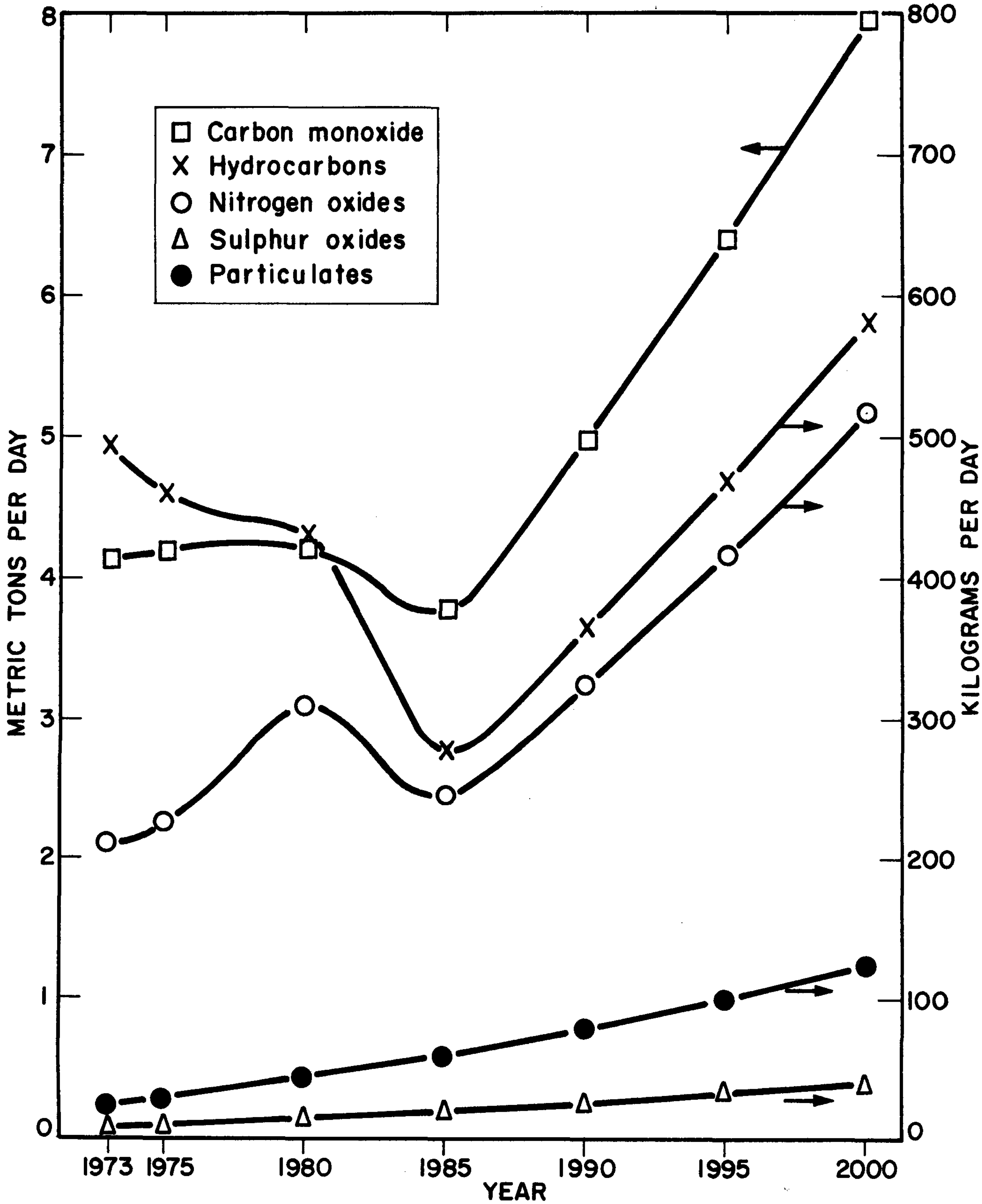


TABLE 5.8

ACCESS TRAFFIC 12-HOUR DAY EMISSIONS OF CARBON MONOXIDE AND HYDROCARBONS*

VANCOUVER INTERNATIONAL AIRPORT

	CO kg/day			HC kg/day		
Year	Hot operation	Cold Start	Total	Hot operation	Cold Start	Total
1973	3,432	695.2	4,127	429.0	66.00	495.0
1975	3,354	821.6	4,176	382.2	78.00	460.2
1980	3,555	655.7	4,211	367.4	63.99	431.4
1985	3,107	664.9	3,772	212.6	63.22	275.8
1990	4,104	878.4	4,982	280.8	83.52	364.3
1995	5,273	1129	6,402	360.8	107.3	468.1
2000	6,555	1403	7,958	448.5	133.4	581.9

* Distance from collection point to terminal = 3 km

5.7 Total Airport Emissions

The summation of the total airport emission rates is given in Table 5.9 for carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates. Average 24-hour day, peak 12-hour day and peak hour total airport emissions are given. In calculation of peak emissions corresponding peak aircraft and 12-hour day access traffic emissions were used; from other sources average emissions were utilized. The total airport average daily emissions are also graphically presented in Figure 5.3.

Based on this forecast the total average daily airport emissions would be on the order of 10 metric tons CO, 2.8 metric tons HC, 1.9 metric tons NO_x, 0.53 metric tons SO_x and 0.18 metric tons PT in the year 1975. In 1980 the total daily emissions would be 13 tons CO, 4.5 tons HC, 2.9 tons NO_x, 0.83 tons SO_x and 0.28 tons PT. By the end of the century the total daily airport emissions would amount to about 35 tons CO, 11 tons HC, 10 tons NO_x, 3.1 tons SO_x and 0.9 tons PT.

The summation of the individual contributions to the total average emission rates is given in Table 5.10. The biggest source of pollution is aircraft; aircraft accounts for 39-62% CO, 65-83% HC, 72-84% NO_x, 11-26% SO_x and 47-62% PT emission.

The second largest source of pollution is access traffic. Access traffic contributes between 30-56% CO, 6-24% HC, 7-18% NO_x, 1-2% SO_x and 15-21% of PT emission.

The third most significant source of air pollutants is heating plants. Emissions of CO and HC from heating plant operations is less than 1% but emissions of NO_x, SO_x and PT are substantial. Contributions from heating plants are 6-16% NO_x, 70-88% SO_x and 17-37% PT.

Emission rates resulting from ground service vehicle, fuel storage and distribution, and engine tests and maintenance activities are less significant; these emissions together amount to about 5% of the total airport emissions.

TABLE 5.9

TOTAL POLLUTANT EMISSIONS

VANCOUVER INTERNATIONAL AIPORT

Year	Average 24-hr Day Emissions, kg					Peak 12-hr Day Emissions, kg					Peak Hour Emissions, kg				
	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT
1973	9,863	2,751	1,562	513.4	164.1	7,018	1,872	1,059	282.1	108.4	975	289.2	168.0	31.7	16.3
1975	10,422	2,805	1,907	533.6	179.6	7,555	1,970	1,346	300.8	123.1	1,074	309.3	218.9	35.0	18.7
1980	13,464	4,508	2,884	828.7	281.3	9,680	3,164	2,033	465.6	192.8	1,415	515.8	330.9	53.7	29.2
1985	16,301	5,842	4,636	2713	525.5	11,597	4,075	3,158	1430	336.4	1,773	681.3	508.8	140.7	46.8
1990	22,078	7,743	6,468	2834	644.5	15,702	5,409	4,471	1516	422.5	2,404	899.9	731.7	155.3	60.8
1995	28,165	9,581	8,418	2958	770.9	20,022	6,692	5,863	1605	513.6	3,051	1108	966.5	170.2	75.2
2000	34,619	11,487	10,383	3083	901.0	24,578	8,018	7,266	1695	607.7	3,722	1322	1203	185.2	90.1

Figure 5·3

TOTAL AVERAGE 24-HR DAY EMISSIONS
VANCOUVER INTERNATIONAL AIRPORT

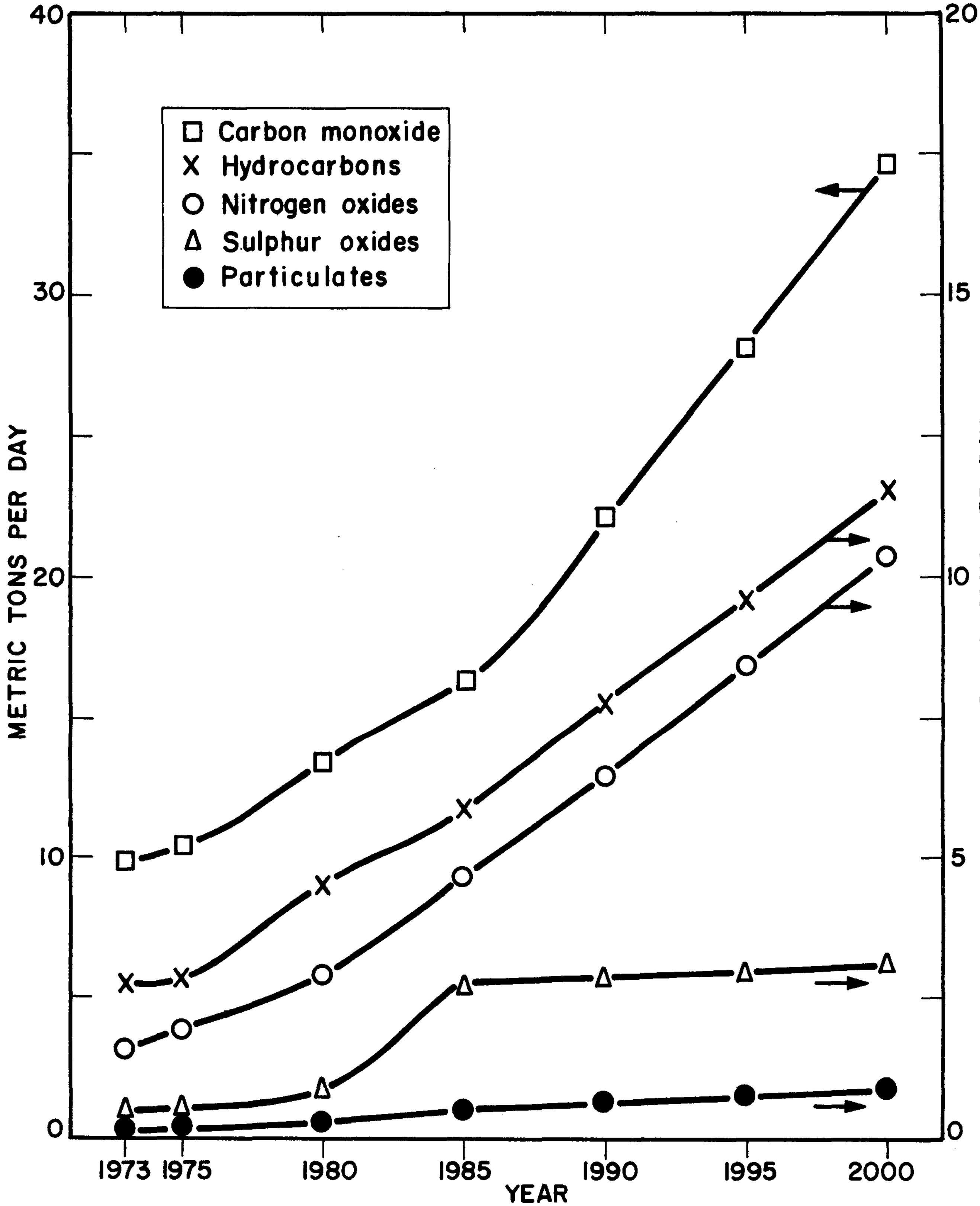


TABLE 5.10

AVERAGE POLLUTANT EMISSIONS BY VARIOUS SOURCES

VANCOUVER INTERNATIONAL AIRPORT

CARBON MONOXIDE												
Year	Total	Aircraft		Ground Service Vehicles		Engine tests and maintenance		Heating and air conditioning		Access Traffic		
	kg/day	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%	
1973	9,863	3,808	38.6	533.2	5.4	19.0	0.2	13.9	0.1	5,489	55.7	
1975	10,422	4,315	41.4	518.3	5.0	20.9	0.2	13.9	0.1	5,554	53.3	
1980	13,464	7,028	52.2	780.4	5.8	33.2	0.2	21.4	0.2	5,601	41.6	
1985	16,301	9,991	61.3	1158	7.1	47.5	0.3	87.4	0.5	5,017	30.8	
1990	22,078	13,693	62.0	1607	7.3	64.7	0.3	87.4	0.4	6,626	30.0	
1995	28,165	17,412	61.8	2069	7.3	81.7	0.3	87.4	0.3	8,515	30.2	
2000	34,619	21,142	61.1	2708	7.8	98.0	0.3	87.4	0.2	10,584	30.6	

TABLE 5.10 (cont'd)

AVERAGE POLLUTANT EMISSIONS BY VARIOUS SOURCES

VANCOUVER INTERNATIONAL AIRPORT

HYDROCARBONS													
Year	Total	Aircraft		Ground Service Vehicles		Fuel storage and distribution		Engine tests and maintenance		Heating and air conditioning		Access Traffic	
	kg/day	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%
1973	2,751	1,792	65.1	119.2	4.3	162.7	5.9	11.5	0.4	7.1	0.3	658.4	23.9
1975	2,805	1,887	67.3	115.8	4.1	171.1	6.1	11.6	0.4	7.1	0.3	612.1	21.8
1980	4,508	3,502	77.7	174.4	3.9	226.4	5.0	19.9	0.4	11.0	0.2	573.8	12.7
1985	5,842	4,858	83.2	258.6	4.4	286.9	4.9	27.1	0.5	44.9	0.8	366.8	6.3
1990	7,743	6,474	83.6	359.0	4.6	345.3	4.5	34.9	0.5	44.9	0.6	484.5	6.3
1995	9,581	8,005	83.6	462.3	4.8	403.8	4.2	42.3	0.4	44.9	0.5	622.6	6.5
2000	11,487	9,551	83.1	605.9	5.3	461.8	4.0	49.3	0.4	44.9	0.4	773.9	6.7

TABLE 5.10 (cont'd)

AVERAGE POLLUTANT EMISSIONS BY VARIOUS SOURCES

VANCOUVER INTERNATIONAL AIRPORT

NITROGEN OXIDES											
Year	Total	Aircraft		Ground Service Vehicles		Engine tests and maintenance		Heating and air conditioning		Access Traffic	
	kg/day	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%
1973	1,562	1,121	71.8	33.3	2.1	7.8	0.5	118.8	7.6	280.9	18.0
1975	1,907	1,447	75.9	32.2	1.7	8.5	0.4	118.8	6.2	300.8	15.8
1980	2,884	2,228	77.3	49.4	1.7	12.6	0.4	184.4	6.4	409.8	14.2
1985	4,636	3,470	74.8	73.2	1.6	19.3	0.4	747.2	16.1	326.2	7.0
1990	6,468	5,160	79.8	101.6	1.6	28.1	0.4	747.2	11.6	430.9	6.7
1995	8,418	6,949	82.5	130.4	1.5	37.2	0.4	747.2	8.9	553.7	6.6
2000	10,383	8,732	84.1	169.5	1.6	46.0	0.4	747.2	7.2	688.3	6.6

TABLE 5.10 (cont'd)

AVERAGE POLLUTANT EMISSIONS BY VARIOUS SOURCES

VANCOUVER INTERNATIONAL AIRPORT

SULPHUR OXIDES												
Year	Total	Aircraft		Ground Service Vehicles		Engine tests and maintenance		Heating and air conditioning		Access Traffic		
	kg/day	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%	
1973	513.4	122.8	23.9	0.96	0.2	0.8	0.2	378.3	73.7	10.5	2.0	
1975	533.6	141.0	26.4	0.92	0.2	0.9	0.2	378.3	70.9	12.5	2.3	
1980	828.7	212.6	25.7	1.45	0.2	1.3	0.2	594.4	71.7	18.9	2.3	
1985	2713	305.1	11.2	2.15	0.1	1.9	0.1	2378	87.7	26.1	1.0	
1990	2834	415.8	14.7	2.98	0.1	2.5	0.1	2378	83.9	34.5	1.2	
1995	2958	528.6	17.9	3.80	0.1	3.1	0.1	2378	80.4	44.3	1.5	
2000	3083	641.7	20.8	4.88	0.2	3.6	0.1	2378	77.1	55.1	1.8	

TABLE 5.10 (cont'd)

AVERAGE POLLUTANT EMISSIONS BY VARIOUS SOURCES

VANCOUVER INTERNATIONAL AIRPORT

PARTICULATES												
Year	Total	Aircraft		Ground Service Vehicles		Engine tests and maintenance		Heating and air conditioning		Access Traffic		
	kg/day	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%
1973	164.1	99.4	60.6	1.2	0.7	0.6	0.4	31.3	19.1	31.6	19.3
1975	179.6	109.2	60.8	1.1	0.6	0.6	0.3	31.3	17.4	37.4	20.8
1980	281.3	173.2	61.6	1.8	0.6	0.9	0.3	48.7	17.3	56.7	20.2
1985	525.5	246.8	47.0	2.6	0.5	1.3	0.2	196.5	37.4	78.3	14.9
1990	644.5	339.2	52.6	3.7	0.6	1.7	0.3	196.5	30.5	103.4	16.0
1995	770.9	434.6	56.4	4.7	0.6	2.2	0.3	196.5	25.5	132.9	17.2
2000	901.0	530.7	58.9	6.0	0.7	2.6	0.3	196.5	21.8	165.2	18.3

5.8 Spatial Distribution of Emission Sources

The spatial distribution of various activities contributing to the emission of air pollutants is outlined on the map in Figure 5.4. Emissions are divided into major line source emissions and major area source emissions. The individual treatment of point sources is not justified at Vancouver International Airport since they are relatively small and are scattered in separate smaller areas. Consequently they are treated as area sources.

The spatial distribution of pollutant emissions is given in Table 5.11.

5.8.1 Line Sources

At present there are three major line sources at the Vancouver International Airport; main runway (Runway No. 1), cross runway (Runway No. 2) and access road. It is assumed that in 1985 the new runway (Runway No. 3) will be added. The location of this proposed runway (Figure 5.4) corresponds to the MOT Development Concept I.

The emissions from the line sources are summarized in Tables 5.12, 5.13 and 5.14.

The topographic position of line sources will be defined with respect to the east/west-north/south coordinate system shown in Figure 5.4.

Spatial coordinates of the line sources are given in Table 5.15 together with the respective source lengths. The access road is divided into two straight sections in order to closely approximate the curved nature of the road.

FIGURE 5.4

SPATIAL DISTRIBUTION OF EMISSION SOURCES

VANCOUVER INTERNATIONAL AIRPORT

scale 1cm=240m

Runway No.1 = Present main runway

Runway No.2 = Present cross runway

Runway No.3 = Projected runway

Area No.1 = Terminal area, parking lot and heating plant.

Area No.2 = CPA maintenance and heating plant

Area No.3 = A number of heating plants

Area No.4 = A number of heating plants

Figure 5.4
SPATIAL DISTRIBUTION OF EMISSION SOURCES
VANCOUVER INTERNATIONAL AIRPORT
Scale: 1 cm = 240m

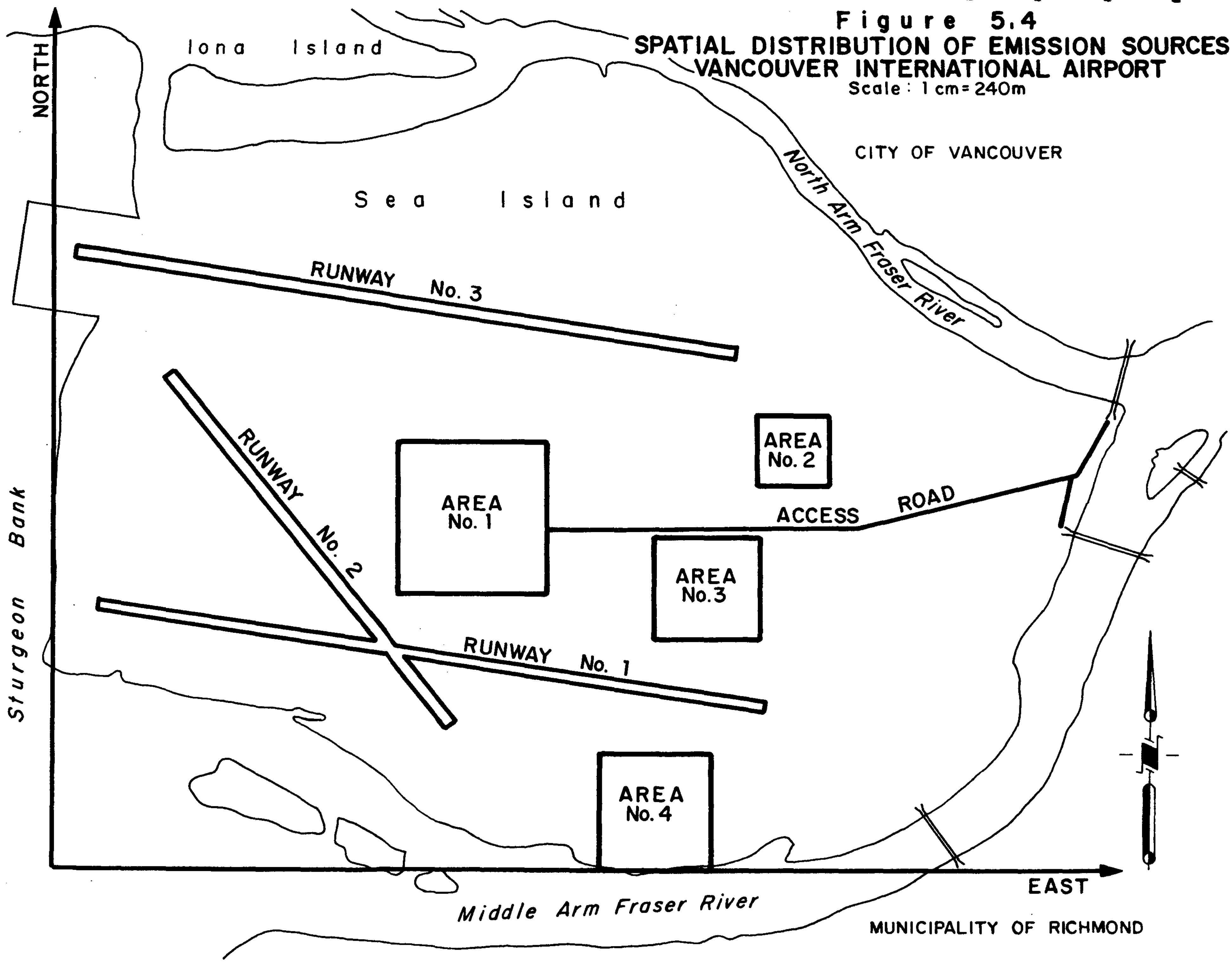


TABLE 5.11

SPATIAL DISTRIBUTION OF POLLUTANT EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

	1973 - 1980		1985 - 2000	
Runway No. 1:	80% Taxi-idle	Emissions	40% Taxi-idle	Emissions
	90% Takeoff	"	45% Takeoff	"
	90% Landing	"	45% Landing	"
Climbout No. 1:	90% Climbout	"	45% Climbout	"
Approach No. 1:	90% Approach	"	45% Approach	"
Runway No. 2:	10% Taxi-idle	"	10% Taxi-idle	"
	10% Takeoff	"	10% Takeoff	"
	10% Landing	"	10% Landing	"
Climbout No. 2:	10% Climbout	"	10% Climbout	"
Approach No. 2:	10% Approach	"	10% Approach	"
Runway No. 3:	-		40% Taxi-idle	"
	-		45% Takeoff	"
	-		45% Landing	"
Climbout No. 3:	-		45% Climbout	"
Approach No. 3:	-		45% Approach	"
Access Road:	80% Access Traffic	"	80% Access Traffic	"

	1973 - 2000	
Area No. 1:	10% Taxi-idle	"
	100% Ground Service	"
	100% Fuel Storage	"
	40% Gas Heating	"
	10% Oil Heating	"
	20% Access Traffic	"
Area No. 2:	100% Engine Test	"
	10% Gas Heating	"
	10% Oil Heating	"
Area No. 3:	20% Gas Heating	"
	30% Oil Heating	"
Area No. 4:	30% Gas Heating	"
	50% Oil Heating	"

TABLE 5.12

LINE SOURCE AVERAGE 24-HOUR DAY EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

	Runway No. 1	Climbout No. 1	Approach No. 1	Runway No. 2	Climbout No. 2	Approach No. 2	Runway No. 3	Climbout No. 3	Approach No. 3	Access Road
1973 CO	2442	372.4	315.8	304.4	41.38	35.09	-	-	-	4391
HC	1397	14.50	27.00	174.6	1.612	3.000	-	-	-	526.7
(Kg) NO_x	359.5	451.3	183.6	41.54	50.14	20.40	-	-	-	224.7
SO_x	53.08	28.65	24.02	6.433	3.183	2.669	-	-	-	8.424
PT	40.55	18.16	27.03	4.922	2.018	3.003	-	-	-	25.28
1975 CO	2802	396.5	344.3	349.2	44.05	38.25	-	-	-	4443
HC	1471	15.69	28.83	183.7	1.744	3.203	-	-	-	489.7
(Kg) NO_x	464.3	604.9	215.8	53.48	67.21	23.78	-	-	-	240.6
SO_x	61.16	33.27	26.98	7.411	3.692	2.997	-	-	-	9.960
PT	47.15	19.05	27.56	5.741	2.117	3.062	-	-	-	29.88
1980 CO	4710	532.0	508.2	587.2	59.11	56.46	-	-	-	4481
HC	2739	24.62	48.50	342.0	2.735	5.388	-	-	-	459.0
(Kg) NO_x	712.2	953.4	315.8	81.83	105.9	35.09	-	-	-	327.8
SO_x	84.37	51.06	40.73	11.06	5.674	4.525	-	-	-	15.13
PT	72.36	30.85	45.87	8.800	3.428	5.096	-	-	-	45.39
1985 CO	3406	333.7	340.2	935.0	74.16	75.60	3406	333.7	340.2	4014
HC	1900	16.63	33.16	474.7	3.695	7.368	1900	16.63	33.16	293.4
(Kg) NO_x	544.0	760.1	229.5	127.1	168.9	51.01	544.0	760.1	229.5	261.0
SO_x	65.70	37.00	28.72	15.90	8.224	6.383	65.70	37.00	28.72	20.87
PT	54.00	21.01	30.78	13.17	4.669	6.841	54.00	21.01	30.78	62.62
1990 CO	4740	403.2	437.5	1182	89.60	97.21	4740	403.2	437.5	5301
HC	2533	21.69	43.29	632.9	4.821	9.620	2533	21.69	43.29	387.6
(Kg) NO_x	823.9	1158	315.9	188.6	257.2	70.21	823.9	1158	315.9	344.7
SO_x	89.77	51.02	38.32	21.64	11.34	8.51	89.77	51.02	38.32	27.58
PT	78.23	27.20	39.33	19.14	6.044	8.740	78.23	27.20	39.33	82.72
1995 CO	6083	472.1	533.7	1518	104.9	118.6	6083	472.1	533.7	6812
HC	3133	26.67	52.94	782.8	5.927	11.76	3133	26.67	52.94	498.1
(Kg) NO_x	1110	1580	405.0	253.7	351.2	90.01	1110	1580	405.0	443.0
SO_x	114.4	65.33	47.94	27.69	14.52	10.65	114.4	65.33	47.94	35.43
PT	104.2	33.19	47.44	25.54	7.375	10.54	104.2	33.19	47.44	106.3
2000 CO	7430	541.8	630.6	1854	120.4	140.1	7430	541.8	630.6	8467
HC	3739	31.69	62.66	934.2	7.042	13.92	3739	31.69	62.66	619.1
(Kg) NO_x	1395	2002	488.5	318.7	444.8	109.8	1395	2002	488.5	550.6
SO_x	139.2	79.65	57.59	33.67	17.70	12.80	139.2	79.65	57.59	44.05
PT	130.3	39.24	55.69	31.98	8.720	12.38	130.3	39.24	55.69	132.2

TABLE 5.13

LINE SOURCE PEAK 12-HOUR DAY EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

		Runway No. 1	Climbout No. 1	Approach No. 1	Runway No. 2	Climbout No. 2	Approach No. 2	Runway No. 3	Climbout No. 3	Approach No. 3	Access Road
1973	CO	1673	255.0	216.3	208.4	28.34	24.03	-	-	-	3302
	HC	957.0	9.932	18.49	119.6	1.104	2.055	-	-	-	396.0
(Kg)	NO_x	246.2	309.0	125.7	28.44	34.33	13.97	-	-	-	169.0
	SO_x	36.35	19.62	16.45	4.405	2.180	1.828	-	-	-	6.336
	PT	27.77	12.44	18.51	3.371	1.382	2.057	-	-	-	19.01
1975	CO	2015	285.1	247.6	251.1	31.68	27.51	-	-	-	3341
	HC	1058	11.29	20.73	132.1	1.254	2.303	-	-	-	368.2
(Kg)	NO_x	333.8	434.9	155.2	38.45	48.33	17.24	-	-	-	181.0
	SO_x	43.97	23.89	19.40	5.328	2.655	2.155	-	-	-	7.488
	PT	33.90	13.70	19.81	4.128	1.522	2.202	-	-	-	22.46
1980	CO	3385	382.3	365.3	422.1	42.48	40.59	-	-	-	3369
	HC	1968	17.69	34.86	245.8	1.966	3.873	-	-	-	345.1
(Kg)	NO_x	511.9	685.2	227.0	58.82	76.14	25.22	-	-	-	246.5
	SO_x	65.66	36.70	29.27	7.948	4.078	3.252	-	-	-	11.38
	PT	52.02	22.17	32.97	6.325	2.464	3.663	-	-	-	34.13
1985	CO	2447	239.8	244.4	610.3	53.29	54.32	2447	239.8	244.4	3018
	HC	1365	11.95	23.82	341.1	2.655	5.294	1365	11.95	23.82	220.6
(Kg)	NO_x	398.1	546.1	164.9	91.30	121.4	36.65	398.1	546.1	164.9	196.2
	SO_x	47.20	26.59	20.64	11.43	5.908	4.586	47.20	26.59	20.64	15.70
	PT	38.80	15.10	22.12	9.461	3.355	4.915	38.80	15.10	22.12	47.09
1990	CO	3407	289.8	314.4	881.5	64.40	69.87	3407	289.8	314.4	3986
	HC	1821	15.59	31.11	454.9	3.465	6.914	1821	15.59	31.11	291.4
(Kg)	NO_x	592.1	831.9	227.1	135.5	184.9	50.46	592.1	831.9	227.1	259.2
	SO_x	64.51	36.67	27.54	15.61	8.148	6.119	64.51	36.67	27.54	20.74
	PT	56.22	19.55	28.26	13.75	4.344	6.281	56.22	19.55	28.26	62.21
1995	CO	4367	338.9	383.2	1090	75.32	85.15	4367	338.9	383.2	5122
	HC	2249	19.15	3801	562.0	4.256	8.446	2249	19.15	38.01	374.5
(Kg)	NO_x	796.6	1134	290.8	182.2	252.1	64.62	796.6	1134	290.8	333.0
	SO_x	82.15	46.90	34.42	19.88	10.42	7.649	82.15	46.90	34.42	26.64
	PT	74.80	23.83	34.06	18.34	5.295	7.569	74.80	23.83	34.06	79.92
2000	CO	5332	388.9	452.5	1330	86.42	100.6	5332	388.9	452.5	6366
	HC	2683	22.74	44.97	670.4	5.055	9.995	2683	22.74	44.97	465.5
(Kg)	NO_x	1001	1437	354.6	228.7	319.2	78.79	1001	1437	354.6	414.0
	SO_x	99.84	57.16	41.33	24.16	12.70	9.185	99.84	57.16	41.33	33.12
	PT	93.51	28.16	39.97	22.95	6.259	8.881	93.51	28.16	39.97	99.36

TABLE 5.14

LINE SOURCE PEAK HOUR EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

		Runway No. 1	Climbout No. 1	Approach No. 1	Runway No. 2	Climbout No. 2	Approach No. 2	Runway No. 3	Climbout No. 3	Approach No. 3	Access Road
1973	CO	297.3	45.34	38.45	37.05	5.037	4.272	-	-	-	390.2
	HC	170.1	1.766	3.287	21.25	0.196	0.365	-	-	-	46.80
(Kg)	NO_x	43.77	54.94	22.35	5.056	6.104	2.484	-	-	-	19.97
	SO_x	6.463	3.488	2.924	0.783	0.388	0.325	-	-	-	0.749
	PT	4.937	2.210	3.290	0.600	0.246	0.366	-	-	-	2.246
1975	CO	358.9	50.43	44.10	44.73	5.643	4.900	-	-	-	398.3
	HC	188.4	2.011	3.693	23.54	0.223	0.410	-	-	-	43.90
(Kg)	NO_x	59.48	77.49	27.64	6.852	8.610	3.072	-	-	-	21.58
	SO_x	7.835	4.257	3.456	0.949	0.473	0.384	-	-	-	0.893
	PT	6.039	2.441	3.531	0.736	0.271	0.392	-	-	-	2.678
1980	CO	603.5	68.16	65.11	75.24	7.573	7.234	-	-	-	383.8
	HC	350.8	3.154	6.214	43.83	0.350	0.690	-	-	-	39.31
(Kg)	NO_x	91.25	122.1	40.46	10.49	13.57	4.495	-	-	-	28.08
	SO_x	11.70	6.542	5.218	1.416	0.727	0.580	-	-	-	1.296
	PT	9.272	3.953	5.876	1.127	0.439	0.653	-	-	-	3.888
1985	CO	437.3	42.85	43.68	109.1	9.522	9.706	437.3	42.85	43.68	348.8
	HC	243.9	2.135	4.257	60.95	0.474	0.946	243.9	2.135	4.257	25.50
(Kg)	NO_x	71.13	97.59	29.47	16.31	21.69	6.549	71.13	97.59	29.47	22.68
	SO_x	8.435	4.751	3.688	2.042	1.056	0.820	8.435	4.751	3.688	1.814
	PT	6.933	2.698	3.952	1.690	0.600	0.878	6.933	2.698	3.952	5.443
1990	CO	603.5	51.33	55.69	150.5	11.41	12.38	603.5	51.33	55.69	470.4
	HC	322.5	2.762	5.512	80.58	0.614	1.225	322.5	2.762	5.512	34.41
(Kg)	NO_x	104.9	147.4	40.22	24.01	32.75	8.938	104.9	147.4	40.22	30.60
	SO_x	11.43	6.495	4.878	2.766	1.443	1.084	11.43	6.495	4.878	2.448
	PT	9.959	3.463	5.007	2.436	0.770	1.113	9.959	3.463	5.007	7.344
1995	CO	770.0	59.74	67.54	192.0	13.28	15.01	770.0	59.74	67.54	603.4
	HC	396.4	3.375	6.699	99.06	0.750	1.489	396.4	3.375	6.699	44.12
(Kg)	NO_x	140.4	200.0	51.25	32.10	44.43	11.39	140.4	200.0	51.25	39.24
	SO_x	14.78	8.267	6.066	3.504	1.837	1.348	14.78	8.267	6.066	3.139
	PT	13.18	4.199	6.003	3.232	0.933	1.334	13.18	4.199	6.003	9.416
2000	CO	937.3	68.34	79.55	233.8	15.19	17.68	937.3	68.34	79.55	747.4
	HC	471.7	3.998	7.905	117.8	0.888	1.757	471.7	3.998	7.905	54.65
(Kg)	NO_x	175.9	252.5	62.32	40.20	56.11	13.85	175.9	252.5	62.32	48.60
	SO_x	17.55	10.05	7.265	4.248	2.233	1.615	17.55	10.05	7.265	3.888
	PT	16.44	4.950	7.025	4.034	1.100	1.561	16.44	4.950	7.025	11.66

TABLE 5.15

LINE SOURCES SPATIAL COORDINATES

VANCOUVER INTERNATIONAL AIRPORT

	Line End Points Coordinates			Line Source Length metres
	East (X) metres	North (Y) metres	Height (Z) metres	
Runway No. 1	191.7 3493	1392 795.2	0 0	3358
Approach No. 1	-4724 191.7	2281 1392	500 0	5000
Climbout No. 1	3493 8409	795.2 -93.4	0 500	5000
Runway No. 2	539.6 1938	2563 725.6	0 0	2286
Approach No. 2	-2519 539.6	6582 2563	500 0	5000
Climbout No. 2	1938 4997	725.6 -3293	0 500	5000
Runway No. 3	42.6 3337	3167 2556	0 0	3358
Approach No. 3	-4863 42.6	4077 3167	500 0	5000
Climbout No. 3	3337 8242	2556 1646	0 500	5000
Access Road				3000
Section No. 1	2100 4010	1687 1687	0 0	1910
Section No. 2	4010 5085	1687 1940	0 0	1090

Approach and Climbout are assumed to be in line with the runway and under the same elevation angle of 6^{o}.

5.8.2 Area Sources

Four area sources will be considered in this study. These areas are shown on the map in Figure 5.4 and marked as Area No. 1, Area No. 2, Area No. 3 and Area No. 4, respectively. Area No. 1 includes the airport terminal, and car parking lot. This area includes 10% of aircraft taxi-idle emissions, 20% of access traffic emissions, ground service vehicle emissions, fuel storage and distribution and emissions from several heating plants. Area No. 2 comprises a number of exhaust ducts from CPA heating plant boilers, testing cell and aircraft engine run-ups in the open space. Area No. 3 and No. 4 comprise a number of point sources from heating plants (see Table 5.11).

The emissions from area sources are summarized in Table 5.16.

The area sources are approximated by squares whose sides are parallel to the axes of the east/west-north/south coordinate system (Figure 5.4). The spatial position of an area is defined by the coordinates of the centre of the square and the length of the side. Such data are given in Table 5.17.

TABLE 5.16

AREA SOURCES EMISSIONS

VANCOUVER INTERNATIONAL AIRPORT

Year	CO, kg/day				HC, kg/day				NOx, kg/day				SOx, kg/day				PT, kg/day			
	Area No.1	Area No.2	Area No.3	Area No.4	Area No.1	Area No.2	Area No.3	Area No.4	Area No.1	Area No.2	Area No.3	Area No.4	Area No.1	Area No.2	Area No.3	Area No.4	Area No.1	Area No.2	Area No.3	Area No.4
1973	1,932	20.39	3.30	5.22	589.2	12.21	1.80	2.88	128.6	19.68	31.32	50.76	45.77	38.63	113.5	189.1	16.84	3.73	8.56	14.00
1975	1,974	22.29	3.30	5.22	594.0	12.31	1.80	2.88	134.2	20.38	31.32	50.76	46.85	38.73	113.5	189.1	18.67	3.73	8.56	14.00
1980	2,482	35.34	5.10	8.06	858.9	21.00	2.78	4.47	193.8	31.04	48.76	79.08	72.96	60.74	178.3	297.1	28.55	5.37	13.37	21.86
1985	3,020	56.24	20.78	32.82	1,103	31.59	11.28	18.08	330.3	94.02	197.0	319.2	257.3	239.7	713.1	1,188	63.84	20.95	53.83	88.00
1990	4,119	73.44	20.78	32.82	1,442	39.39	11.28	18.08	393.6	102.8	197.0	319.2	264.1	240.3	713.1	1,188	75.20	21.35	53.83	88.00
1995	5,289	90.44	20.78	32.82	1,781	46.79	11.28	18.08	461.7	111.9	197.0	319.2	271.3	240.9	713.1	1,188	87.82	21.85	53.83	88.00
2000	6,674	106.7	20.78	32.82	2,164	53.79	11.28	18.08	542.4	120.7	197.0	319.2	278.9	241.4	713.1	1,188	101.3	22.25	53.83	88.00

TABLE 5.17

AREA SOURCES SPATIAL COORDINATES

VANCOUVER INTERNATIONAL AIRPORT

	Coordinates of Square Centre		Length of a Side of the Square	Area of a Source
	East (X) metres	North (Y) metres	metres	sq. km
Area No. 1	2060	1780	700	0.4900
Area No. 2	3660	2060	350	0.1225
Area No. 3	3230	1420	530	0.2809
Area No. 4	2950	280	570	0.3249

6. REGIONAL METEOROLOGY

The dispersion of air pollutants is controlled by regional meteorological conditions. The ability of the atmosphere to dilute pollutants is governed by turbulence which increases with increase in wind speed, wind shear, surface roughness and instability. This chapter describes the wind and atmospheric stability conditions at Vancouver International Airport.

6.1 Wind Conditions

Table 6.1 presents a summary of data on average wind speed in different directions at Vancouver International Airport during a period from 1955 to 1966 (16).

The average wind speed in all directions is shown graphically in Figure 6.1; the wind speed is higher during the months of November through May with the peak in March amounting to 13.6 km/hr. During the months of June through October daily average wind in all directions is of lower intensity with the minimum of 10.7 km/hr occurring in August.

The average wind speed for all months in different directions is shown graphically by a wind rose in Figure 6.2. The strongest average wind for all months is from the WNW direction amounting to 17.8 km/hr. The lowest average wind speed for all months is from the northerly direction amounting to 5.8 km/hr.

The percentage frequency wind direction and calm weather at the Vancouver International Airport during the period from 1955 to 1966 is shown in Table 6.2 (16). The average frequency-direction distributions for all months are presented by wind rose in Figure 6.3. The frequency of the easterly wind at 21% of the time is the highest, followed by the ENE and ESE winds with 10%, and westerly wind with 9%. For our purpose the winds blowing inland are of most significance, i.e., S, SSW, SW, WSW, W, WNW, NW, NNW and N winds. Their percentage frequency is 4, 2, 3, 4, 9, 6, 4 and 1%, respectively.

The highest percentage frequency of calm weather is in September amounting to 11%, and the lowest is in April, May and June being 5% of the time. The average percentage frequency of calm weather for all months is 7%.

TABLE 6.1

AVERAGE WIND SPEED BY MONTHS *

VANCOUVER INTERNATIONAL AIRPORT

Speed	Kilometres per hour												
Direction \ Month	J	F	M	A	M	J	J	A	S	O	N	D	All Months Average
N	5.6	6.1	5.9	6.1	6.4	6.4	5.6	5.8	5.4	5.3	5.8	5.6	5.8
NNE	7.7	9.4	10.6	8.3	7.7	8.5	6.7	6.7	7.2	8.5	7.7	6.7	8.0
NE	11.8	12.8	11.5	9.8	10.1	9.3	8.6	9.6	8.8	9.8	10.2	9.9	10.2
ENE	14.4	14.2	14.2	12.6	11.5	11.4	11.5	10.7	11.4	12.3	13.4	13.4	12.6
E	12.2	11.7	12.6	12.0	11.2	10.9	10.9	10.2	10.1	11.5	12.6	13.1	11.5
ESE	12.5	12.0	13.8	13.1	11.5	11.8	11.5	11.8	10.7	12.2	12.0	13.0	12.2
SE	13.8	13.0	15.4	14.2	12.5	12.2	11.4	11.5	11.0	14.2	14.6	14.9	13.3
SSE	19.4	16.5	18.2	16.6	13.4	12.3	11.4	12.0	12.2	17.4	18.4	19.4	15.7
S	17.6	15.4	15.8	15.2	11.8	11.5	10.4	11.0	9.4	15.4	17.0	15.5	13.9
SSW	15.0	15.0	16.2	15.5	12.5	11.5	10.6	9.3	8.6	15.2	13.9	16.0	13.3
SW	10.7	9.8	12.6	12.6	12.3	11.2	9.9	10.2	9.8	11.2	12.5	14.7	11.5
WSW	12.3	13.1	14.9	16.0	14.1	13.4	12.6	11.8	14.1	13.9	12.5	16.2	13.8
W	15.8	18.6	19.0	18.1	15.4	16.0	17.0	13.3	16.0	15.5	18.2	17.1	16.6
WNW	16.0	17.8	19.0	19.2	18.9	18.2	18.1	16.6	17.4	15.2	20.0	17.3	17.8
NW	10.1	11.8	13.9	14.1	16.0	15.5	15.5	14.4	13.3	10.9	11.8	12.3	13.3
NNW	7.2	8.2	8.0	7.8	8.0	9.0	9.4	10.9	7.7	7.4	8.6	7.5	8.3
All Directions	12.2	12.5	13.6	13.4	12.3	11.8	11.7	10.7	10.7	11.5	12.5	12.6	12.2

* Data from Ref. 16

Figure 6.1

AVERAGE WIND SPEED IN ALL DIRECTIONS BY MONTH
VANCOUVER INTERNATIONAL AIRPORT

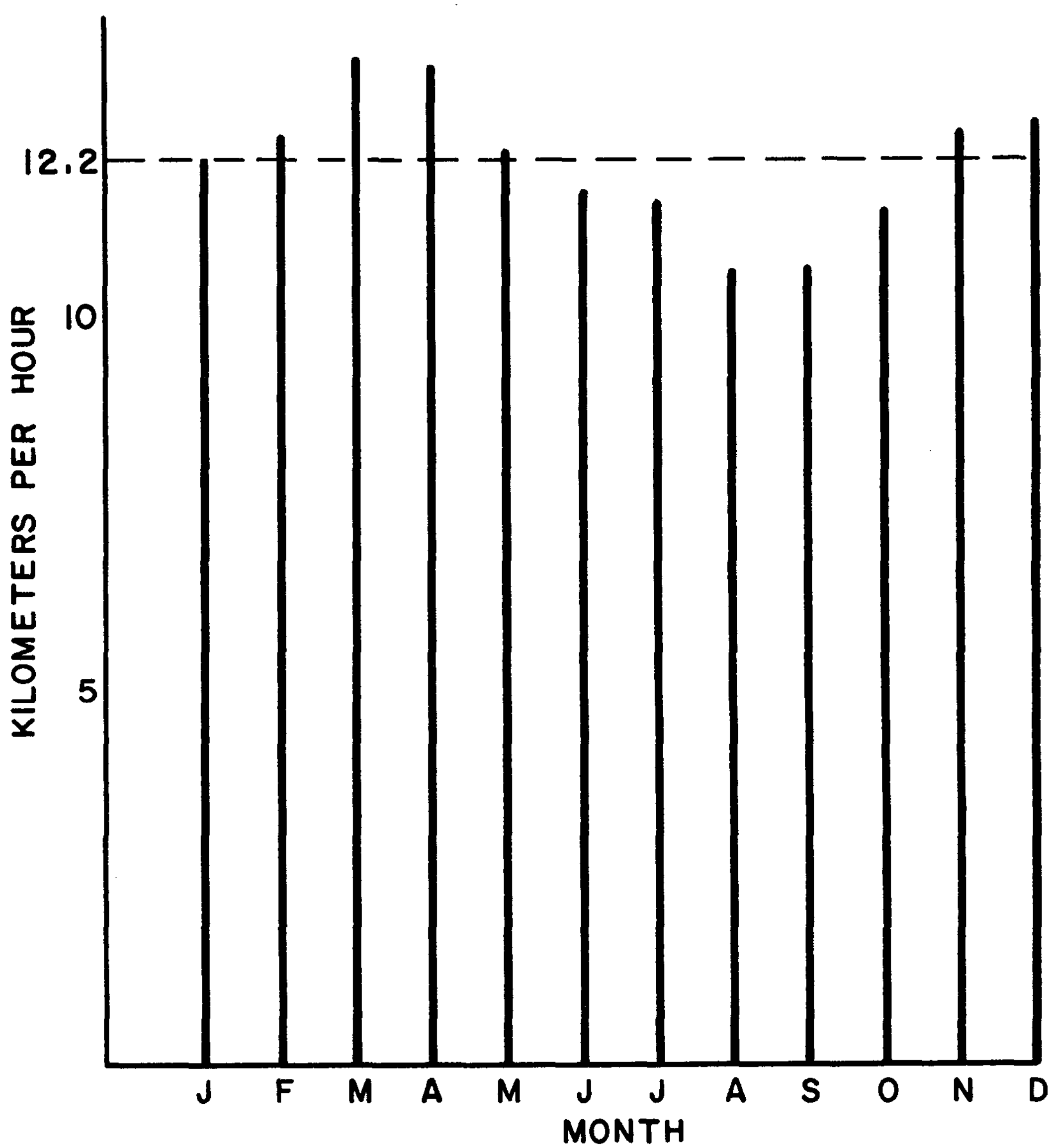


Figure 6.2

AVERAGE WIND SPEED FOR ALL MONTHS IN DIFFERENT DIRECTIONS
VANCOUVER INTERNATIONAL AIRPORT

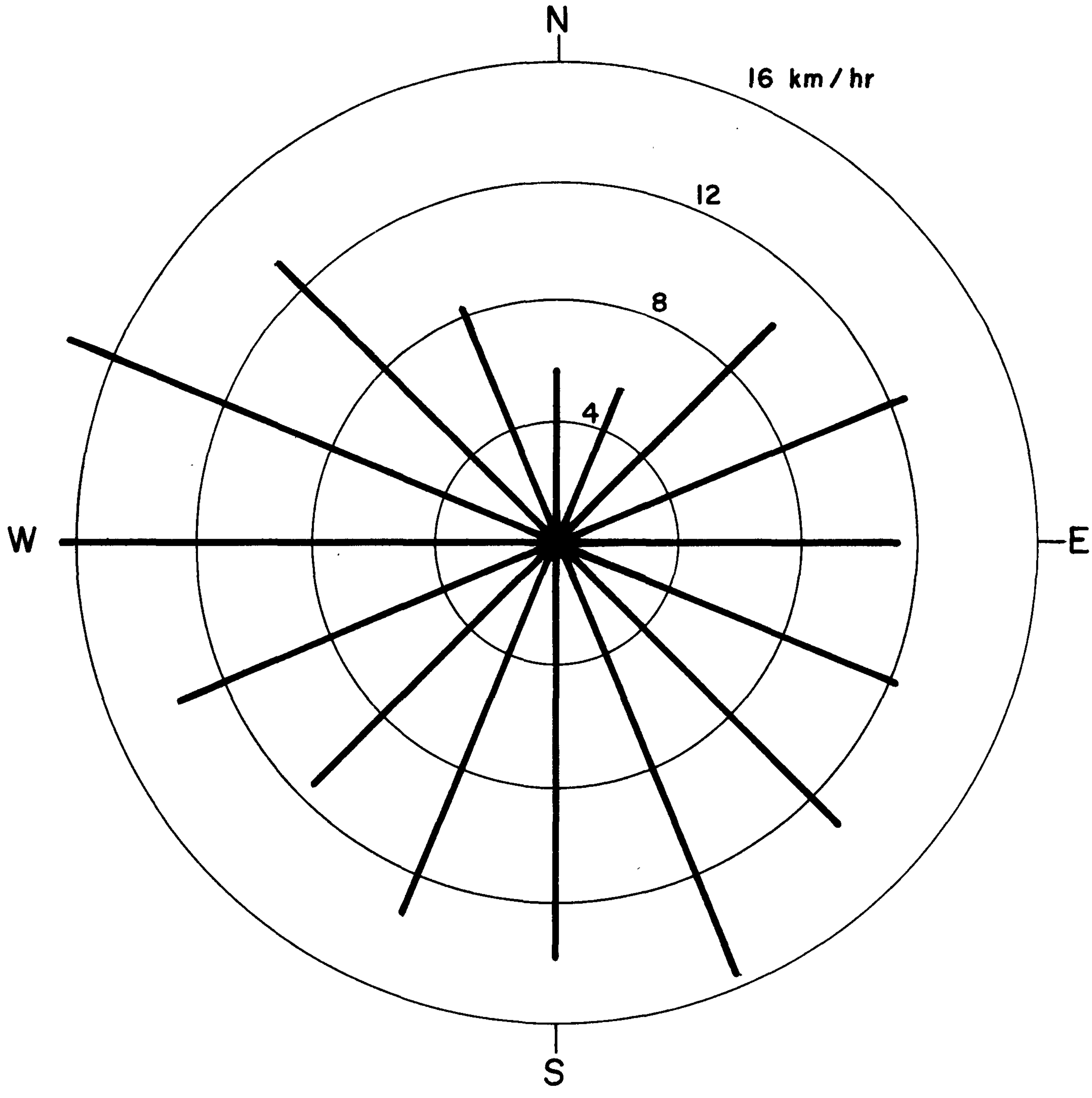


TABLE 6.2

PERCENTAGE FREQUENCY - WIND DIRECTION BY MONTHS*

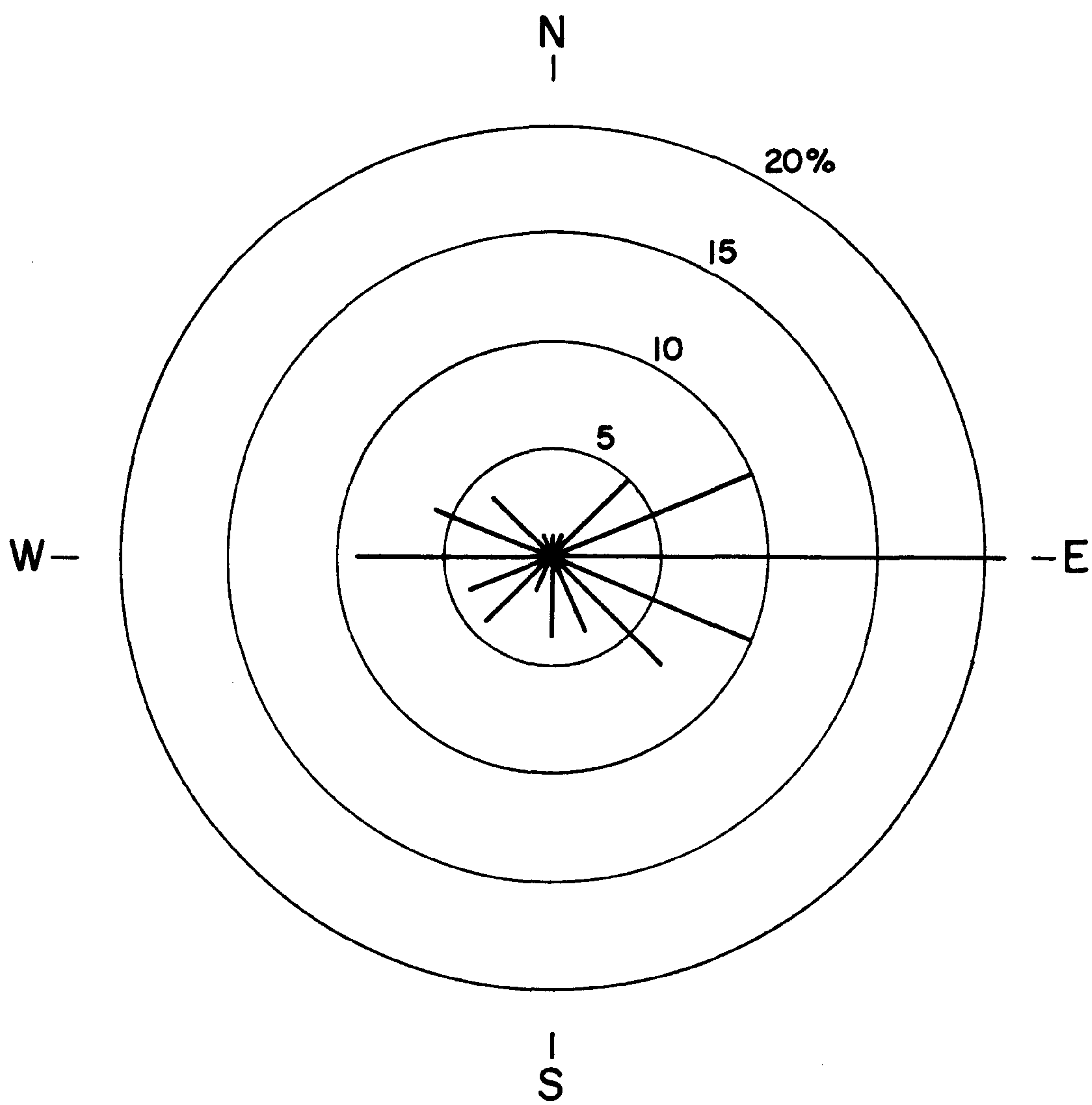
VANCOUVER INTERNATIONAL AIRPORT

	Percentage Frequency												
Month / Direction	J	F	M	A	M	J	J	A	S	O	N	D	All Months Average
N	1	2	1	2	1	1	1	1	2	1	2	1	1
NNE	1	1	2	1	1	1	*	1	1	1	1	1	1
NE	6	7	6	5	6	4	4	5	4	5	6	6	5
ENE	17	14	10	7	8	8	7	7	7	9	12	13	10
E	29	24	20	17	16	18	17	19	16	21	24	29	21
ESE	9	8	9	8	8	11	11	12	10	10	10	11	10
SE	6	5	6	7	6	9	9	8	6	6	6	6	7
SSE	3	3	4	4	4	5	4	3	3	4	4	4	4
S	3	4	6	6	5	6	4	4	3	3	4	3	4
SSW	1	2	3	4	4	4	3	2	1	2	1	2	2
SW	2	3	3	5	5	4	5	4	3	3	2	2	3
WSW	2	3	4	6	6	5	6	5	4	3	2	2	4
W	5	7	8	10	11	9	12	10	11	9	7	5	9
WNW	3	5	6	8	9	6	7	6	10	7	6	4	6
NW	3	4	5	4	4	3	4	4	6	5	4	3	4
NNW	1	1	1	1	1	1	*	1	2	1	1	1	1
Calm	8	7	6	5	5	5	6	8	11	10	8	7	7

*Data from Ref. 16

Figure 6.3

AVERAGE PERCENTAGE FREQUENCY WIND DIRECTION FOR ALL MONTHS
VANCOUVER INTERNATIONAL AIRPORT



6.2 Stability

The diffusive potential of the lower atmosphere is described by the six stability classes presented in Table 6.3 (17, 11, p. 304). The classes are specified in terms of wind speed, insolation and cloudiness. The class A is the most unstable (very unstable), class F the most stable (moderately stable) and class D is the neutral class. Night refers to the period from 1 hour before sunset to 1 hour after sunrise. "Strong" insolation corresponds to a solar altitude greater than 60° with clear skies; "slight" insolation corresponds to solar altitudes from 15 to 35° with clear skies.

TABLE 6.3*

KEY TO STABILITY CATEGORIES

Surface Wind Speed (at 10m),		Day			Night	
		Insolation			Thinly Overcast or ≥4/8 Low Cloud	≤3/8 Cloud
m/sec	km/hr	Strong	Moderate	Slight		
<2	<7.2	A	A–B	B		
2–3	7.2–10.8	A–B	B	C	E	F
3–5	10.8–18.0	B	B–C	C	D	E
5–6	18.0–21.6	C	C–D	D	D	D
>6	>21.6	C	D	D	D	D

The neutral class D, should be assumed for overcast conditions during day or night regardless of wind speed.

* From ref 17.

Cloudiness will decrease incoming solar radiation and should be considered along with solar altitude in determining insolation (17). The number of hours with bright sunshine and cloud normals are given in Table 6.4 (18). Hours of sunshine average 44 in December, 17% of the total possible, and 310 in July, 64% of the total possible. The average number of hours of sunshine for the whole year is 1,925 or 44% of the total possible.

The average annual atmospheric conditions during a period from 1968 to 1972 are presented in Table 6.5 (19). The average wind speeds, and relative frequencies of stability categories, calm weather and wind directions are presented.

TABLE 6.4

BRIGHT SUNSHINE AND CLOUD NORMALS *

VANCOUVER INTERNATIONAL AIRPORT

	J	F	M	A	M	J	J	A	S	O	N	D	Year
No. of hours with bright sunshine	58	89	124	195	250	229	310	250	190	114	71	44	1,925
Percent of possible sunshine	22	32	33	48	53	47	64	56	51	35	26	17	44
Mean cloud	8.0	7.5	7.1	6.8	6.4	6.8	4.8	5.1	5.4	7.1	7.9	8.1	6.8
Frequency of 8 - $^{10}/10$	77	69	64	59	54	59	39	42	48	65	74	77	61
3 - $^{7}/10$	9	13	16	19	20	20	19	19	15	13	11	11	15
0 - $^{2}/10$	14	18	20	22	26	21	42	39	37	22	15	12	24

* Data from ref.18

TABLE 6.5

AVERAGE ANNUAL ATMOSPHERIC CONDITIONS*
VANCOUVER INTERNATIONAL AIRPORT

	STABILITY CLASS												All Classes	
	A		B		C		D		E		F			
Class Frequency, %	0.32		6.71		11.88		51.45		8.33		21.31		100.00	
Calm Frequency, %	0.11		0.79		1.09		1.54		0.00		7.00		10.53	
Wind Direction	Fre-quency %	Avg Wind Speed km/hr	Fre-quency %	Avg Wind Speed km/hr	Fre-quency %	Avg Wind Speed km/hr	Fre-quency %	Avg Wind Speed km/hr	Fre-quency %	Avg Wind Speed km/hr	Fre-quency %	Avg Wind Speed km/hr	Fre-quency %	Avg Wind Speed km/hr
N	0.00	1.9	0.03	4.6	0.11	5.0	0.22	6.9	0.07	9.1	1.36	5.4	1.79	5.7
NNE	0.00	0.0	0.02	4.1	0.05	5.4	0.23	9.1	0.07	10.0	0.76	4.8	1.13	6.3
NE	0.00	0.0	0.02	4.4	0.11	6.1	0.77	12.0	0.12	11.3	0.96	5.0	1.98	8.7
ENE	0.00	0.0	0.06	4.4	0.19	7.0	3.58	14.0	0.61	10.0	1.83	5.9	6.27	11.9
E	0.01	2.8	0.29	5.4	1.00	8.7	16.42	15.4	2.94	10.9	6.25	6.3	26.91	12.8
ESE	0.01	6.9	0.39	6.5	1.06	10.0	6,86	14.4	1.61	10.7	3.14	6.5	13.07	11.9
SE	0.02	5.7	0.49	7.6	0.91	12.4	4.19	17.4	0.32	10.4	1.14	5.9	7.07	14.4
SSE	0.02	5.6	0.37	8.1	0.58	11.9	2.44	18.7	0.16	9.6	0.55	5.7	4.12	15.2
S	0.02	6.7	0.41	7.8	0.66	10.9	2.37	18.0	0.22	10.4	0.72	5.7	4.40	14.1
SSW	0.01	6.9	0.28	7.6	0.44	10.7	1.18	17.8	0.13	11.5	0.35	5.6	2.39	13.5
SW	0.03	6.9	0.48	8.0	0.63	10.9	1.02	17.4	0.15	13.0	0.33	5.6	2.64	12.8
WSW	0.08	7.6	1.16	9.3	1.20	11.5	1.12	16.5	0.19	12.4	0.38	5.6	4.13	11.9
W	0.09	7.4	1.75	9.3	2.14	12.2	3.46	23.2	0.39	12.6	0.89	5.9	8.72	15.7
WNW	0.02	7.6	0.74	10.4	2.15	15.4	5.75	25.0	0.58	13.7	0.93	6.9	10.17	20.0
NW	0.00	0.0	0.19	7.4	0.54	14.1	1.56	18.5	0.61	13.9	1.02	6.7	3.92	14.3
NNW	0.00	0.0	0.04	4.8	0.11	7.4	0.28	12.0	0.16	11.3	0.72	6.1	1.31	8.5
All directions Avg Wind Speed, km/hr		4.6		7.4		10.7		16.9		11.3		4.1		12.2

* Data from ref. 19

7. DISPERSION MODEL DESCRIPTION

This section describes the mathematical atmospheric diffusion model which was used to estimate the effect of expanded airport activity on ambient air quality in nearby communities.

7.1 General Methodology

Pollutants emitted from a source are diluted with ambient air due to turbulent eddy mixing. The amount of dilution that occurs will hence be proportional to the intensity of these turbulent eddies. Turbulent diffusivity is a complex function of the temperature stratification (or stability), wind shear, surface roughness, and the convective heat flux. If this relationship is known then the dispersion equations can be solved numerically to yield downwind pollutant concentrations.

While research is being done to derive this type of relationship, at present the method of Pasquill and Gifford is more commonly used. Here the stability of the lower atmosphere is empirically correlated to horizontal and vertical dispersion coefficients as a function of downwind distance from the source. As discussed in Section 6.2, atmospheric stability is classified according to surface wind speed, cloudiness, and intensity of sunshine. It can be appreciated that this simple classification cannot accommodate the mechanically induced turbulence caused by gross topological features.

If certain assumptions (steady state, no sinks, constant wind velocity, etc.) are made concerning the dispersion equations, then an analytical solution, commonly called the Gaussian plume model, is obtained. This solution gives a normal distribution of the pollutant in both the horizontal and vertical directions. The standard deviation of these distributions are simply the Pasquill-Gifford dispersion coefficients. This is the fundamental model used in Turner's "Workbook of Atmospheric Dispersion Estimates" (17) which in turn forms the basis of our dispersion model ("PALSE" - Point, Area, and Line Source Evaluation).

Pollutant sources are divided into three categories. Point sources are those sources emitting significant quantities of pollutants from a small area, such as would occur from a large smoke stack. Area sources occur when the emissions are diffuse. They generally consist of an aggregate of small point sources spread over a relatively large area. Line sources refer to straight-line sources where it can be assumed that emissions are steady and uniform over the entire length. For long averaging times this is a reasonable assumption for highways and airport runways.

Receptors are defined as those geographic locations where it is desired to know the ambient pollutant concentration.

The geographic location of these receptors, along with those of the point, area, and line sources, must be specified relative to a Cartesian coordinate system. It is generally convenient to use east/west and north/south as the two axes. Data on source strength and source parameters (stack height, mixing cell dimensions, etc.) as well as meteorological data (wind speed and direction, atmospheric stability) must be specified.

Since the Gaussian plume model was derived such that the downwind direction lies parallel to the major axis it is necessary, for a specified meteorological condition, to rotate the geographic coordinates to satisfy this condition. Then, for a given receptor, contribution from each pollutant source is computed and printed, as well as the total concentration at that point. In this manner the relative contribution of say access vehicular traffic to that of airplane activity can be easily determined.

Figure 7.1 illustrates the mainline logic as described above. Figures 7.2 and 7.3 show the subroutine logic used to estimate the pollutant contribution from each source category. These will be described in the following subsections.

Figure 7.1
PALSE MAINLINE LOGIC

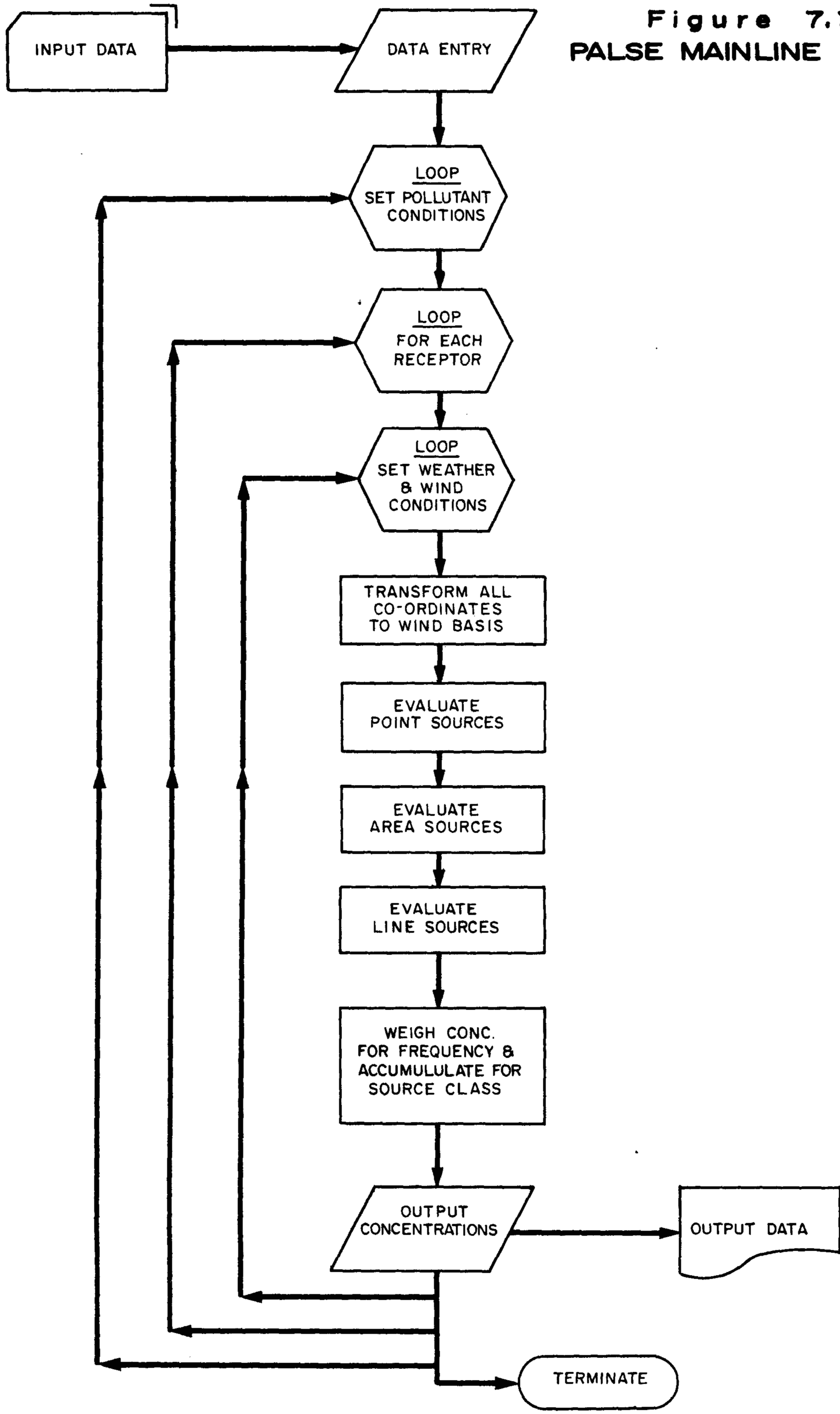


Figure 7.2

POINT SOURCE AND AREA SOURCE EVALUATION LOGIC

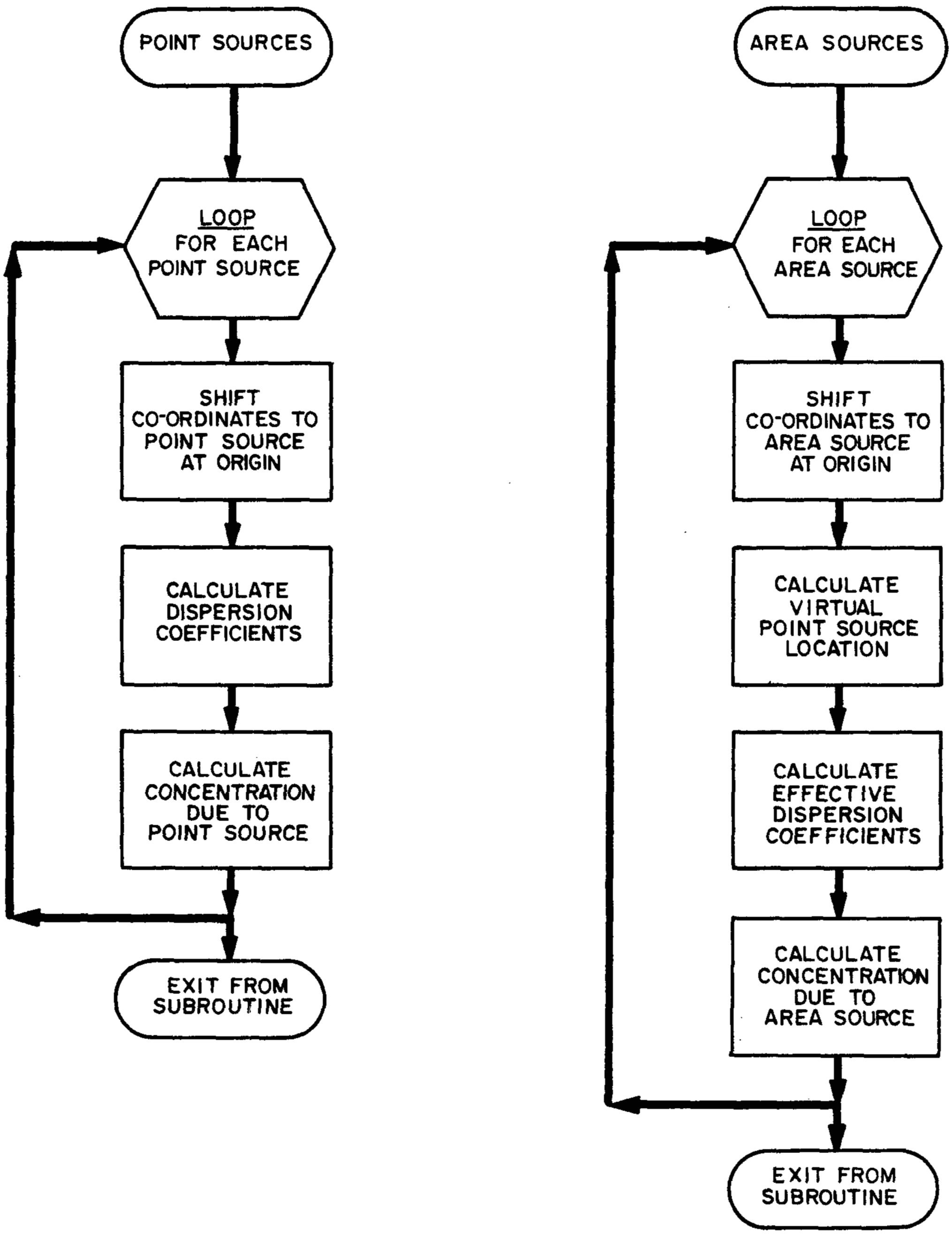
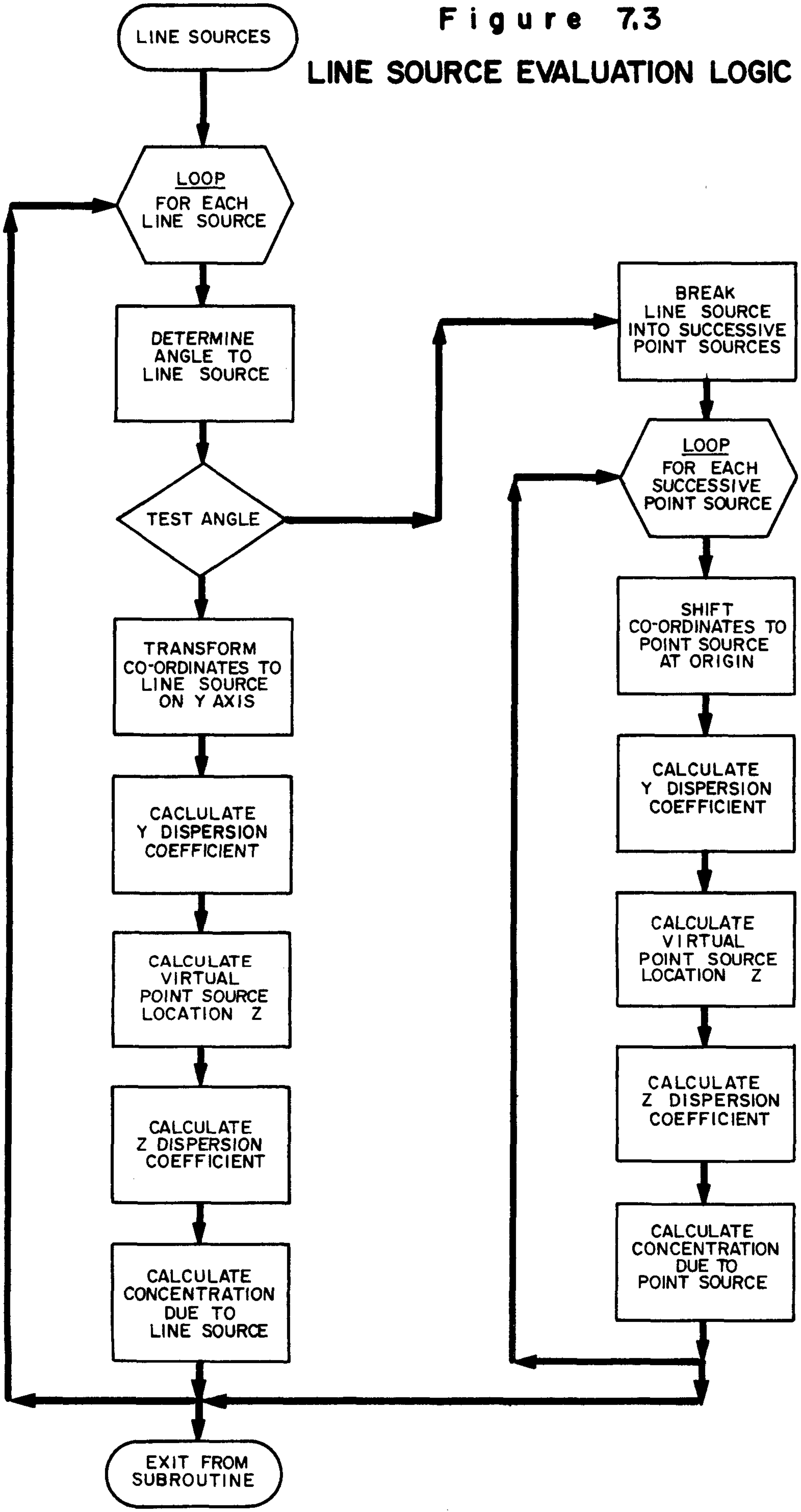


Figure 7.3

LINE SOURCE EVALUATION LOGIC



7.2 Point Source Evaluation

The estimation of pollutant dispersion from point sources can be delineated into two parts:

1 - estimation of the plume rise due to the kinetic and thermal energy of the emitted gases. The sum of the plume rise and the stack height gives the effective stack height.

2 - estimation of plume dispersion due to turbulent diffusion in the atmosphere.

Plume rise is computed using the Moses-Carson 1968 formulae for stability classes. These formulae were compared (20) with data from 711 plume rise observations and yielded the smallest standard error. The data were obtained from single stacks whose heat emission rate varied over four orders of magnitude. Hence it is felt that the formulae should be appropriate for our diffusion model which is intended to be reasonably general in applicability.

The plume rise formulae are:

A, B, C Stability: $$\Delta h = \frac{3.47\ Vd + 10.53\sqrt{Q_H}}{u}$$

D Stability: $$\Delta h = \frac{0.35\ Vd + 5.41\sqrt{Q_H}}{u}$$

E, F Stability: $$\Delta h = \frac{-1.04\ Vd + 4.58\sqrt{Q_H}}{u}$$

where

V = stack exit velocity (m/s)
d = stack diameter (m)
Q_H = heat emission rate (Kcal/s)
u = wind speed at top of stack (m/s)

The Pasquill-Gifford Gaussian plume model as used by Turner (17) has been further extended (21) to allow for partial ground absorption and for decay due to a simple chemical reaction. For a downwind receptor the pollutant concentration is given as

$$C(x,y,z) = \frac{Q}{2\pi u \sigma_y \sigma_z} \exp\left(-\frac{\lambda x}{u}\right) \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \left[\exp\left(-\frac{(z-h)^2}{2\sigma_z^2}\right) + P \exp\left(-\frac{(z+h)^2}{2\sigma_z^2}\right)\right]$$

where

$C(x,y,z)$ = ambient concentration at (x,y,z), (gm/m^3)

x = downwind distance from source, (m)

y = cross-wind distance from plume axis, (m)

z = receptor height above ground level (m)

Q = source strength (gm/s)

u = mean wind velocity (m/s)

σ_y, σ_z = plume dispersion coefficients (m)

λ = pollutant decay coefficient (sec^{-1})

P = fraction of plume reflection

h = effective stack height (m)

($h = h_s + \Delta h$, where h_s is the true stack height)

The dispersion coefficients σ_y and σ_z are those of Pasquill-Gifford and are obtained by curve-fitting the graphs given in Turner's Workbook (17). This process yields a family of equations of the form $\sigma_y(x,s) = f_{y,s}(x)$ and $\sigma_z(x,s) = f_{z,s}(x)$ where s denotes the stability class.

Figure 7.2 shows the logic used to evaluate a point source. The source and receptor coordinates must be shifted so that the source is located at the origin.

7.3 Area Source Evaluation

A diffuse area source is treated as a mixing cell with initial horizontal and vertical dispersion coefficients $\sigma_y°$ and $\sigma_z°$. The initial standard deviation (dispersion) for a square area with sides of length s can be approximated by $\sigma_y° \approx s/4.3$. The initial vertical dispersion would correspond to the standard deviation of the variation in individual source heights.

The area source can now be treated as a point source located at an upwind virtual origin. This strategy reduces to determining the virtual origin distances d_y and d_z from the dispersion coefficient relationships described previously:

$$\sigma_y° = f_{y,s}(d_y)$$

$$\sigma_z° = f_{z,s}(d_z)$$

For purposes of diffusion calculations the dispersion coefficients are then evaluated using

$$\sigma_y(x,s) = f_{y,s}(x + d_y) \text{ and}$$

$$\sigma_z(x,s) = f_{z,s}(x + d_z) \text{ .}$$

The mean stack height is taken as the effective stack height when using the point source diffusion model, i.e., it is assumed that there is no significant plume rise associated with an area source.

Figure 7.2 shows the simplified program logic used to evaluate area sources.

7.4 Line Source Evaluation

When a receptor is located adjacent to a line source then this source can be treated as an infinite line source and the resultant diffusion equation is greatly simplified. Sutton (21) presents an expression for the case where the wind is perpendicular to the infinite line source. Turner (17) extends this relation to oblique winds when the angle ϕ between the line source and the wind direction is greater than 45^o. Calder (22) shows that Turner's relation gives incorrect results for very oblique winds. He derives an approximation formula which yields accurate results for values of ϕ down to 15^o.

For finite line sources one must account for edge effects. Sutton (21) does this for a wind orientated perpendicular to the finite line. For an oblique finite line source no appropriate diffusion equation existed. Hence we used Calder's (22) methodology to extend Sutton's expression to this general case. Figure 7.4 illustrates the source/receptor relation used in the derivation. It is assumed that the line source lies on the Y axis as shown. This implies that a coordinate transformation must be made before the derived equation can be utilized. For a value of $\beta > 15^o$ ($\beta = 90-\theta$) the ground-level concentration from an oblique line source is given by:

$$C_L{}^{\theta}(x,y,0) = \frac{\sqrt{\pi/2}\ \sigma_y(D)\ K\ (x,0)}{\cos\theta}\ [\mathrm{Erf}(p_1) - \mathrm{Erf}(p_2)]$$

where

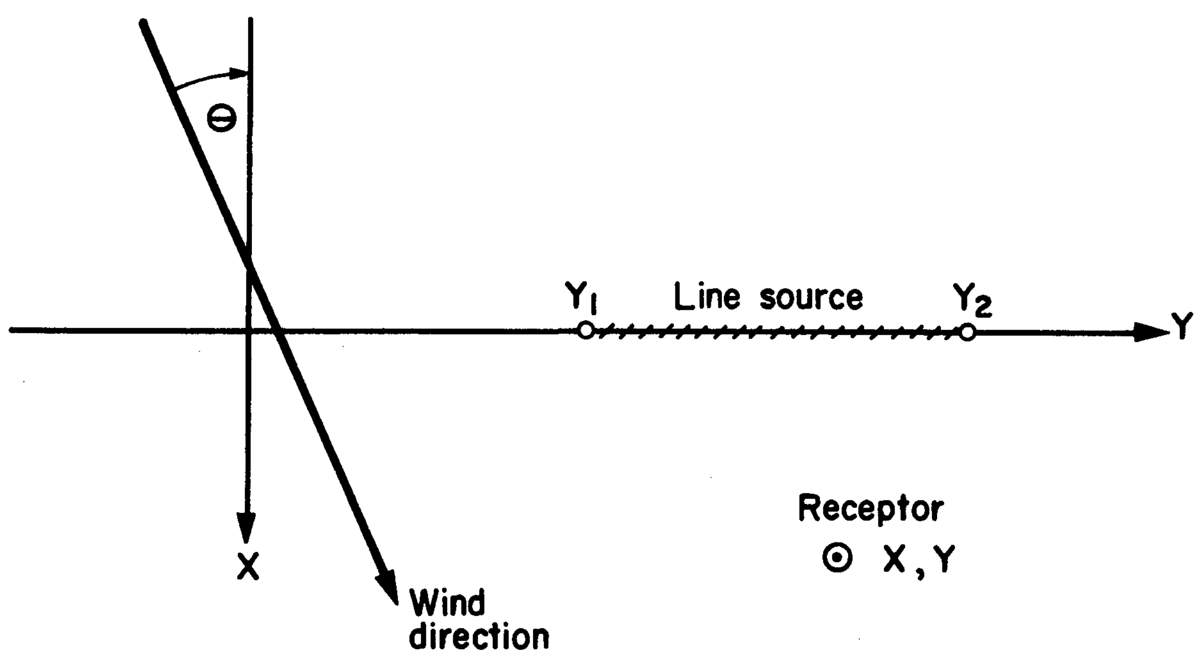
$$K(x,0) = \frac{(1+P)\ Q_L}{2\pi u\sigma_y(D)\sigma_z(D)}\ \exp\left(\frac{-\lambda x}{u\cos\theta}\right)\ \exp\left(\frac{-h^2}{2\sigma_z^2\ (D)}\right)$$

$$pi = \frac{(Y - Yi)\cos\theta - X\sin\theta}{\sqrt{2}\ \sigma_y\ (D)}$$

$$D = x\sec\theta$$

Figure 7.4

ORIENTATION OF AN OBLIQUE FINITE LINE SOURCE



NOTES

Θ = Angle from wind vector to line source normal.

Y_1 and Y_2 defined such that $Y_2 > Y_1$.

$\sigma_y(D)$, $\sigma_z(D)$ = dispersion coefficients as previously defined (m)

Erf = error function

P = fraction ground reflectance

λ = decay coefficient

Q_L = source strength (gms/m/s)

u = mean wind velocity (m/s)

h = mean height of line emission (m)

Initial vertical dispersion, due to the turbulent wake caused by a moving vehicle or aircraft, is allowed for by specifying a value σ_z^o (22). The subsequent computation of σ_z is then modified to allow for this initial mixing, as was done for the area source methodology previously described.

When the angle between the wind direction and the line source is less than 15° then the line source is approximated by a series of equi-spaced point sources. Point source spacing is based on the plume spread that occurs in a very stable atmosphere and on the minimum distance between the receptor and the line source terminals as given by

$$D_{min} = \underset{i = 1,2}{\text{Min}} \sqrt{(Xr - Xi)^2 + (Yr - Yi)^2} .$$

Then the spacing, ΔL, is

$$\Delta L = \frac{34}{\cos\theta} \left(\frac{D_{min}}{1000}\right)^{0.91} \text{ meters.}$$

From this the number of points and their specific source strength can easily be calculated.

7.5 Runway Climb-out and Approach Zones

Subsequent to the construction of the above computer model it was decided to further refine the model to include a realistic spatial distribution of aircraft emissions during runway approach and climb-out modes. Hence these inclined line sources are treated as a non-equispaced sequence of point sources, with spacing based on the vertical resolution desired.

For purposes of this study each inclined line source is approximated by 16 point sources, resulting in 96 points for all three runways. Spatial distribution is determined by the normalized coefficients c_i, where $c_i = 0.01(1.2147)^{i-1} + c_{i-1}$. Hence, if $P1$ and $P2$ are the vector coordinates of the beginning and end points of an incline, per Table 5.15, then the vector coordinate of the i^{th} point source is given by

$$p_i = P1 + c_i \cdot (P2 - P1) \ .$$

It can be readily ascertained from the above that maximum resolution (minimum spacing) occurs near the ground where the receptors are located.

Given the appropriate inclined line source emission rate (Tables 5.12 - 5.14) W, the computer then assigns to point source p_i an emission w_i according to

$$w_i = 0.01(1.2147)^{i-1} \ W.$$

In other words, point source strength is in direct proportion to the length of the line segment which it approximates.

7.6 Maximum Short-term Concentrations

Maximum ambient pollutant concentrations will occur during peak source emissions and under adverse weather conditions. Each receptor will have associated with it a critical wind angle which yields a maximum concentration.

Hence the methodology to estimate this value is to input peak emissions and then to vary the allowable weather conditions until a maximum occurs. The resulting concentration is applicable for a 10 minute sampling period. To extend this to longer periods the method recommended by Turner (17) is used:

$$C_s = C_{10} \left(\frac{10}{t_s}\right)^{0.185}$$

where C_s is the desired concentration estimate for the sampling time t_s and C_{10} is the concentration estimated using the Pasquill-Gifford dispersion coefficients.

While this procedure is useful for establishing an upper bound on airport derived ambient pollutant levels, it should be emphasized that such episodes — a combination of peak emissions and very adverse weather — would be infrequent. Table 6.5 lists the average frequency of occurrence of various meteorological conditions. No data is available on the joint probability between adverse conditions and maximum emissions, nor is suitable data available on the duration of such an episode.

7.7 Annual Mean Concentrations

Long term ambient pollutant concentrations are always considerably less than the short term maximums. This is mainly due to the variations in wind direction, velocity, and atmospheric turbulence. Historical data on these parameters are averaged to give rise to wind roses or to wind stability roses. While these averaged weather conditions obviously are of little value in estimating short term maximum concentrations, they do furnish the necessary meteorological input for computing expected long term averages.

An estimate of the annual mean ambient concentration at receptor "r" due to pollutant emissions from source "s" can be obtained by the following expression:

$$\overline{C}_{r,s} = \sum_{\phi} f_{\phi} \sum_{w} f_w(\phi)\ C_{r,s}(\phi,w)$$

where

f_{ϕ} is the fraction of the year that the wind blows from direction "ϕ",

$f_w(\phi)$ is the relative frequency of weather condition "w" (wind speed and atmospheric stability) given a wind direction "ϕ",

$C_{r,s}(\phi,w)$ is the short term (one-hour) concentration calculated using program PALSE.

8. DIFFUSION MODELING RESULTS

Diffusion modeling was carried out for five potential pollutants: nitrogen oxides, carbon monoxide, sulfur dioxide, suspended particulates, and hydrocarbons. The contribution to the ambient air quality, for the respective pollutants, was estimated at four representative locations and the results were compared with federal air quality objectives. This was done for the year 1975 through to the year 2000. The study includes emissions associated with the operation of a proposed expanded airport, and from the proposed ferry terminal and its associated access traffic (see Appendix).

Figure 8.1 shows the relative position of the four points (receptors R1 - R4) where the contributions to ambient pollutant concentrations were estimated. For a given receptor the maximum one hour concentration will occur when the peak hour emissions coincide with adverse weather conditions. As previously described (Section 7.6), there is associated with each receptor a critical wind angle which will result in maximum pollutant concentration. For the four receptors these were found to be:

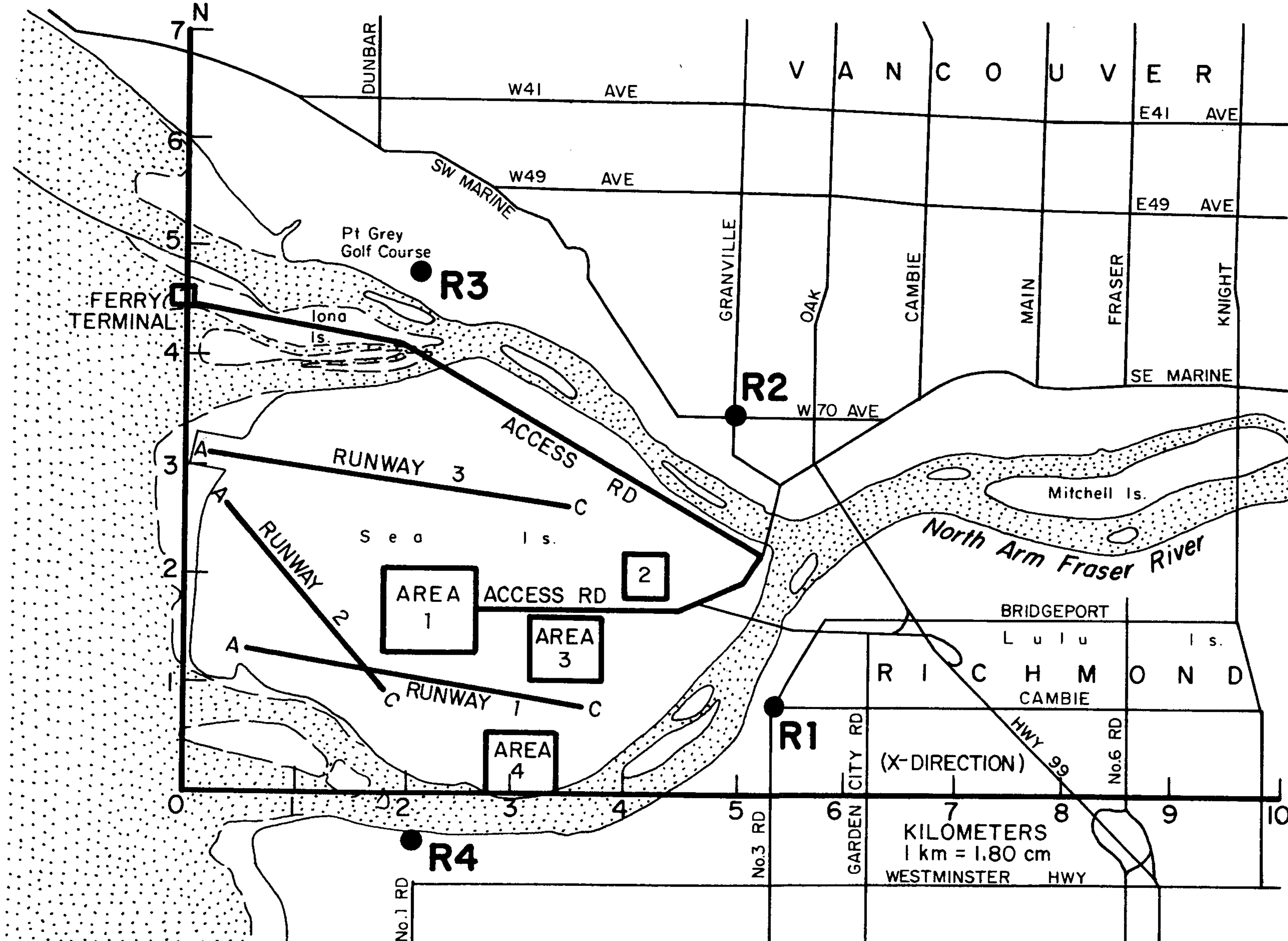
TABLE 8.1

CRITICAL WIND ANGLES

Receptor Number	Critical Wind Angle*	Wind Sector	Inversion Frequency (Table 6.5)	Associated Average Wind Speed (m/s)
1	295°	WNW	0.0093	1.9
2	242°	WSW	0.0038	1.5
3	183°	S	0.0072	1.6
4	355°	N	0.0136	1.5

* Angle is taken clockwise from true north.

Figure 8.1
LOCATION OF RECEPTORS



Hence for adverse weather conditions it was assumed that the wind persistently blew from the critical angle at 1 m/s during a deep ground-based inversion (Class F stability). These conditions, coinciding with peak source emissions, would occur only infrequently but do serve to place an upper bound on possible ground level concentration. The above table shows the average frequency of occurrence of stable conditions when the wind blows in a sector associated with the critical wind angle. Shown also is the average wind speed for this condition. From available meteorological data (19) a wind speed of 1 m/s, or less, occurs in approximately 50% of the instances of a ground-based inversion. If we now arbitrarily choose a joint probability of 0.1 between peak emissions and the assumed adverse conditions, then we can estimate the number of hours per year during which the calculated maximum ground level concentrations may occur: hours/year $\approx 0.5 \times 0.1 f_F = 438 f_F$, where f_F is the frequency from Table 8.1. For receptor #2 this works out to 2 hours per year, while for receptor #4 the value is 6 hours/year. The reader should keep these figures in mind when reviewing the maximum concentrations presented in the following text.

A reasonable estimate of 24-hour average ambient concentrations can be made by assuming that there is a steady wind shift from the east to the north-west during which time a cloudy sky and a 5-knot (2.6 m/s) wind result in a neutral stability atmosphere (19). Hence for eleven compass sectors the wind duration per sector would be 2.2 hours and the resulting weighting factor to be used in the equation of Section 7.7 would be 0.079.

The methodology for estimating expected annual mean pollutant concentrations was described in Section 7.7. Weighting factors associated with various non-isotopic average weather conditions were obtained from Table 6.5.

The following subsections will present the results of the computer modeling described above. Ambient pollutant concentration is plotted versus year, with the concentration further delineated as to source class:

1. Airport - terminal area, runways, and climb-out and approach zones.

2. Access Roads - automobile access roads from east side of Sea Island to the terminal area.

3. Miscellaneous Sources - hanger areas, utility plants, etc. per Areas 2, 3, and 4 of Figure 8.1.

4. Ferry Terminal - includes the terminal proper plus its associated access road. The terminal is shown (Figure 8.1) situated on Iona Island. Its actual location is not yet known but would probably be about 3 miles west of this island.

8.1 Oxides of Nitrogen

Federal objectives have been established for nitrogen dioxide (23). These are:

Averaging Period	Concentration (μg/m^3)	
1 hour	400	(Maximum Acceptable)
24 hours	200	(Maximum Acceptable)
1 year	100	(Maximum Acceptable)
1 year	60	(Maximum Desirable)

It will be noted that the above ambient air quality objectives pertain to NO_2, while the source emissions tabulated in Section 5 are given as total oxides of nitrogen. During most combustion processes oxides of nitrogen are mainly emitted in the form of nitric oxide (NO). The NO is subsequently oxidized to NO_2 which can participate in various complex photochemical reactions among which is a photodecomposition back to NO and atomic oxygen. The mechanisms and kinetics of the many complex atmospheric reactions undergone by the oxides of nitrogen are not yet well understood. Our diffusion model does not include photochemical reactions and so cannot estimate ambient NO_2 levels. Since the total oxides of nitrogen (NO_x), and not just NO_2, are photochemical smog precursors, we feel that estimated ambient concentrations of NO_x can and should be compared directly with NO_2 standards if the object is to assess the smog potential. It should be remembered, however, that the actual NO_2 levels will be somewhat lower than the estimated NO_x concentrations.

Figures 8.2 - 8.5 show the maximum one-hour NO_x concentrations calculated for the four receptors. In all four cases the airport (terminal plus runways) is the major contributor. For receptor #1 the airport access road is initially a major contributor. It can be observed that by 1985 the air quality objective of 400 $\mu g/m^3$ may be occasionally exceeded. Also apparent is the temporary decrease in NO_x concentration (1980 - 1985) resulting from federal automobile emission standards coming into effect.

Figure 8.5 shows a maximum one-hour concentration, for the year 2000, of 1040 $\mu g/m^3$ of NO_x which is attributable to aircraft related sources. A further breakdown of this figure is shown below:

Source	Contribution ($\mu g/m^3$)
Terminal	164
Runway 1	468
Runway 2	13
Runway 3	312
Climb-out/Approaches	80

Figure 8·2
MAXIMUM ONE-HOUR NO_x CONCENTRATION
RECEPTOR No. 1

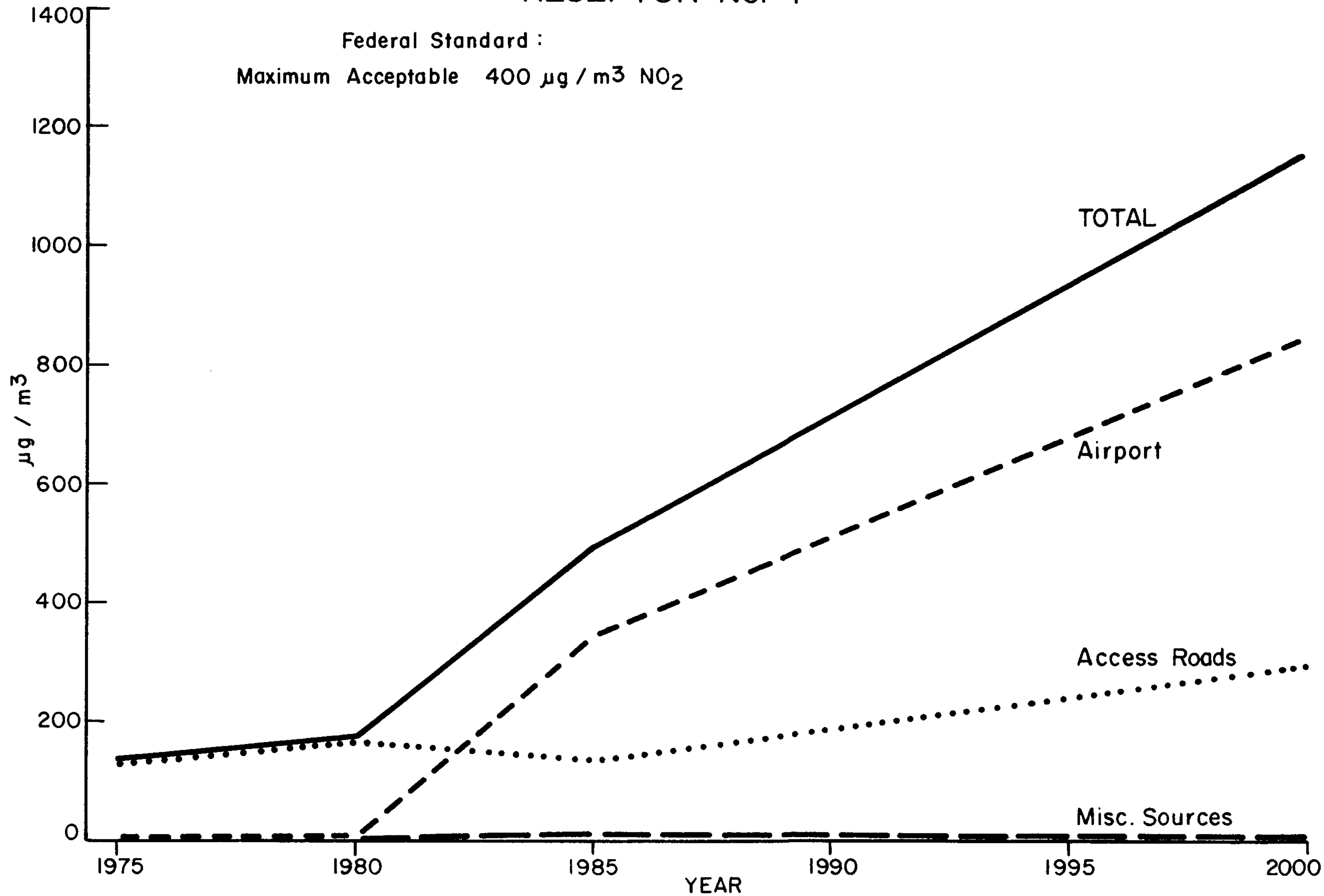


Figure 8·3

MAXIMUM ONE-HOUR NO_x CONCENTRATION

RECEPTOR No. 2

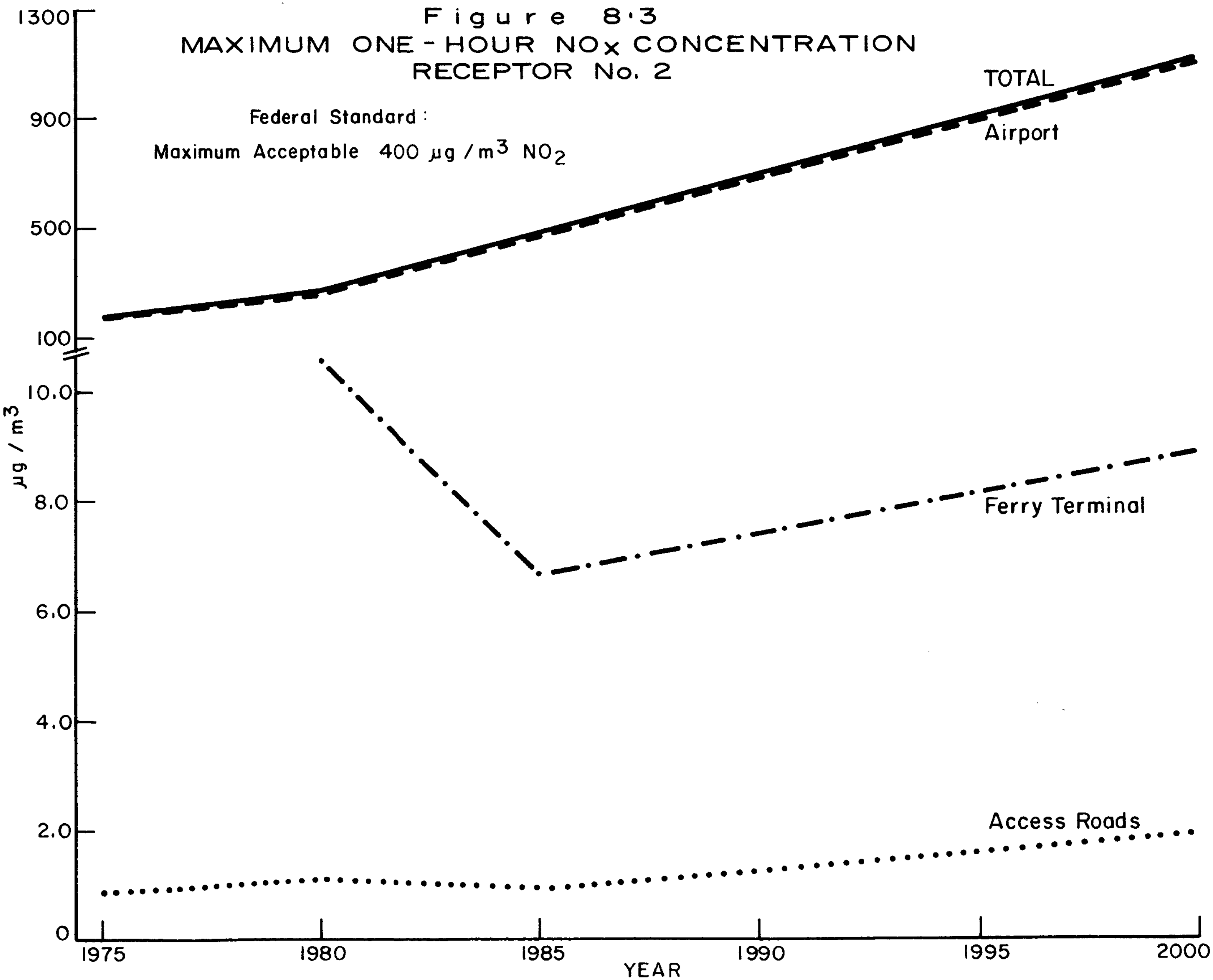


Figure 8·4

MAXIMUM ONE-HOUR NO_x CONCENTRATION

RECEPTOR No. 3

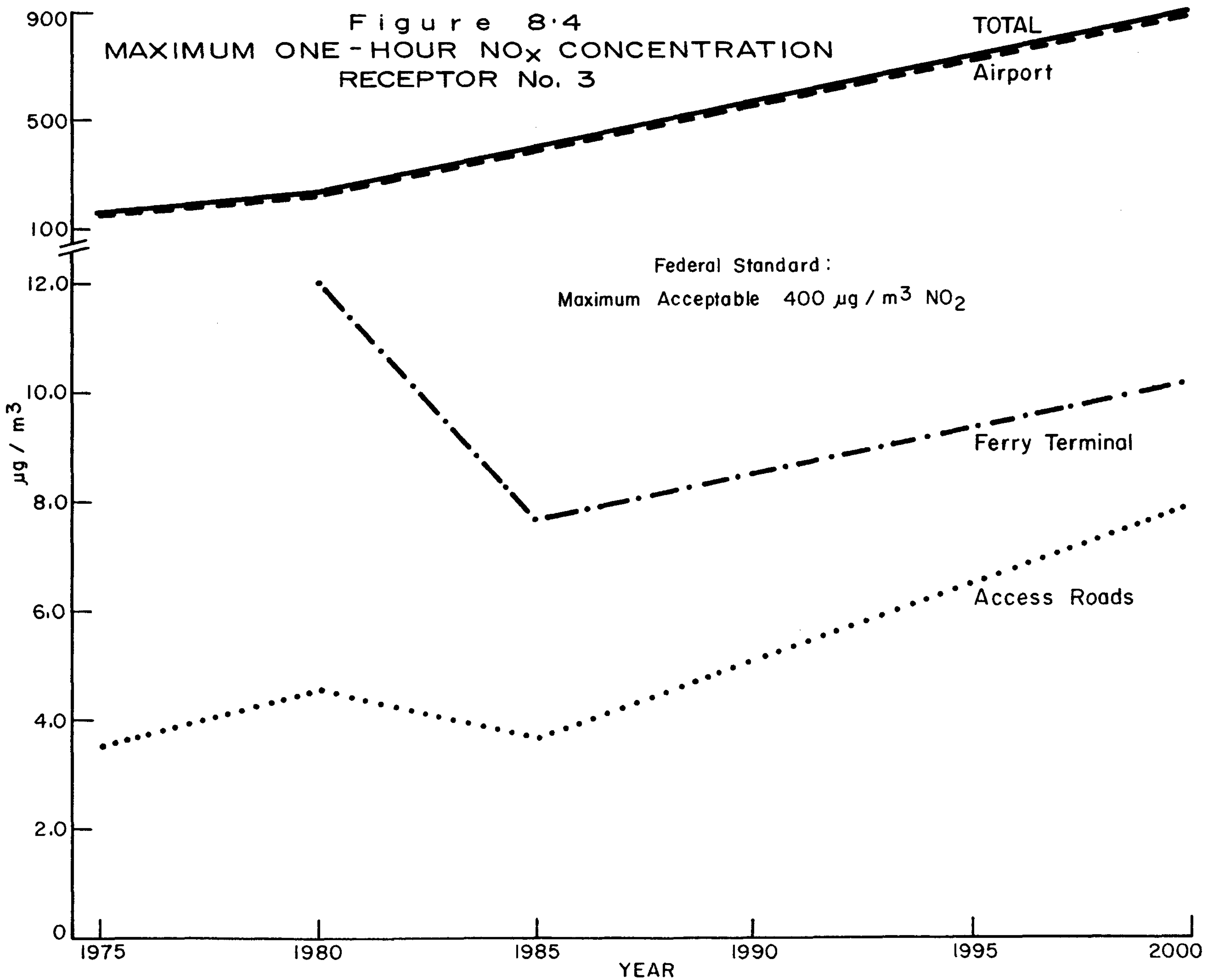
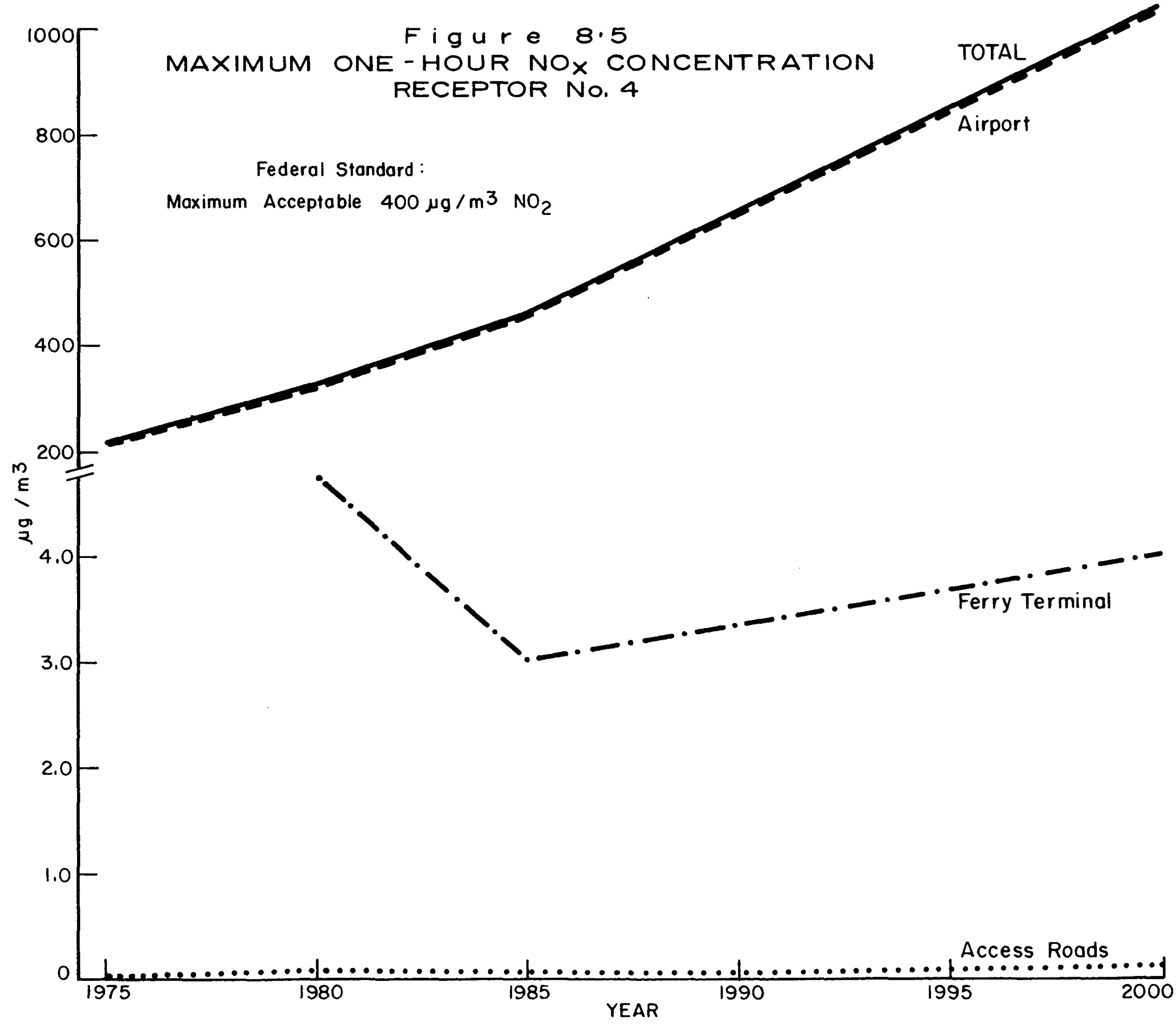


Figure 8·5
MAXIMUM ONE-HOUR NO_x CONCENTRATION
RECEPTOR No. 4



In order to check the model for the line source approximation (Section 7.4) the contribution from runway 1 to the concentration at receptor 4 was estimated using the recently published (28) boundary layer model of Ragland and Peirce. Assuming an upper (300 m) geostrophic wind speed of 5 m/s, a stable atmosphere, and a surface roughness of 0.2 m, their numerical model yields a concentration of 580 $\mu g/m^3$ NO_x. The results of our model, where a wind speed of 1 m/s near the ground is assumed, is seen to be 468 $\mu g/m^3$. The somewhat lower concentration predicted would be partially due to our use of an initial mixing cell volume in order to allow for traffic generated turbulence. In any event the close agreement between the two independent methods is gratifying. It should be noted that researchers testing several mathematical models for reliability in forecasting the dispersion of vehicle emissions have concluded that the Gaussian model is the most reliable under the greatest amount of circumstances (29).

Figures 8.6 to 8.9 show typical 24-hour ambient NO_x concentrations for the four receptors during the years 1975 through 2000. It should be reiterated that only airport related emissions are included - the ground level concentrations would be correspondingly higher if emission sources from the surrounding urban and industrial areas were included.

Expected annual mean NO_x concentrations are depicted in Figure 8.10 to 8.13. The relatively low annual NO_x concentrations reflect the highly non-isotopic average weather conditions tabulated in Table 6.5, where it can be seen that there often occurs a strongly ventilating wind from the east. This would, of course, tend to blow airport related emissions away from the receptors shown in Figure 8.1.

Figure 8.10 shows a slight decrease in NO_x concentration at receptor No. 1 between 1980 and 1985. This apparent anomaly is due to a shift in aircraft traffic when a new runway comes into service in 1985.

8.2 Sulfur Dioxide

The federal ambient air quality objectives (24) for sulfur dioxide are listed below:

Figure 8·6

24 HOUR NOx CONCENTRATION

RECEPTOR No. 1

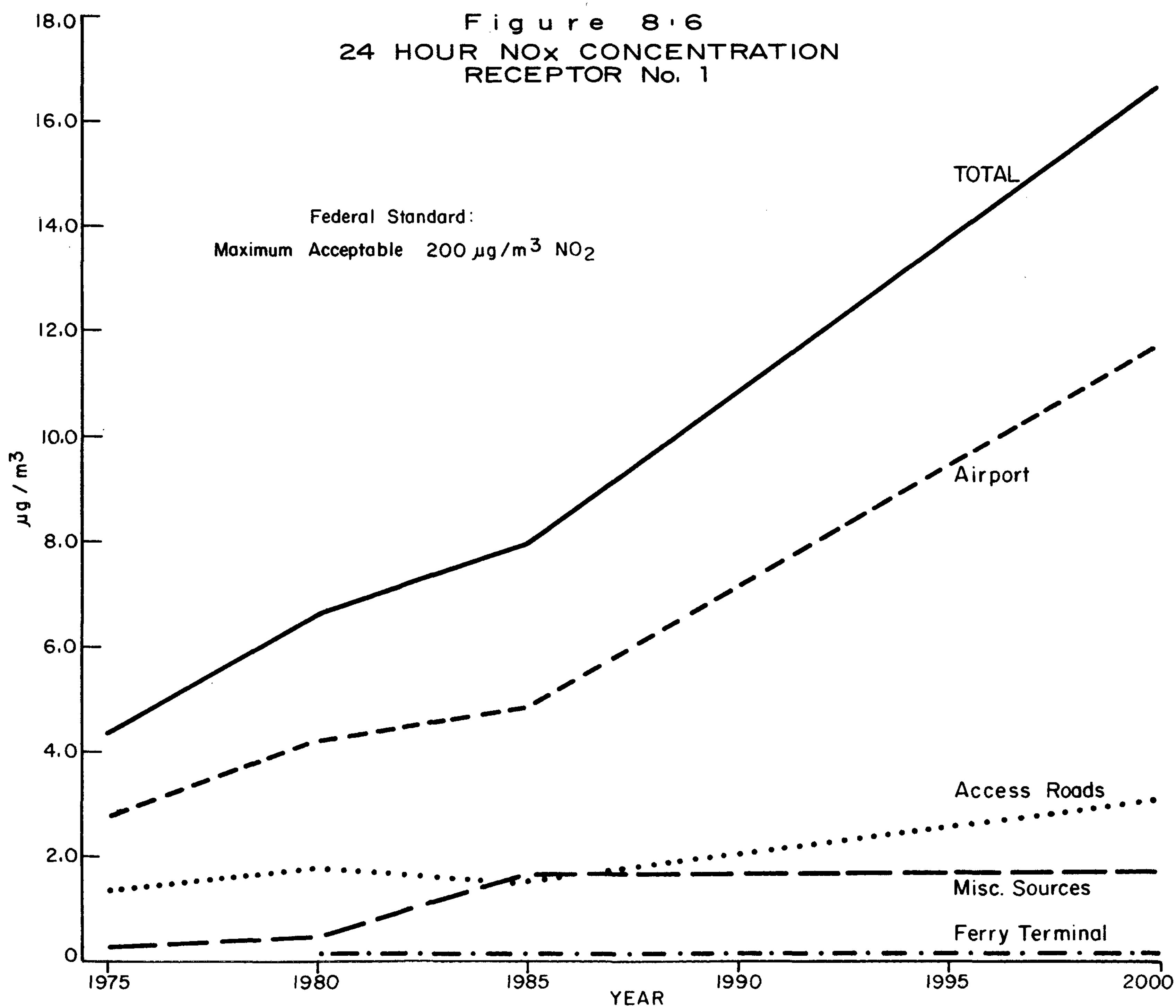


Figure 8·7
24 HOUR NOx CONCENTRATION
RECEPTOR No. 2

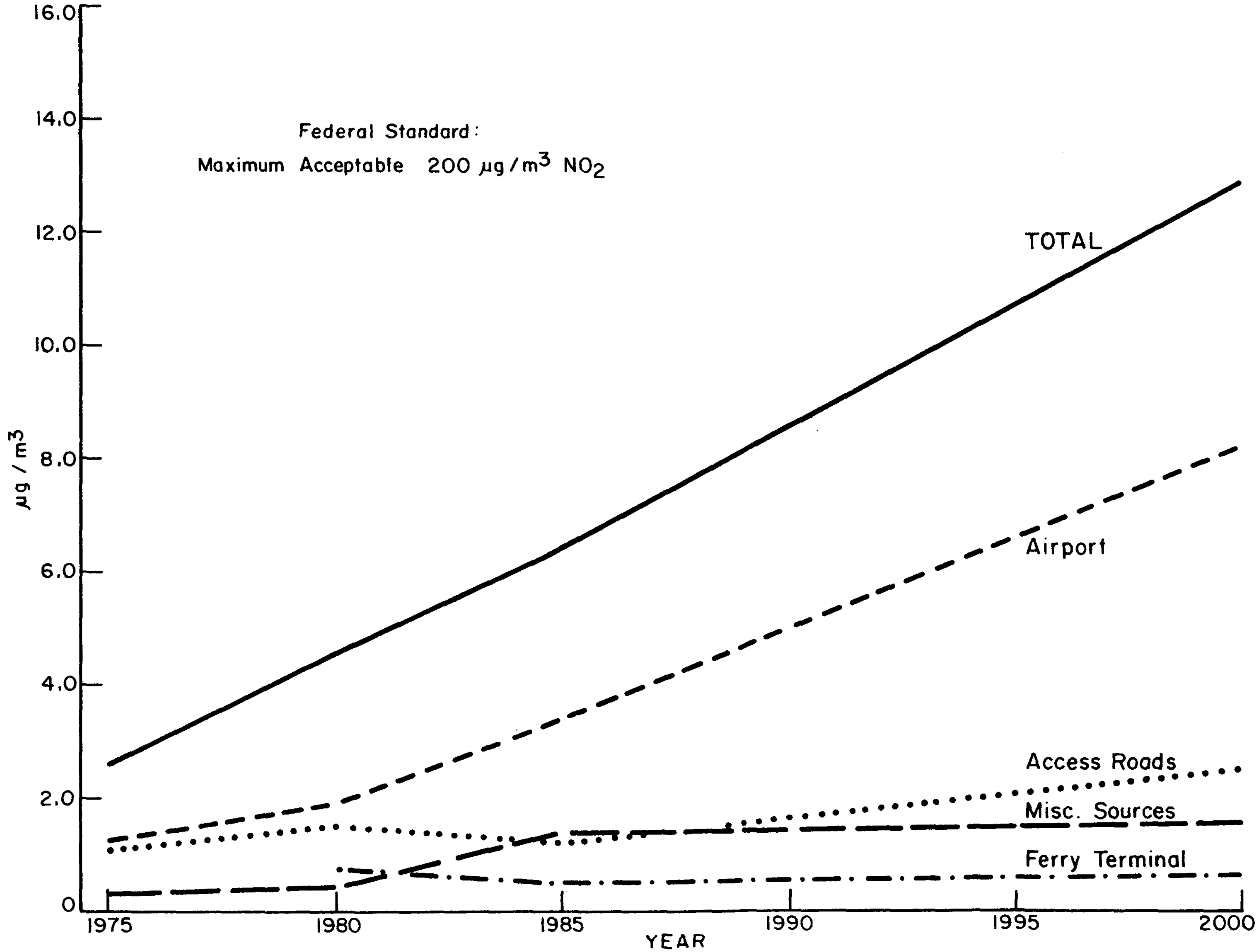


Figure 8·8
24 HOUR NOx CONCENTRATION
RECEPTOR No. 3

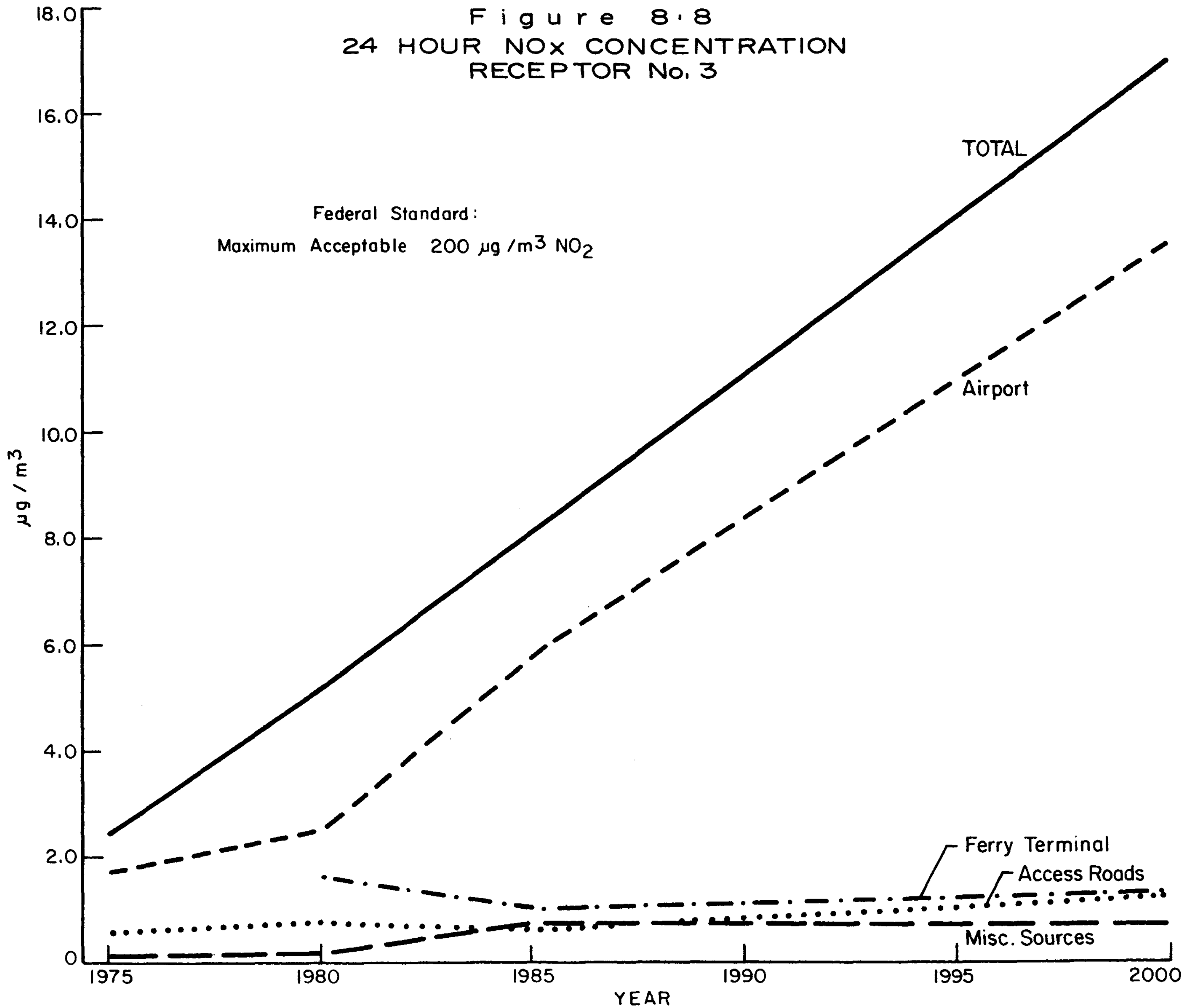


Figure 8·9
24 HOUR NOx CONCENTRATION
RECEPTOR No. 4

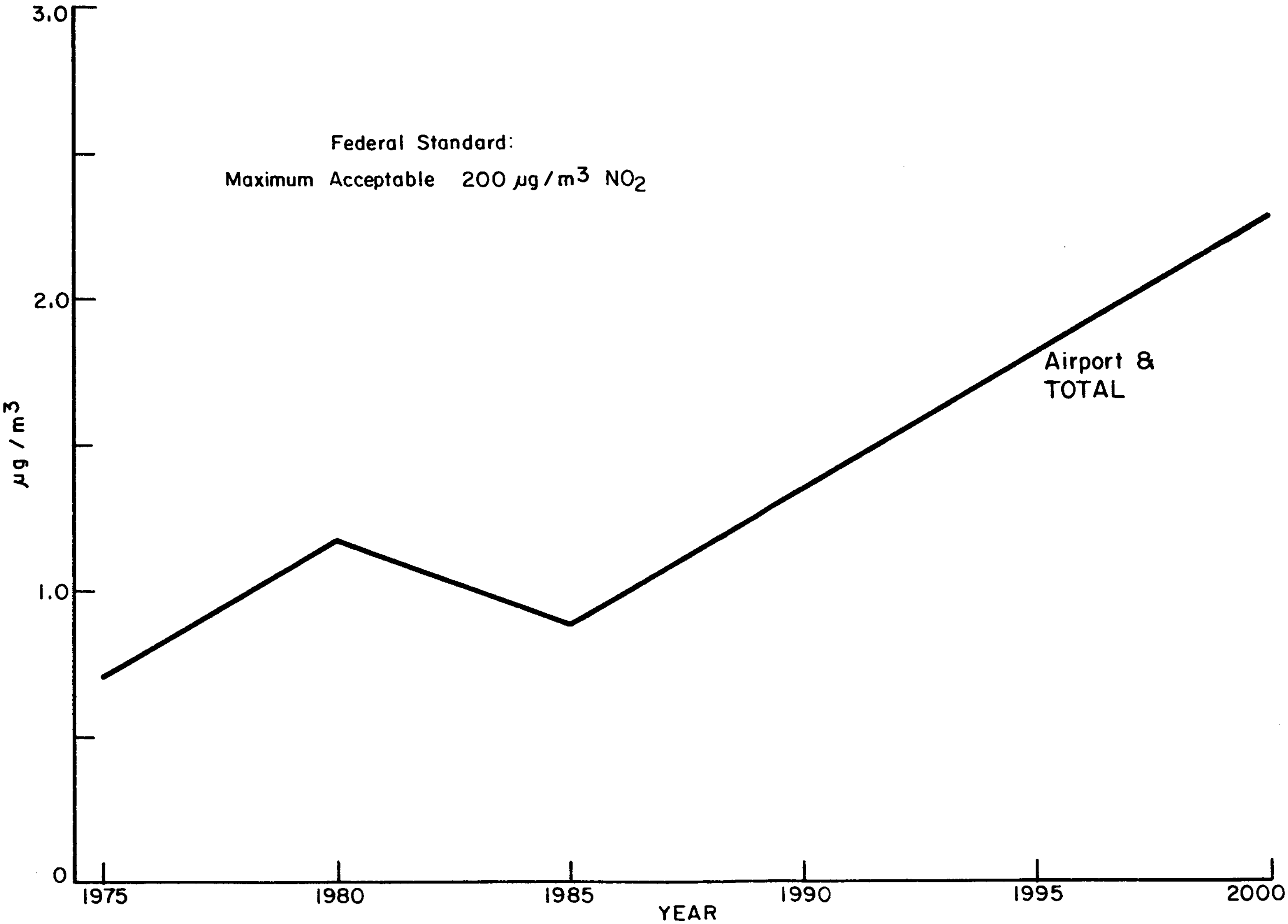


Figure 8.10
ANNUAL MEAN NOx CONCENTRATION
RECEPTOR No. 1

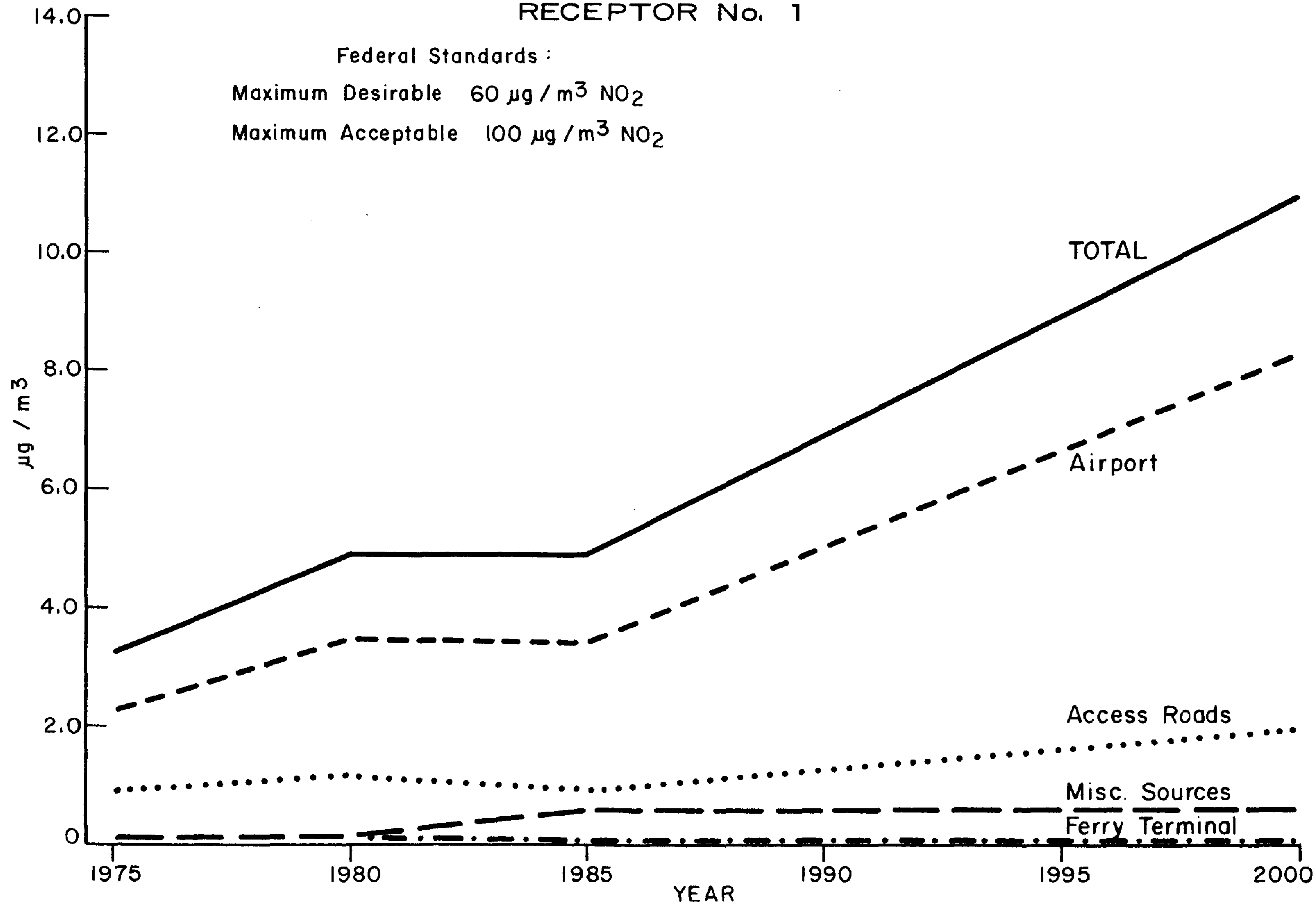


Figure 8·11
ANNUAL MEAN NOx CONCENTRATION
RECEPTOR No. 2

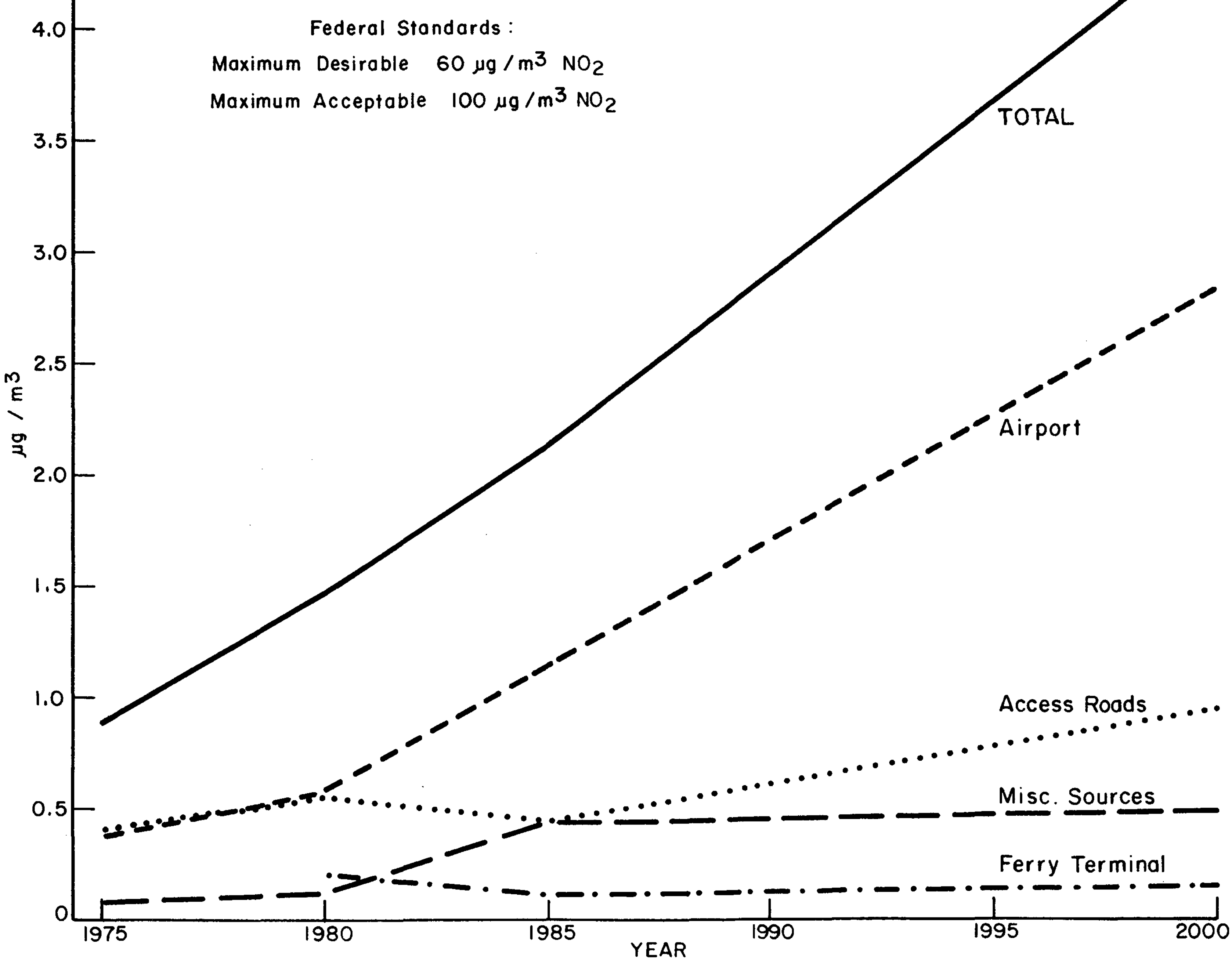
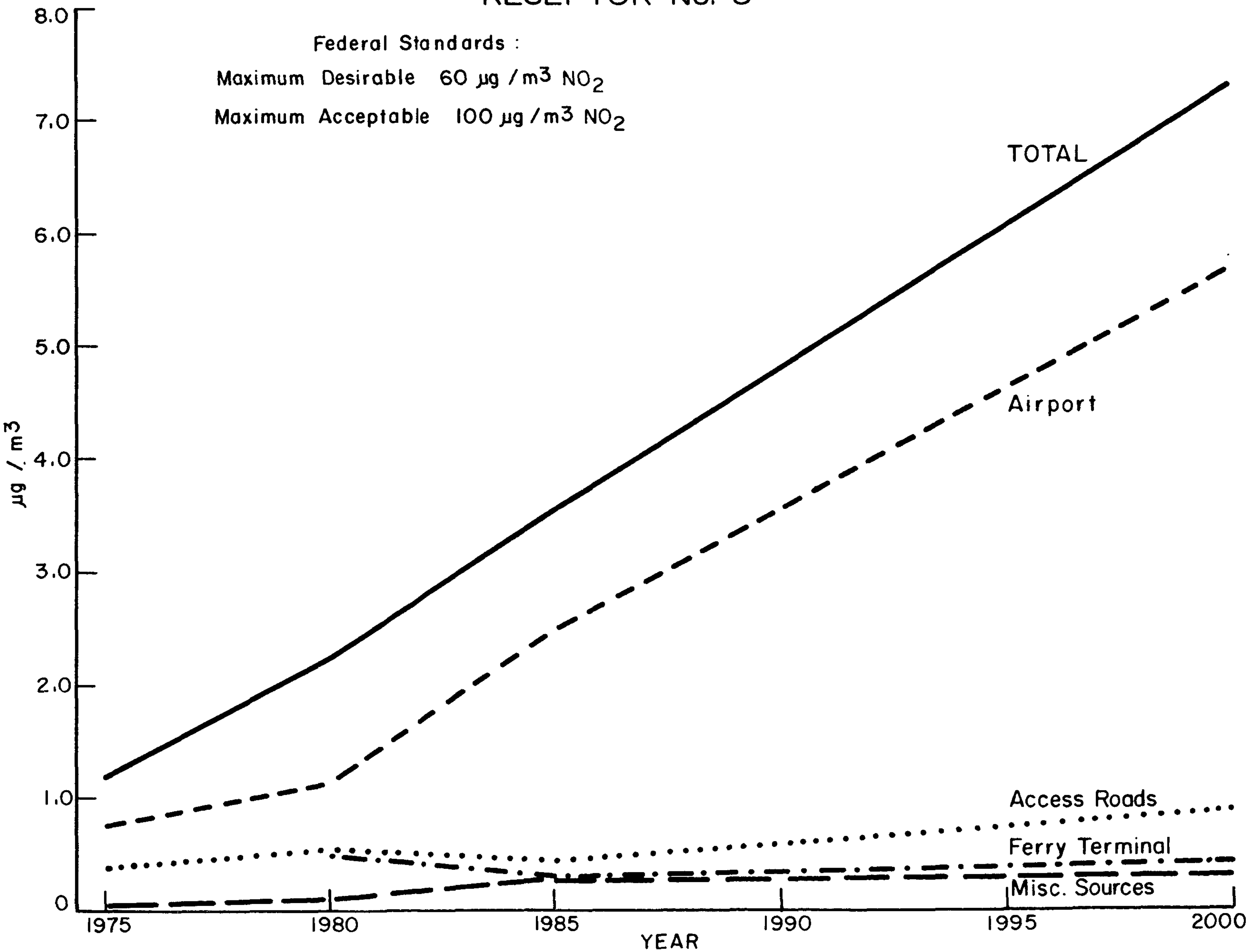


Figure 8·12
ANNUAL MEAN NOx CONCENTRATION
RECEPTOR No. 3



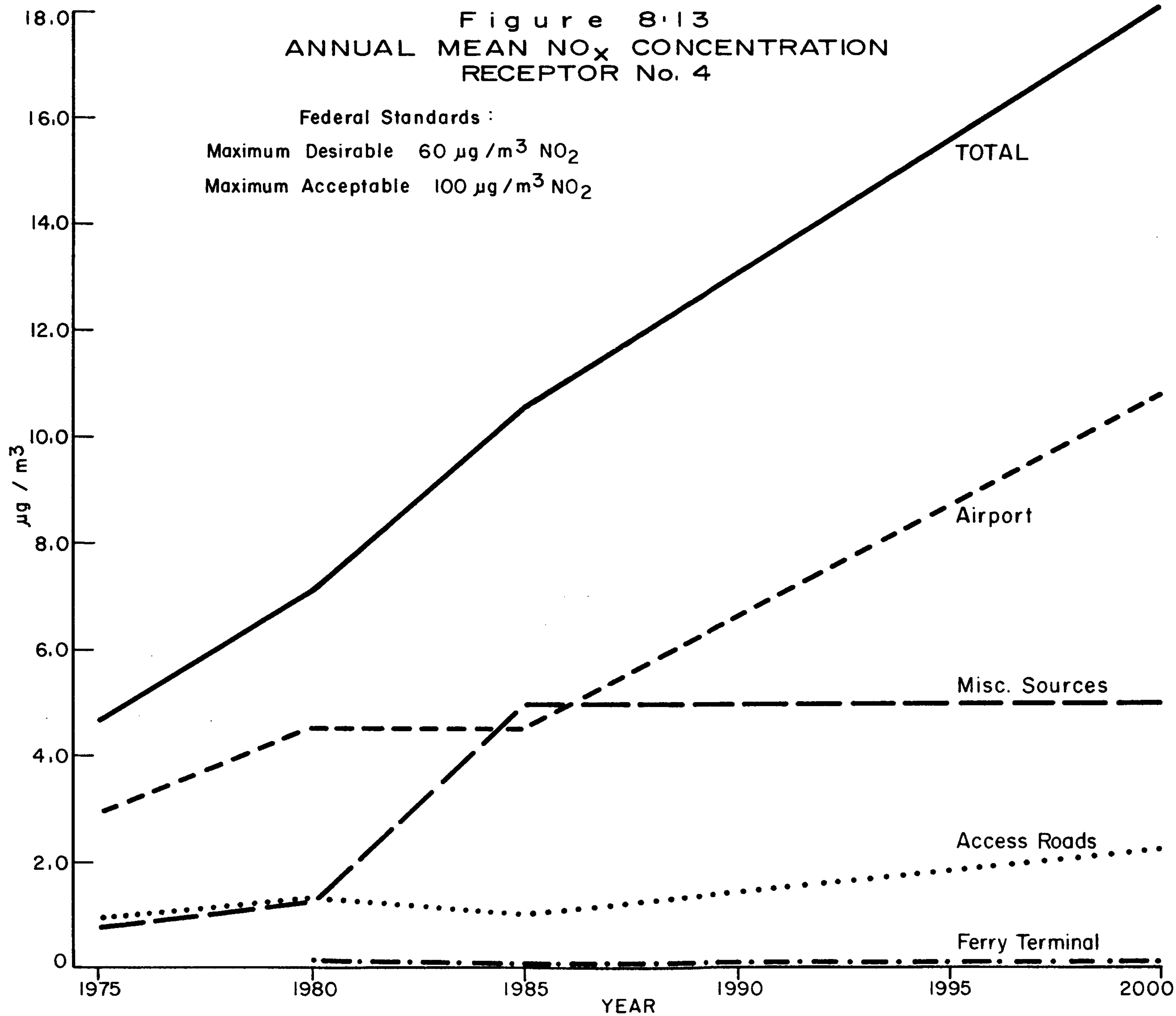


Figure 8·13
ANNUAL MEAN NO_x CONCENTRATION
RECEPTOR No. 4

Averaging Period	Desirable ($\mu g/m^3$)	Acceptable ($\mu g/m^3$)
1 hour	450	900
24 hours	150	300
1 year	30	60

Using the previously described methodology the maximum one hour, typical 24 hour, and expected annual mean SO_2 concentrations attributable to airport related sources were estimated for the four receptor locations. Maximum one-hour SO_2 concentrations are presented in Figure 8.14 to 8.17, while typical 24-hour SO_2 concentrations are shown in Figures 8.18 to 8.21.

The major source of SO_2 is that derived from fuel oil combustion that occurs in areas 3 and 4 (Table 5.16). Since the maximum one-hour SO_2 concentrations are based on critical wind angles associated with transportation related emissions, the actual maximum SO_2levels would be higher than those shown. Peak SO_2 would occur when a light (1 m/s) wind blows directly from area 4 to receptor 4 (see Figure 8.1) during a ground based inversion. Using our previous assumptions on the frequency of occurrence of such phenomena, it is estimated that the maximum concentration would occur about 8 hours per year on the average. This value is estimated to be about 170 $\mu g/m^3$ for 1975, rising to a peak of 1100 $\mu g/m^3$ during the year 2000. These estimates are based on the present practice of using roof-level vents. Hence consideration should be given to stack design during any future heating plant expansion.

The typical 24 hour ground-level SO_2 concentrations (Figures 8.18 to 8.21) generally reflect the major source of this pollutant — the miscellaneous source class. Receptor 4 (Figure 8.21) however, does not "see" these sources when the wind vector shifts clockwise from the east to the northwest. The concentration shown is derived mainly from aircraft movements on runway 1.

Expected annual mean SO_2 concentrations are generally small when compared with federal objectives as is done in Figures 8.22 to 8.25. An exception is at receptor 4 (Figure 8.25) where the close proximity to area 4 can, as previously discussed, lead to occasional high SO_2 levels.

Figure 8·14
MAXIMUM ONE HOUR SO_2 CONCENTRATION
RECEPTOR No. 1

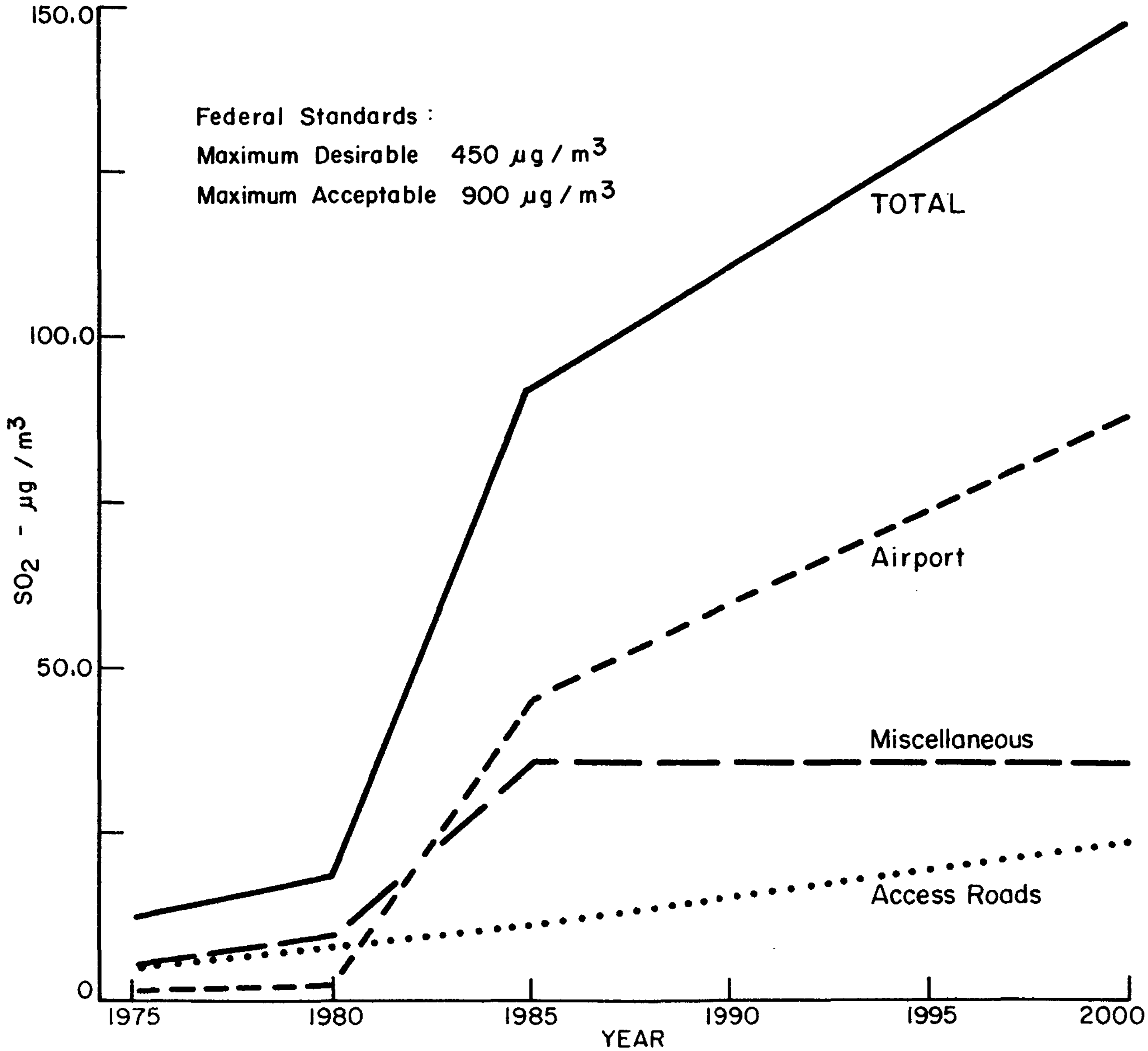


Figure 8.15
MAXIMUM ONE HOUR SO_2 CONCENTRATION
RECEPTOR No. 2

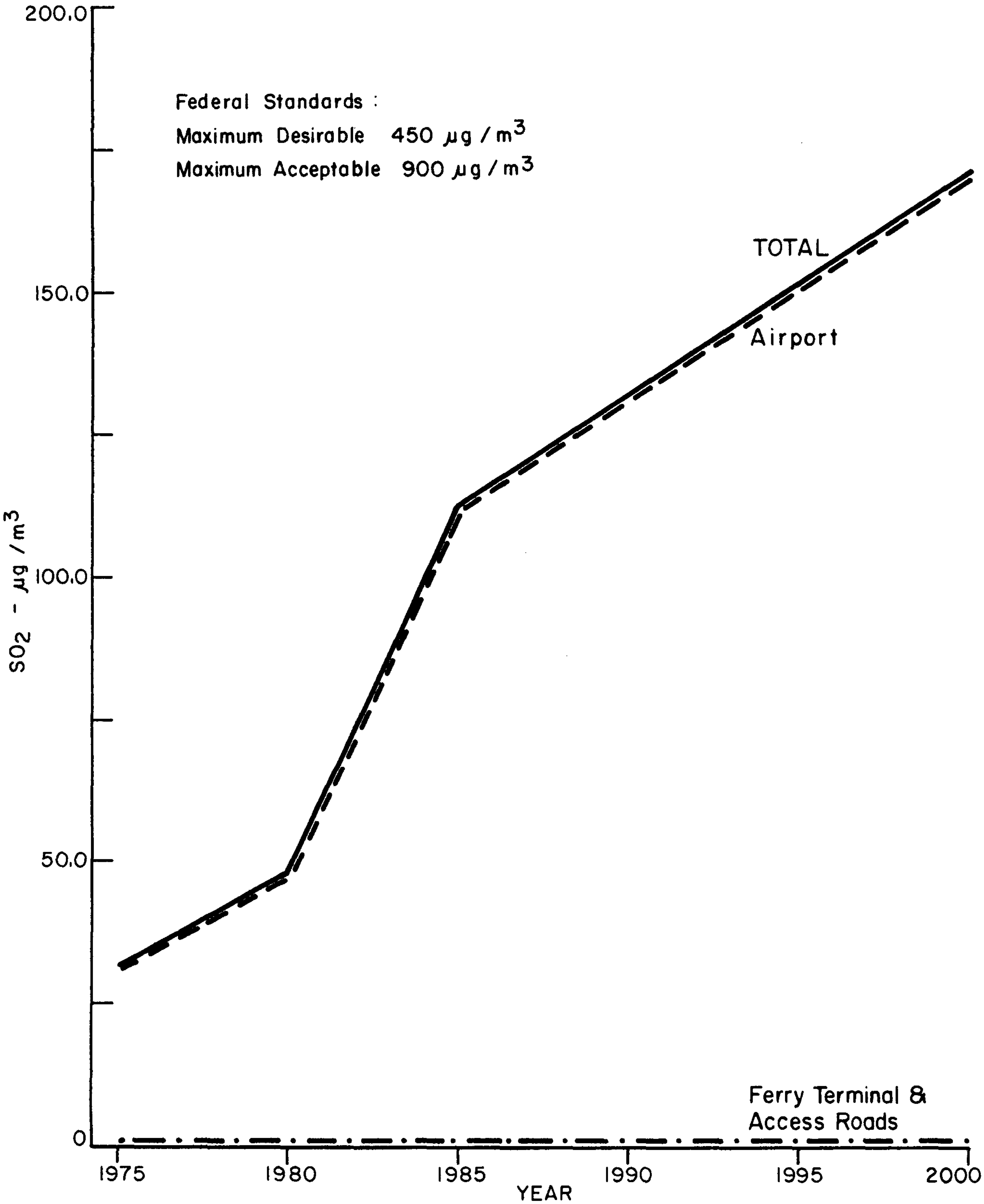


Figure 8.16
MAXIMUM ONE HOUR SO_2 CONCENTRATION
RECEPTOR No. 3

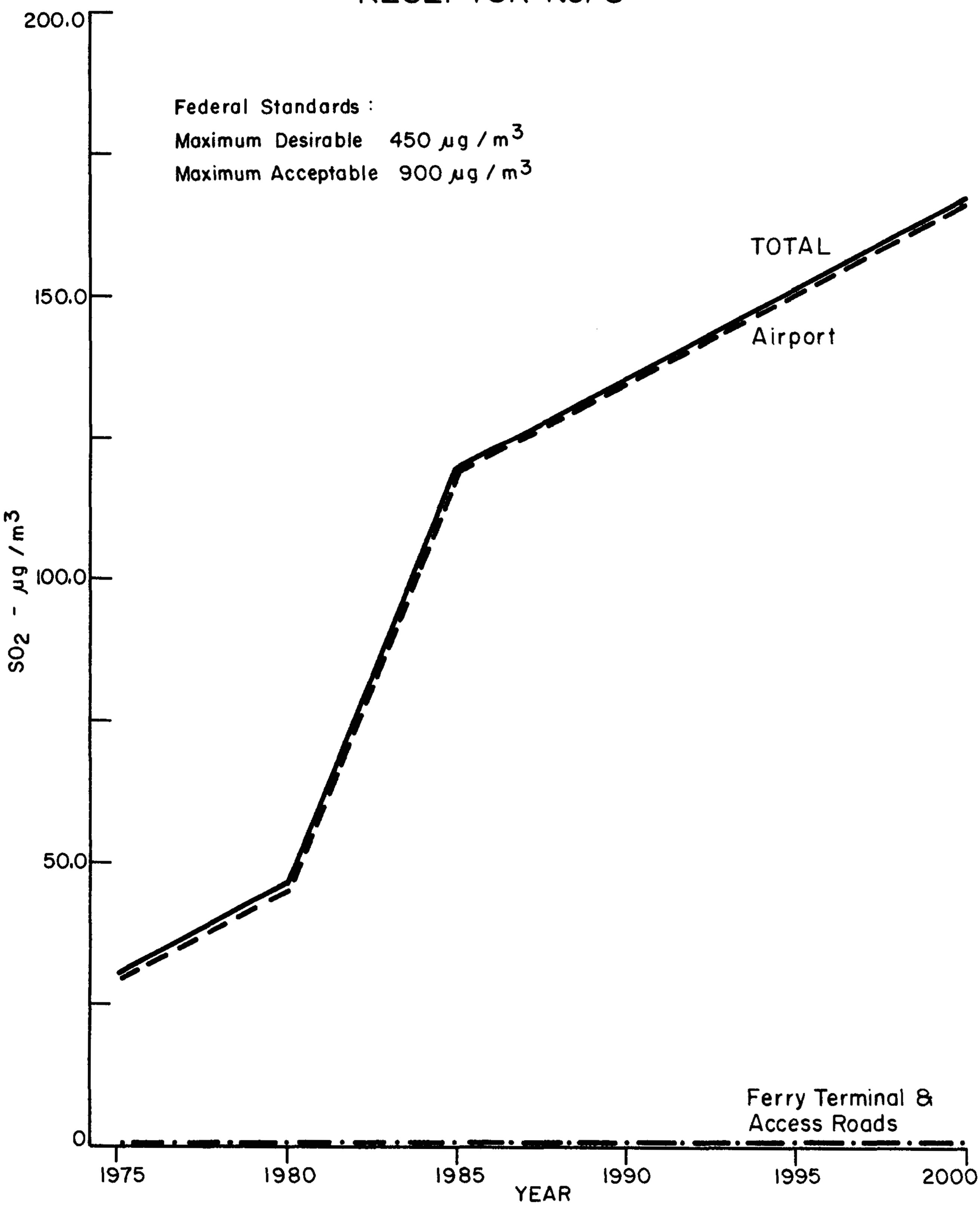


Figure 8·17
MAXIMUM ONE HOUR SO_2 CONCENTRATION
RECEPTOR No. 4

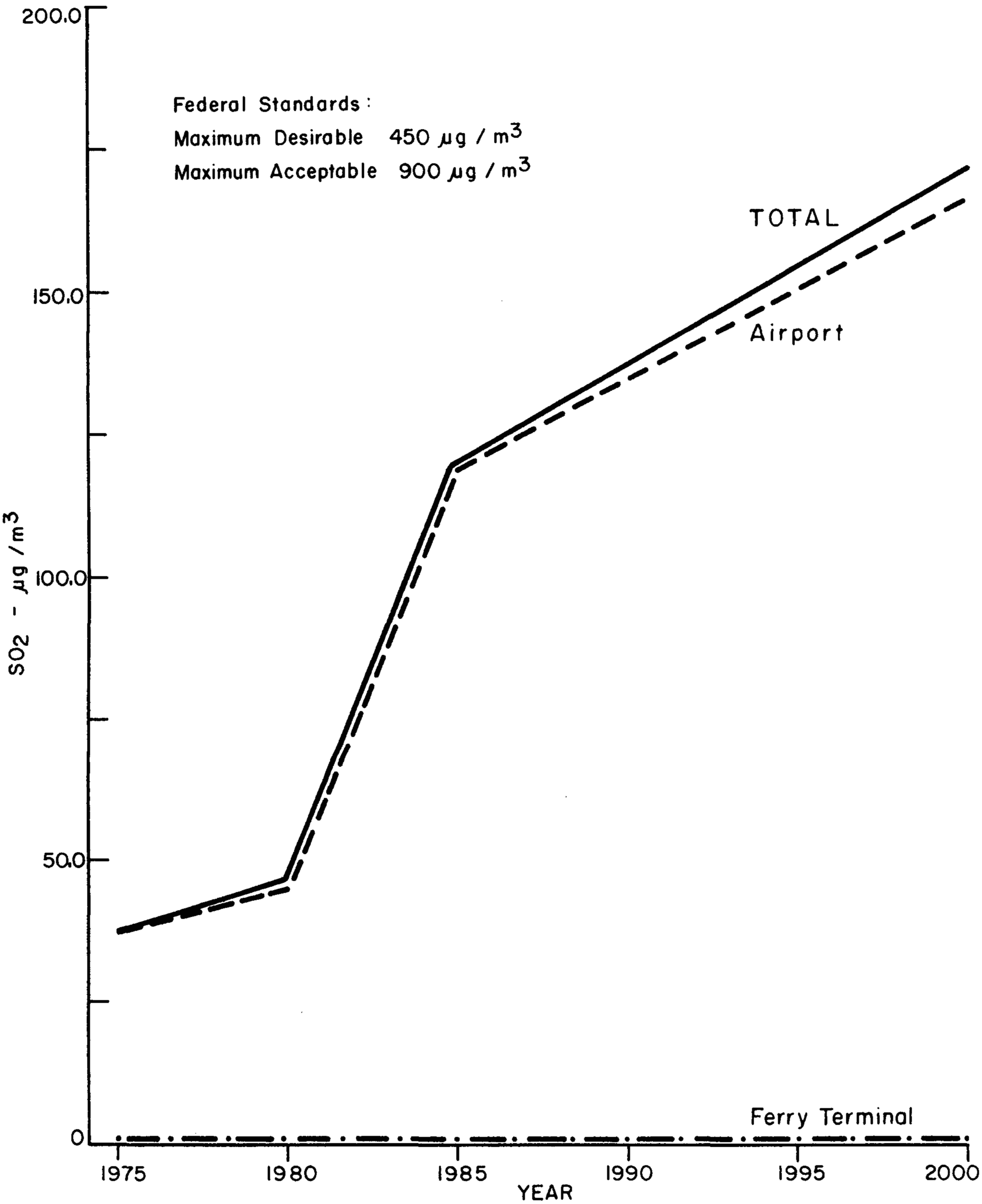


Figure 8.19
24-HOUR SO_2 CONCENTRATION
RECEPTOR No. 2

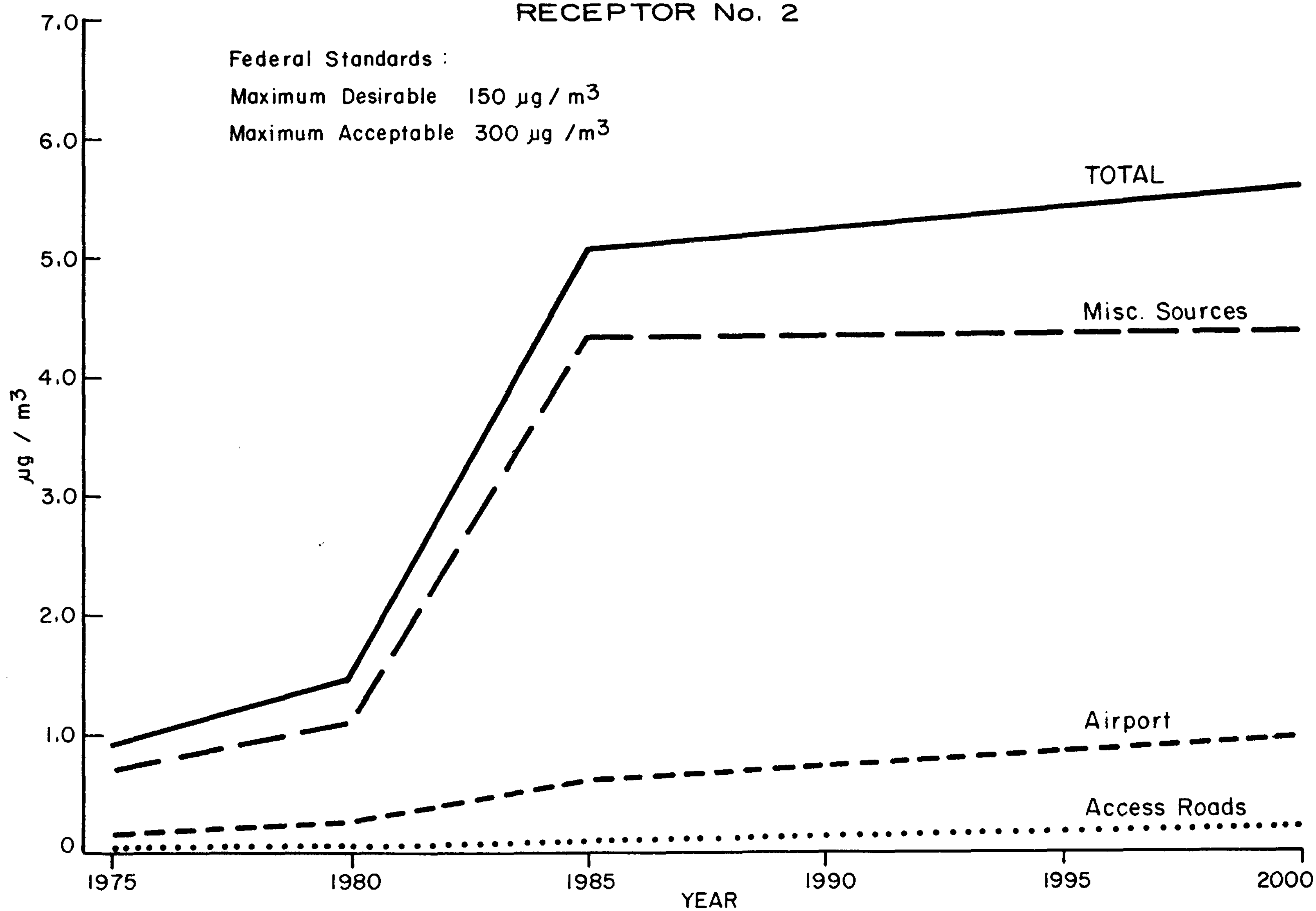


Figure 8.20
24-HOUR SO_2 CONCENTRATION
RECEPTOR No. 3

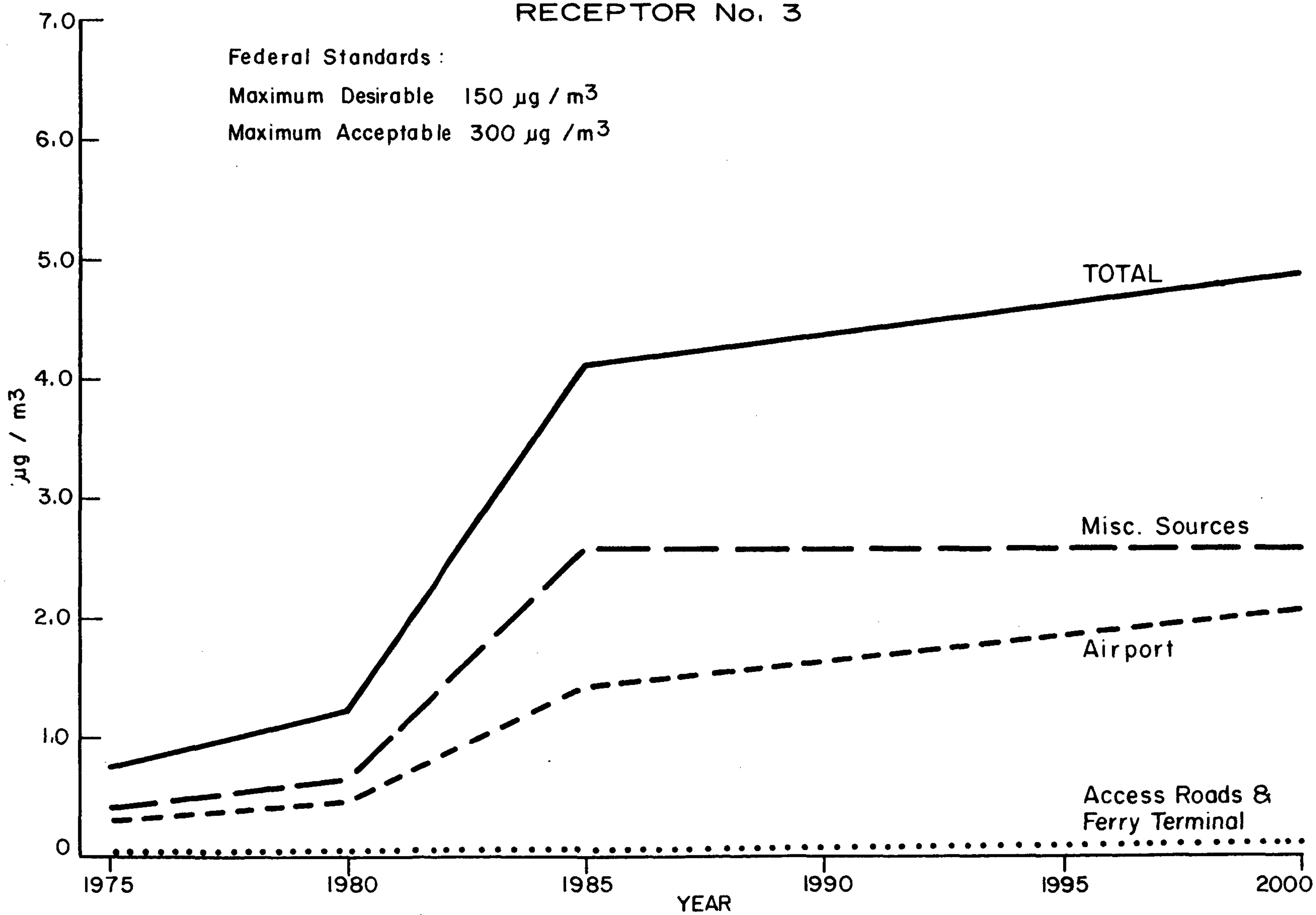


Figure 8.21
24-HOUR SO_2 CONCENTRATION
RECEPTOR No. 4

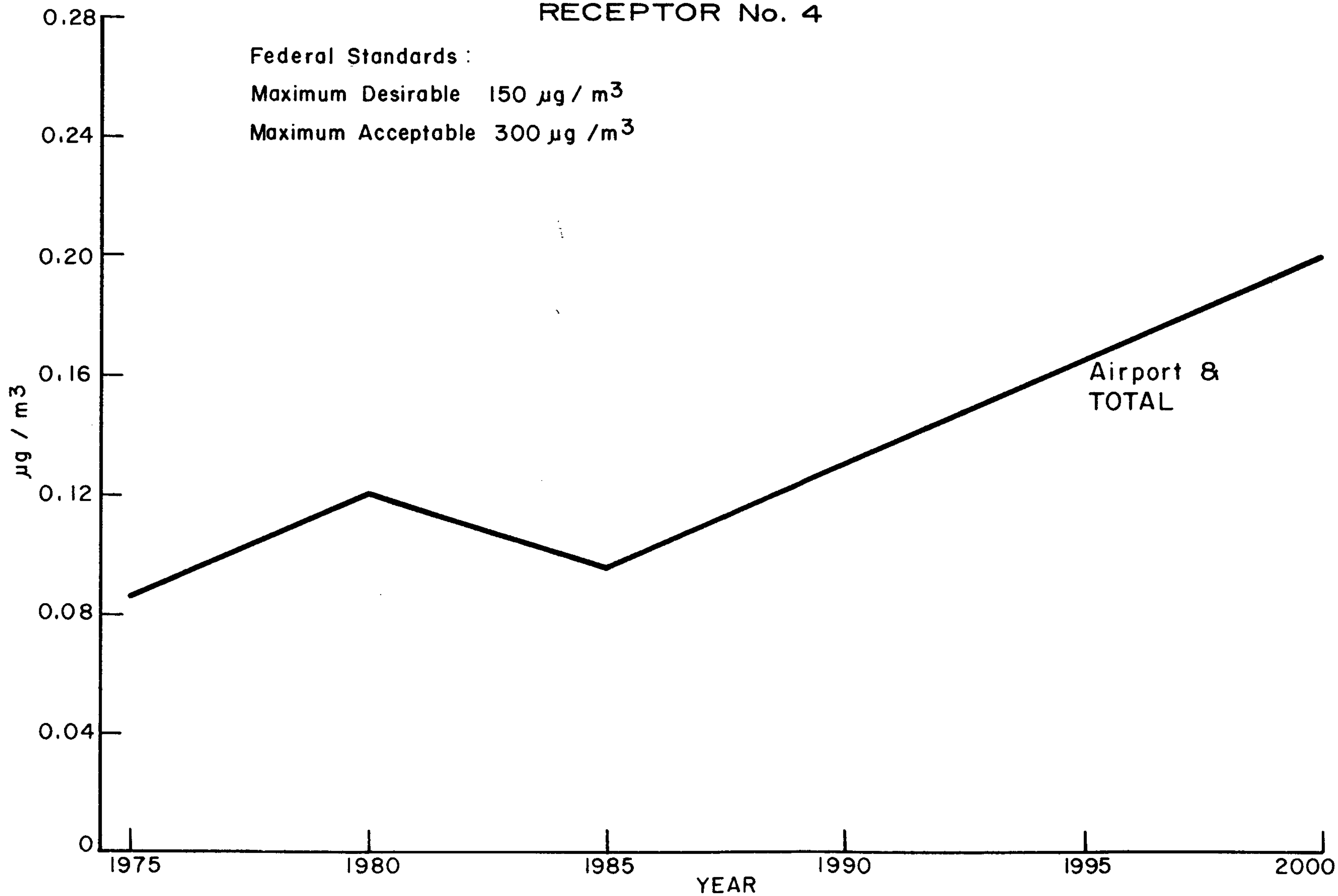


Figure 8.22
POLLUTANT SO_2 ANNUAL MEAN μg / m³
RECEPTOR No. 1

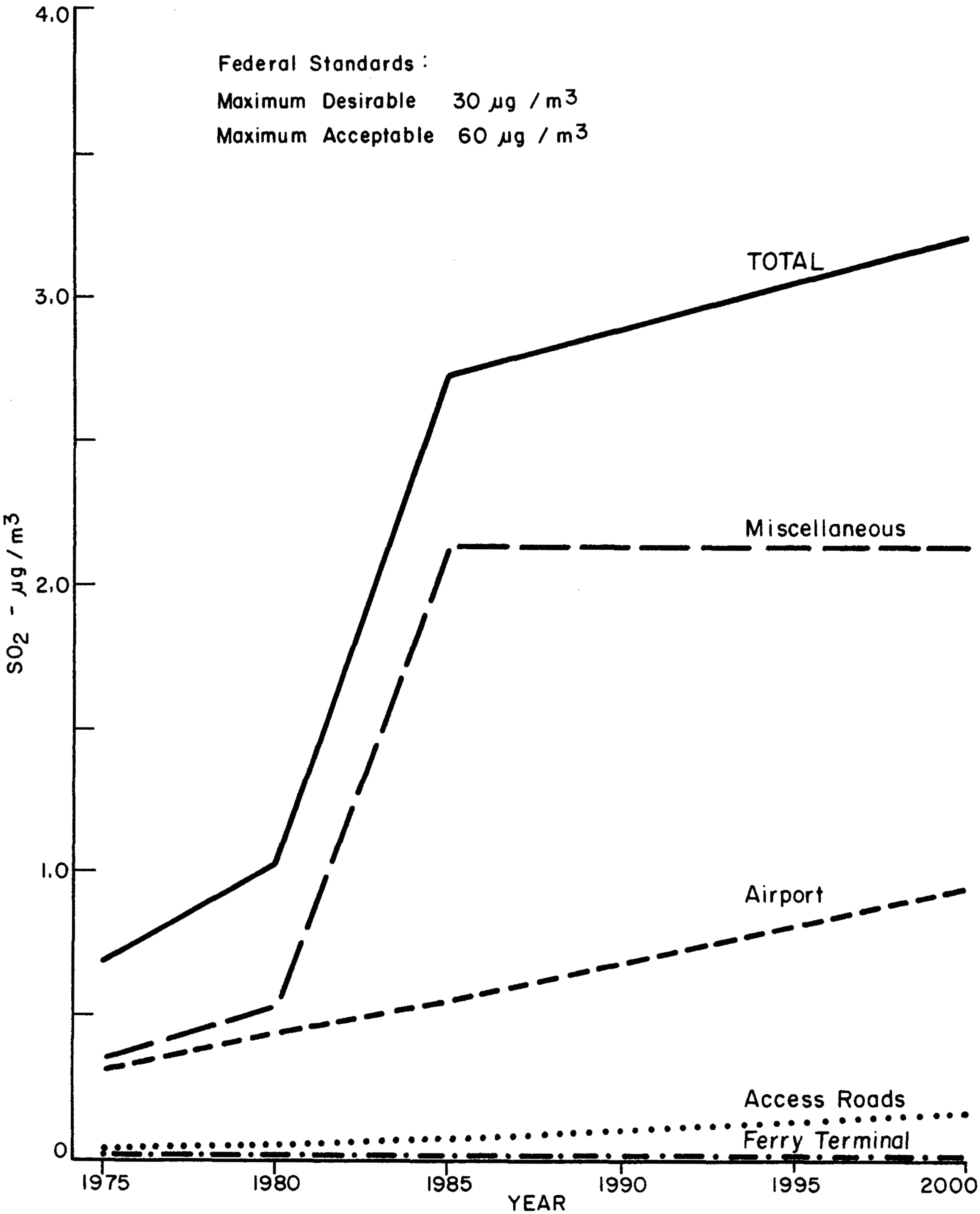


Figure 8·23
POLLUTANT SO_2 ANNUAL MEAN $\mu g/m^3$
RECEPTOR No. 2

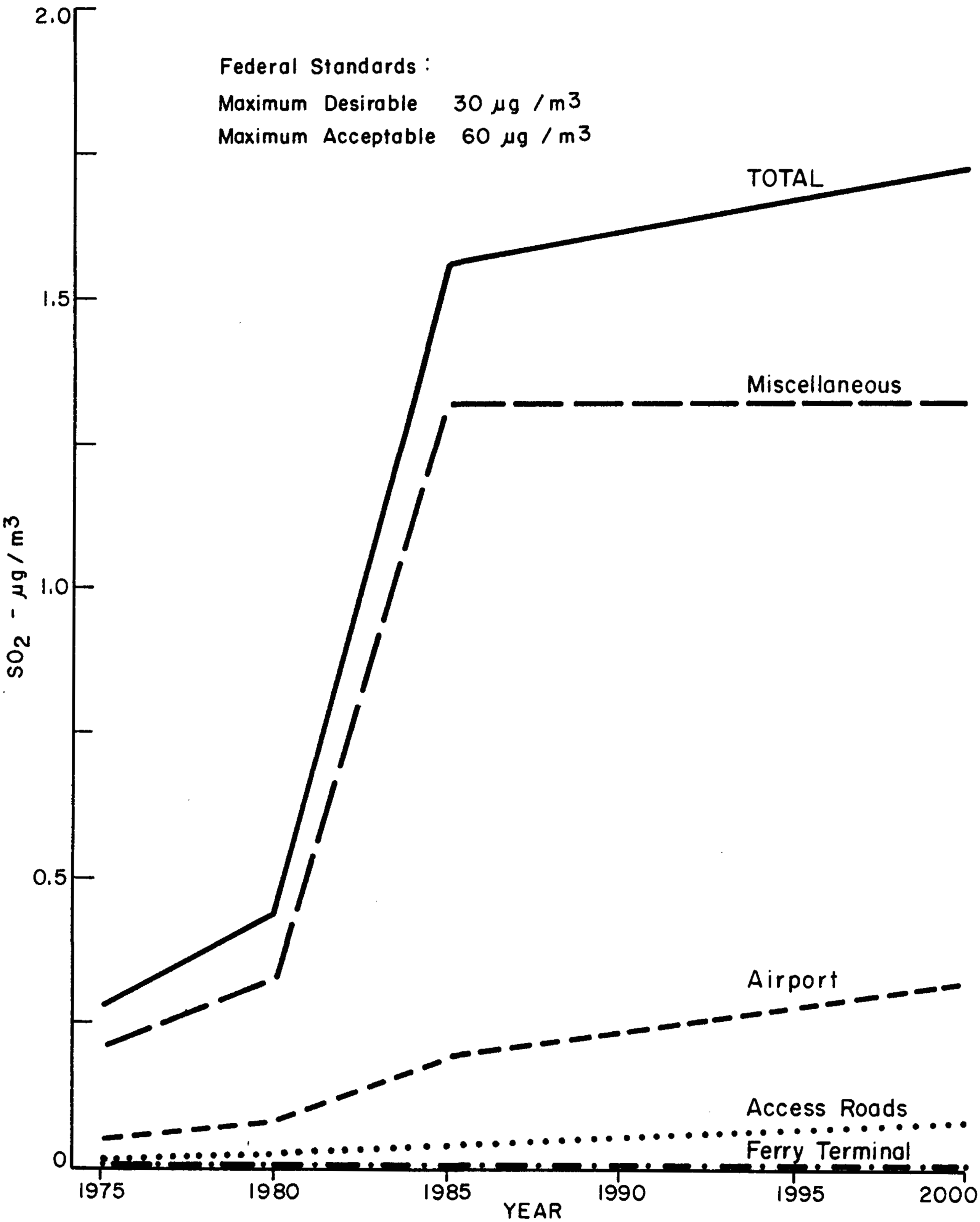


Figure 8·24
POLLUTANT SO_2 ANNUAL MEAN μg / m³
RECEPTOR No. 3

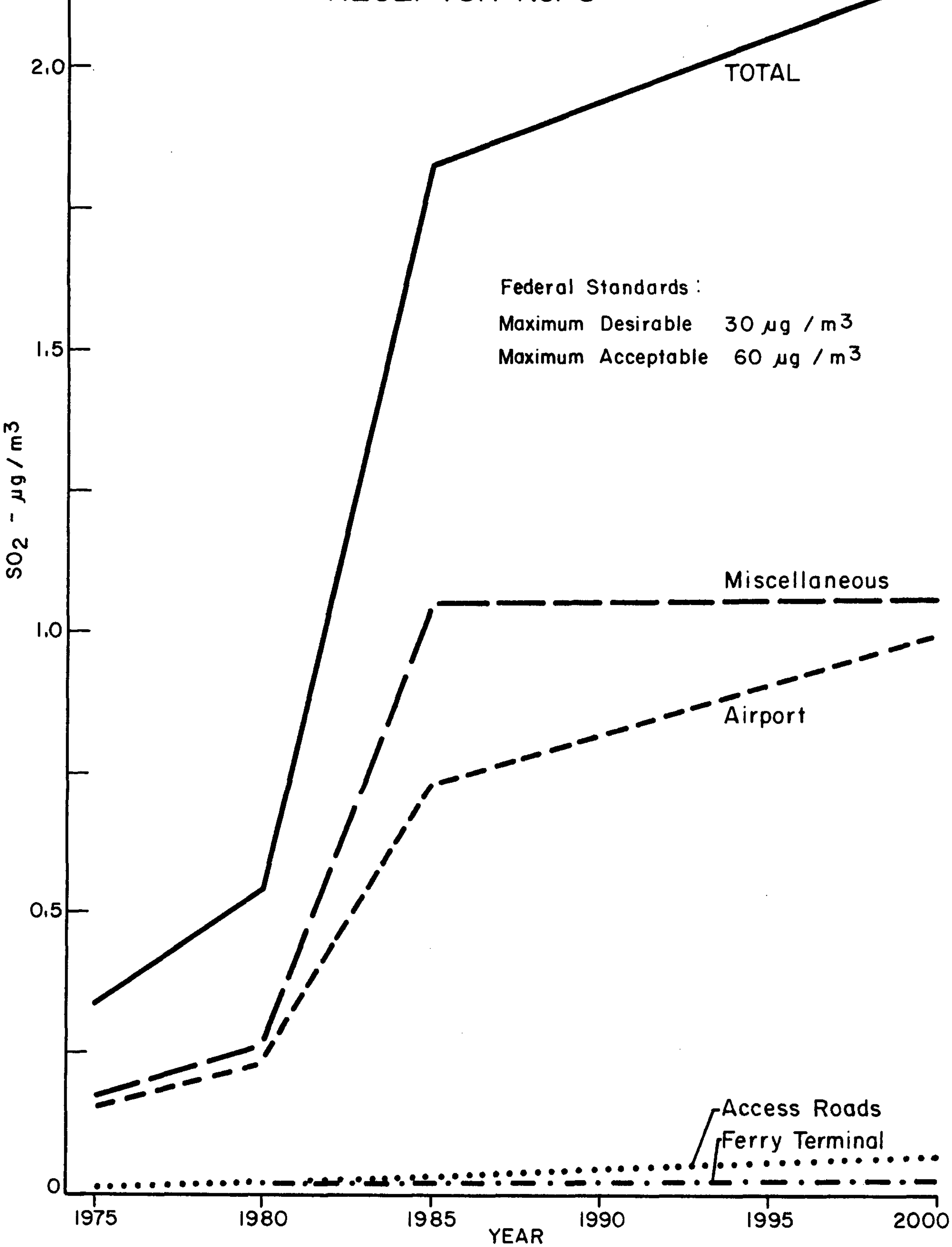
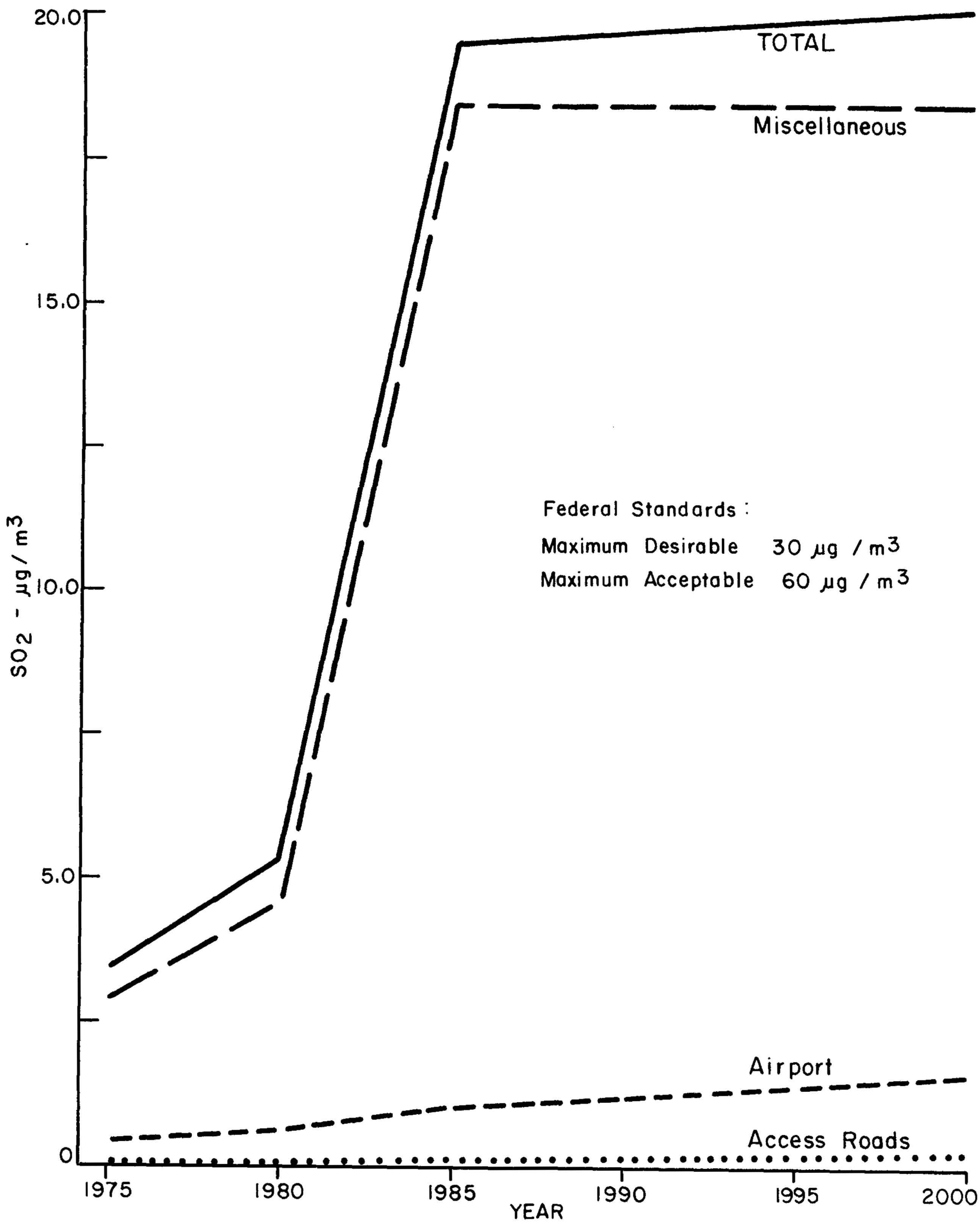


Figure 8.25
POLLUTANT SO_2 ANNUAL MEAN $\mu g/m^3$
RECEPTOR No. 4



8.3 Carbon Monoxide

The federal air quality objectives for carbon monoxide are (24):

Averaging Period (hours)	Desirable (mg/m^3)	Acceptable (mg/m^3)
1	15	35
8	6	15

Figures 8.26 to 8.29 show the estimated maximum one hour CO concentrations at the four receptors. It can be seen that by the year 2000 the airport could increase the ambient concentrations to a significant fraction of the maximum desirable ambient CO level.

Figures 8.30 to 8.33 show expected annual mean CO levels. Although the federal objective for CO is not based on this averaging time, it was felt that such estimates would be useful for purposes of comparison with actual field surveys.

8.4 Suspended Particulate

Federal objectives (24) for suspended particulate matter are given as:

Averaging Period	Desirable ($\mu g/m^3$)	Acceptable ($\mu g/m^3$
24 hours	-	120
1 year	60	70

Figures 8.34 to 8.37 show typical 24-hour concentrations while Figures 8.38 to 8.41 illustrate the expected annual mean particulate concentrations at the four receptor sites. The contribution of the airport to ambient particulate burden is relatively low.

Figure 8·26
MAXIMUM ONE HOUR CO CONCENTRATION
RECEPTOR No. 1

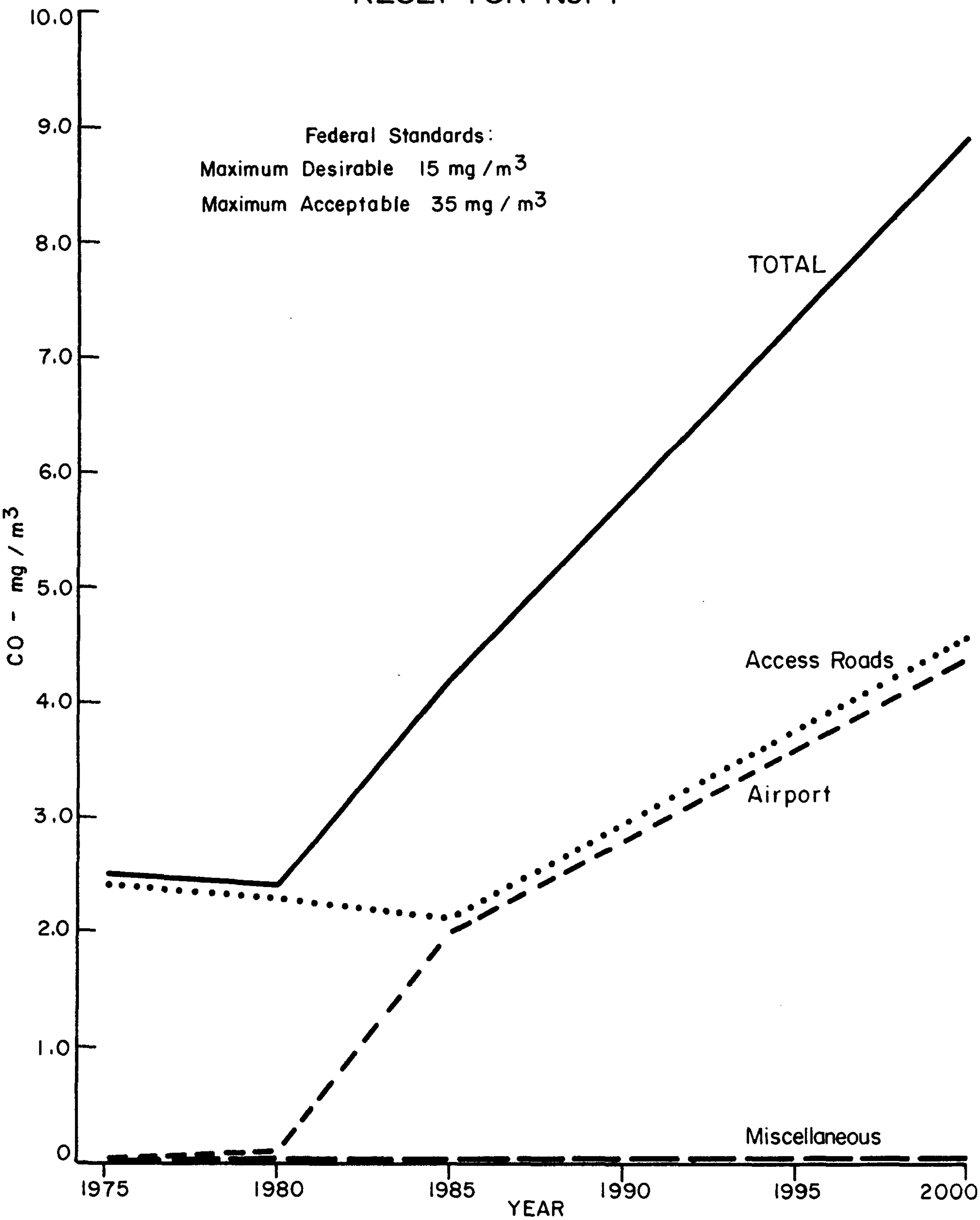


Figure 8·27

MAXIMUM ONE HOUR CO CONCENTRATION
RECEPTOR No. 2

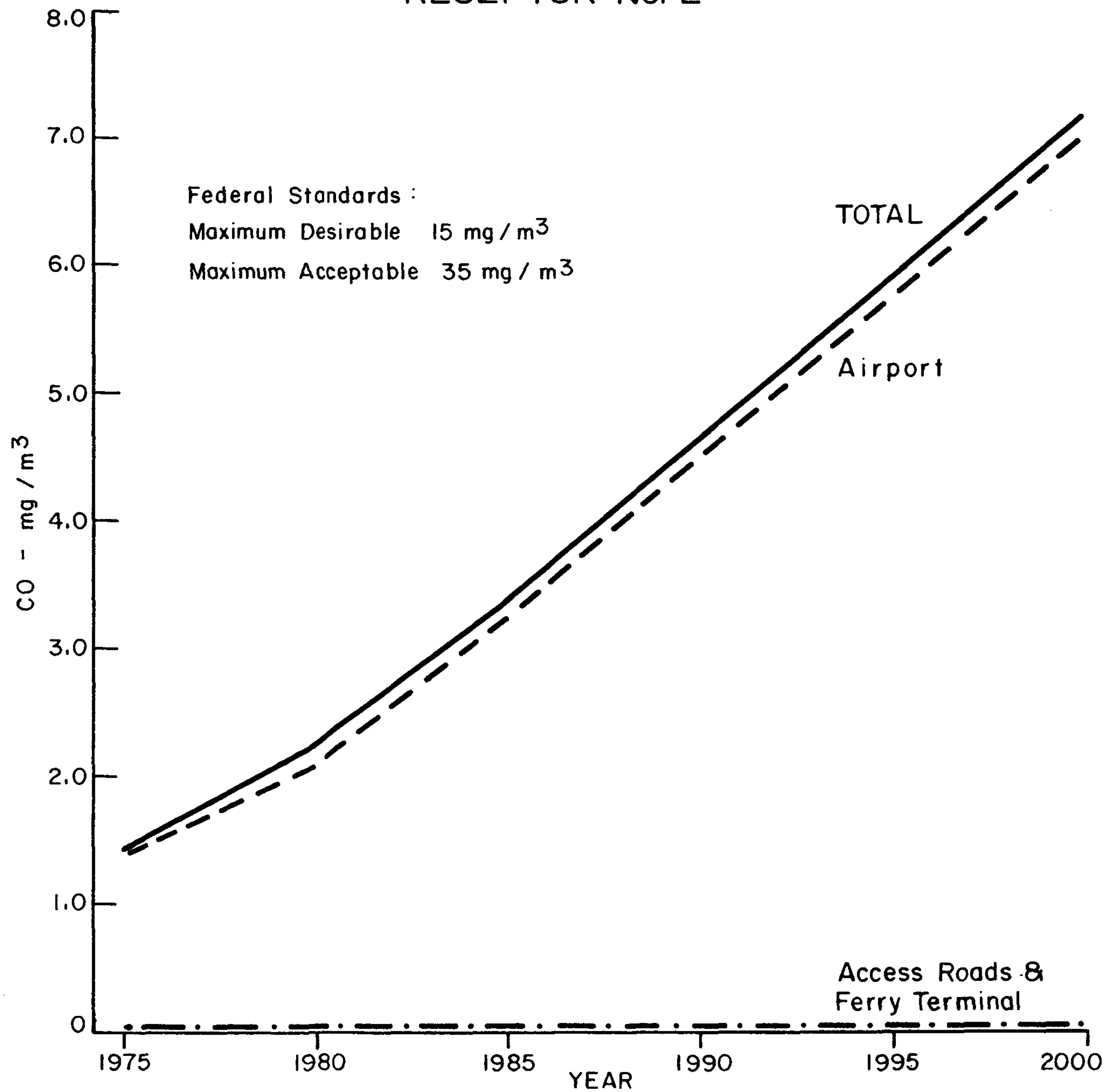


Figure 8·28

MAXIMUM ONE HOUR CO CONCENTRATION
RECEPTOR No. 3

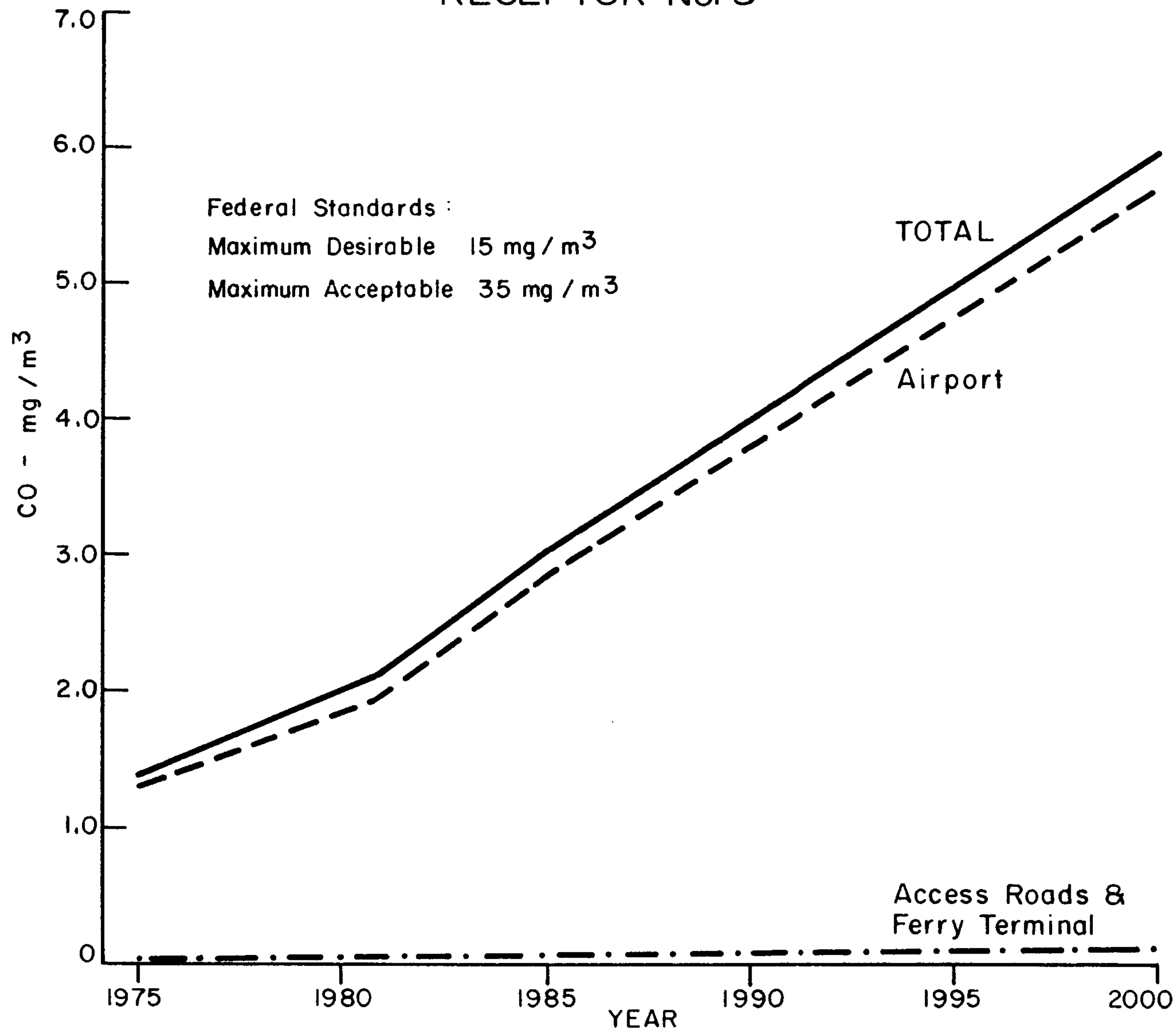


Figure 8·29
MAXIMUM ONE HOUR CO CONCENTRATION
RECEPTOR No. 4

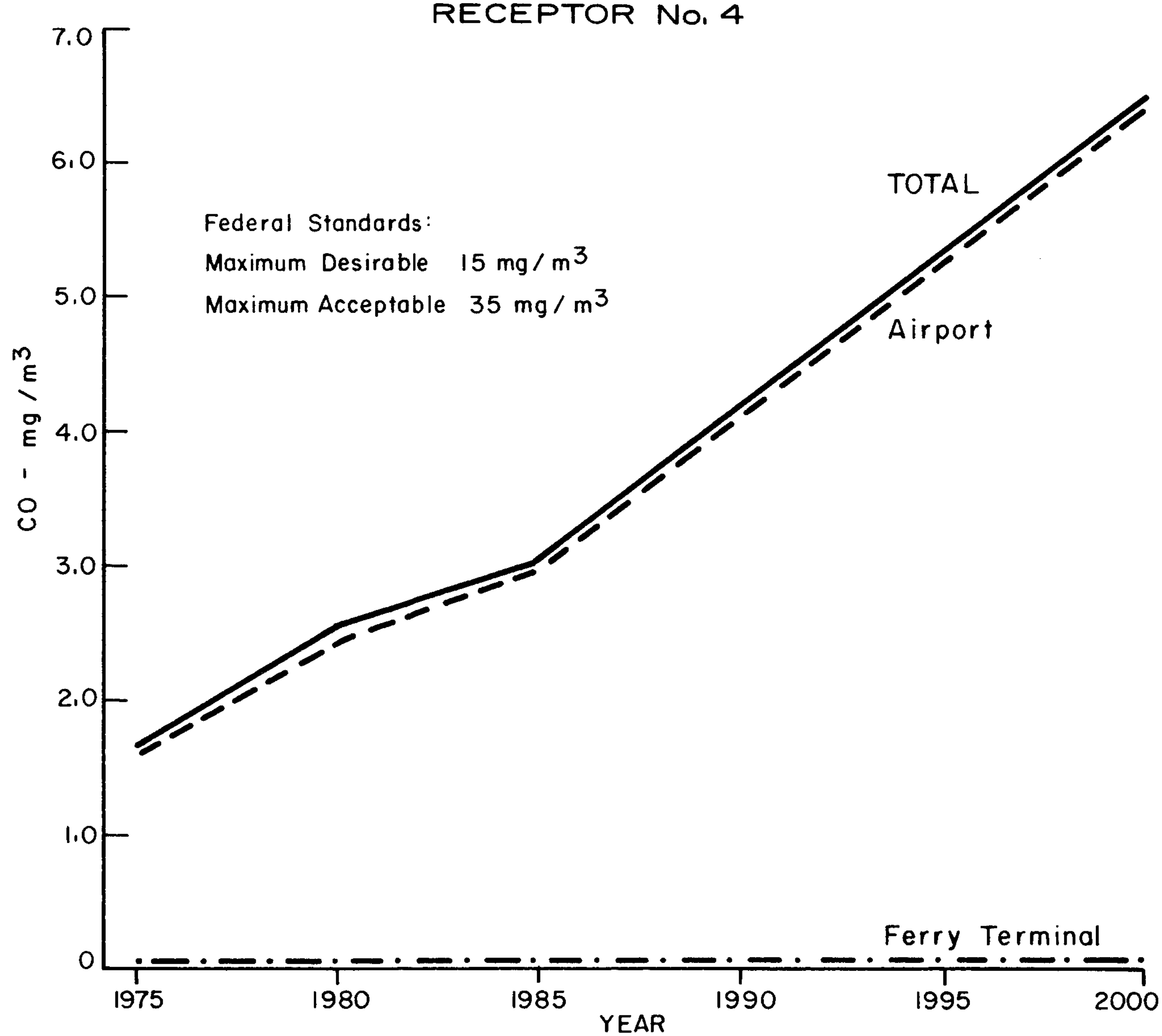


Figure 8.30
POLLUTANT CO ANNUAL MEAN mg / m3
RECEPTOR No. 1

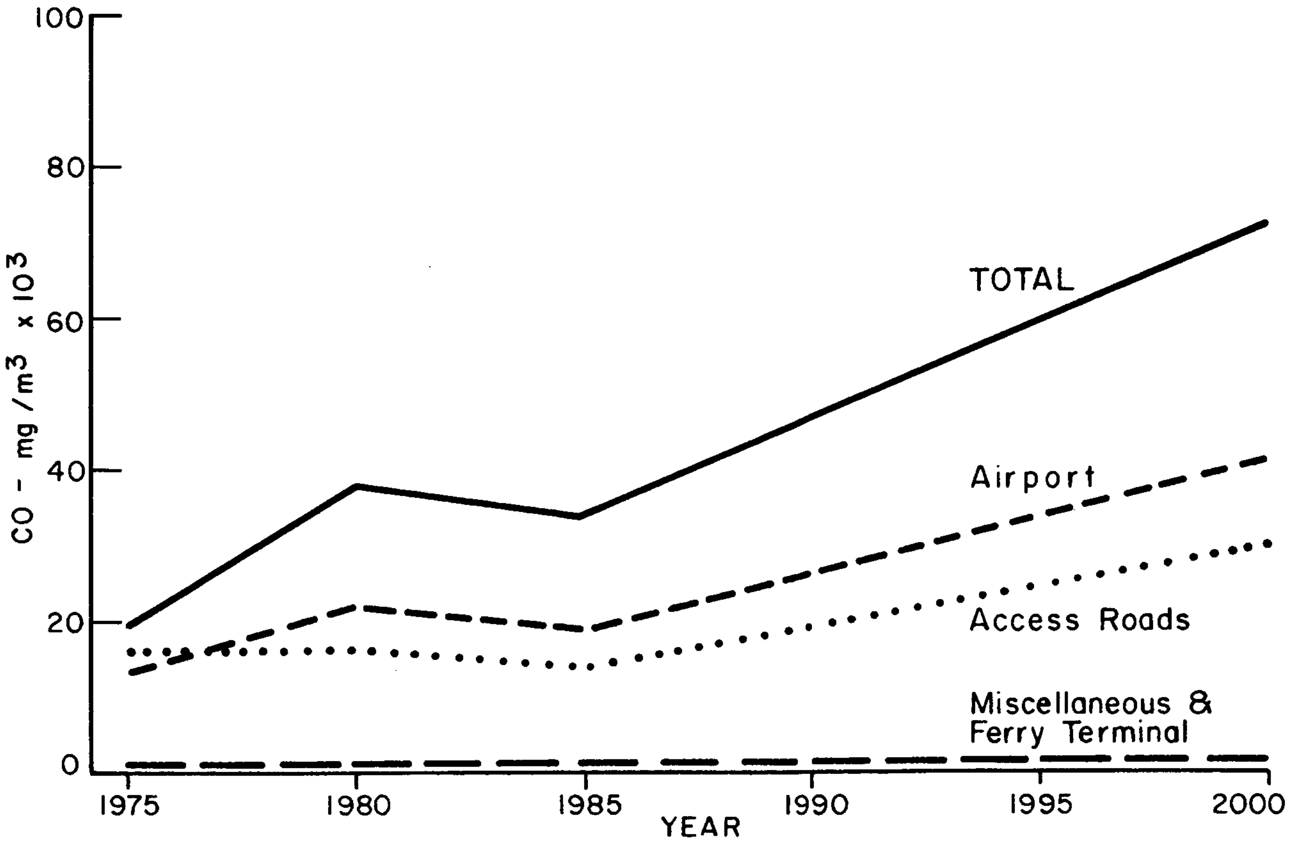


Figure 8.31
POLLUTANT CO ANNUAL MEAN mg / m³
RECEPTOR No. 2

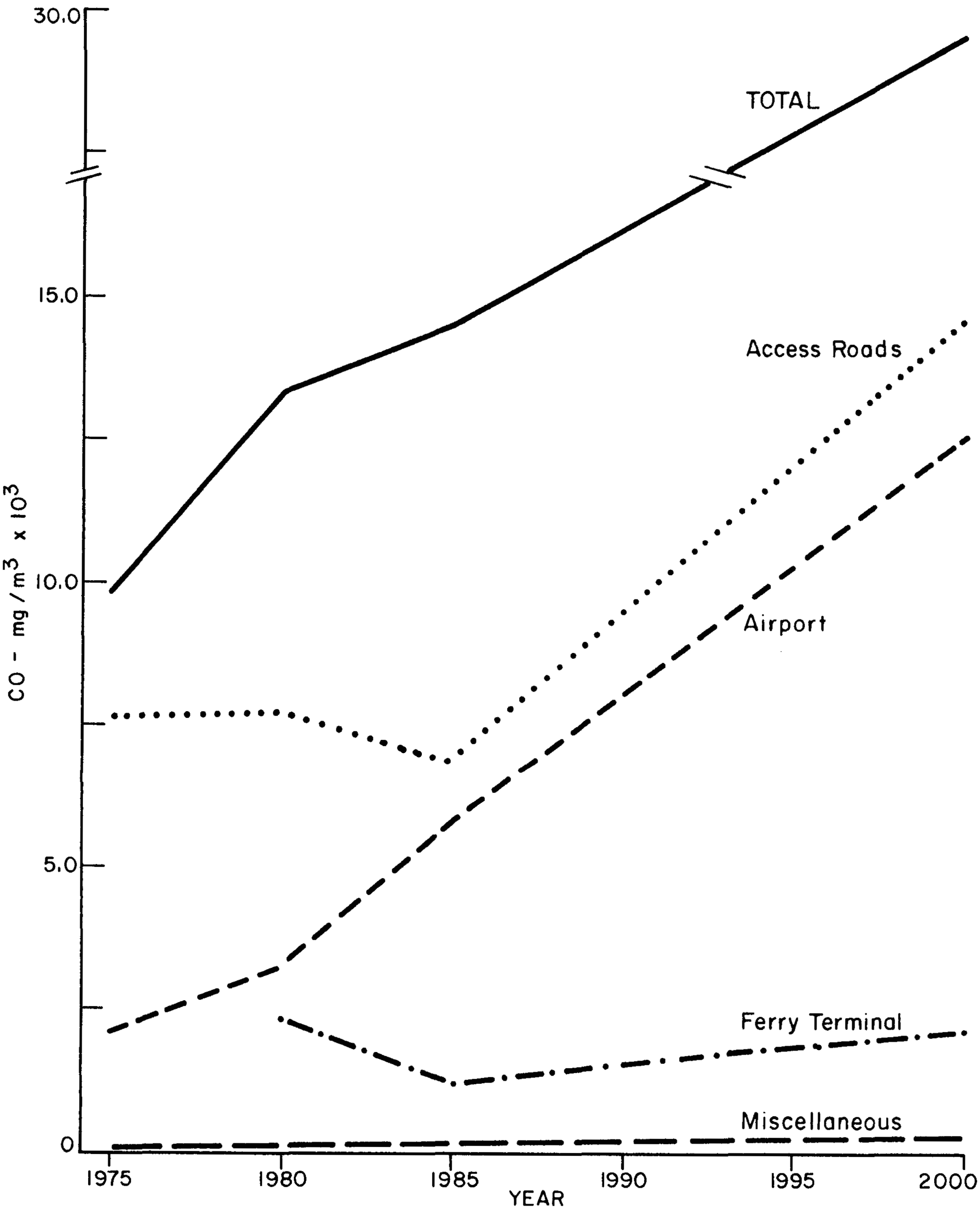


Figure 8·32
POLLUTANT CO ANNUAL MEAN mg / m³
RECEPTOR No. 3

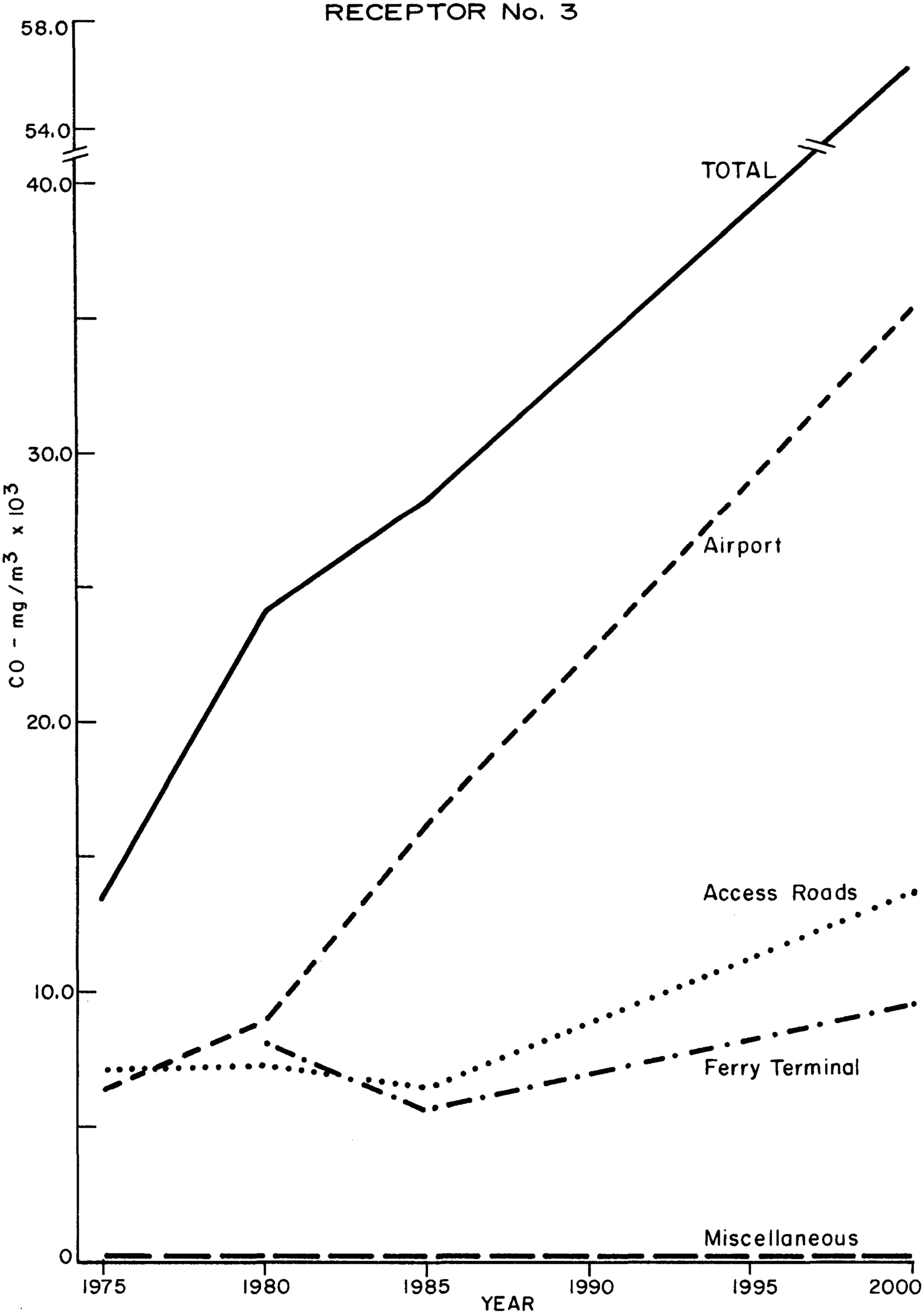


Figure 8.33
POLLUTANT CO ANNUAL MEAN mg / m³
RECEPTOR No. 4

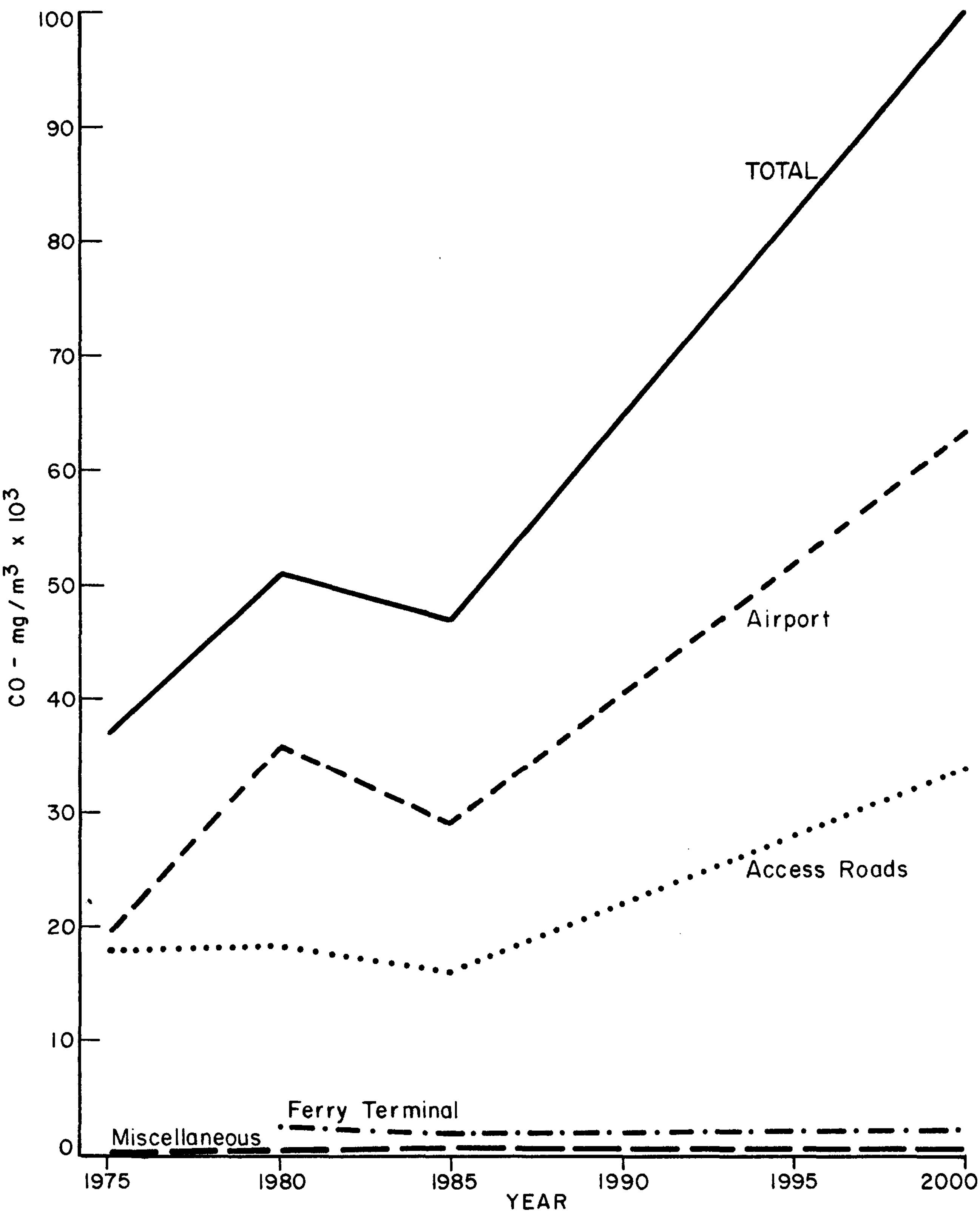


Figure 8·34
24-HOUR PARTICULATE
RECEPTOR No. 1

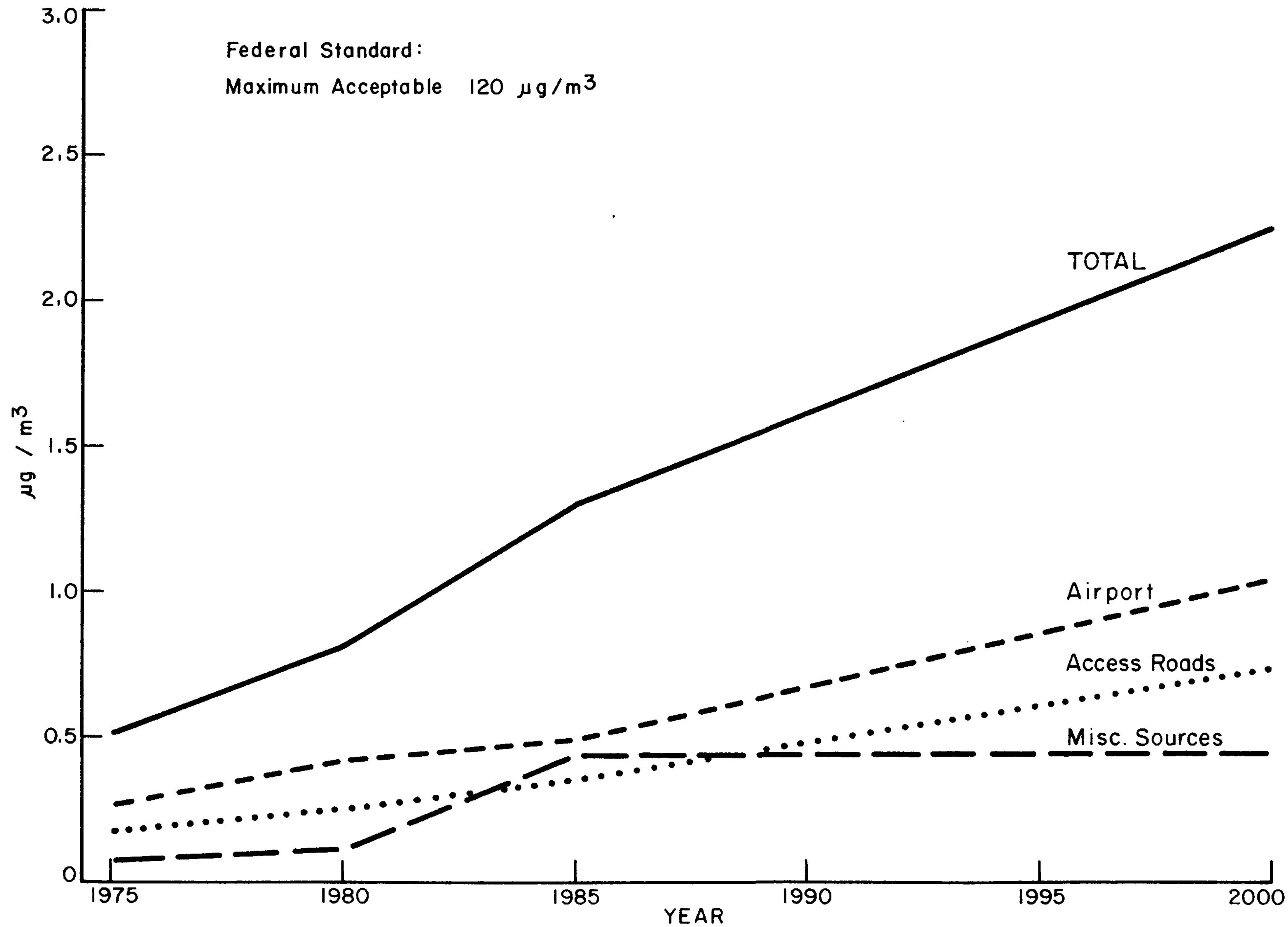


Figure 8·35
24-HOUR PARTICULATE
RECEPTOR No. 2

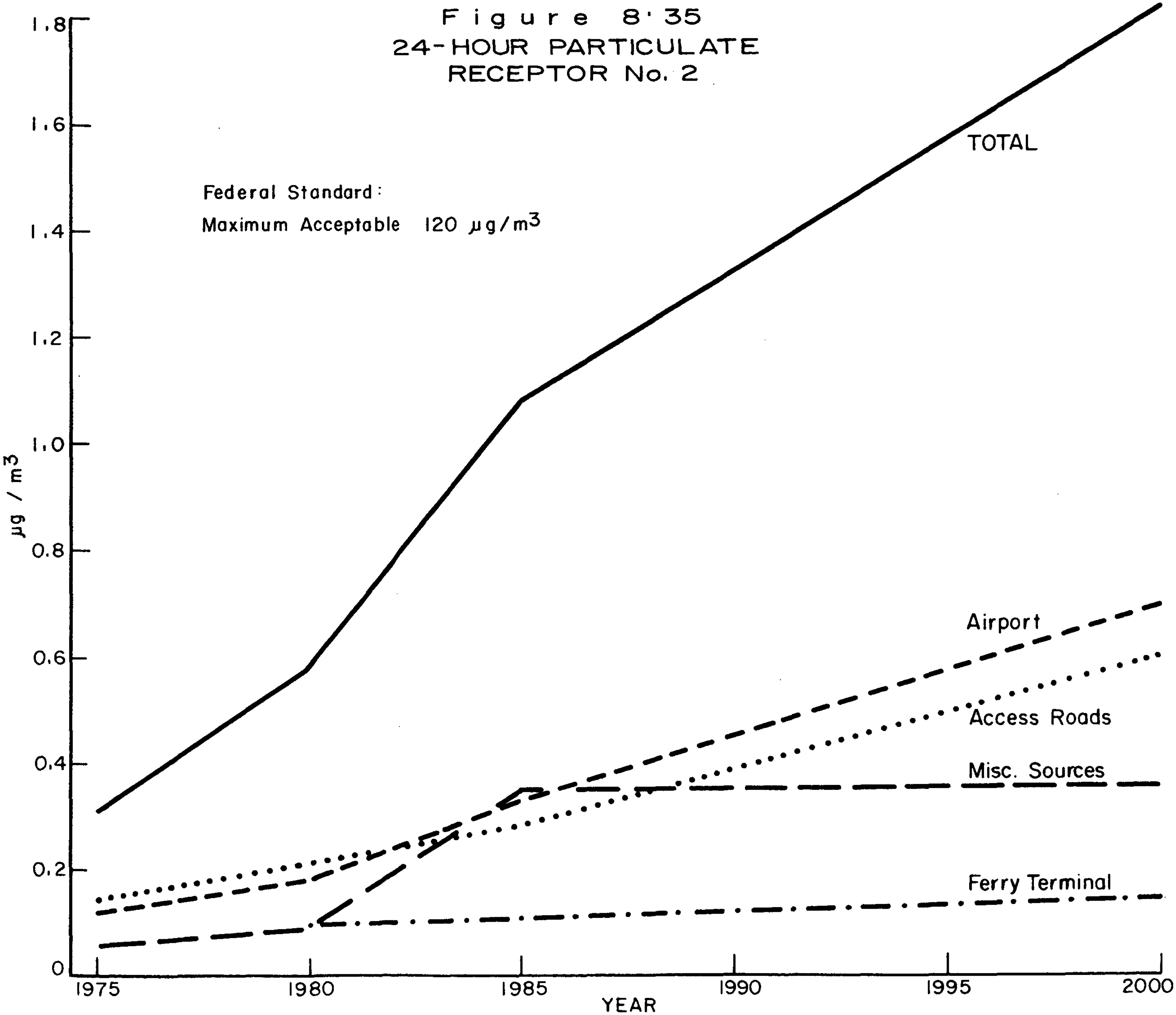


Figure 8'36
24-HOUR PARTICULATE
RECEPTOR No. 3

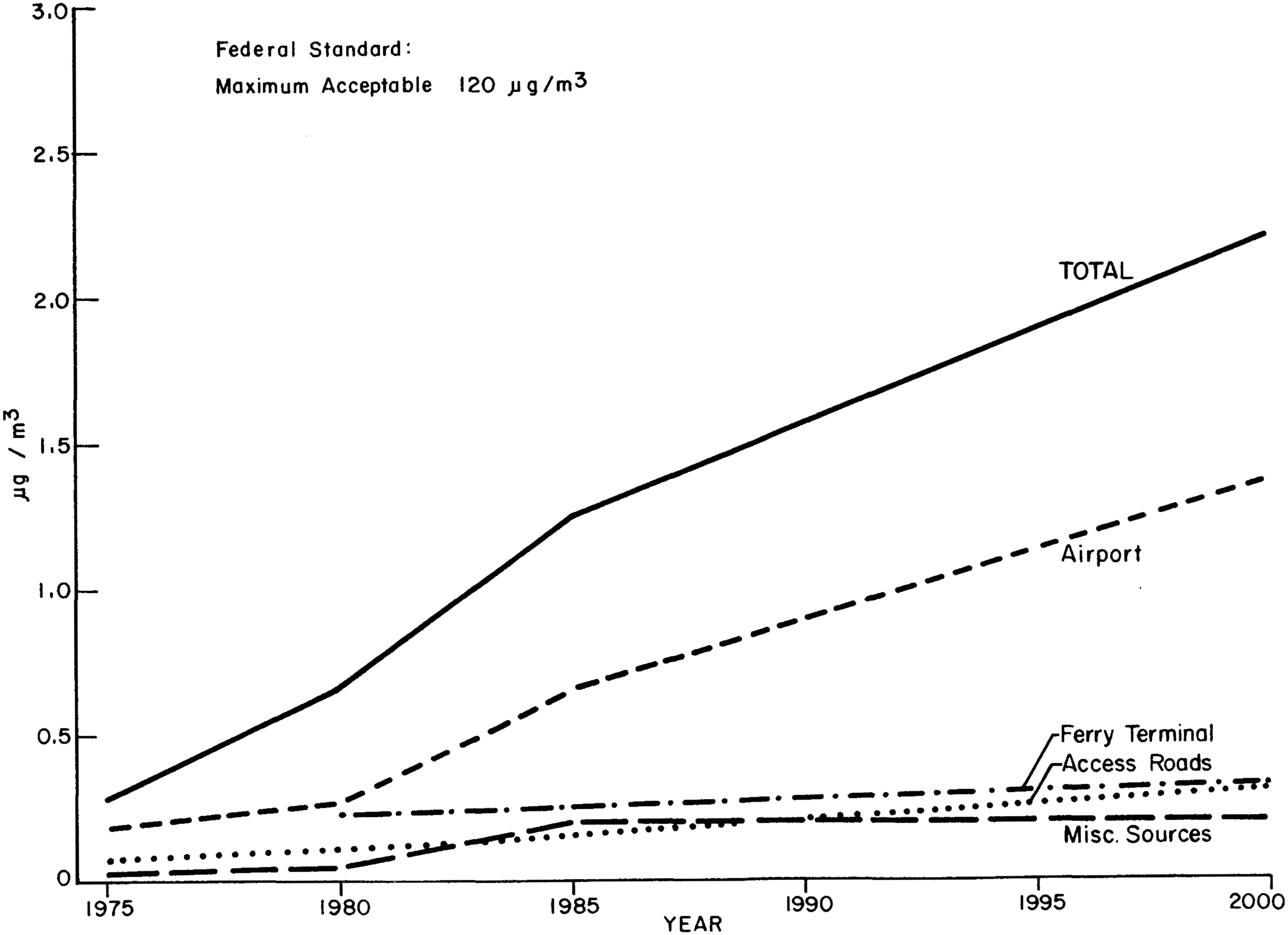


Figure 8·37
24-HOUR PARTICULATE
RECEPTOR No. 4

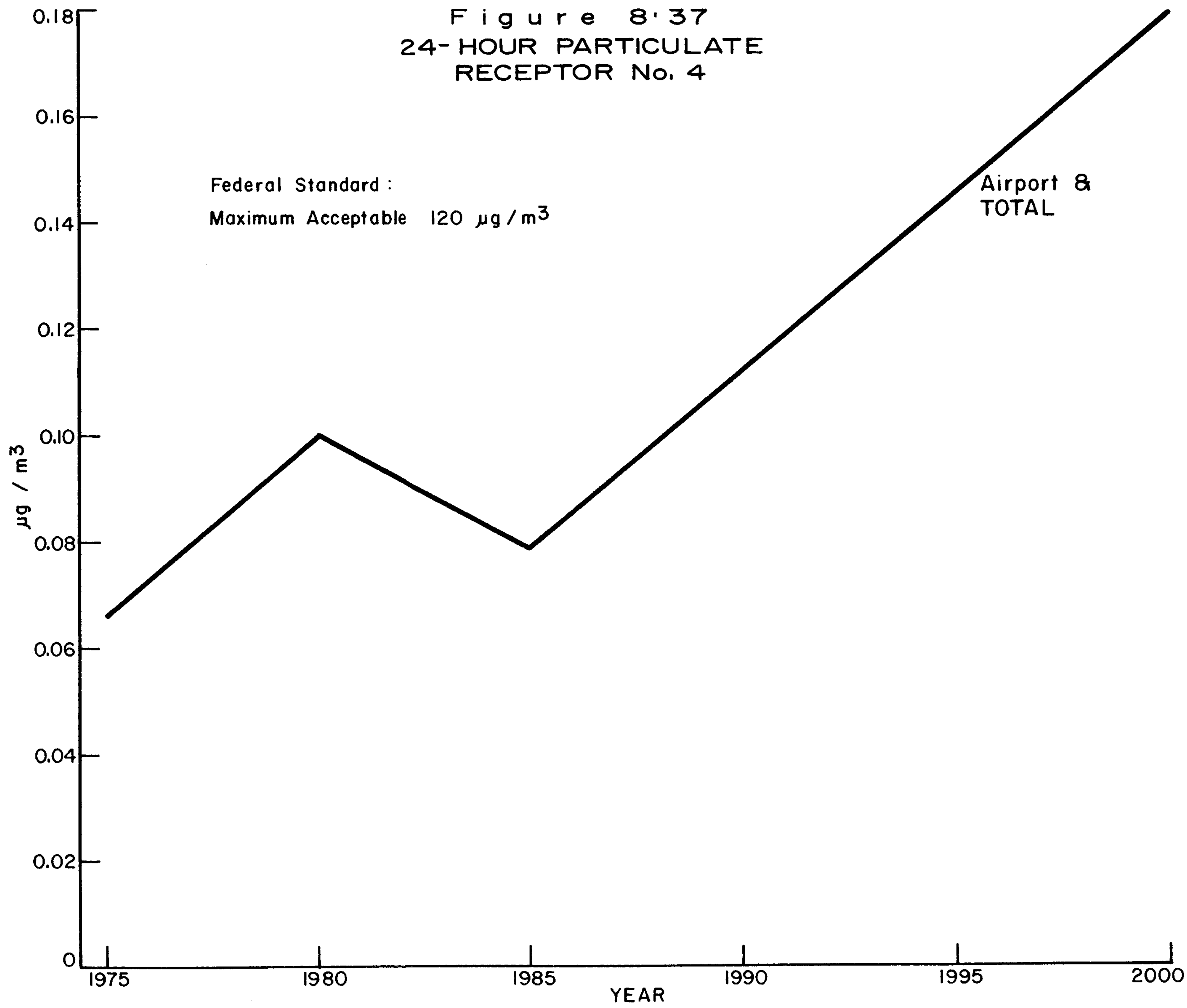


Figure 8·38
ANNUAL MEAN PARTICULATE CONCENTRATION
RECEPTOR No. 1

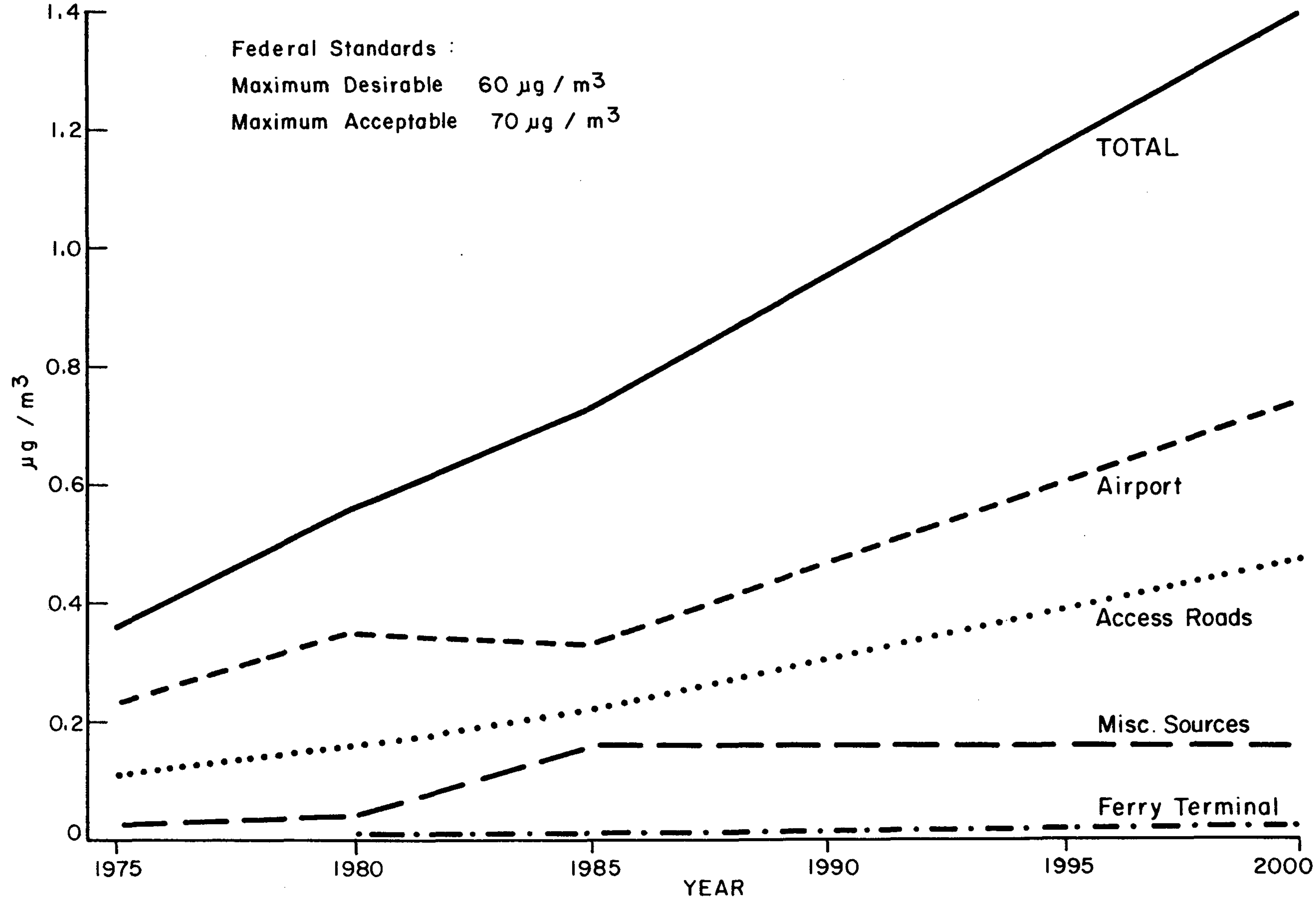


Figure 8·39
ANNUAL MEAN PARTICULATE CONCENTRATION
RECEPTOR No. 2

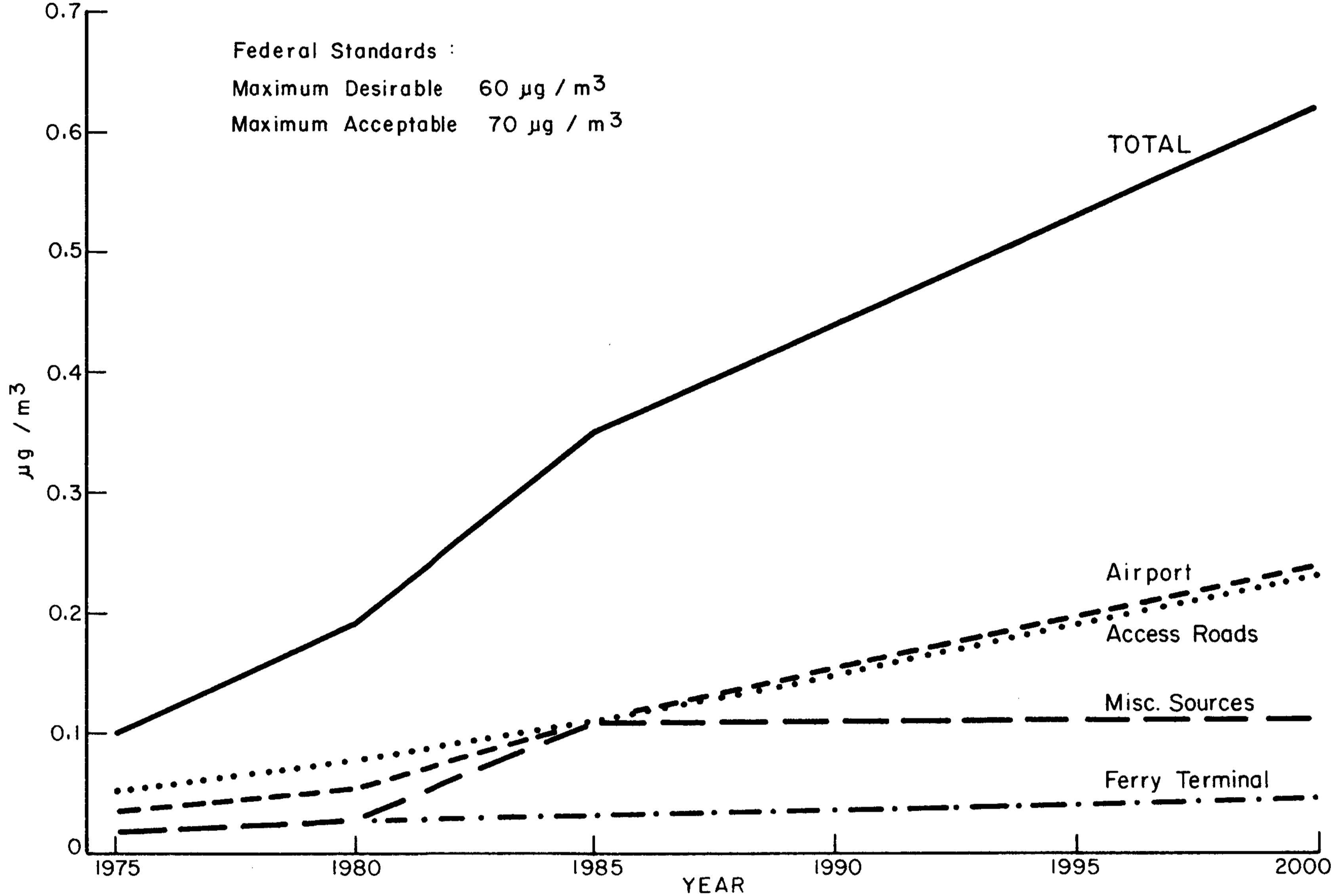


Figure 8.40
ANNUAL MEAN PARTICULATE CONCENTRATION
RECEPTOR No. 3

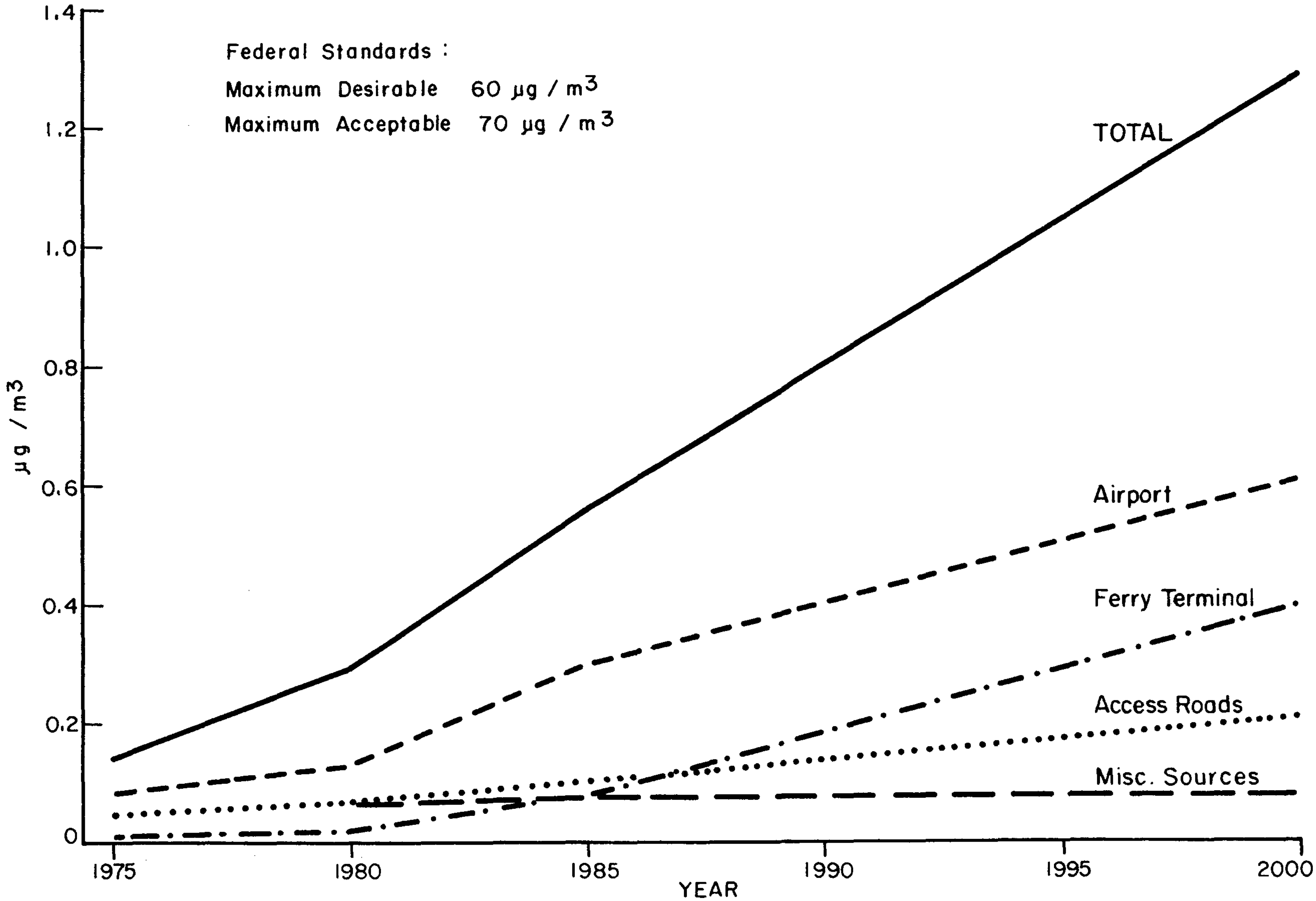
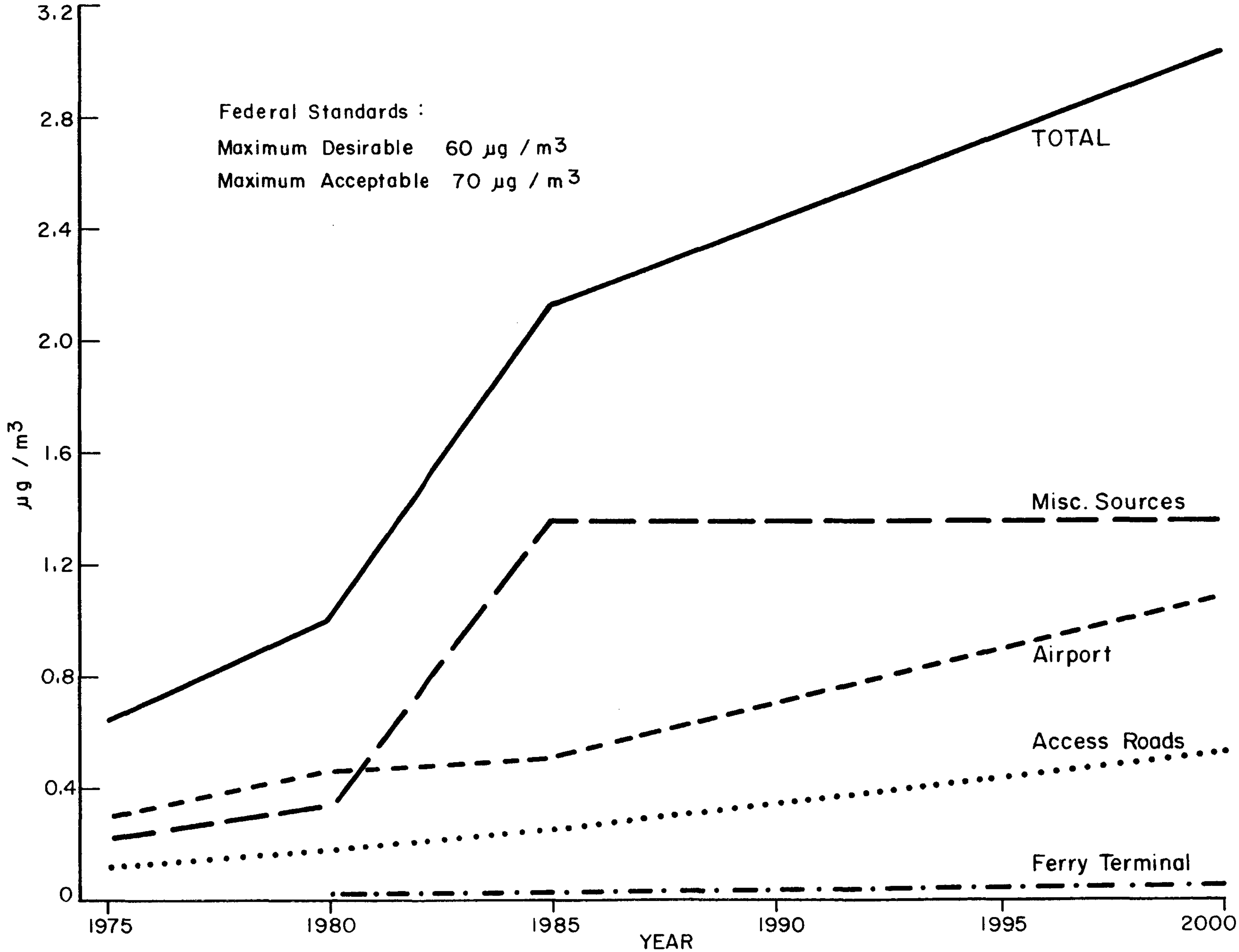


Figure 8·41
ANNUAL MEAN PARTICULATE CONCENTRATION
RECEPTOR No. 4



8.5 Hydrocarbons

The Canadian government does not presently have standards for ambient hydrocarbons. The U.S. federal objectives for this pollutant are designed to limit photochemical oxidant buildup and hence are set at 160 $\mu g/m^3$ (0.24 ppm) maximum 3-hour concentrations (6 - 9 a.m.), not to be exceeded more than once per year (25). Their primary and secondary standards are the same, and are corrected to exclude the non-reactive methane portion of the total hydrocarbons. These standards thus prevent the injection of gross quantities of reactive hydrocarbons into a stagnant air basin where the subsequent effects of NO_x accumulation and intense solar radiation would lead to the formulation of photochemical oxidants.

Using the previously described methodology maximum one hour HC concentrations were calculated for the four receptor sites and are shown in Figures 8.42 to 8.45. It can be seen that aircraft related sources are the major contributor towards the very high estimated ambient hydrocarbon level.

Figure 8.42
MAXIMUM ONE-HOUR HC CONCENTRATION
RECEPTOR No. 1

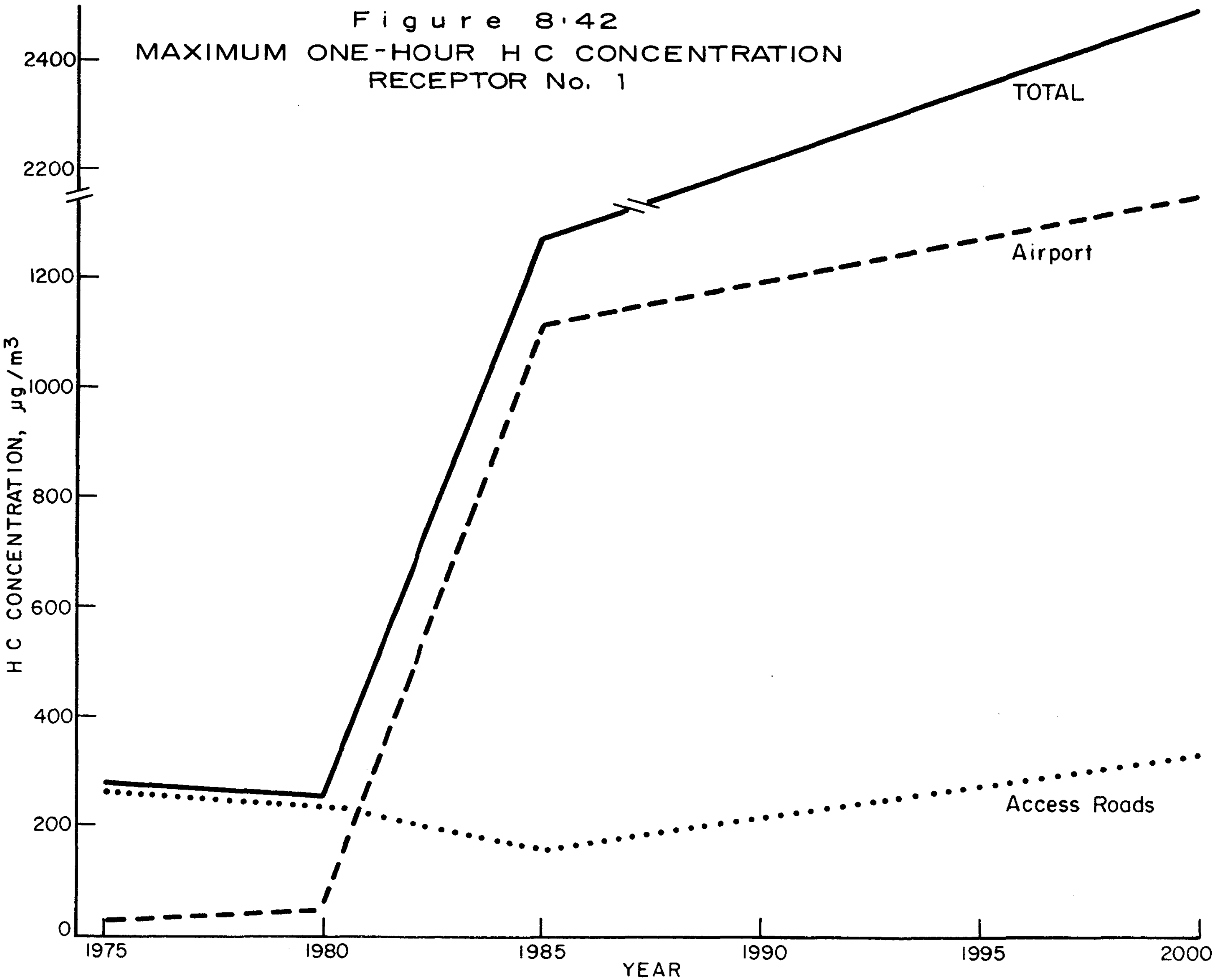


Figure 8.43
MAXIMUM ONE-HOUR H C CONCENTRATION
RECEPTOR No. 2

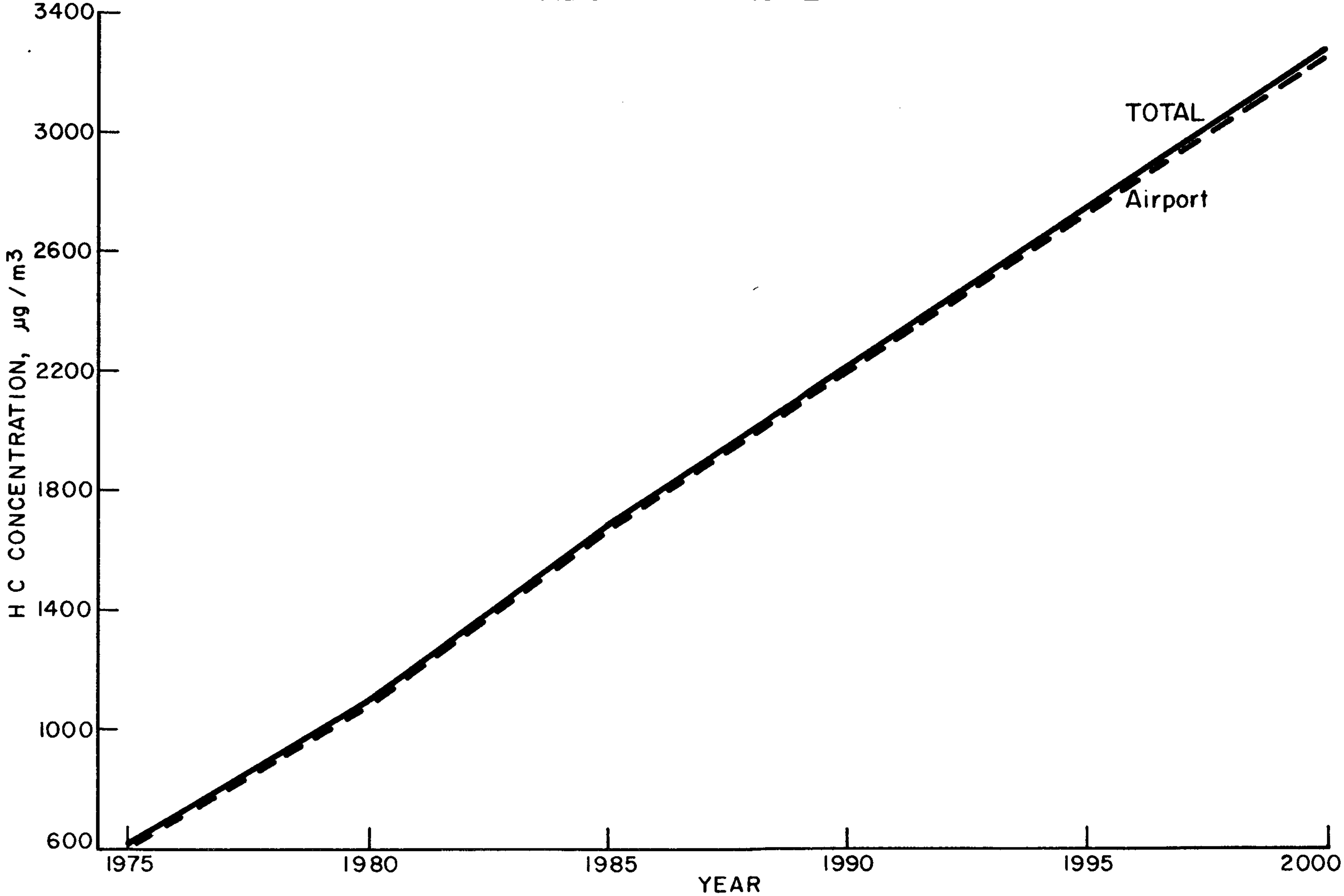


Figure 8.44
MAXIMUM ONE-HOUR HC CONCENTRATION
RECEPTOR No. 3

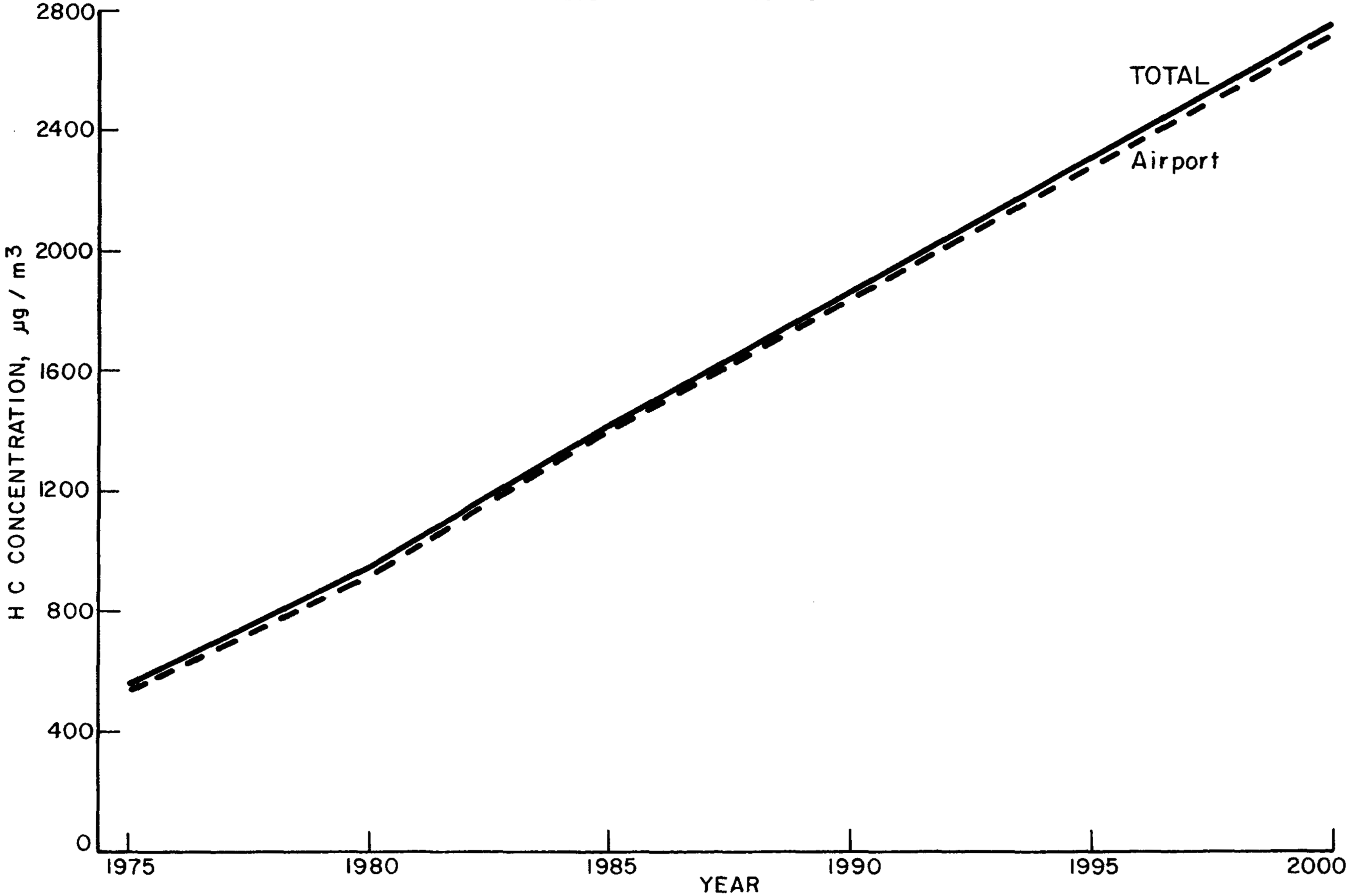
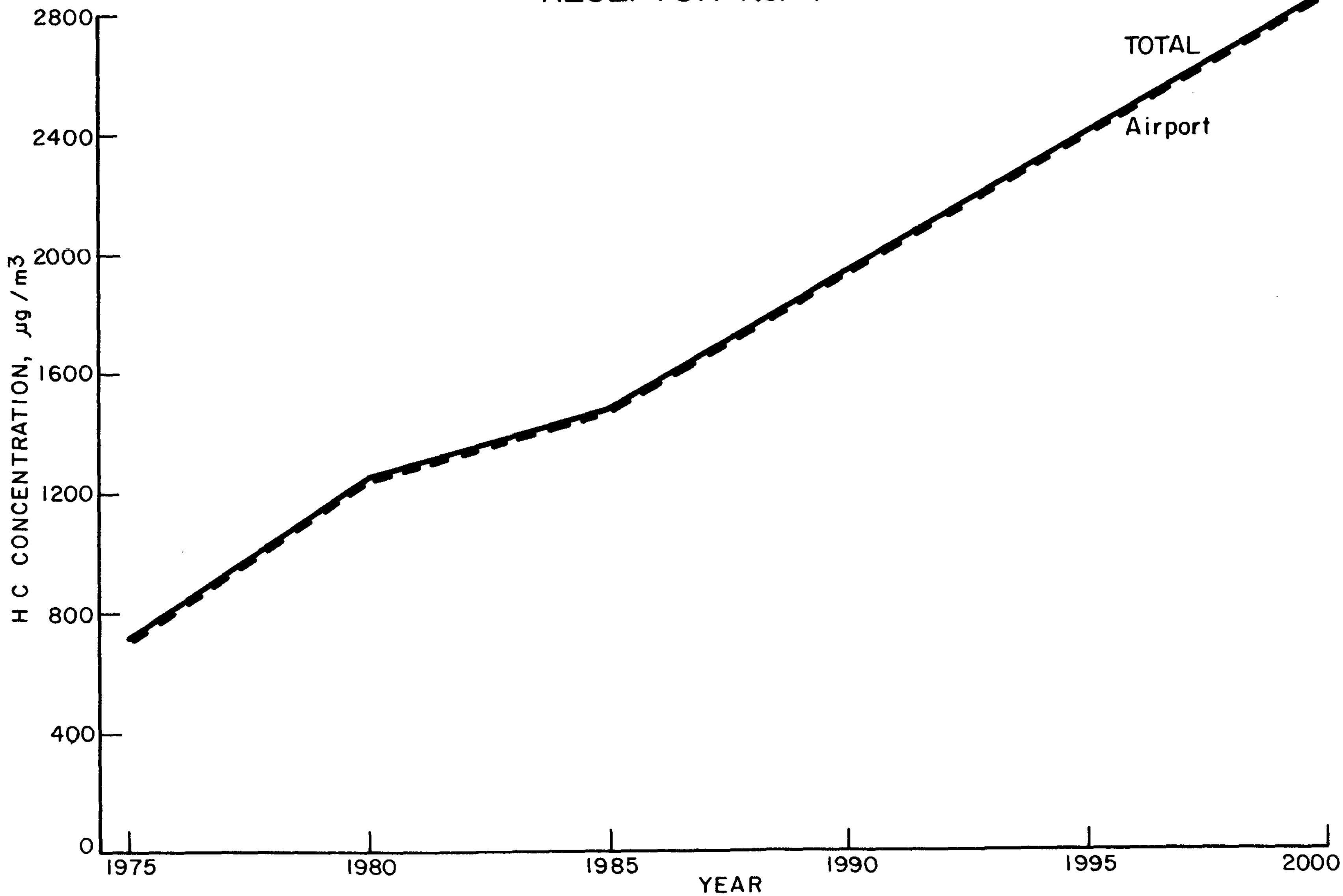


Figure 8.45

MAXIMUM ONE-HOUR H C CONCENTRATION
RECEPTOR No. 4



9. DISCUSSION AND RECOMMENDATIONS

The previous section presented forecasts on the contribution to ambient air quality reduction by pollutants emanating from airport-related sources. These estimates were done for short-term maximum concentrations, where peak airport emissions coincide with adverse weather conditions, for typical 24-hour average concentrations, and for expected annual mean concentrations.

It was seen that maximum one-hour concentrations of nitrogen oxides and hydrocarbons could reach high levels at all four receptor sites before the year 2000. For example, by the year 2000 receptor 1 could occasionally experience NO_x at 1200 $\mu g/m^3$ and HC at 2500 $\mu g/m^3$. It is generally accepted that nitrogen oxides act as smog precursors in heavily polluted atmospheres containing relatively high concentrations of hydrocarbons. The nitrogen oxides are felt to participate in photochemical reactions which produce ozone and the peroxyacyl nitrates (PANS), two highly phytotoxic oxidants.

Hence there would appear to be cause for alarm until it is recalled that the above high ambient pollutant concentrations are calculated for an adverse weather condition based on a ground level temperature inversion. Since such an inversion cannot persist during the prolonged, strong solar radiation that is required for smog, it is obvious that the estimated short-term maximum levels are not a reliable pollution indicator in this instance.

Vegetation is generally more susceptible to injury by air pollutants than are humans. The injury threshold for nitrogen dioxide is given (31) as 2.5 ppm (4800 $\mu g/m^3$) for a four hour exposure dosage. Thus it does not seem likely that the maximum short-term levels calculated are going to result in serious environmental impact, even though ambient air quality objectives may be exceeded occasionally each year.

The maximum one-hour concentration of sulfur dioxide was shown to be 1100 $\mu g/m^3$ (0.4 ppm). It was estimated that receptor 4 could experience such a level by 1985 during instances of unfavourable weather. This value is approaching the dose required for sensitive plant injury as estbalished by Dreisinger and McGovern (32):

0.70 ppm for 1 hour,
or 0.40 ppm for 2 hours,
or 0.26 ppm for 4 hours,
or 0.18 ppm for 8 hours.

Hence it is recommended that special attention be devoted to the design of flue gas exhaust stacks for the utility plants.

The human taste threshold for SO_2 is commonly considered to be 0.3 ppm, although available data on the physiological effects of the pure pollutant indicate that it is relatively innocuous at considerably higher levels (33).

There is, however, a synergistic effect between SO_2 and aerosols (particulates) which greatly enhances the physiological impact of SO_2. This could be due to SO_2 being catalytically oxidized to SO_3, and hence forming sulfuric acid, after being absorbed by the particulate. (Catalysis can be effected by trace materials such as vanadium and the alkali metal salts.) Urban air pollution episodes arising from SO_2 generally occur when the particulate concentration exceeds 200 $\mu g/m^3$ and the SO_2 exceeds 500 $\mu g/m^3$ on a 24-hour average. These episodes resulted in an increase in the mortality rate accompanied by an increase in hospital admissions for acute illness. Those predominantly affected were individuals with chronic pulmonary disease or cardiac disorders, or very young or very old individuals (33).

An examination of the estimated typical 24-hour average concentrations of SO_2 and particulates (Figures 8.18 to 8.21 and 8.34 to 8.37) will show levels two or more orders of magnitude below the above episode threshold and hence should pose little danger to human health.

While it has been argued above that the short-term maximum pollutant concentrations will not be serious from an ecological point of view, they may contribute to an over-all pollution problem. In certain air basins the pollutants can become trapped under a persistent, elevated inversion lid. They build up within this stagnant air mass and undergo photochemical reactions which eventually lead to noxious levels of photochemical smog. This phenomenon, which is common to the Los Angeles air basin, also happens to some extent in the Lower Mainland. Here the basin is flanked to the north and east by the Coast Mountains (elevation 4,000 - 6,000 feet), to the northwest by the Tantalus Range (6,000 feet), and to the west and south, across the Georgia Strait, by the Vancouver Island and Olympic Mountains (3,000 - 7,000 feet). During stable atmospheric conditions the air within this basin is not rapidly replenished, but instead tends to flow backwards and forwards through the valley due to a land/sea breeze mechanism. It has been observed (26) that the concentration of carbon monoxide will build up during such an episode, and that such episodes, lasting three to eleven days, will occur between twenty to forty times each year. Several factors, however, limit the impact of such an episode upon local air quality: the episodes are generally of relatively short duration; solar radiation is of a lower intensity due to our more northern latitude; our air basin contains a low ambient concentration of particulate due to frequent washout by precipitation; and during an episode some of the pollutant burden will be absorbed from the air mass due to the presence of forests and green belts located at the land-air interface.

At this time it would be speculative to discuss how airport-derived emissions contribute to air quality degradation during a land/sea breeze episode. A more thorough study is required on the mesoscale mixing and circulation within the Lower Mainland basin and on the roles played by various pollutant sinks. We can, however, do some comparisons between the airport emissions and those from the GVRD and from the total Lower Mainland region. Table 9.1 shows that the airport-related emissions are a very small fraction of the total emissions in the Lower Mainland. The majority of the emissions stem from vehicular activity and domestic fuel consumption in the GVRD area. Hence airport-derived pollutants can be expected to play a relatively minor role during one of the previously discussed episodes.

As we have seen in the previous section, however, the airport can have a significant effect upon air quality in the area immediately adjacent to it. To put this into perspective we can compare some of the estimated worst case pollutant concentrations, near the airport during the year 2000, with pollutant concentrations actually measured (26) at Vanier Park during the years 1969 - 1970. Table 9.2 shows that by the year 2000 the local air quality degradation, due solely to airport activity, will be similar to that presently occurring in central Vancouver due to urban activity. Hence, if the present urban levels are considered to be serious then this conclusion must be extended to future airport derived pollutants.

In any case the need for a realistic air quality model of the Lower Mainland air basin is obvious. This model should be tuned by conducting the appropriate meteorological and air quality surveys. In this way reasonably reliable forecasting could be conducted and the ramifications of urban growth and technological advances on air quality in the shole basin could be studied.

TABLE 9.1

POLLUTANT EMISSIONS

(Metric Tons per Year)

Pollutant Species	Lower Mainland 1973 Total (30)	GVRD 1970 Vehicular and Domestic Fuel (27)	Airport (This Study)	
			1973	2000
Carbon Monoxide	624,000	435,000	3,600	13,000
Hydrocarbons	80,000	80,000	1,000	4.200
Nitrogen Oxides	48,000	23,000	600	4,000
Sulfur Oxides	15,000	6,000	190	1,100
Particulates	47,000	3,600	60	300

TABLE 9.2

AMBIENT POLLUTANT CONCENTRATIONS

($\mu g/m^3$)

Pollutant Species	Vanier Park (Measured, 1969 - 1970)	Airport Vicinity (estimated)	
		1975	2000
Carbon Monoxide			
One Hour Maximum	25,000 (0.1% frequency)	2,500	8,900
Annual Mean	2,450	37	100
Oxides of Nitrogen			
One Hour Maximum	1,670 (0.1% frequency)	219	1,160
24 Hour Maximum	134 (20% frequency)	4.4	17
Annual Mean	117	4.6	18
Hydrocarbons			
One Hour Maximum	6,656 (peak)	705	3,270
Sulfur Dioxide			
One Hour Maximum	453 (peak)	170	1,100*
Annual Mean	26.6 (Mean over study period)	3.4	20.1

* Estimation based on use of roof-level exhaust vents.

10. CONCLUSIONS

A study of the effects on local air quality due to expanded activity at the Vancouver International Airport has shown that on the average these effects will be minor. When peak emissions coincide with very adverse weather conditions, however, the air quality adjacent to the airport will, by the year 2000, be of impaired quality similar to that presently occurring in the central Vancouver area. Under these adverse conditions the federal limit for ambient nitrogen dioxide may be exceeded.

The effect on air quality from emissions emanating from the proposed ferry terminal on Iona Island will be negligible when compared to that of the airport.

It is recommended that work be commenced on a tuned air quality model of the Lower Mainland air basin in order that the ramifications of future urban and industrial growth, as well as the effects of evolving air pollution regulations, can be determined with a reasonable degree of accuracy. In conjunction with this we recommend that a program of detailed monitoring of air quality in the Lower Mainland be initiated. This should involve the study of common primary air pollutants, oxidants and ozone. The results of such a program would enable the testing of an air quality model for the area.

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APPENDIX I

FERRY TERMINAL ACCESS TRAFFIC

A ferry terminal has been proposed for Sea Island or Iona Island. The final decision regarding the development and location has yet not been reached. Since a request from the sponsor of this project for including this emission source into the study came after the draft report covering emissions for the airport had been completed the ferry terminal access traffic is treated separately in this Appendix.

The limited information on the traffic activity obtained from the Department of Highways, Government of B.C. is summarized in Table A.1. The forecast average daily two-way traffic is 8000 vehicles per day in the peak month of August 1980 and 2500 vehicles per day in January 1980. The activity in January is at its minimum level and amounts to only 30% of the activity in August. The access traffic activities for other months are assumed to vary between that in August and January as indicated in Table A.1. The forecast for other years is based on a compound growth rate of 10% per year.

The average emission factors for highway vehicles in Table 4.7 are used in estimations of emission rates. The emissions in the month of August are displayed in Table A.2; for emissions in other months the percentage activities in Table A.1 should be used. The emissions on the access road are calculated for the average speed of 40 km/hr. At the ferry terminal an average speed of 20 km/hr is assumed. The emission factors for CO and HC for 20 km/hr speed are about 2.1 and 1.7 times those for 40 km/hr speed (7), respectively. The duration of unloading/loading operations of ½ hour is assumed. The emissions at the ferry terminal during unloading/loading operation are estimated per 300 vehicles operating for ½ hour, which is equivalent to 3000 vehicle kilometers travelled.

TABLE A.1

ACCESS TRAFFIC ACTIVITY

IONA ISLAND FERRY TERMINAL

	Distance from Collection Point to Terminal (km)	Average Speed (km/hr)	Average Daily Two-Way Traffic in August	Average Daily Vehicle Kilometers Travelled in August	Average Daily Number of Unloading/loading Operations in August**	Activities in Other Months as Percentage of August Activity				
						July	June, Sept	May, Oct	March, April, Nov	Jan, Feb, Dec
1980*	5.8	40	8,000	46,400	13.3	100	70	50	40	30
1985	"	"	8,800	51,040	14.7	"	"	"	"	"
1990	"	"	9,680	56,144	16.1	"	"	"	"	"
1995	"	"	10,645	61,758	17.7	"	"	"	"	"
2000	"	"	11,713	67,935	19.5	"	"	"	"	"

* Compound growth rate = 10% per year.

** Based on average 300 cars per ferry.

TABLE A.2

ACCESS TRAFFIC EMISSIONS IN MONTH OF AUGUST*

IONA ISLAND FERRY TERMINAL

		AVERAGE DAILY EMISSIONS, kg														
		ACCESS ROAD**					FERRY TERMINAL***					TOTAL				
		CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT	CO	HC	NO_x	SO_x	PT
1980	Aug	1392	143.8	120.6	5.568	16.70	2514	210.3	103.7	4.788	14.36	3906	354.1	224.3	10.36	31.06
1985	Aug	969.8	66.35	76.56	6.125	18.37	1760	97.46	66.15	5.292	15.88	2730	163.8	142.7	11.42	34.25
1990	Aug	1067	72.99	84.22	6.737	20.21	1927	106.7	72.45	5.796	17.39	2994	179.7	156.7	12.53	37.60
1995	Aug	1173	80.29	92.64	7.411	22.23	2119	117.4	79.65	6.372	19.12	3292	197.7	172.3	13.78	41.35
2000	Aug	1291	88.32	101.9	8.152	24.46	2334	129.3	87.75	7.020	21.06	3625	217.6	189.7	15.17	45.52

* For emissions in other months use percentage activities in Table A.1

** Distance from collection point to terminal = 5.8 km

*** Based on 3000 vehicle kilometers travelled at 20 km/hr per unloading/loading operation

The access road is treated as a line source, and ferry terminal as an area source. Spatial coordinates with respect to the east/west-north/south coordinate system shown in Figure 5.4 are given in Table A.3.

TABLE A.3

LINE AND AREA SOURCES SPATIAL COORDINATES

IONA ISLAND FERRY TERMINAL

	Coordinates		
	East (X), meters	North (Y), meters	Source Length, meters
Access Road			5800
Section No. 1	0 1680	4560 4130	 1740
Section No. 2	1680 5259	4130 2275	4060
Ferry Terminal	0	4560	350 (0.1225 km^2)

The emission densities per unit length of line source and unit area of area source are given in Table A.4.

TABLE A.4

ACCESS TRAFFIC EMISSIONS PER UNIT LENGTH AND UNIT AREA IN THE MONTH OF AUGUST*

IONA ISLAND FERRY TERMINAL

		CO		HC		NO_x		SO_x		PT	
		Access Road kg/day/km	Terminal Area $kg/day/km^2$	Access Road kg/day/km	Terminal Area $kg/day/km^2$	Access Road kg/day/km	Terminal Area $kg/day/km^2$	Access Road kg/day/km	Terminal Area $kg/day/km^2$	Access Road kg/day/km	Terminal Area $kg/day/km^2$
1980	Aug	240.0	20,522	24.79	1,717	20.79	846.5	0.960	39.09	2.879	117.2
1985	Aug	167.2	14,367	11.44	795.6	13.20	540.0	1.056	43.20	3.167	129.6
1990	Aug	184.0	15,731	12.58	871.0	14.52	591.4	1.162	47.31	3.484	142.0
1995	Aug	202.2	17,298	13.84	958.4	15.97	650.2	1.278	52.02	3.833	156.1
2000	Aug	222.6	19,053	15.23	1,056	17.57	716.3	1.406	57.31	4.217	171.9

* For emissions in other months use percentage activities in Table A.1

APPENDIX II

FIRE FIGHTING DRILLS

As part of Emergency Services personnel training at Vancouver International Airport aircraft crash fires are simulated. The amount of fuel burned in each training exercise is about 2000 litres. Duration of the fire is one to two minutes. The number of training sessions varies from four to twelve per month. The pollution effect of open gasoline fires has been investigated at Vancouver's airport (15). We quote the concluding remarks from that report:

> "Based on the results in the previous section, the ignition and deflagration combustions of fire training gasoline spillages contributes less serious pollutants percentage-wise, to the immediate vicinity of the Airport environment per any 15 minute period than any other major air polluter source.
>
> The results indicated low level of air pollution and except for the very fine sootiness, slight visibility reduction at 100 feet above ground and aesthetic nuisance for periods up to 10-15 minutes duration, constitute only a minor hazard in the surveillance of air pollution source programs at the present time."

The emissions from fire fighting drills have, therefore, not been included in this study.

APPENDIX III

TABLE A.5.2

EMISSIONS BY AIRCRAFT MIX AND MODE OF OPERATION
VANCOUVER INTERNATIONAL AIRPORT

Based on aircraft activity in Table 3.4 and emission factors in Table 4.2. Emission factors for landing operation assumed to be equal to those for approach operation.

General aviation assumed to be 50% turboprop and 50% piston aircrafts.

Cargo aviation emissions assumed to be 2% of air carrier emissions.

TABLE 5.2 (CONTINUED)

1973 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	3808.401 KG	100.00 %
JUMBO 350	=	118.466 KG	3.11 %
JUMBO 250	=	74.041 KG	1.94 %
LONG 200	=	595.994 KG	15.65 %
LONG 150	=	1042.990 KG	27.39 %
MED. 100	=	978.029 KG	25.68 %
SHORT 50	=	53.160 KG	1.40 %
TOTAL AIR CARRIER EMISSION	=	2862.680 KG	75.17 %
TOTAL AIR CARGO EMISSION	=	57.254 KG	1.50 %
TURBO	=	120.243 KG	3.16 %
PISTON	=	768.224 KG	20.17 %
TOTAL GENERAL AV. EMISSION	=	888.467 KG	23.33 %

GRAND TOTAL AIRCRAFT EMISSION	=	3808.401 KG	100.00 %
TAXIIDLE	=	2968.719 KG	77.95 %
TAKE OFF	=	35.184 KG	0.92 %
CLIMBOUT	=	413.790 KG	10.87 %
APPROACH	=	350.937 KG	9.21 %
LANDING	=	39.773 KG	1.04 %

TABLE 5.2 (CONTINUED)

1975 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	4315.285 KG	100.00 %
JUMBO 350	=	311.616 KG	7.22 %
JUMBO 250	=	358.359 KG	8.30 %
LONG 200	=	358.337 KG	8.30 %
LONG 150	=	1254.180 KG	29.06 %
MED. 100	=	985.955 KG	22.85 %
SHORT 50	=	37.289 KG	0.86 %
TOTAL AIR CARRIER EMISSION	=	3305.736 KG	76.61 %
TOTAL AIR CARGO EMISSION	=	66.115 KG	1.53 %
TURBO	=	127.683 KG	2.96 %
PISTON	=	815.755 KG	18.90 %
TOTAL GENERAL AV. EMISSION	=	943.437 KG	21.86 %

GRAND TOTAL AIRCRAFT EMISSION	=	4315.285 KG	100.00 %
TAXIIDLE	=	3410.637 KG	79.04 %
TAKE OFF	=	37.532 KG	0.87 %
CLIMBOUT	=	440.546 KG	10.21 %
APPRCACH	=	382.534 KG	8.86 %
LANDING	=	44.041 KG	1.02 %

TABLE 5.2 (CONTINUED)

1980 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	7028.000 KG	100.00 %
JUMBO 350	=	686.759 KG	9.77 %
JUMBO 250	=	679.891 KG	9.67 %
LONG 200	=	355.375 KG	5.06 %
LONG 150	=	2872.622 KG	40.87 %
MED. 100	=	1047.268 KG	14.90 %
SHORT 50	=	30.817 KG	0.44 %
TOTAL AIR CARRIER EMISSION	=	5672.727 KG	80.72 %
TOTAL AIR CARGO EMISSION	=	113.455 KG	1.61 %
TURBO	=	168.066 KG	2.39 %
PISTON	=	1073.758 KG	15.28 %
TOTAL GENERAL AV. EMISSION	=	1241.823 KG	17.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	7028.000 KG	100.00 %
TAXIIDLE	=	5751.477 KG	81.84 %
TAKE OFF	=	52.094 KG	0.74 %
CLIMBOUT	=	591.059 KG	8.41 %
APPROACH	=	564.630 KG	8.03 %
LANDING	=	68.737 KG	0.98 %

TABLE 5.2 (CONTINUED)

1985 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	9991.480 KG	100.00 %
JUMBO 350	=	1460.221 KG	14.61 %
JUMBO 250	=	1329.844 KG	13.31 %
LONG 200	=	787.102 KG	7.88 %
LONG 150	=	3523.215 KG	35.26 %
MED. 100	=	1163.149 KG	11.64 %
SHORT 50	=	26.522 KG	0.27 %
TOTAL AIR CARRIER EMISSION	=	8290.047 KG	82.97 %
TOTAL AIR CARGO EMISSION	=	165.801 KG	1.66 %
TURBO	=	207.830 KG	2.08 %
PISTON	=	1327.807 KG	13.29 %
TOTAL GENERAL AV. EMISSION	=	1535.636 KG	15.37 %

GRAND TOTAL AIRCRAFT EMISSION	=	9991.480 KG	100.00 %
TAXIIDLE	=	8331.977 KG	83.39 %
TAKE OFF	=	66.823 KG	0.67 %
CLIMBOUT	=	741.583 KG	7.42 %
APPROACH	=	755.950 KG	7.57 %
LANDING	=	95.150 KG	0.95 %

TABLE 5.2 (CONTINUED)

1990 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION		=13692.731 KG	100.00 %
	JUMBO 350	= 2675.612 KG	19.54 %
	JUMBO 250	= 2508.387 KG	18.32 %
	LONG 200	= 1261.954 KG	9.22 %
	LONG 150	= 4236.555 KG	30.94 %
	MED. 100	= 932.434 KG	6.81 %
	SHORT 50	= 13.132 KG	0.10 %
TOTAL AIR CARRIER EMISSION		=11628.066 KG	84.92 %
TOTAL AIR CARGO EMISSION		= 232.561 KG	1.70 %
	TURBO	= 247.953 KG	1.81 %
	PISTON	= 1584.154 KG	11.57 %
TOTAL GENERAL AV. EMISSION		= 1832.107 KG	13.38 %

GRAND TOTAL AIRCRAFT EMISSION		=13692.731 KG	100.00 %
	TAXIIDLE	=11616.703 KG	84.84 %
	TAKE OFF	= 81.996 KG	0.60 %
	CLIMBOUT	= 896.040 KG	6.54 %
	APPROACH	= 972.112 KG	7.10 %
	LANDING	= 125.882 KG	0.92 %

TABLE 5.2 (CONTINUED)

1995 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION		=17411.711 KG	100.00 %
	JUMBO 350	= 4151.887 KG	23.85 %
	JUMBO 250	= 3663.429 KG	21.04 %
	LONG 200	= 1632.415 KG	9.38 %
	LONG 150	= 4897.238 KG	28.13 %
	MED. 100	= 633.393 KG	3.64 %
	SHORT 50	= 6.576 KG	0.04 %
TOTAL AIR CARRIER EMISSION		=14984.930 KG	86.06 %
TOTAL AIR CARGO EMISSION		= 299.698 KG	1.72 %
	TURBO	= 287.875 KG	1.65 %
	PISTON	= 1839.213 KG	10.56 %
TOTAL GENERAL AV. EMISSION		= 2127.088 KG	12.22 %

GRAND TOTAL AIRCRAFT EMISSION		=17411.711 KG	100.00 %
	TAXIIDLE	=14923.426 KG	85.71 %
	TAKE OFF	= 96.850 KG	0.56 %
	CLIMBOUT	= 1049.153 KG	6.03 %
	APPROACH	= 1186.056 KG	6.81 %
	LANDING	= 156.234 KG	0.90 %

TABLE 5.2 (CONTINUED)

2000 CO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=21142.262	KG	100.00 %
JUMBO 350	= 5412.508	KG	25.60 %
JUMBO 250	= 5021.918	KG	23.75 %
LONG 200	= 2165.571	KG	10.24 %
LONG 150	= 5413.918	KG	25.61 %
MED. 100	= 332.837	KG	1.57 %
SHORT 50	= 2.504	KG	0.01 %
TOTAL AIR CARRIER EMISSION	=18349.250	KG	86.79 %
TOTAL AIR CARGO EMISSION	= 366.985	KG	1.74 %
TURBO	= 328.333	KG	1.55 %
PISTON	= 2097.698	KG	9.92 %
TOTAL GENERAL AV. EMISSION	= 2426.031	KG	11.47 %

GRAND TOTAL AIRCRAFT EMISSION	=21142.262	KG	100.00 %
TAXIIDLE	=18238.414	KG	86.27 %
TAKE OFF	= 111.850	KG	0.53 %
CLIMBOUT	= 1204.075	KG	5.70 %
APPROACH	= 1401.252	KG	6.63 %
LANDING	= 186.700	KG	0.88 %

TABLE 5.2 (CONTINUED)

1973 HC AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1791.975 KG	100.CC %	
JUMBO 350	=	30.578 KG	1.71 %	
JUMBO 250	=	19.111 KG	1.C7 %	
LONG 200	=	508.895 KG	28.40 %	
LONG 150	=	890.566 KG	49.7C %	
MED. 1CO	=	222.634 KG	12.42 %	
SHORT 50	=	40.660 KG	2.27 %	
TOTAL AIR CARRIER EMISSION	=	1712.443 KG	95.56 %	
TOTAL AIR CARGO EMISSION	=	34.249 KG	1.91 %	
TURBO	=	27.429 KG	1.53 %	
PISTON	=	17.854 KG	1.00 %	
TOTAL GENERAL AV. EMISSION	=	45.283 KG	2.53 %	

GRAND TOTAL AIRCRAFT EMISSION	=	1791.975 KG	1CC.CC %
TAXIIDLE	=	1738.071 KG	96.99 %
TAKE OFF	=	3.060 KG	0.17 %
CLIMBOUT	=	16.115 KG	0.90 %
APPROACH	=	29.999 KG	1.67 %
LANDING	=	4.731 KG	0.26 %

TABLE 5.2 (CONTINUED)

1975 HC AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1886.890 KG	100.00 %
JUMBO 350	=	80.433 KG	4.26 %
JUMBO 250	=	92.498 KG	4.90 %
LONG 200	=	305.969 KG	16.22 %
LONG 150	=	1070.891 KG	56.75 %
MED. 100	=	224.438 KG	11.89 %
SHORT 50	=	28.521 KG	1.51 %
TOTAL AIR CARRIER EMISSION	=	1802.750 KG	95.54 %
TOTAL AIR CARGO EMISSION	=	36.055 KG	1.91 %
TURBO	=	29.126 KG	1.54 %
PISTON	=	18.958 KG	1.00 %
TOTAL GENERAL AV. EMISSION	=	48.085 KG	2.55 %

GRAND TOTAL AIRCRAFT EMISSION	=	1886.890 KG	100.00 %
TAXIIDLE	=	1828.955 KG	96.93 %
TAKE OFF	=	3.409 KG	0.18 %
CLIMBOUT	=	17.437 KG	0.92 %
APPROACH	=	32.029 KG	1.70 %
LANDING	=	5.061 KG	0.27 %

TABLE 5.2 (CONTINUED)

1980 HC AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	3501.683	KG	100.00 %
JUMBO 350	=	177.264	KG	5.06 %
JUMBO 250	=	175.491	KG	5.01 %
LONG 200	=	303.440	KG	8.67 %
LONG 150	=	2452.810	KG	70.05 %
MED. 100	=	238.395	KG	6.81 %
SHORT 50	=	23.571	KG	0.67 %
TOTAL AIR CARRIER EMISSION	=	3370.971	KG	96.27 %
TOTAL AIR CARGO EMISSION	=	67.419	KG	1.93 %
TURBO	=	38.338	KG	1.09 %
PISTON	=	24.955	KG	0.71 %
TOTAL GENERAL AV. EMISSION	=	63.293	KG	1.81 %

GRAND TOTAL AIRCRAFT EMISSION	=	3501.683	KG	100.00 %
TAXIIDLE	=	3405.838	KG	97.26 %
TAKE OFF	=	5.890	KG	0.17 %
CLIMBOUT	=	27.351	KG	0.78 %
APPROACH	=	53.884	KG	1.54 %
LANDING	=	8.720	KG	0.25 %

TABLE 5.2 (CONTINUED)

1985 HC AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	4857.586 KG	100.00 %	
JUMBO 350	=	376.907 KG	7.76 %	
JUMBO 250	=	343.254 KG	7.07 %	
LONG 200	=	672.073 KG	13.84 %	
LONG 150	=	3008.324 KG	61.93 %	
MED. 100	=	264.773 KG	5.45 %	
SHORT 50	=	20.286 KG	0.42 %	
TOTAL AIR CARRIER EMISSION	=	4685.609 KG	96.46 %	
TOTAL AIR CARGO EMISSION	=	93.712 KG	1.93 %	
TURBO	=	47.409 KG	0.98 %	
PISTON	=	30.859 KG	0.64 %	
TOTAL GENERAL AV. EMISSION	=	78.268 KG	1.61 %	

GRAND TOTAL AIRCRAFT EMISSION	=	4857.586 KG	100.00 %
TAXIIDLE	=	4726.582 KG	97.30 %
TAKE OFF	=	8.361 KG	0.17 %
CLIMBOUT	=	36.946 KG	0.76 %
APPROACH	=	73.679 KG	1.52 %
LANDING	=	12.021 KG	0.25 %

TABLE 5.2 (CONTINUED)

1990 HC AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	6473.801 KG	100.00 %
JUMBO 350	=	690.619 KG	10.67 %
JUMBO 250	=	647.456 KG	10.00 %
LONG 200	=	1077.529 KG	16.64 %
LONG 150	=	3617.419 KG	55.88 %
MED. 100	=	212.255 KG	3.28 %
SHORT 50	=	10.044 KG	0.16 %
TOTAL AIR CARRIER EMISSION	=	6255.320 KG	96.63 %
TOTAL AIR CARGO EMISSION	=	125.106 KG	1.93 %
TURBO	=	56.562 KG	0.87 %
PISTON	=	36.816 KG	0.57 %
TOTAL GENERAL AV. EMISSION	=	93.378 KG	1.44 %

GRAND TOTAL AIRCRAFT EMISSION	=	6473.801 KG	100.00 %
TAXIIDLE	=	6302.117 KG	97.35 %
TAKE OFF	=	11.466 KG	0.18 %
CLIMBOUT	=	48.210 KG	0.74 %
APPROACH	=	96.203 KG	1.49 %
LANDING	=	15.801 KG	0.24 %

TABLE 5.2 (CONTINUED)

1995 HC AVERAGE DAY EMISSICNS

GRAND TOTAL AIRCRAFT EMISSION	= 8005.105	KG	10C.CC %
JUMBO 350	= 1071.671	KG	13.39 %
JUMBO 250	= 945.591	KG	11.81 %
LONG 200	= 1393.849	KG	17.41 %
LONG 150	= 4181.543	KG	52.24 %
MED. 100	= 144.182	KG	1.80 %
SHORT 50	= 5.030	KG	0.06 %
TOTAL AIR CARRIER EMISSION	= 7741.859	KG	96.71 %
TOTAL AIR CARGO EMISSION	= 154.837	KG	1.93 %
TURBO	= 65.669	KG	0.82 %
PISTON	= 42.744	KG	0.53 %
TOTAL GENERAL AV. EMISSION	= 108.413	KG	1.35 %

GRAND TOTAL AIRCRAFT EMISSION	= 8005.105	KG	10C.CC %
TAXIIDLE	= 7794.262	KG	97.37 %
TAKE OFF	= 14.544	KG	0.18 %
CLIMBOUT	= 59.274	KG	0.74 %
APPRCACH	= 117.641	KG	1.47 %
LANDING	= 19.389	KG	0.24 %

TABLE 5.2 (CONTINUED)

2000 HC AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	9551.285	KG	100.00 %
JUMBO 350	=	1397.059	KG	14.63 %
JUMBO 250	=	1296.241	KG	13.57 %
LONG 200	=	1849.089	KG	19.36 %
LONG 150	=	4622.719	KG	48.40 %
MED. 100	=	75.765	KG	0.79 %
SHORT 50	=	1.915	KG	0.02 %
TOTAL AIR CARRIER EMISSION	=	9242.781	KG	96.77 %
TOTAL AIR CARGO EMISSION	=	184.856	KG	1.94 %
TURBO	=	74.898	KG	0.78 %
PISTON	=	48.751	KG	0.51 %
TOTAL GENERAL AV. EMISSION	=	123.649	KG	1.29 %

GRAND TOTAL AIRCRAFT EMISSION	=	9551.285	KG	100.00 %
TAXIIDLE	=	9300.980	KG	97.38 %
TAKE OFF	=	17.636	KG	0.18 %
CLIMBOUT	=	70.420	KG	0.74 %
APPROACH	=	139.247	KG	1.46 %
LANDING	=	23.004	KG	0.24 %

TABLE 5.2 (CONTINUED)

1973 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1120.764 KG	100.00 %
JUMBO 350	=	80.330 KG	7.17 %
JUMBO 250	=	50.206 KG	4.48 %
LONG 200	=	88.549 KG	7.90 %
LONG 150	=	154.960 KG	13.83 %
MED. 100	=	645.023 KG	57.55 %
SHORT 50	=	28.870 KG	2.58 %
TOTAL AIR CARRIER EMISSION	=	1047.937 KG	93.50 %
TOTAL AIR CARGO EMISSION	=	20.959 KG	1.87 %
TURBO	=	49.081 KG	4.38 %
PISTON	=	2.786 KG	0.25 %
TOTAL GENERAL AV. EMISSION	=	51.868 KG	4.63 %

GRAND TOTAL AIRCRAFT EMISSION	=	1120.764 KG	100.00 %
TAXIIDLE	=	143.281 KG	12.78 %
TAKE OFF	=	237.414 KG	21.18 %
CLIMBOUT	=	501.390 KG	44.74 %
APPROACH	=	204.017 KG	18.20 %
LANDING	=	34.662 KG	3.09 %

TABLE 5.2 (CONTINUED)

1975 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1446.740	KG	100.00 %
JUMBO 350	=	211.302	KG	14.61 %
JUMBO 250	=	242.997	KG	16.80 %
LONG 200	=	53.239	KG	3.68 %
LONG 150	=	186.337	KG	12.88 %
MED. 100	=	650.250	KG	44.95 %
SHORT 50	=	20.251	KG	1.40 %
TOTAL AIR CARRIER EMISSION	=	1364.376	KG	94.31 %
TOTAL AIR CARGO EMISSION	=	27.288	KG	1.89 %
TURBO	=	52.118	KG	3.60 %
PISTON	=	2.959	KG	0.20 %
TOTAL GENERAL AV. EMISSION	=	55.077	KG	3.81 %

GRAND TOTAL AIRCRAFT EMISSION	=	1446.740	KG	100.00 %
TAXIIDLE	=	170.332	KG	11.77 %
TAKE OFF	=	323.457	KG	22.36 %
CLIMBOUT	=	672.141	KG	46.46 %
APPROACH	=	239.791	KG	16.57 %
LANDING	=	41.019	KG	2.84 %

TABLE 5.2 (CONTINUED)

1980 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	2228.487	KG	100.00 %
JUMBO 350	=	465.679	KG	20.90 %
JUMBO 250	=	461.023	KG	20.69 %
LONG 200	=	52.799	KG	2.37 %
LONG 150	=	426.793	KG	19.15 %
MED. 100	=	690.687	KG	30.99 %
SHORT 50	=	16.736	KG	0.75 %
TOTAL AIR CARRIER EMISSION	=	2113.717	KG	94.85 %
TOTAL AIR CARGO EMISSION	=	42.274	KG	1.90 %
TURBO	=	68.602	KG	3.08 %
PISTON	=	3.895	KG	0.17 %
TOTAL GENERAL AV. EMISSION	=	72.497	KG	3.25 %

GRAND TOTAL AIRCRAFT EMISSION	=	2228.487	KG	100.00 %
TAXIIDLE	=	243.323	KG	10.92 %
TAKE OFF	=	514.712	KG	23.10 %
CLIMBOUT	=	1059.292	KG	47.53 %
APPROACH	=	350.850	KG	15.74 %
LANDING	=	60.310	KG	2.71 %

TABLE 5.2 (CONTINUED)

1985 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	3469.731	KG	100.00 %
JUMBO 350	=	990.151	KG	28.54 %
JUMBO 250	=	901.745	KG	25.99 %
LONG 200	=	116.942	KG	3.37 %
LONG 150	=	523.454	KG	15.09 %
MED. 100	=	767.112	KG	22.11 %
SHORT 50	=	14.403	KG	0.42 %
TOTAL AIR CARRIER EMISSION	=	3313.806	KG	95.51 %
TOTAL AIR CARGO EMISSION	=	66.276	KG	1.91 %
TURBO	=	84.833	KG	2.44 %
PISTON	=	4.816	KG	0.14 %
TOTAL GENERAL AV. EMISSION	=	89.649	KG	2.58 %

GRAND TOTAL AIRCRAFT EMISSION	=	3469.731	KG	100.00 %
TAXIIDLE	=	355.288	KG	10.24 %
TAKE OFF	=	827.306	KG	23.84 %
CLIMBOUT	=	1689.053	KG	48.68 %
APPROACH	=	510.069	KG	14.70 %
LANDING	=	88.013	KG	2.54 %

TABLE 5.2 (CONTINUED)

1990 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	5160.223	KG	100.00 %
JUMBO 350	=	1814.286	KG	35.16 %
JUMBO 250	=	1700.695	KG	32.96 %
LONG 200	=	187.492	KG	3.63 %
LONG 150	=	629.437	KG	12.20 %
MED. 100	=	614.953	KG	11.92 %
SHORT 50	=	7.132	KG	0.14 %
TOTAL AIR CARRIER EMISSION	=	4954.188	KG	96.01 %
TOTAL AIR CARGO EMISSION	=	99.084	KG	1.92 %
TURBO	=	101.211	KG	1.96 %
PISTON	=	5.746	KG	0.11 %
TOTAL GENERAL AV. EMISSION	=	106.957	KG	2.07 %

GRAND TOTAL AIRCRAFT EMISSION	=	5160.223	KG	100.00 %
TAXIIDLE	=	495.200	KG	9.60 %
TAKE OFF	=	1269.114	KG	24.59 %
CLIMBOUT	=	2572.320	KG	49.85 %
APPROACH	=	702.071	KG	13.61 %
LANDING	=	121.528	KG	2.36 %

TABLE 5.2 (CONTINUED)

1995 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	6948.848	KG	100.00 %
JUMBO 350	=	2815.323	KG	40.51 %
JUMBO 250	=	2484.110	KG	35.75 %
LONG 200	=	242.532	KG	3.49 %
LONG 150	=	727.597	KG	10.47 %
MED. 100	=	417.731	KG	6.01 %
SHORT 50	=	3.571	KG	0.05 %
TOTAL AIR CARRIER EMISSION	=	6690.855	KG	96.29 %
TOTAL AIR CARGO EMISSION	=	133.817	KG	1.93 %
TURBO	=	117.506	KG	1.69 %
PISTON	=	6.671	KG	0.10 %
TOTAL GENERAL AV. EMISSION	=	124.178	KG	1.79 %

GRAND TOTAL AIRCRAFT EMISSION	=	6948.848	KG	100.00 %
TAXIIDLE	=	642.070	KG	9.24 %
TAKE OFF	=	1739.085	KG	25.03 %
CLIMBOUT	=	3511.613	KG	50.54 %
APPROACH	=	900.056	KG	12.95 %
LANDING	=	156.034	KG	2.25 %

TABLE 5.2 (CONTINUED)

2000 NO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	8732.461	KG	100.00 %
JUMBO 350	=	3670.136	KG	42.03 %
JUMBO 250	=	3405.283	KG	39.00 %
LONG 200	=	321.745	KG	3.68 %
LONG 150	=	804.363	KG	9.21 %
MED. 100	=	219.511	KG	2.51 %
SHORT 50	=	1.360	KG	0.02 %
TOTAL AIR CARRIER EMISSION	=	8422.387	KG	96.45 %
TOTAL AIR CARGO EMISSION	=	168.448	KG	1.93 %
TURBO	=	134.021	KG	1.53 %
PISTON	=	7.609	KG	0.09 %
TOTAL GENERAL AV. EMISSION	=	141.630	KG	1.62 %

GRAND TOTAL AIRCRAFT EMISSION	=	8732.461	KG	100.00 %
TAXIIDLE	=	788.806	KG	9.03 %
TAKE OFF	=	2207.421	KG	25.28 %
CLIMBOUT	=	4447.941	KG	50.94 %
APPROACH	=	1097.812	KG	12.57 %
LANDING	=	190.476	KG	2.18 %

TABLE 5.2 (CONTINUED)

1973 SO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	122.845	KG	100.00 %
JUMBO 350	=	4.717	KG	3.84 %
JUMBO 250	=	2.948	KG	2.40 %
LONG 200	=	13.527	KG	11.01 %
LONG 150	=	23.673	KG	19.27 %
MED. 100	=	63.039	KG	51.32 %
SHORT 50	=	5.267	KG	4.29 %
TOTAL AIR CARRIER EMISSION	=	113.172	KG	92.13 %
TOTAL AIR CARGO EMISSION	=	2.263	KG	1.84 %
TURBO	=	6.629	KG	5.40 %
PISTON	=	0.781	KG	0.64 %
TOTAL GENERAL AV. EMISSION	=	7.409	KG	6.03 %

GRAND TOTAL AIRCRAFT EMISSION	=	122.845	KG	100.00 %
TAXIIDLE	=	48.126	KG	39.18 %
TAKE OFF	=	11.685	KG	9.51 %
CLIMBOUT	=	31.829	KG	25.91 %
APPROACH	=	26.690	KG	21.73 %
LANDING	=	4.514	KG	3.67 %

TABLE 5.2 (CONTINUED)

1975 SO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	141.001 KG	100.00 %
JUMBO 350	=	12.409 KG	8.80 %
JUMBO 250	=	14.270 KG	10.12 %
LONG 200	=	8.133 KG	5.77 %
LONG 150	=	28.466 KG	20.19 %
MED. 100	=	63.550 KG	45.07 %
SHORT 50	=	3.694 KG	2.62 %
TOTAL AIR CARRIER EMISSION	=	130.523 KG	92.57 %
TOTAL AIR CARGO EMISSION	=	2.610 KG	1.85 %
TURBO	=	7.039 KG	4.99 %
PISTON	=	0.829 KG	0.59 %
TOTAL GENERAL AV. EMISSION	=	7.868 KG	5.58 %

GRAND TOTAL AIRCRAFT EMISSION	=	141.001 KG	100.00 %
TAXIIDLE	=	55.345 KG	39.25 %
TAKE OFF	=	13.656 KG	9.68 %
CLIMBOUT	=	36.923 KG	26.19 %
APPROACH	=	29.974 KG	21.26 %
LANDING	=	5.104 KG	3.62 %

TABLE 5.2 (CONTINUED)

1980 SO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	212.564 KG	100.00 %
JUMBO 350	=	27.347 KG	12.87 %
JUMBO 250	=	27.074 KG	12.74 %
LONG 200	=	8.066 KG	3.79 %
LONG 150	=	65.200 KG	30.67 %
MED. 100	=	67.502 KG	31.76 %
SHORT 50	=	3.053 KG	1.44 %
TOTAL AIR CARRIER EMISSION	=	198.243 KG	93.26 %
TOTAL AIR CARGO EMISSION	=	3.965 KG	1.87 %
TURBO	=	9.265 KG	4.36 %
PISTON	=	1.091 KG	0.51 %
TOTAL GENERAL AV. EMISSION	=	10.356 KG	4.87 %

GRAND TOTAL AIRCRAFT EMISSION	=	212.564 KG	100.00 %
TAXIIDLE	=	81.650 KG	38.41 %
TAKE OFF	=	21.170 KG	9.96 %
CLIMBOUT	=	56.735 KG	26.69 %
APPROACH	=	45.252 KG	21.29 %
LANDING	=	7.757 KG	3.65 %

TABLE 5.2 (CONTINUED)

1985 SO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	305.070 KG	100.00 %
JUMBO 350	=	58.147 KG	19.06 %
JUMBO 250	=	52.955 KG	17.36 %
LONG 200	=	17.865 KG	5.86 %
LONG 150	=	79.967 KG	26.21 %
MED. 100	=	74.971 KG	24.58 %
SHORT 50	=	2.628 KG	0.86 %
TOTAL AIR CARRIER EMISSION	=	286.533 KG	93.92 %
TOTAL AIR CARGO EMISSION	=	5.731 KG	1.88 %
TURBO	=	11.457 KG	3.76 %
PISTON	=	1.350 KG	0.44 %
TOTAL GENERAL AV. EMISSION	=	12.807 KG	4.20 %

GRAND TOTAL AIRCRAFT EMISSION	=	305.070 KG	100.00 %
TAXIIDLE	=	117.218 KG	38.42 %
TAKE OFF	=	30.810 KG	10.10 %
CLIMBOUT	=	82.224 KG	26.95 %
APPROACH	=	63.832 KG	20.92 %
LANDING	=	10.986 KG	3.60 %

TABLE 5.2 (CONTINUED)

1990 SO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	415.764 KG	100.00 %
JUMBO 350	=	106.545 KG	25.63 %
JUMBO 250	=	99.886 KG	24.02 %
LONG 200	=	28.643 KG	6.89 %
LONG 150	=	96.158 KG	23.13 %
MED. 100	=	60.101 KG	14.46 %
SHORT 50	=	1.301 KG	0.31 %
TOTAL AIR CARRIER EMISSION	=	392.632 KG	94.44 %
TOTAL AIR CARGO EMISSION	=	7.853 KG	1.89 %
TURBO	=	13.669 KG	3.29 %
PISTON	=	1.610 KG	0.39 %
TOTAL GENERAL AV. EMISSION	=	15.279 KG	3.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	415.764 KG	100.00 %
TAXIIDLE	=	159.905 KG	38.46 %
TAKE OFF	=	42.635 KG	10.25 %
CLIMBOUT	=	113.372 KG	27.27 %
APPROACH	=	85.147 KG	20.48 %
LANDING	=	14.705 KG	3.54 %

TABLE 5.2 (CONTINUED)

1995 SO AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	528.649 KG	100.00 %
JUMBO 350	=	165.331 KG	31.27 %
JUMBO 250	=	145.860 KG	27.59 %
LONG 200	=	37.051 KG	7.01 %
LONG 150	=	111.154 KG	21.03 %
MED. 100	=	40.826 KG	7.72 %
SHORT 50	=	0.651 KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	500.893 KG	94.75 %
TOTAL AIR CARGO EMISSION	=	10.018 KG	1.89 %
TURBO	=	15.869 KG	3.00 %
PISTON	=	1.870 KG	0.35 %
TOTAL GENERAL AV. EMISSION	=	17.739 KG	3.36 %

GRAND TOTAL AIRCRAFT EMISSION	=	528.649 KG	100.00 %
TAXIIDLE	=	203.829 KG	38.56 %
TAKE OFF	=	54.678 KG	10.34 %
CLIMBOUT	=	145.176 KG	27.46 %
APPROACH	=	106.539 KG	20.15 %
LANDING	=	18.428 KG	3.49 %

TABLE 5.2 (CCNTINUED)

2000 SO AVERAGE CAY EMISSICNS

GRAND TOTAL AIRCRAFT EMISSION	=	641.657 KG	100.00 %
JUMBO 350	=	215.530 KG	33.59 %
JUMBO 250	=	199.976 KG	31.17 %
LONG 200	=	49.152 KG	7.66 %
LONG 150	=	122.881 KG	19.15 %
MED. 100	=	21.453 KG	3.34 %
SHORT 50	=	0.248 KG	0.04 %
TOTAL AIR CARRIER EMISSION	=	609.241 KG	94.95 %
TOTAL AIR CARGO EMISSION	=	12.185 KG	1.90 %
TURBO	=	18.100 KG	2.82 %
PISTON	=	2.132 KG	0.33 %
TOTAL GENERAL AV. EMISSION	=	20.232 KG	3.15 %

GRAND TOTAL AIRCRAFT EMISSION	=	641.657 KG	100.00 %
TAXIIDLE	=	247.806 KG	38.62 %
TAKE OFF	=	66.720 KG	10.40 %
CLIMBOUT	=	176.999 KG	27.58 %
APPROACH	=	127.978 KG	19.94 %
LANDING	=	22.156 KG	3.45 %

TABLE 5.2 (CONTINUED)

1973 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	99.436 KG	100.00 %
JUMBO 350	=	3.298 KG	3.32 %
JUMBO 250	=	2.061 KG	2.07 %
LONG 200	=	14.292 KG	14.37 %
LONG 150	=	25.012 KG	25.15 %
MED. 100	=	24.570 KG	24.71 %
SHORT 50	=	13.952 KG	14.03 %
TOTAL AIR CARRIER EMISSION	=	83.186 KG	83.66 %
TOTAL AIR CARGO EMISSION	=	1.664 KG	1.67 %
TURBO	=	14.586 KG	14.67 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	14.586 KG	14.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	99.436 KG	100.00 %
TAXIIDLE	=	37.536 KG	37.75 %
TAKE OFF	=	6.815 KG	6.85 %
CLIMBOUT	=	20.178 KG	20.29 %
APPROACH	=	30.034 KG	30.20 %
LANDING	=	4.873 KG	4.90 %

TABLE 5.2 (CONTINUED)

1975 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	109.204 KG	100.00 %
JUMBO 350	=	8.676 KG	7.94 %
JUMBO 250	=	9.977 KG	9.14 %
LONG 200	=	8.593 KG	7.87 %
LONG 150	=	30.076 KG	27.54 %
MED. 100	=	24.769 KG	22.68 %
SHORT 50	=	9.786 KG	8.96 %
TOTAL AIR CARRIER EMISSION	=	91.878 KG	84.13 %
TOTAL AIR CARGO EMISSION	=	1.838 KG	1.68 %
TURBO	=	15.489 KG	14.18 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	15.489 KG	14.18 %

GRAND TOTAL AIRCRAFT EMISSION	=	109.204 KG	100.00 %
TAXIIDLE	=	45.247 KG	41.43 %
TAKE OFF	=	7.145 KG	6.54 %
CLIMBOUT	=	21.171 KG	19.39 %
APPROACH	=	30.621 KG	28.04 %
LANDING	=	5.020 KG	4.60 %

TABLE 5.2 (CONTINUED)

1980 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	173.241	KG	100.00	%
JUMBO 350	=	19.120	KG	11.04	%
JUMBO 250	=	18.929	KG	10.93	%
LONG 200	=	8.522	KG	4.92	%
LONG 150	=	68.888	KG	39.76	%
MED. 100	=	26.309	KG	15.19	%
SHORT 50	=	8.088	KG	4.67	%
TOTAL AIR CARRIER EMISSION	=	149.856	KG	86.50	%
TOTAL AIR CARGO EMISSION	=	2.997	KG	1.73	%
TURBO	=	20.387	KG	11.77	%
PISTON	=	0.0	KG	0.0	%
TOTAL GENERAL AV. EMISSION	=	20.387	KG	11.77	%

GRAND TOTAL AIRCRAFT EMISSION	=	173.241	KG	100.00	%
TAXIIDLE	=	68.319	KG	39.44	%
TAKE OFF	=	11.145	KG	6.43	%
CLIMBOUT	=	34.277	KG	19.79	%
APPROACH	=	50.962	KG	29.42	%
LANDING	=	8.538	KG	4.93	%

TABLE 5.2 (CONTINUED)

1985 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	246.780 KG	100.00 %
JUMBO 350	=	40.654 KG	16.47 %
JUMBO 250	=	37.024 KG	15.00 %
LONG 200	=	18.875 KG	7.65 %
LONG 150	=	84.490 KG	34.24 %
MED. 100	=	29.221 KG	11.84 %
SHORT 50	=	6.961 KG	2.82 %
TOTAL AIR CARRIER EMISSION	=	217.225 KG	88.02 %
TOTAL AIR CARGO EMISSION	=	4.344 KG	1.76 %
TURBO	=	25.211 KG	10.22 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	25.211 KG	10.22 %

GRAND TOTAL AIRCRAFT EMISSION	=	246.780 KG	100.00 %
TAXIIDLE	=	105.159 KG	42.61 %
TAKE OFF	=	14.979 KG	6.07 %
CLIMBOUT	=	46.691 KG	18.92 %
APPROACH	=	68.409 KG	27.72 %
LANDING	=	11.543 KG	4.68 %

TABLE 5.2 (CONTINUED)

1990 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	339.196	KG	100.00 %
JUMBO 350	=	74.491	KG	21.96 %
JUMBO 250	=	69.836	KG	20.59 %
LONG 200	=	30.263	KG	8.92 %
LONG 150	=	101.596	KG	29.95 %
MED. 100	=	23.425	KG	6.91 %
SHORT 50	=	3.446	KG	1.02 %
TOTAL AIR CARRIER EMISSION	=	303.057	KG	89.35 %
TOTAL AIR CARGO EMISSION	=	6.061	KG	1.79 %
TURBO	=	30.078	KG	8.87 %
PISTON	=	0.0	KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	30.078	KG	8.87 %

GRAND TOTAL AIRCRAFT EMISSION	=	339.196	KG	100.00 %
TAXIIDLE	=	157.592	KG	46.46 %
TAKE OFF	=	18.917	KG	5.58 %
CLIMBOUT	=	60.444	KG	17.82 %
APPROACH	=	87.396	KG	25.77 %
LANDING	=	14.848	KG	4.38 %

TABLE 5.2 (CONTINUED)

1995 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	434.567 KG	100.00 %
JUMBO 350	=	115.592 KG	26.60 %
JUMBO 250	=	101.993 KG	23.47 %
LONG 200	=	39.147 KG	9.01 %
LONG 150	=	117.440 KG	27.02 %
MED. 100	=	15.912 KG	3.66 %
SHORT 50	=	1.726 KG	0.40 %
TOTAL AIR CARRIER EMISSION	=	391.810 KG	90.16 %
TOTAL AIR CARGO EMISSION	=	7.836 KG	1.80 %
TURBO	=	34.921 KG	8.04 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	34.921 KG	8.04 %

GRAND TOTAL AIRCRAFT EMISSION	=	434.567 KG	100.00 %
TAXIIDLE	=	214.792 KG	49.43 %
TAKE OFF	=	22.645 KG	5.21 %
CLIMBOUT	=	73.747 KG	16.97 %
APPROACH	=	105.422 KG	24.26 %
LANDING	=	17.962 KG	4.13 %

TABLE 5.2 (CONTINUED)

2000 PT AVERAGE DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	530.740 KG	100.00 %
JUMBO 350	=	150.689 KG	28.39 %
JUMBO 250	=	139.815 KG	26.34 %
LONG 200	=	51.932 KG	9.78 %
LONG 150	=	129.831 KG	24.46 %
MED. 100	=	8.362 KG	1.58 %
SHORT 50	=	0.657 KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	481.285 KG	90.68 %
TOTAL AIR CARGO EMISSION	=	9.626 KG	1.81 %
TURBO	=	39.829 KG	7.50 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	39.829 KG	7.50 %

GRAND TOTAL AIRCRAFT EMISSION	=	530.740 KG	100.00 %
TAXIIDLE	=	272.255 KG	51.30 %
TAKE OFF	=	26.413 KG	4.98 %
CLIMBOUT	=	87.204 KG	16.43 %
APPROACH	=	123.750 KG	23.32 %
LANDING	=	21.118 KG	3.98 %

TABLE 5.2 (CONTINUED)

1973 CO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	5215.852 KG	100.00 %
JUMBO 350	=	162.247 KG	3.11 %
JUMBO 250	=	101.404 KG	1.94 %
LONG 200	=	816.254 KG	15.65 %
LONG 150	=	1428.444 KG	27.39 %
MED. 100	=	1339.475 KG	25.68 %
SHORT 50	=	72.806 KG	1.40 %
TOTAL AIR CARRIER EMISSION	=	3920.630 KG	75.17 %
TOTAL AIR CARGO EMISSION	=	78.413 KG	1.50 %
TURBO	=	164.681 KG	3.16 %
PISTON	=	1052.133 KG	20.17 %
TOTAL GENERAL AV. EMISSION	=	1216.814 KG	23.33 %

GRAND TOTAL AIRCRAFT EMISSION	=	5215.852 KG	100.00 %
TAXIIDLE	=	4065.855 KG	77.95 %
TAKE OFF	=	48.187 KG	0.92 %
CLIMBOUT	=	566.712 KG	10.87 %
APPROACH	=	480.631 KG	9.21 %
LANDING	=	54.472 KG	1.04 %

TABLE 5.2 (CONTINUED)

1975 CO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	6205.449 KG	100.00 %
JUMBO 350	=	448.110 KG	7.22 %
JUMBO 250	=	515.326 KG	8.30 %
LONG 200	=	515.295 KG	8.30 %
LONG 150	=	1803.531 KG	29.06 %
MED. 100	=	1417.821 KG	22.85 %
SHORT 50	=	53.622 KG	0.86 %
TOTAL AIR CARRIER EMISSION	=	4753.703 KG	76.61 %
TOTAL AIR CARGO EMISSION	=	95.074 KG	1.53 %
TURBO	=	183.610 KG	2.96 %
PISTON	=	1173.069 KG	18.90 %
TOTAL GENERAL AV. EMISSION	=	1356.679 KG	21.86 %

GRAND TOTAL AIRCRAFT EMISSION	=	6205.449 KG	100.00 %
TAXIIDLE	=	4904.543 KG	79.04 %
TAKE OFF	=	53.972 KG	0.87 %
CLIMBOUT	=	633.512 KG	10.21 %
APPROACH	=	550.090 KG	8.86 %
LANDING	=	63.332 KG	1.02 %

TABLE 5.2 (CONTINUED)

1985 CO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION		=14358.133	KG	100.00 %
JUMBO	350	= 2098.391	KG	14.61 %
JUMBO	250	= 1911.035	KG	13.31 %
LONG	200	= 1131.094	KG	7.88 %
LONG	150	= 5062.988	KG	35.26 %
MED.	100	= 1671.489	KG	11.64 %
SHORT	50	= 38.113	KG	0.27 %
TOTAL AIR CARRIER EMISSION		=11913.106	KG	82.97 %
TOTAL AIR CARGO EMISSION		= 238.262	KG	1.66 %
TURBO		= 298.658	KG	2.08 %
PISTON		= 1908.108	KG	13.29 %
TOTAL GENERAL AV. EMISSION		= 2206.766	KG	15.37 %

GRAND TOTAL AIRCRAFT EMISSION	=14358.133	KG	100.00 %
TAXIIDLE	=11973.363	KG	83.39 %
TAKE OFF	= 96.028	KG	0.67 %
CLIMBOUT	= 1065.683	KG	7.42 %
APPROACH	= 1086.328	KG	7.57 %
LANDING	= 136.734	KG	0.95 %

TABLE 5.2 (CONTINUED)

1980 CO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	10102.750 KG	100.00 %
JUMBO 350	=	987.216 KG	9.77 %
JUMBO 250	=	977.344 KG	9.67 %
LONG 200	=	510.852 KG	5.06 %
LONG 150	=	4129.387 KG	40.87 %
MED. 100	=	1505.449 KG	14.90 %
SHORT 50	=	44.300 KG	0.44 %
TOTAL AIR CARRIER EMISSION	=	8154.539 KG	80.72 %
TOTAL AIR CARGO EMISSION	=	163.091 KG	1.61 %
TURBO	=	241.595 KG	2.39 %
PISTON	=	1543.529 KG	15.28 %
TOTAL GENERAL AV. EMISSION	=	1785.123 KG	17.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	10102.750 KG	100.00 %
TAXIIDLE	=	8267.754 KG	81.84 %
TAKE OFF	=	74.885 KG	0.74 %
CLIMBOUT	=	849.647 KG	8.41 %
APPROACH	=	811.655 KG	8.03 %
LANDING	=	98.810 KG	0.98 %

TABLE 5.2 (CONTINUED)

1995 CO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=25000.641	KG	100.00 %
JUMBO 350	= 5961.488	KG	23.85 %
JUMBO 250	= 5260.137	KG	21.04 %
LONG 200	= 2343.907	KG	9.38 %
LONG 150	= 7031.711	KG	28.13 %
MED. 100	= 909.459	KG	3.64 %
SHORT 50	= 9.442	KG	0.04 %
TOTAL AIR CARRIER EMISSION	=21516.141	KG	86.06 %
TOTAL AIR CARGO EMISSION	= 430.323	KG	1.72 %
TURBO	= 413.346	KG	1.65 %
PISTON	= 2640.838	KG	10.56 %
TOTAL GENERAL AV. EMISSION	= 3054.183	KG	12.22 %

GRAND TOTAL AIRCRAFT EMISSION	=25000.641	KG	100.00 %
TAXIIDLE	=21427.844	KG	85.71 %
TAKE OFF	= 139.062	KG	0.56 %
CLIMBOUT	= 1506.428	KG	6.03 %
APPROACH	= 1703.002	KG	6.81 %
LANDING	= 224.329	KG	0.90 %

TABLE 5.2 (CONTINUED)

1990	CO	PEAK DAY EMISSIONS			
GRAND TOTAL AIRCRAFT EMISSION		=	19681.539	KG	100.00 %
	JUMBO 350	=	3845.846	KG	19.54 %
	JUMBO 250	=	3605.486	KG	18.32 %
	LONG 200	=	1813.896	KG	9.22 %
	LONG 150	=	6089.500	KG	30.94 %
	MED. 100	=	1340.255	KG	6.81 %
	SHORT 50	=	18.876	KG	0.10 %
TOTAL AIR CARRIER EMISSION		=	16713.852	KG	84.92 %
TOTAL AIR CARGO EMISSION		=	334.277	KG	1.70 %
	TURBO	=	356.400	KG	1.81 %
	PISTON	=	2277.017	KG	11.57 %
TOTAL GENERAL AV. EMISSION		=	2633.417	KG	13.38 %
GRAND TOTAL AIRCRAFT EMISSION		=	19681.539	KG	100.00 %
	TAXIIDLE	=	16697.527	KG	84.84 %
	TAKE OFF	=	117.859	KG	0.60 %
	CLIMBOUT	=	1287.942	KG	6.54 %
	APPROACH	=	1397.286	KG	7.10 %
	LANDING	=	180.939	KG	0.92 %

TABLE 5.2 (CONTINUED)

1973 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	2454.226	KG	100.00 %
JUMBO 350	=	41.879	KG	1.71 %
JUMBO 250	=	26.174	KG	1.07 %
LONG 200	=	696.964	KG	28.40 %
LONG 150	=	1219.687	KG	49.70 %
MED. 100	=	304.911	KG	12.42 %
SHORT 50	=	55.687	KG	2.27 %
TOTAL AIR CARRIER EMISSION	=	2345.302	KG	95.56 %
TOTAL AIR CARGO EMISSION	=	46.906	KG	1.91 %
TURBO	=	37.566	KG	1.53 %
PISTON	=	24.452	KG	1.00 %
TOTAL GENERAL AV. EMISSION	=	62.018	KG	2.53 %

GRAND TOTAL AIRCRAFT EMISSION	=	2454.226	KG	100.00 %
TAXIIDLE	=	2380.401	KG	96.99 %
TAKE OFF	=	4.190	KG	0.17 %
CLIMBOUT	=	22.071	KG	0.90 %
APPROACH	=	41.086	KG	1.67 %
LANDING	=	6.479	KG	0.26 %

TABLE 5.2 (CONTINUED)

2000 CO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=30347.301	KG	100.00 %
JUMBO 350	= 7769.043	KG	25.60 %
JUMBO 250	= 7208.387	KG	23.75 %
LONG 200	= 3108.429	KG	10.24 %
LONG 150	= 7771.059	KG	25.61 %
MED. 100	= 477.750	KG	1.57 %
SHORT 50	= 3.594	KG	0.01 %
TOTAL AIR CARRIER EMISSION	=26338.254	KG	86.79 %
TOTAL AIR CARGO EMISSION	= 526.765	KG	1.74 %
TURBO	= 471.284	KG	1.55 %
PISTON	= 3011.002	KG	9.92 %
TOTAL GENERAL AV. EMISSION	= 3482.286	KG	11.47 %

GRAND TOTAL AIRCRAFT EMISSION	=30347.301	KG	100.00 %
TAXIIDLE	=26179.148	KG	86.27 %
TAKE OFF	= 160.548	KG	0.53 %
CLIMBOUT	= 1728.310	KG	5.70 %
APPROACH	= 2011.336	KG	6.63 %
LANDING	= 267.987	KG	0.88 %

TABLE 5.2 (CONTINUED)

1975 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	2713.379	KG	100.00 %
JUMBO 350	=	115.665	KG	4.26 %
JUMBO 250	=	133.014	KG	4.90 %
LONG 200	=	439.988	KG	16.22 %
LONG 150	=	1539.959	KG	56.75 %
MED. 100	=	322.745	KG	11.89 %
SHORT 50	=	41.014	KG	1.51 %
TOTAL AIR CARRIER EMISSION	=	2592.385	KG	95.54 %
TOTAL AIR CARGO EMISSION	=	51.848	KG	1.91 %
TURBO	=	41.884	KG	1.54 %
PISTON	=	27.263	KG	1.00 %
TOTAL GENERAL AV. EMISSION	=	69.147	KG	2.55 %

GRAND TOTAL AIRCRAFT EMISSION	=	2713.379	KG	100.00 %
TAXIIDLE	=	2630.068	KG	96.93 %
TAKE OFF	=	4.903	KG	0.18 %
CLIMBOUT	=	25.075	KG	0.92 %
APPROACH	=	46.058	KG	1.70 %
LANDING	=	7.278	KG	0.27 %

TABLE 5.2 (CONTINUED)

1980 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	5033.656 KG	100.00 %
JUMBO 350	=	254.817 KG	5.06 %
JUMBO 250	=	252.269 KG	5.01 %
LONG 200	=	436.195 KG	8.67 %
LONG 150	=	3525.909 KG	70.05 %
MED. 100	=	342.692 KG	6.81 %
SHORT 50	=	33.884 KG	0.67 %
TOTAL AIR CARRIER EMISSION	=	4845.762 KG	96.27 %
TOTAL AIR CARGO EMISSION	=	96.915 KG	1.93 %
TURBO	=	55.111 KG	1.09 %
PISTON	=	35.872 KG	0.71 %
TOTAL GENERAL AV. EMISSION	=	90.984 KG	1.81 %

GRAND TOTAL AIRCRAFT EMISSION	=	5033.656 KG	100.00 %
TAXIIDLE	=	4895.875 KG	97.26 %
TAKE OFF	=	8.466 KG	0.17 %
CLIMBOUT	=	39.316 KG	0.78 %
APPROACH	=	77.459 KG	1.54 %
LANDING	=	12.535 KG	0.25 %

TABLE 5.2 (CONTINUED)

1985 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	6980.531 KG	100.00 %
JUMBO 350	=	541.629 KG	7.76 %
JUMBO 250	=	493.270 KG	7.07 %
LONG 200	=	965.794 KG	13.84 %
LONG 150	=	4323.066 KG	61.93 %
MED. 100	=	380.489 KG	5.45 %
SHORT 50	=	29.152 KG	0.42 %
TOTAL AIR CARRIER EMISSION	=	6733.395 KG	96.46 %
TOTAL AIR CARGO EMISSION	=	134.668 KG	1.93 %
TURBO	=	68.129 KG	0.98 %
PISTON	=	44.345 KG	0.64 %
TOTAL GENERAL AV. EMISSION	=	112.474 KG	1.61 %

GRAND TOTAL AIRCRAFT EMISSION	=	6980.531 KG	100.00 %
TAXIIDLE	=	6792.273 KG	97.30 %
TAKE OFF	=	12.016 KG	0.17 %
CLIMBOUT	=	53.093 KG	0.76 %
APPROACH	=	105.880 KG	1.52 %
LANDING	=	17.274 KG	0.25 %

TABLE 5.2 (CONTINUED)

1990 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	9305.242 KG	100.00 %
JUMBO 350	=	992.676 KG	10.67 %
JUMBO 250	=	930.635 KG	10.00 %
LONG 200	=	1548.810 KG	16.64 %
LONG 150	=	5199.566 KG	55.88 %
MED. 100	=	305.088 KG	3.28 %
SHORT 50	=	14.437 KG	0.16 %
TOTAL AIR CARRIER EMISSION	=	8991.203 KG	96.63 %
TOTAL AIR CARGO EMISSION	=	179.824 KG	1.93 %
TURBO	=	81.300 KG	0.87 %
PISTON	=	52.919 KG	0.57 %
TOTAL GENERAL AV. EMISSION	=	134.219 KG	1.44 %

GRAND TOTAL AIRCRAFT EMISSION	=	9305.242 KG	100.00 %
TAXIIDLE	=	9058.484 KG	97.35 %
TAKE OFF	=	16.481 KG	0.18 %
CLIMBOUT	=	69.295 KG	0.74 %
APPROACH	=	138.279 KG	1.49 %
LANDING	=	22.712 KG	0.24 %

TABLE 5.2 (CONTINUED)

1995 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=11494.156	KG	100.00 %
JUMBO 350	= 1538.761	KG	13.39 %
JUMBO 250	= 1357.730	KG	11.81 %
LONG 200	= 2001.362	KG	17.41 %
LONG 150	= 6004.078	KG	52.24 %
MED. 100	= 207.025	KG	1.80 %
SHORT 50	= 7.222	KG	0.06 %
TOTAL AIR CARRIER EMISSION	=11116.172	KG	96.71 %
TOTAL AIR CARGO EMISSION	= 222.323	KG	1.93 %
TURBO	= 94.290	KG	0.82 %
PISTON	= 61.374	KG	0.53 %
TOTAL GENERAL AV. EMISSION	= 155.665	KG	1.35 %

GRAND TOTAL AIRCRAFT EMISSION	=11494.156	KG	100.00 %
TAXIIDLE	=11191.414	KG	97.37 %
TAKE OFF	= 20.883	KG	0.18 %
CLIMBOUT	= 85.108	KG	0.74 %
APPROACH	= 168.915	KG	1.47 %
LANDING	= 27.840	KG	0.24 %

TABLE 5.2 (CONTINUED)

2000 HC PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=13709.770	KG	100.00 %
JUMBO 350	= 2005.319	KG	14.63 %
JUMBO 250	= 1860.606	KG	13.57 %
LONG 200	= 2654.156	KG	19.36 %
LONG 150	= 6635.379	KG	48.40 %
MED. 100	= 108.753	KG	0.79 %
SHORT 50	= 2.749	KG	0.02 %
TOTAL AIR CARRIER EMISSION	=13266.953	KG	96.77 %
TOTAL AIR CARGO EMISSION	= 265.339	KG	1.94 %
TURBO	= 107.507	KG	0.78 %
PISTON	= 69.977	KG	0.51 %
TOTAL GENERAL AV. EMISSION	= 177.484	KG	1.29 %

GRAND TOTAL AIRCRAFT EMISSION	=13709.770	KG	100.00 %
TAXIIDLE	=13350.496	KG	97.38 %
TAKE OFF	= 25.315	KG	0.18 %
CLIMBOUT	= 101.080	KG	0.74 %
APPRCACH	= 199.873	KG	1.46 %
LANDING	= 33.019	KG	0.24 %

TABLE 5.2 (CONTINUED)

1973 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1534.959 KG	100.00 %
JUMBO 350	=	110.017 KG	7.17 %
JUMBO 250	=	68.760 KG	4.48 %
LONG 200	=	121.273 KG	7.90 %
LONG 150	=	212.228 KG	13.83 %
MED. 100	=	883.402 KG	57.55 %
SHORT 50	=	39.539 KG	2.58 %
TOTAL AIR CARRIER EMISSION	=	1435.219 KG	93.50 %
TOTAL AIR CARGO EMISSION	=	28.704 KG	1.87 %
TURBO	=	67.220 KG	4.38 %
PISTON	=	3.816 KG	0.25 %
TOTAL GENERAL AV. EMISSION	=	71.037 KG	4.63 %

GRAND TOTAL AIRCRAFT EMISSION	=	1534.959 KG	100.00 %
TAXIIDLE	=	196.233 KG	12.78 %
TAKE OFF	=	325.154 KG	21.18 %
CLIMBOUT	=	686.687 KG	44.74 %
APPROACH	=	279.414 KG	18.20 %
LANDING	=	47.471 KG	3.09 %

TABLE 5.2 (CONTINUED)

1975 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	2080.437 KG	100.00 %
JUMBO 350	=	303.855 KG	14.61 %
JUMBO 250	=	349.434 KG	16.80 %
LONG 200	=	76.559 KG	3.68 %
LONG 150	=	267.956 KG	12.88 %
MED. 100	=	935.071 KG	44.95 %
SHORT 50	=	29.121 KG	1.40 %
TOTAL AIR CARRIER EMISSION	=	1961.996 KG	94.31 %
TOTAL AIR CARGO EMISSION	=	39.240 KG	1.89 %
TURBO	=	74.947 KG	3.60 %
PISTON	=	4.255 KG	0.20 %
TOTAL GENERAL AV. EMISSION	=	79.202 KG	3.81 %

GRAND TOTAL AIRCRAFT EMISSION	=	2080.437 KG	100.00 %
TAXIIDLE	=	244.940 KG	11.77 %
TAKE OFF	=	465.137 KG	22.36 %
CLIMBOUT	=	966.551 KG	46.46 %
APPROACH	=	344.822 KG	16.57 %
LANDING	=	58.986 KG	2.84 %

TABLE 5.2 (CONTINUED)

1980 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	3203.452	KG	100.00 %
JUMBO 350	=	669.414	KG	20.90 %
JUMBO 250	=	662.720	KG	20.69 %
LONG 200	=	75.899	KG	2.37 %
LONG 150	=	613.515	KG	19.15 %
MED. 100	=	992.863	KG	30.99 %
SHORT 50	=	24.058	KG	0.75 %
TOTAL AIR CARRIER EMISSION	=	3038.469	KG	94.85 %
TOTAL AIR CARGO EMISSION	=	60.769	KG	1.90 %
TURBO	=	98.615	KG	3.08 %
PISTON	=	5.599	KG	0.17 %
TOTAL GENERAL AV. EMISSION	=	104.214	KG	3.25 %

GRAND TOTAL AIRCRAFT EMISSION	=	3203.452	KG	100.00 %
TAXIIDLE	=	349.777	KG	10.92 %
TAKE OFF	=	739.899	KG	23.10 %
CLIMBOUT	=	1522.732	KG	47.53 %
APPROACH	=	504.347	KG	15.74 %
LANDING	=	86.695	KG	2.71 %

TABLE 5.2 (CONTINUED)

1985 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	4986.125	KG	100.00 %
JUMBO 350	=	1422.883	KG	28.54 %
JUMBO 250	=	1295.840	KG	25.99 %
LONG 200	=	168.050	KG	3.37 %
LONG 150	=	752.223	KG	15.09 %
MED. 100	=	1102.369	KG	22.11 %
SHORT 50	=	20.698	KG	0.42 %
TOTAL AIR CARRIER EMISSION	=	4762.059	KG	95.51 %
TOTAL AIR CARGO EMISSION	=	95.241	KG	1.91 %
TURBO	=	121.908	KG	2.44 %
PISTON	=	6.921	KG	0.14 %
TOTAL GENERAL AV. EMISSION	=	128.829	KG	2.58 %

GRAND TOTAL AIRCRAFT EMISSION	=	4986.125	KG	100.00 %
TAXIIDLE	=	510.563	KG	10.24 %
TAKE OFF	=	1188.870	KG	23.84 %
CLIMBOUT	=	2427.233	KG	48.68 %
APPROACH	=	732.988	KG	14.70 %
LANDING	=	126.478	KG	2.54 %

TABLE 5.2 (CONTINUED)

1990 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	7417.164	KG	100.00 %
JUMBO 350	=	2607.803	KG	35.16 %
JUMBO 250	=	2444.818	KG	32.96 %
LONG 200	=	269.496	KG	3.63 %
LONG 150	=	904.735	KG	12.20 %
MED. 100	=	883.916	KG	11.92 %
SHORT 50	=	10.251	KG	0.14 %
TOTAL AIR CARRIER EMISSION	=	7121.012	KG	96.01 %
TOTAL AIR CARGO EMISSION	=	142.420	KG	1.92 %
TURBO	=	145.478	KG	1.96 %
PISTON	=	8.259	KG	0.11 %
TOTAL GENERAL AV. EMISSION	=	153.737	KG	2.07 %

GRAND TOTAL AIRCRAFT EMISSION	=	7417.164	KG	100.00 %
TAXIIDLE	=	711.787	KG	9.60 %
TAKE OFF	=	1824.189	KG	24.59 %
CLIMBOUT	=	3697.380	KG	49.85 %
APPROACH	=	1009.137	KG	13.61 %
LANDING	=	174.681	KG	2.36 %

TABLE 5.2 (CONTINUED)

1995 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	= 9977.520	KG	100.00 %
JUMBO 350	= 4042.390	KG	40.51 %
JUMBO 250	= 3566.816	KG	35.75 %
LONG 200	= 348.241	KG	3.49 %
LONG 150	= 1044.722	KG	10.47 %
MED. 100	= 599.800	KG	6.01 %
SHORT 50	= 5.127	KG	0.05 %
TOTAL AIR CARRIER EMISSION	= 9607.082	KG	96.29 %
TOTAL AIR CARGO EMISSION	= 192.142	KG	1.93 %
TURBO	= 168.722	KG	1.69 %
PISTON	= 9.579	KG	0.10 %
TOTAL GENERAL AV. EMISSION	= 178.301	KG	1.79 %

GRAND TOTAL AIRCRAFT EMISSION	= 9977.520	KG	100.00 %
TAXIIDLE	= 921.918	KG	9.24 %
TAKE OFF	= 2497.069	KG	25.03 %
CLIMBOUT	= 5042.148	KG	50.54 %
APPROACH	= 1292.348	KG	12.95 %
LANDING	= 224.042	KG	2.25 %

TABLE 5.2 (CONTINUED)

2000 NO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=12534.438	KG	100.00 %
JUMBO 350	= 5268.055	KG	42.03 %
JUMBO 250	= 4887.887	KG	39.00 %
LONG 200	= 461.828	KG	3.68 %
LONG 150	= 1154.570	KG	9.21 %
MED. 100	= 315.082	KG	2.51 %
SHORT 50	= 1.952	KG	0.02 %
TOTAL AIR CARRIER EMISSION	=12089.363	KG	96.45 %
TOTAL AIR CARGO EMISSION	= 241.787	KG	1.93 %
TURBO	= 192.371	KG	1.53 %
PISTON	= 10.921	KG	0.09 %
TOTAL GENERAL AV. EMISSION	= 203.293	KG	1.62 %

GRAND TOTAL AIRCRAFT EMISSION	=12534.438	KG	100.00 %
TAXIIDLE	= 1132.241	KG	9.03 %
TAKE OFF	= 3168.497	KG	25.28 %
CLIMBOUT	= 6384.516	KG	50.94 %
APPROACH	= 1575.783	KG	12.57 %
LANDING	= 273.406	KG	2.18 %

TABLE 5.2 (CONTINUED)

1973 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	168.244	KG	100.00 %
JUMBO 350	=	6.461	KG	3.84 %
JUMBO 250	=	4.038	KG	2.40 %
LONG 200	=	18.527	KG	11.01 %
LONG 150	=	32.422	KG	19.27 %
MED. 100	=	86.337	KG	51.32 %
SHORT 50	=	7.213	KG	4.29 %
TOTAL AIR CARRIER EMISSION	=	154.997	KG	92.13 %
TOTAL AIR CARGO EMISSION	=	3.100	KG	1.84 %
TURBO	=	9.078	KG	5.40 %
PISTON	=	1.069	KG	0.64 %
TOTAL GENERAL AV. EMISSION	=	10.148	KG	6.03 %

GRAND TOTAL AIRCRAFT EMISSION	=	168.244	KG	100.00 %
TAXIIDLE	=	65.912	KG	39.18 %
TAKE OFF	=	16.003	KG	9.51 %
CLIMBOUT	=	43.593	KG	25.91 %
APPROACH	=	36.554	KG	21.73 %
LANDING	=	6.182	KG	3.67 %

TABLE 5.2 (CONTINUED)

1975 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	202.762 KG	100.00 %
JUMBO 350	=	17.844 KG	8.80 %
JUMBO 250	=	20.521 KG	10.12 %
LONG 200	=	11.696 KG	5.77 %
LONG 150	=	40.935 KG	20.19 %
MED. 100	=	91.386 KG	45.07 %
SHORT 50	=	5.312 KG	2.62 %
TOTAL AIR CARRIER EMISSION	=	187.694 KG	92.57 %
TOTAL AIR CARGO EMISSION	=	3.754 KG	1.85 %
TURBO	=	10.122 KG	4.99 %
PISTON	=	1.192 KG	0.59 %
TOTAL GENERAL AV. EMISSION	=	11.314 KG	5.58 %

GRAND TOTAL AIRCRAFT EMISSION	=	202.762 KG	100.00 %
TAXIIDLE	=	79.586 KG	39.25 %
TAKE OFF	=	19.637 KG	9.68 %
CLIMBOUT	=	53.096 KG	26.19 %
APPROACH	=	43.103 KG	21.26 %
LANDING	=	7.340 KG	3.62 %

TABLE 5.2 (CONTINUED)

1980 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	305.560 KG	100.00 %
JUMBO 350	=	39.312 KG	12.87 %
JUMBO 250	=	38.918 KG	12.74 %
LONG 200	=	11.595 KG	3.79 %
LONG 150	=	93.726 KG	30.67 %
MED. 100	=	97.035 KG	31.76 %
SHORT 50	=	4.389 KG	1.44 %
TOTAL AIR CARRIER EMISSION	=	284.974 KG	93.26 %
TOTAL AIR CARGO EMISSION	=	5.699 KG	1.87 %
TURBO	=	13.318 KG	4.36 %
PISTON	=	1.569 KG	0.51 %
TOTAL GENERAL AV. EMISSION	=	14.887 KG	4.87 %

GRAND TOTAL AIRCRAFT EMISSION	=	305.560 KG	100.00 %
TAXIIDLE	=	117.372 KG	38.41 %
TAKE OFF	=	30.431 KG	9.96 %
CLIMBOUT	=	81.557 KG	26.69 %
APPROACH	=	65.049 KG	21.29 %
LANDING	=	11.151 KG	3.65 %

TABLE 5.2 (CONTINUED)

1985 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	438.397 KG	100.00 %
JUMBO 350	=	83.559 KG	19.06 %
JUMBO 250	=	76.099 KG	17.36 %
LONG 200	=	25.673 KG	5.86 %
LONG 150	=	114.916 KG	26.21 %
MED. 100	=	107.737 KG	24.58 %
SHORT 50	=	3.776 KG	0.86 %
TOTAL AIR CARRIER EMISSION	=	411.759 KG	93.92 %
TOTAL AIR CARGO EMISSION	=	8.235 KG	1.88 %
TURBO	=	16.464 KG	3.76 %
PISTON	=	1.940 KG	0.44 %
TOTAL GENERAL AV. EMISSION	=	18.403 KG	4.20 %

GRAND TOTAL AIRCRAFT EMISSION	=	438.397 KG	100.00 %
TAXIIDLE	=	168.447 KG	38.42 %
TAKE OFF	=	44.276 KG	10.10 %
CLIMBOUT	=	118.159 KG	26.95 %
APPROACH	=	91.729 KG	20.92 %
LANDING	=	15.787 KG	3.60 %

TABLE 5.2 (CONTINUED)

1990 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION		=	597.607 KG	100.00 %
	JUMBO 350	=	153.144 KG	25.63 %
	JUMBO 250	=	143.573 KG	24.02 %
	LONG 200	=	41.170 KG	6.89 %
	LONG 150	=	138.215 KG	23.13 %
	MED. 100	=	86.387 KG	14.46 %
	SHORT 50	=	1.870 KG	0.31 %
TOTAL AIR CARRIER EMISSION		=	564.358 KG	94.44 %
TOTAL AIR CARGO EMISSION		=	11.287 KG	1.89 %
	TURBO	=	19.647 KG	3.29 %
	PISTON	=	2.315 KG	0.39 %
TOTAL GENERAL AV. EMISSION		=	21.962 KG	3.67 %
GRAND TOTAL AIRCRAFT EMISSION		=	597.607 KG	100.00 %
	TAXIIDLE	=	229.843 KG	38.46 %
	TAKE OFF	=	61.282 KG	10.25 %
	CLIMBOUT	=	162.958 KG	27.27 %
	APPROACH	=	122.389 KG	20.48 %
	LANDING	=	21.136 KG	3.54 %

TABLE 5.2 (CONTINUED)

1995 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	759.063	KG	100.00 %
JUMBO 350	=	237.391	KG	31.27 %
JUMBO 250	=	209.462	KG	27.59 %
LONG 200	=	53.200	KG	7.01 %
LONG 150	=	159.600	KG	21.03 %
MED. 100	=	58.620	KG	7.72 %
SHORT 50	=	0.935	KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	719.208	KG	94.75 %
TOTAL AIR CARGO EMISSION	=	14.384	KG	1.89 %
TURBO	=	22.786	KG	3.00 %
PISTON	=	2.684	KG	0.35 %
TOTAL GENERAL AV. EMISSION	=	25.471	KG	3.36 %

GRAND TOTAL AIRCRAFT EMISSION	=	759.063	KG	100.00 %
TAXIIDLE	=	292.668	KG	38.56 %
TAKE OFF	=	78.510	KG	10.34 %
CLIMBOUT	=	208.451	KG	27.46 %
APPROACH	=	152.974	KG	20.15 %
LANDING	=	26.460	KG	3.49 %

TABLE 5.2 (CONTINUED)

2000 SO PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	921.025 KG	100.00 %
JUMBO 350	=	309.368 KG	33.59 %
JUMBO 250	=	287.043 KG	31.17 %
LONG 200	=	70.553 KG	7.66 %
LONG 150	=	176.382 KG	19.15 %
MED. 100	=	30.794 KG	3.34 %
SHORT 50	=	0.356 KG	0.04 %
TOTAL AIR CARRIER EMISSION	=	874.494 KG	94.95 %
TOTAL AIR CARGO EMISSION	=	17.490 KG	1.90 %
TURBO	=	25.980 KG	2.82 %
PISTON	=	3.061 KG	0.33 %
TOTAL GENERAL AV. EMISSION	=	29.041 KG	3.15 %

GRAND TOTAL AIRCRAFT EMISSION	=	921.025 KG	100.00 %
TAXIIDLE	=	355.696 KG	38.62 %
TAKE OFF	=	95.768 KG	10.40 %
CLIMBOUT	=	254.061 KG	27.58 %
APPROACH	=	183.697 KG	19.94 %
LANDING	=	31.803 KG	3.45 %

TABLE 5.2 (CONTINUED)

1973   PT   PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	136.184	KG	100.00 %
JUMBO 350	=	4.517	KG	3.32 %
JUMBO 250	=	2.823	KG	2.07 %
LONG 200	=	19.574	KG	14.37 %
LONG 150	=	34.255	KG	25.15 %
MED. 100	=	33.650	KG	24.71 %
SHORT 50	=	19.108	KG	14.03 %
TOTAL AIR CARRIER EMISSION	=	113.928	KG	83.66 %
TOTAL AIR CARGO EMISSION	=	2.279	KG	1.67 %
TURBO	=	19.977	KG	14.67 %
PISTON	=	0.0	KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	19.977	KG	14.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	136.184	KG	100.00 %
TAXIIDLE	=	51.408	KG	37.75 %
TAKE OFF	=	9.333	KG	6.85 %
CLIMBOUT	=	27.635	KG	20.29 %
APPROACH	=	41.133	KG	30.20 %
LANDING	=	6.674	KG	4.90 %

TABLE 5.2 (CONTINUED)

1975 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	157.037	KG	100.00 %
JUMBO 350	=	12.476	KG	7.94 %
JUMBO 250	=	14.347	KG	9.14 %
LONG 200	=	12.357	KG	7.87 %
LONG 150	=	43.250	KG	27.54 %
MED. 100	=	35.618	KG	22.68 %
SHORT 50	=	14.073	KG	8.96 %
TOTAL AIR CARRIER EMISSION	=	132.122	KG	84.13 %
TOTAL AIR CARGO EMISSION	=	2.642	KG	1.68 %
TURBO	=	22.273	KG	14.18 %
PISTON	=	0.0	KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	22.273	KG	14.18 %

GRAND TOTAL AIRCRAFT EMISSION	=	157.037	KG	100.00 %
TAXIIDLE	=	65.067	KG	41.43 %
TAKE OFF	=	10.274	KG	6.54 %
CLIMBOUT	=	30.444	KG	19.39 %
APPROACH	=	44.033	KG	28.04 %
LANDING	=	7.220	KG	4.60 %

TABLE 5.2 (CONTINUED)

1980 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	249.034 KG	100.00 %
JUMBO 350	=	27.485 KG	11.04 %
JUMBO 250	=	27.210 KG	10.93 %
LONG 200	=	12.251 KG	4.92 %
LONG 150	=	99.026 KG	39.76 %
MED. 100	=	37.820 KG	15.19 %
SHORT 50	=	11.626 KG	4.67 %
TOTAL AIR CARRIER EMISSION	=	215.419 KG	86.50 %
TOTAL AIR CARGO EMISSION	=	4.308 KG	1.73 %
TURBO	=	29.307 KG	11.77 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	29.307 KG	11.77 %

GRAND TOTAL AIRCRAFT EMISSION	=	249.034 KG	100.00 %
TAXIIDLE	=	98.208 KG	39.44 %
TAKE OFF	=	16.021 KG	6.43 %
CLIMBOUT	=	49.273 KG	19.79 %
APPROACH	=	73.257 KG	29.42 %
LANDING	=	12.273 KG	4.93 %

TABLE 5.2 (CONTINUED)

1985 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	354.632 KG	100.00 %
JUMBO 350	=	58.421 KG	16.47 %
JUMBO 250	=	53.205 KG	15.00 %
LONG 200	=	27.125 KG	7.65 %
LONG 150	=	121.415 KG	34.24 %
MED. 100	=	41.991 KG	11.84 %
SHORT 50	=	10.003 KG	2.82 %
TOTAL AIR CARRIER EMISSION	=	312.159 KG	88.02 %
TOTAL AIR CARGO EMISSION	=	6.243 KG	1.76 %
TURBO	=	36.229 KG	10.22 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	36.229 KG	10.22 %

GRAND TOTAL AIRCRAFT EMISSION	=	354.632 KG	100.00 %
TAXIIDLE	=	151.117 KG	42.61 %
TAKE OFF	=	21.525 KG	6.07 %
CLIMBOUT	=	67.096 KG	18.92 %
APPROACH	=	98.307 KG	27.72 %
LANDING	=	16.587 KG	4.68 %

TABLE 5.2 (CONTINUED)

1990 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION =	487.551 KG	100.00 %
JUMBO 350 =	107.072 KG	21.96 %
JUMBO 250 =	100.380 KG	20.59 %
LONG 200 =	43.499 KG	8.92 %
LONG 150 =	146.032 KG	29.95 %
MED. 100 =	33.670 KG	6.91 %
SHORT 50 =	4.954 KG	1.02 %
TOTAL AIR CARRIER EMISSION =	435.606 KG	89.35 %
TOTAL AIR CARGO EMISSION =	8.712 KG	1.79 %
TURBO =	43.233 KG	8.87 %
PISTON =	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION =	43.233 KG	8.87 %

GRAND TOTAL AIRCRAFT EMISSION =	487.551 KG	100.00 %
TAXIIDLE =	226.518 KG	46.46 %
TAKE OFF =	27.191 KG	5.58 %
CLIMBOUT =	86.880 KG	17.82 %
APPROACH =	125.621 KG	25.77 %
LANDING =	21.342 KG	4.38 %

TABLE 5.2 (CONTINUED)

1995 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	623.974 KG	100.00 %
JUMBO 350	=	165.973 KG	26.60 %
JUMBO 250	=	146.447 KG	23.47 %
LONG 200	=	56.209 KG	9.01 %
LONG 150	=	168.627 KG	27.02 %
MED. 100	=	22.847 KG	3.66 %
SHORT 50	=	2.478 KG	0.40 %
TOTAL AIR CARRIER EMISSION	=	562.581 KG	90.16 %
TOTAL AIR CARGO EMISSION	=	11.252 KG	1.80 %
TURBO	=	50.141 KG	8.04 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	50.141 KG	8.04 %

GRAND TOTAL AIRCRAFT EMISSION	=	623.974 KG	100.00 %
TAXIIDLE	=	308.409 KG	49.43 %
TAKE OFF	=	32.514 KG	5.21 %
CLIMBOUT	=	105.890 KG	16.97 %
APPROACH	=	151.371 KG	24.26 %
LANDING	=	25.790 KG	4.13 %

TABLE 5.2 (CONTINUED)

2000 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	761.816 KG	100.00 %
JUMBO 350	=	216.297 KG	28.39 %
JUMBO 250	=	200.688 KG	26.34 %
LONG 200	=	74.543 KG	9.78 %
LONG 150	=	186.357 KG	24.46 %
MED. 100	=	12.002 KG	1.58 %
SHORT 50	=	0.943 KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	690.830 KG	90.68 %
TOTAL AIR CARGO EMISSION	=	13.817 KG	1.81 %
TURBO	=	57.170 KG	7.50 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	57.170 KG	7.50 %

GRAND TOTAL AIRCRAFT EMISSION	=	761.816 KG	100.00 %
TAXIIDLE	=	390.790 KG	51.30 %
TAKE OFF	=	37.912 KG	4.98 %
CLIMBOUT	=	125.172 KG	16.43 %
APPROACH	=	177.629 KG	23.32 %
LANDING	=	30.313 KG	3.98 %

TABLE 5.2 (CONTINUED)

1973 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	463.631 KG	100.00 %
JUMBO 350	=	14.422 KG	3.11 %
JUMBO 250	=	9.014 KG	1.94 %
LONG 200	=	72.556 KG	15.65 %
LONG 150	=	126.973 KG	27.39 %
MED. 100	=	119.065 KG	25.68 %
SHORT 50	=	6.472 KG	1.40 %
TOTAL AIR CARRIER EMISSION	=	348.500 KG	75.17 %
TOTAL AIR CARGO EMISSION	=	6.970 KG	1.50 %
TURBO	=	14.638 KG	3.16 %
PISTON	=	93.523 KG	20.17 %
TOTAL GENERAL AV. EMISSION	=	108.161 KG	23.33 %

GRAND TOTAL AIRCRAFT EMISSION	=	463.631 KG	100.00 %
TAXIIDLE	=	361.409 KG	77.95 %
TAKE OFF	=	4.283 KG	0.92 %
CLIMBOUT	=	50.374 KG	10.87 %
APPROACH	=	42.723 KG	9.21 %
LANDING	=	4.842 KG	1.04 %

TABLE 5.2 (CONTINUED)

2000 PT PEAK DAY EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	761.816 KG	100.00 %
JUMBO 350	=	216.297 KG	28.39 %
JUMBO 250	=	200.688 KG	26.34 %
LONG 200	=	74.543 KG	9.78 %
LONG 150	=	186.357 KG	24.46 %
MED. 100	=	12.002 KG	1.58 %
SHORT 50	=	0.943 KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	690.830 KG	90.68 %
TOTAL AIR CARGO EMISSION	=	13.817 KG	1.81 %
TURBO	=	57.170 KG	7.50 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	57.170 KG	7.50 %

GRAND TOTAL AIRCRAFT EMISSION	=	761.816 KG	100.00 %
TAXIIDLE	=	390.790 KG	51.30 %
TAKE OFF	=	37.912 KG	4.98 %
CLIMBOUT	=	125.172 KG	16.43 %
APPROACH	=	177.629 KG	23.32 %
LANDING	=	30.313 KG	3.98 %

TABLE 5.2 (CONTINUED)

1973 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	463.631 KG	100.00 %
JUMBO 350	=	14.422 KG	3.11 %
JUMBO 250	=	9.014 KG	1.94 %
LONG 200	=	72.556 KG	15.65 %
LONG 150	=	126.973 KG	27.39 %
MED. 100	=	119.065 KG	25.68 %
SHORT 50	=	6.472 KG	1.40 %
TOTAL AIR CARRIER EMISSION	=	348.500 KG	75.17 %
TOTAL AIR CARGO EMISSION	=	6.970 KG	1.50 %
TURBO	=	14.638 KG	3.16 %
PISTON	=	93.523 KG	20.17 %
TOTAL GENERAL AV. EMISSION	=	108.161 KG	23.33 %

GRAND TOTAL AIRCRAFT EMISSION	=	463.631 KG	100.00 %
TAXIIDLE	=	361.409 KG	77.95 %
TAKE OFF	=	4.283 KG	0.92 %
CLIMBOUT	=	50.374 KG	10.87 %
APPROACH	=	42.723 KG	9.21 %
LANDING	=	4.842 KG	1.04 %

TABLE 5.2 (CONTINUED)

1975 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	552.785 KG	100.00 %
JUMBO 350	=	39.918 KG	7.22 %
JUMBO 250	=	45.906 KG	8.30 %
LONG 200	=	45.903 KG	8.30 %
LONG 150	=	160.660 KG	29.06 %
MED. 100	=	126.300 KG	22.85 %
SHORT 50	=	4.777 KG	0.86 %
TOTAL AIR CARRIER EMISSION	=	423.462 KG	76.61 %
TOTAL AIR CARGO EMISSION	=	8.469 KG	1.53 %
TURBO	=	16.356 KG	2.96 %
PISTON	=	104.498 KG	18.90 %
TOTAL GENERAL AV. EMISSION	=	120.854 KG	21.86 %

GRAND TOTAL AIRCRAFT EMISSION	=	552.785 KG	100.00 %
TAXIIDLE	=	436.900 KG	79.04 %
TAKE OFF	=	4.808 KG	0.87 %
CLIMBOUT	=	56.434 KG	10.21 %
APPROACH	=	49.002 KG	8.86 %
LANDING	=	5.642 KG	1.02 %

TABLE 5.2 (CONTINUED)

1980 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	900.463 KG	100.00 %
JUMBO 350	=	87.991 KG	9.77 %
JUMBO 250	=	87.111 KG	9.67 %
LONG 200	=	45.532 KG	5.06 %
LONG 150	=	368.054 KG	40.87 %
MED. 100	=	134.181 KG	14.90 %
SHORT 50	=	3.948 KG	0.44 %
TOTAL AIR CARRIER EMISSION	=	726.818 KG	80.72 %
TOTAL AIR CARGO EMISSION	=	14.536 KG	1.61 %
TURBO	=	21.533 KG	2.39 %
PISTON	=	137.575 KG	15.28 %
TOTAL GENERAL AV. EMISSION	=	159.109 KG	17.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	900.463 KG	100.00 %
TAXIIDLE	=	736.909 KG	81.84 %
TAKE OFF	=	6.674 KG	0.74 %
CLIMBOUT	=	75.729 KG	8.41 %
APPROACH	=	72.343 KG	8.03 %
LANDING	=	8.807 KG	0.98 %

TABLE 5.2 (CONTINUED)

1985 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1282.857	KG	100.00 %
JUMBO 350	=	187.485	KG	14.61 %
JUMBO 250	=	170.745	KG	13.31 %
LONG 200	=	101.060	KG	7.88 %
LONG 150	=	452.363	KG	35.26 %
MED. 100	=	149.343	KG	11.64 %
SHORT 50	=	3.405	KG	0.27 %
TOTAL AIR CARRIER EMISSION	=	1064.401	KG	82.97 %
TOTAL AIR CARGO EMISSION	=	21.288	KG	1.66 %
TURBO	=	26.684	KG	2.08 %
PISTON	=	170.484	KG	13.29 %
TOTAL GENERAL AV. EMISSION	=	197.168	KG	15.37 %

GRAND TOTAL AIRCRAFT EMISSION	=	1282.857	KG	100.00 %
TAXIIDLE	=	1069.785	KG	83.39 %
TAKE OFF	=	8.580	KG	0.67 %
CLIMBOUT	=	95.215	KG	7.42 %
APPROACH	=	97.060	KG	7.57 %
LANDING	=	12.217	KG	0.95 %

TABLE 5.2 (CONTINUED)

1990 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1743.222 KG	100.00 %
JUMBO 350	=	340.632 KG	19.54 %
JUMBO 250	=	319.342 KG	18.32 %
LONG 200	=	160.660 KG	9.22 %
LONG 150	=	539.356 KG	30.94 %
MED. 100	=	118.708 KG	6.81 %
SHORT 50	=	1.672 KG	0.10 %
TOTAL AIR CARRIER EMISSION	=	1480.369 KG	84.92 %
TOTAL AIR CARGO EMISSION	=	29.607 KG	1.70 %
TURBO	=	31.567 KG	1.81 %
PISTON	=	201.679 KG	11.57 %
TOTAL GENERAL AV. EMISSION	=	233.246 KG	13.38 %

GRAND TOTAL AIRCRAFT EMISSION	=	1743.222 KG	100.00 %
TAXIIDLE	=	1478.924 KG	84.84 %
TAKE OFF	=	10.439 KG	0.60 %
CLIMBOUT	=	114.075 KG	6.54 %
APPROACH	=	123.760 KG	7.10 %
LANDING	=	16.026 KG	0.92 %

TABLE 5.2 (CONTINUED)

1995 CO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	2203.240	KG	100.00 %
JUMBO 350	=	525.370	KG	23.85 %
JUMBO 250	=	463.562	KG	21.04 %
LONG 200	=	206.562	KG	9.38 %
LONG 150	=	619.686	KG	28.13 %
MED. 100	=	80.148	KG	3.64 %
SHORT 50	=	0.832	KG	0.04 %
TOTAL AIR CARRIER EMISSION	=	1896.160	KG	86.06 %
TOTAL AIR CARGO EMISSION	=	37.923	KG	1.72 %
TURBO	=	36.427	KG	1.65 %
PISTON	=	232.730	KG	10.56 %
TOTAL GENERAL AV. EMISSION	=	269.157	KG	12.22 %

GRAND TOTAL AIRCRAFT EMISSION	=	2203.240	KG	100.00 %
TAXIIDLE	=	1888.378	KG	85.71 %
TAKE OFF	=	12.255	KG	0.56 %
CLIMBOUT	=	132.757	KG	6.03 %
APPROACH	=	150.081	KG	6.81 %
LANDING	=	19.770	KG	0.90 %

TABLE 5.2 (CONTINUED)

2000 CO PEAK HCUR EMISSICNS

GRAND TOTAL AIRCRAFT EMISSION	=	2667.180	KG	100.00 %
JUMBC 350	=	682.810	KG	25.60 %
JUMBO 250	=	633.535	KG	23.75 %
LONG 200	=	273.195	KG	10.24 %
LONG 150	=	682.987	KG	25.61 %
MED. 100	=	41.989	KG	1.57 %
SHORT 50	=	0.316	KG	0.01 %
TOTAL AIR CARRIER EMISSION	=	2314.830	KG	86.79 %
TOTAL AIR CARGO EMISSION	=	46.297	KG	1.74 %
TURBO	=	41.421	KG	1.55 %
PISTON	=	264.633	KG	9.92 %
TOTAL GENERAL AV. EMISSION	=	306.053	KG	11.47 %

GRAND TCTAL AIRCRAFT EMISSION	=	2667.180	KG	100.00 %
TAXIIDLE	=	2300.847	KG	86.27 %
TAKE OFF	=	14.110	KG	0.53 %
CLIMBOUT	=	151.899	KG	5.70 %
APPROACH	=	176.773	KG	6.63 %
LANDING	=	23.553	KG	0.88 %

TABLE 5.2 (CONTINUED)

1973 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	218.154	KG	100.00 %
JUMBO 350	=	3.723	KG	1.71 %
JUMBO 250	=	2.327	KG	1.07 %
LONG 200	=	61.952	KG	28.40 %
LONG 150	=	108.417	KG	49.70 %
MED. 100	=	27.103	KG	12.42 %
SHORT 50	=	4.950	KG	2.27 %
TOTAL AIR CARRIER EMISSION	=	208.471	KG	95.56 %
TOTAL AIR CARGO EMISSION	=	4.169	KG	1.91 %
TURBO	=	3.339	KG	1.53 %
PISTON	=	2.174	KG	1.00 %
TOTAL GENERAL AV. EMISSION	=	5.513	KG	2.53 %

GRAND TOTAL AIRCRAFT EMISSION	=	218.154	KG	100.00 %
TAXIIDLE	=	211.591	KG	96.99 %
TAKE OFF	=	0.372	KG	0.17 %
CLIMBOUT	=	1.962	KG	0.90 %
APPROACH	=	3.652	KG	1.67 %
LANDING	=	0.576	KG	0.26 %

TABLE 5.2 (CONTINUED)

1975 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION =	241.709 KG	100.00 %
JUMBO 350 =	10.303 KG	4.26 %
JUMBO 250 =	11.849 KG	4.90 %
LONG 200 =	39.194 KG	16.22 %
LONG 150 =	137.180 KG	56.75 %
MED. 100 =	28.750 KG	11.89 %
SHORT 50 =	3.654 KG	1.51 %
TOTAL AIR CARRIER EMISSION =	230.931 KG	95.54 %
TOTAL AIR CARGO EMISSION =	4.619 KG	1.91 %
TURBO =	3.731 KG	1.54 %
PISTON =	2.429 KG	1.00 %
TOTAL GENERAL AV. EMISSION =	6.160 KG	2.55 %

GRAND TOTAL AIRCRAFT EMISSION =	241.709 KG	100.00 %
TAXIIDLE =	234.288 KG	96.93 %
TAKE OFF =	0.437 KG	0.18 %
CLIMBOUT =	2.234 KG	0.92 %
APPROACH =	4.103 KG	1.70 %
LANDING =	0.648 KG	0.27 %

TABLE 5.2 (CONTINUED)

1980 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	448.652 KG	100.00 %
JUMBO 350	=	22.712 KG	5.06 %
JUMBO 250	=	22.485 KG	5.01 %
LONG 200	=	38.878 KG	8.67 %
LONG 150	=	314.266 KG	70.05 %
MED. 100	=	30.544 KG	6.81 %
SHORT 50	=	3.020 KG	0.67 %
TOTAL AIR CARRIER EMISSION	=	431.905 KG	96.27 %
TOTAL AIR CARGO EMISSION	=	8.638 KG	1.93 %
TURBO	=	4.912 KG	1.09 %
PISTON	=	3.197 KG	0.71 %
TOTAL GENERAL AV. EMISSION	=	8.109 KG	1.81 %

GRAND TOTAL AIRCRAFT EMISSION	=	448.652 KG	100.00 %
TAXIIDLE	=	436.372 KG	97.26 %
TAKE OFF	=	0.755 KG	0.17 %
CLIMBOUT	=	3.504 KG	0.78 %
APPROACH	=	6.904 KG	1.54 %
LANDING	=	1.117 KG	0.25 %

TABLE 5.2 (CONTINUED)

1985 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	623.690 KG	100.00 %
JUMBO 350	=	48.393 KG	7.76 %
JUMBO 250	=	44.072 KG	7.07 %
LONG 200	=	86.291 KG	13.84 %
LONG 150	=	386.254 KG	61.93 %
MED. 100	=	33.996 KG	5.45 %
SHORT 50	=	2.605 KG	0.42 %
TOTAL AIR CARRIER EMISSION	=	601.609 KG	96.46 %
TOTAL AIR CARGO EMISSION	=	12.032 KG	1.93 %
TURBO	=	6.087 KG	0.98 %
PISTON	=	3.962 KG	0.64 %
TOTAL GENERAL AV. EMISSION	=	10.049 KG	1.61 %

GRAND TOTAL AIRCRAFT EMISSION	=	623.690 KG	100.00 %
TAXIIDLE	=	606.870 KG	97.30 %
TAKE OFF	=	1.074 KG	0.17 %
CLIMBOUT	=	4.744 KG	0.76 %
APPROACH	=	9.460 KG	1.52 %
LANDING	=	1.543 KG	0.25 %

TABLE 5.2 (CONTINUED)

1990 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	824.180 KG	100.00 %
JUMBO 350	=	87.923 KG	10.67 %
JUMBO 250	=	82.428 KG	10.00 %
LONG 200	=	137.180 KG	16.64 %
LONG 150	=	460.533 KG	55.88 %
MED. 100	=	27.022 KG	3.28 %
SHORT 50	=	1.279 KG	0.16 %
TOTAL AIR CARRIER EMISSION	=	796.365 KG	96.63 %
TOTAL AIR CARGO EMISSION	=	15.927 KG	1.93 %
TURBO	=	7.201 KG	0.87 %
PISTON	=	4.687 KG	0.57 %
TOTAL GENERAL AV. EMISSION	=	11.888 KG	1.44 %

GRAND TOTAL AIRCRAFT EMISSION	=	824.180 KG	100.00 %
TAXIIDLE	=	802.324 KG	97.35 %
TAKE OFF	=	1.460 KG	0.18 %
CLIMBOUT	=	6.138 KG	0.74 %
APPROACH	=	12.248 KG	1.49 %
LANDING	=	2.012 KG	0.24 %

TABLE 5.2 (CONTINUED)

1995 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1012.950 KG	100.00 %
JUMBO 350	=	135.607 KG	13.39 %
JUMBO 250	=	119.653 KG	11.81 %
LONG 200	=	176.375 KG	17.41 %
LONG 150	=	529.124 KG	52.24 %
MED. 100	=	18.244 KG	1.80 %
SHORT 50	=	0.636 KG	0.06 %
TOTAL AIR CARRIER EMISSION	=	979.639 KG	96.71 %
TOTAL AIR CARGO EMISSION	=	19.593 KG	1.93 %
TURBO	=	8.310 KG	0.82 %
PISTON	=	5.409 KG	0.53 %
TOTAL GENERAL AV. EMISSION	=	13.718 KG	1.35 %

GRAND TOTAL AIRCRAFT EMISSION	=	1012.950 KG	100.00 %
TAXIIDLE	=	986.270 KG	97.37 %
TAKE OFF	=	1.840 KG	0.18 %
CLIMBOUT	=	7.500 KG	0.74 %
APPROACH	=	14.886 KG	1.47 %
LANDING	=	2.453 KG	0.24 %

TABLE 5.2 (CONTINUED)

2000 HC PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1204.932	KG	100.00 %
JUMBO 350	=	176.245	KG	14.63 %
JUMBO 250	=	163.526	KG	13.57 %
LONG 200	=	233.270	KG	19.36 %
LONG 150	=	583.174	KG	48.40 %
MED. 100	=	9.558	KG	0.79 %
SHORT 50	=	0.242	KG	0.02 %
TOTAL AIR CARRIER EMISSION	=	1166.013	KG	96.77 %
TOTAL AIR CARGO EMISSION	=	23.320	KG	1.94 %
TURBO	=	9.449	KG	0.78 %
PISTON	=	6.150	KG	0.51 %
TOTAL GENERAL AV. EMISSION	=	15.599	KG	1.29 %

GRAND TOTAL AIRCRAFT EMISSION	=	1204.932	KG	100.00 %
TAXIIDLE	=	1173.356	KG	97.38 %
TAKE OFF	=	2.225	KG	0.18 %
CLIMBOUT	=	8.884	KG	0.74 %
APPROACH	=	17.566	KG	1.46 %
LANDING	=	2.902	KG	0.24 %

TABLE 5.2 (CONTINUED)

1973 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	136.441 KG	100.00 %
JUMBO 350	=	9.779 KG	7.17 %
JUMBO 250	=	6.112 KG	4.48 %
LONG 200	=	10.780 KG	7.90 %
LONG 150	=	18.865 KG	13.83 %
MED. 100	=	78.525 KG	57.55 %
SHORT 50	=	3.515 KG	2.58 %
TOTAL AIR CARRIER EMISSION	=	127.575 KG	93.50 %
TOTAL AIR CARGO EMISSION	=	2.551 KG	1.87 %
TURBO	=	5.975 KG	4.38 %
PISTON	=	0.339 KG	0.25 %
TOTAL GENERAL AV. EMISSION	=	6.314 KG	4.63 %

GRAND TOTAL AIRCRAFT EMISSION	=	136.441 KG	100.00 %
TAXIIDLE	=	17.443 KG	12.78 %
TAKE OFF	=	28.903 KG	21.18 %
CLIMBOUT	=	61.039 KG	44.74 %
APPROACH	=	24.837 KG	18.20 %
LANDING	=	4.220 KG	3.09 %

TABLE 5.2 (CONTINUED)

1975 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION =	185.326 KG	100.00 %
JUMBO 350 =	27.068 KG	14.61 %
JUMBO 250 =	31.128 KG	16.80 %
LONG 200 =	6.820 KG	3.68 %
LONG 150 =	23.870 KG	12.88 %
MED. 100 =	83.297 KG	44.95 %
SHORT 50 =	2.594 KG	1.40 %
TOTAL AIR CARRIER EMISSION =	174.776 KG	94.31 %
TOTAL AIR CARGO EMISSION =	3.496 KG	1.89 %
TURBO =	6.676 KG	3.60 %
PISTON =	0.379 KG	0.20 %
TOTAL GENERAL AV. EMISSION =	7.055 KG	3.81 %

GRAND TOTAL AIRCRAFT EMISSION =	185.326 KG	100.00 %
TAXIIDLE =	21.819 KG	11.77 %
TAKE OFF =	41.435 KG	22.36 %
CLIMBOUT =	86.101 KG	46.46 %
APPROACH =	30.717 KG	16.57 %
LANDING =	5.255 KG	2.84 %

TABLE 5.2 (CONTINUED)

1980 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	285.525 KG	100.00 %
JUMBO 350	=	59.665 KG	20.90 %
JUMBO 250	=	59.069 KG	20.69 %
LONG 200	=	6.765 KG	2.37 %
LONG 150	=	54.683 KG	19.15 %
MED. 100	=	88.494 KG	30.99 %
SHORT 50	=	2.144 KG	0.75 %
TOTAL AIR CARRIER EMISSION	=	270.820 KG	94.85 %
TOTAL AIR CARGO EMISSION	=	5.416 KG	1.90 %
TURBO	=	8.790 KG	3.08 %
PISTON	=	0.499 KG	0.17 %
TOTAL GENERAL AV. EMISSION	=	9.289 KG	3.25 %

GRAND TOTAL AIRCRAFT EMISSION	=	285.525 KG	100.00 %
TAXIIDLE	=	31.176 KG	10.92 %
TAKE OFF	=	65.948 KG	23.10 %
CLIMBOUT	=	135.722 KG	47.53 %
APPROACH	=	44.953 KG	15.74 %
LANDING	=	7.727 KG	2.71 %

TABLE 5.2 (CONTINUED)

1985 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	445.496 KG	100.00 %
JUMBO 350	=	127.130 KG	28.54 %
JUMBO 250	=	115.780 KG	25.99 %
LONG 200	=	15.015 KG	3.37 %
LONG 150	=	67.209 KG	15.09 %
MED. 100	=	98.493 KG	22.11 %
SHORT 50	=	1.849 KG	0.42 %
TOTAL AIR CARRIER EMISSION	=	425.476 KG	95.51 %
TOTAL AIR CARGO EMISSION	=	8.510 KG	1.91 %
TURBO	=	10.892 KG	2.44 %
PISTON	=	0.618 KG	0.14 %
TOTAL GENERAL AV. EMISSION	=	11.510 KG	2.58 %

GRAND TOTAL AIRCRAFT EMISSION	=	445.496 KG	100.00 %
TAXIIDLE	=	45.617 KG	10.24 %
TAKE OFF	=	106.222 KG	23.84 %
CLIMBOUT	=	216.866 KG	48.68 %
APPROACH	=	65.490 KG	14.70 %
LANDING	=	11.300 KG	2.54 %

TABLE 5.2 (CONTINUED)

1990 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	656.949 KG	100.00 %
JUMBO 350	=	230.977 KG	35.16 %
JUMBO 250	=	216.541 KG	32.96 %
LONG 200	=	23.870 KG	3.63 %
LONG 150	=	80.134 KG	12.20 %
MED. 100	=	78.290 KG	11.92 %
SHORT 50	=	0.908 KG	0.14 %
TOTAL AIR CARRIER EMISSION	=	630.718 KG	96.01 %
TOTAL AIR CARGO EMISSION	=	12.614 KG	1.92 %
TURBO	=	12.885 KG	1.96 %
PISTON	=	0.732 KG	0.11 %
TOTAL GENERAL AV. EMISSION	=	13.617 KG	2.07 %

GRAND TOTAL AIRCRAFT EMISSION	=	656.949 KG	100.00 %
TAXIIDLE	=	63.044 KG	9.60 %
TAKE OFF	=	161.571 KG	24.59 %
CLIMBOUT	=	327.481 KG	49.85 %
APPROACH	=	89.381 KG	13.61 %
LANDING	=	15.472 KG	2.36 %

TABLE 5.2 (CONTINUED)

1995 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	879.292	KG	100.00 %
JUMBO 350	=	356.245	KG	40.51 %
JUMBO 250	=	314.333	KG	35.75 %
LONG 200	=	30.690	KG	3.49 %
LONG 150	=	92.069	KG	10.47 %
MED. 100	=	52.659	KG	6.01 %
SHORT 50	=	0.452	KG	0.05 %
TOTAL AIR CARRIER EMISSION	=	846.646	KG	96.29 %
TOTAL AIR CARGO EMISSION	=	16.933	KG	1.93 %
TURBO	=	14.869	KG	1.69 %
PISTON	=	0.844	KG	0.10 %
TOTAL GENERAL AV. EMISSION	=	15.713	KG	1.79 %

GRAND TOTAL AIRCRAFT EMISSION	=	879.292	KG	100.00 %
TAXIIDLE	=	81.246	KG	9.24 %
TAKE OFF	=	220.060	KG	25.03 %
CLIMBOUT	=	444.351	KG	50.54 %
APPROACH	=	113.891	KG	12.95 %
LANDING	=	19.744	KG	2.25 %

TABLE 5.2 (CONTINUED)

2000 NO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	1101.634 KG	100.00 %
JUMBO 350	=	463.002 KG	42.03 %
JUMBO 250	=	429.589 KG	39.00 %
LONG 200	=	40.589 KG	3.68 %
LONG 150	=	101.473 KG	9.21 %
MED. 100	=	27.692 KG	2.51 %
SHORT 50	=	0.172 KG	0.02 %
TOTAL AIR CARRIER EMISSION	=	1062.517 KG	96.45 %
TOTAL AIR CARGO EMISSION	=	21.250 KG	1.93 %
TURBO	=	16.907 KG	1.53 %
PISTON	=	0.960 KG	0.09 %
TOTAL GENERAL AV. EMISSION	=	17.867 KG	1.62 %

GRAND TOTAL AIRCRAFT EMISSION	=	1101.634 KG	100.00 %
TAXIIDLE	=	99.511 KG	9.03 %
TAKE OFF	=	278.474 KG	25.28 %
CLIMBOUT	=	561.126 KG	50.94 %
APPROACH	=	138.493 KG	12.57 %
LANDING	=	24.029 KG	2.18 %

TABLE 5.2 (CONTINUED)

1973 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	14.955 KG	100.00 %
JUMBO 350	=	0.574 KG	3.84 %
JUMBO 250	=	0.359 KG	2.40 %
LONG 200	=	1.647 KG	11.01 %
LONG 150	=	2.882 KG	19.27 %
MED. 100	=	7.674 KG	51.32 %
SHORT 50	=	0.641 KG	4.29 %
TOTAL AIR CARRIER EMISSION	=	13.777 KG	92.13 %
TOTAL AIR CARGO EMISSION	=	0.276 KG	1.84 %
TURBO	=	0.807 KG	5.40 %
PISTON	=	0.095 KG	0.64 %
TOTAL GENERAL AV. EMISSION	=	0.902 KG	6.03 %

GRAND TOTAL AIRCRAFT EMISSION	=	14.955 KG	100.00 %
TAXIIDLE	=	5.859 KG	39.18 %
TAKE OFF	=	1.423 KG	9.51 %
CLIMBOUT	=	3.875 KG	25.91 %
APPROACH	=	3.249 KG	21.73 %
LANDING	=	0.550 KG	3.67 %

TABLE 5.2 (CONTINUED)

1975 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION =	18.062 KG	100.00 %
JUMBO 350 =	1.590 KG	8.80 %
JUMBO 250 =	1.828 KG	10.12 %
LONG 200 =	1.042 KG	5.77 %
LONG 150 =	3.647 KG	20.19 %
MED. 100 =	8.141 KG	45.07 %
SHORT 50 =	0.473 KG	2.62 %
TOTAL AIR CARRIER EMISSION =	16.720 KG	92.57 %
TOTAL AIR CARGO EMISSION =	0.334 KG	1.85 %
TURBO =	0.902 KG	4.99 %
PISTON =	0.106 KG	0.59 %
TOTAL GENERAL AV. EMISSION =	1.008 KG	5.58 %

GRAND TOTAL AIRCRAFT EMISSION =	18.062 KG	100.00 %
TAXIIDLE =	7.090 KG	39.25 %
TAKE OFF =	1.749 KG	9.68 %
CLIMBOUT =	4.730 KG	26.19 %
APPROACH =	3.840 KG	21.26 %
LANDING =	0.654 KG	3.62 %

TABLE 5.2 (CONTINUED)

1980 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	27.235 KG	100.00 %
JUMBO 350	=	3.504 KG	12.87 %
JUMBO 250	=	3.469 KG	12.74 %
LONG 200	=	1.033 KG	3.79 %
LONG 150	=	8.354 KG	30.67 %
MED. 100	=	8.649 KG	31.76 %
SHORT 50	=	0.391 KG	1.44 %
TOTAL AIR CARRIER EMISSION	=	25.400 KG	93.26 %
TOTAL AIR CARGO EMISSION	=	0.508 KG	1.87 %
TURBO	=	1.187 KG	4.36 %
PISTON	=	0.140 KG	0.51 %
TOTAL GENERAL AV. EMISSION	=	1.327 KG	4.87 %

GRAND TOTAL AIRCRAFT EMISSION	=	27.235 KG	100.00 %
TAXIIDLE	=	10.461 KG	38.41 %
TAKE OFF	=	2.712 KG	9.96 %
CLIMBOUT	=	7.269 KG	26.69 %
APPROACH	=	5.798 KG	21.29 %
LANDING	=	0.994 KG	3.65 %

TABLE 5.2 (CONTINUED)

1985 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION =	39.170	KG	100.00 %
JUMBO 350 =	7.466	KG	19.06 %
JUMBO 250 =	6.799	KG	17.36 %
LONG 200 =	2.294	KG	5.86 %
LONG 150 =	10.267	KG	26.21 %
MED. 100 =	9.626	KG	24.58 %
SHORT 50 =	0.337	KG	0.86 %
TOTAL AIR CARRIER EMISSION =	36.789	KG	93.92 %
TOTAL AIR CARGO EMISSION =	0.736	KG	1.88 %
TURBO =	1.471	KG	3.76 %
PISTON =	0.173	KG	0.44 %
TOTAL GENERAL AV. EMISSION =	1.644	KG	4.20 %

GRAND TOTAL AIRCRAFT EMISSION =	39.170	KG	100.00 %
TAXIIDLE =	15.050	KG	38.42 %
TAKE OFF =	3.956	KG	10.10 %
CLIMBOUT =	10.557	KG	26.95 %
APPROACH =	8.196	KG	20.92 %
LANDING =	1.411	KG	3.60 %

TABLE 5.2 (CONTINUED)

1990 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	52.931 KG	100.00 %
JUMBO 350	=	13.564 KG	25.63 %
JUMBO 250	=	12.716 KG	24.02 %
LONG 200	=	3.647 KG	6.89 %
LONG 150	=	12.242 KG	23.13 %
MED. 100	=	7.651 KG	14.46 %
SHORT 50	=	0.166 KG	0.31 %
TOTAL AIR CARRIER EMISSION	=	49.986 KG	94.44 %
TOTAL AIR CARGO EMISSION	=	1.000 KG	1.89 %
TURBO	=	1.740 KG	3.29 %
PISTON	=	0.205 KG	0.39 %
TOTAL GENERAL AV. EMISSION	=	1.945 KG	3.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	52.931 KG	100.00 %
TAXIIDLE	=	20.357 KG	38.46 %
TAKE OFF	=	5.428 KG	10.25 %
CLIMBOUT	=	14.433 KG	27.27 %
APPROACH	=	10.840 KG	20.48 %
LANDING	=	1.872 KG	3.54 %

TABLE 5.2 (CONTINUED)

1995 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	66.894 KG	100.00 %
JUMBO 350	=	20.921 KG	31.27 %
JUMBO 250	=	18.459 KG	27.59 %
LONG 200	=	4.688 KG	7.01 %
LONG 150	=	14.065 KG	21.03 %
MED. 100	=	5.166 KG	7.72 %
SHORT 50	=	0.082 KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	63.382 KG	94.75 %
TOTAL AIR CARGO EMISSION	=	1.268 KG	1.89 %
TURBO	=	2.008 KG	3.00 %
PISTON	=	0.237 KG	0.35 %
TOTAL GENERAL AV. EMISSION	=	2.245 KG	3.36 %

GRAND TOTAL AIRCRAFT EMISSION	=	66.894 KG	100.00 %
TAXIIDLE	=	25.792 KG	38.56 %
TAKE OFF	=	6.919 KG	10.34 %
CLIMBOUT	=	18.370 KG	27.46 %
APPROACH	=	13.481 KG	20.15 %
LANDING	=	2.332 KG	3.49 %

TABLE 5.2 (CONTINUED)

2000 SO PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	80.948 KG	100.00 %
JUMBO 350	=	27.190 KG	33.59 %
JUMBO 250	=	25.228 KG	31.17 %
LONG 200	=	6.201 KG	7.66 %
LONG 150	=	15.502 KG	19.15 %
MED. 100	=	2.706 KG	3.34 %
SHORT 50	=	0.031 KG	0.04 %
TOTAL AIR CARRIER EMISSION	=	76.858 KG	94.95 %
TOTAL AIR CARGO EMISSION	=	1.537 KG	1.90 %
TURBO	=	2.283 KG	2.82 %
PISTON	=	0.269 KG	0.33 %
TOTAL GENERAL AV. EMISSION	=	2.552 KG	3.15 %

GRAND TOTAL AIRCRAFT EMISSION	=	80.948 KG	100.00 %
TAXIIDLE	=	31.262 KG	38.62 %
TAKE OFF	=	8.417 KG	10.40 %
CLIMBOUT	=	22.329 KG	27.58 %
APPROACH	=	16.145 KG	19.94 %
LANDING	=	2.795 KG	3.45 %

TABLE 5.2 (CONTINUED)

1973 PT PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	12.105	KG	100.00 %
JUMBO 350	=	0.402	KG	3.32 %
JUMBO 250	=	0.251	KG	2.07 %
LONG 200	=	1.740	KG	14.37 %
LONG 150	=	3.045	KG	25.15 %
MED. 100	=	2.991	KG	24.71 %
SHORT 50	=	1.698	KG	14.03 %
TOTAL AIR CARRIER EMISSION	=	10.127	KG	83.66 %
TOTAL AIR CARGO EMISSION	=	0.203	KG	1.67 %
TURBO	=	1.776	KG	14.67 %
PISTON	=	0.0	KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	1.776	KG	14.67 %

GRAND TOTAL AIRCRAFT EMISSION	=	12.105	KG	100.00 %
TAXIIDLE	=	4.570	KG	37.75 %
TAKE OFF	=	0.830	KG	6.85 %
CLIMBOUT	=	2.456	KG	20.29 %
APPROACH	=	3.656	KG	30.20 %
LANDING	=	0.593	KG	4.90 %

TABLE 5.2 (CONTINUED)

1975 PT PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	13.989 KG	100.00 %
JUMBO 350	=	1.111 KG	7.94 %
JUMBO 250	=	1.278 KG	9.14 %
LONG 200	=	1.101 KG	7.87 %
LONG 150	=	3.853 KG	27.54 %
MED. 100	=	3.173 KG	22.68 %
SHORT 50	=	1.254 KG	8.96 %
TOTAL AIR CARRIER EMISSION	=	11.769 KG	84.13 %
TOTAL AIR CARGO EMISSION	=	0.235 KG	1.68 %
TURBO	=	1.984 KG	14.18 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	1.984 KG	14.18 %

GRAND TOTAL AIRCRAFT EMISSION	=	13.989 KG	100.00 %
TAXIIDLE	=	5.796 KG	41.43 %
TAKE OFF	=	0.915 KG	6.54 %
CLIMBOUT	=	2.712 KG	19.39 %
APPROACH	=	3.923 KG	28.04 %
LANDING	=	0.643 KG	4.60 %

TABLE 5.2 (CONTINUED)

1980 PT PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	22.196 KG	100.00 %
JUMBO 350	=	2.450 KG	11.04 %
JUMBO 250	=	2.425 KG	10.93 %
LONG 200	=	1.092 KG	4.92 %
LONG 150	=	8.826 KG	39.76 %
MED. 100	=	3.371 KG	15.19 %
SHORT 50	=	1.036 KG	4.67 %
TOTAL AIR CARRIER EMISSION	=	19.200 KG	86.50 %
TOTAL AIR CARGO EMISSION	=	0.384 KG	1.73 %
TURBO	=	2.612 KG	11.77 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	2.612 KG	11.77 %

GRAND TOTAL AIRCRAFT EMISSION	=	22.196 KG	100.00 %
TAXIIDLE	=	8.753 KG	39.44 %
TAKE OFF	=	1.428 KG	6.43 %
CLIMBOUT	=	4.392 KG	19.79 %
APPROACH	=	6.529 KG	29.42 %
LANDING	=	1.094 KG	4.93 %

TABLE 5.2 (CONTINUED)

1985 PT PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	31.685 KG	100.00 %
JUMBO 350	=	5.220 KG	16.47 %
JUMBO 250	=	4.754 KG	15.00 %
LONG 200	=	2.424 KG	7.65 %
LONG 150	=	10.848 KG	34.24 %
MED. 100	=	3.752 KG	11.84 %
SHORT 50	=	0.894 KG	2.82 %
TOTAL AIR CARRIER EMISSION	=	27.891 KG	88.02 %
TOTAL AIR CARGO EMISSION	=	0.558 KG	1.76 %
TURBO	=	3.237 KG	10.22 %
PISTON	=	0.0 KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	3.237 KG	10.22 %

GRAND TOTAL AIRCRAFT EMISSION	=	31.685 KG	100.00 %
TAXIIDLE	=	13.502 KG	42.61 %
TAKE OFF	=	1.923 KG	6.07 %
CLIMBOUT	=	5.995 KG	18.92 %
APPROACH	=	8.783 KG	27.72 %
LANDING	=	1.482 KG	4.68 %

TABLE 5.2 (CONTINUED)

1990 PT PEAK HCUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSICN	=	43.183 KG	1CC.CC %
JUMBO 350	=	9.484 KG	21.96 %
JUMBO 250	=	8.891 KG	2C.59 %
LONG 2CC	=	3.853 KG	8.92 %
LONG 15C	=	12.934 KG	29.95 %
MED. 100	=	2.982 KG	6.91 %
SHORT 50	=	0.439 KG	1.C2 %
TOTAL AIR CARRIER EMISSION	=	38.582 KG	89.35 %
TOTAL AIR CARGC EMISSION	=	0.772 KG	1.79 %
TURBO	=	3.829 KG	8.87 %
PISTON	=	0.0 KG	C.C %
TOTAL GENERAL AV. EMISSION	=	3.829 KG	8.87 %

GRANC TOTAL AIRCRAFT EMISSION	=	43.183 KG	10C.CC %
TAXIIDLE	=	20.063 KG	46.46 %
TAKE OFF	=	2.408 KG	5.58 %
CLIMBOUT	=	7.695 KG	17.82 %
APPROACH	=	11.126 KG	25.77 %
LANCING	=	1.890 KG	4.38 %

TABLE 5.2 (CONTINUED)

1995 PT PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	54.989 KG	100.00	%
JUMBO 350	=	14.627 KG	26.60	%
JUMBO 250	=	12.906 KG	23.47	%
LONG 200	=	4.954 KG	9.01	%
LONG 150	=	14.861 KG	27.02	%
MED. 100	=	2.013 KG	3.66	%
SHORT 50	=	0.218 KG	0.40	%
TOTAL AIR CARRIER EMISSION	=	49.579 KG	90.16	%
TOTAL AIR CARGO EMISSION	=	0.992 KG	1.80	%
TURBO	=	4.419 KG	8.04	%
PISTON	=	0.0 KG	0.0	%
TOTAL GENERAL AV. EMISSION	=	4.419 KG	8.04	%

GRAND TOTAL AIRCRAFT EMISSION	=	54.989 KG	100.00	%
TAXIIDLE	=	27.179 KG	49.43	%
TAKE OFF	=	2.865 KG	5.21	%
CLIMBOUT	=	9.332 KG	16.97	%
APPROACH	=	13.340 KG	24.26	%
LANDING	=	2.273 KG	4.13	%

TABLE 5.2 (CONTINUED)

2000 PT PEAK HOUR EMISSIONS

GRAND TOTAL AIRCRAFT EMISSION	=	66.955	KG	100.00 %
JUMBO 350	=	19.010	KG	28.39 %
JUMBO 250	=	17.638	KG	26.34 %
LONG 200	=	6.551	KG	9.78 %
LONG 150	=	16.379	KG	24.46 %
MED. 100	=	1.055	KG	1.58 %
SHORT 50	=	0.083	KG	0.12 %
TOTAL AIR CARRIER EMISSION	=	60.716	KG	90.68 %
TOTAL AIR CARGO EMISSION	=	1.214	KG	1.81 %
TURBO	=	5.025	KG	7.50 %
PISTON	=	0.0	KG	0.0 %
TOTAL GENERAL AV. EMISSION	=	5.025	KG	7.50 %

GRAND TOTAL AIRCRAFT EMISSION	=	66.955	KG	100.00 %
TAXIIDLE	=	34.346	KG	51.30 %
TAKE OFF	=	3.332	KG	4.98 %
CLIMBOUT	=	11.001	KG	16.43 %
APPROACH	=	15.612	KG	23.32 %
LANDING	=	2.664	KG	3.98 %

APPENDIX IV

EMERGENCY FUEL DUMPING FROM AIRCRAFT

The ensuing documentation on fuel dumping from aircraft has been prepared by Environment Canada as supplementary information to the preceding report. It has been included herein as the result of a number of public queries directed to the department during the course of this study, raising concern over the potential environmental affects from this operation.

The conditions under which aircraft are required to return to the departure airstrip relate to varied emergency conditions encountered by an aircraft after take-off and that necessitate its return to the airfield. An aircraft is therefore required to unload excess fuel to reduce its gross weight to its established landing weight prior to landing. The occurrence of such incidences is very infrequent and are thought to occur perhaps several times per year in the case of the total traffic at the Vancouver International Airport.

The Ministry of Transport has designated two fuel dumping areas in the vicinity of Vancouver to encompass the air traffic at Vancouver International Airport as well as traffic from surrounding airports. They are roughly located over the areas of Garibaldi Park on the mainland and the southern part of Vancouver Island (illustrated on the attached map), but are more specifically defined as follows:

Area (1): from Vancouver 315 radial to the Vancouver 010 radial; between 40 and 100 miles D.M.E. (Distance Measuring Equipment); dumping altitude at 12,000 ft or above.

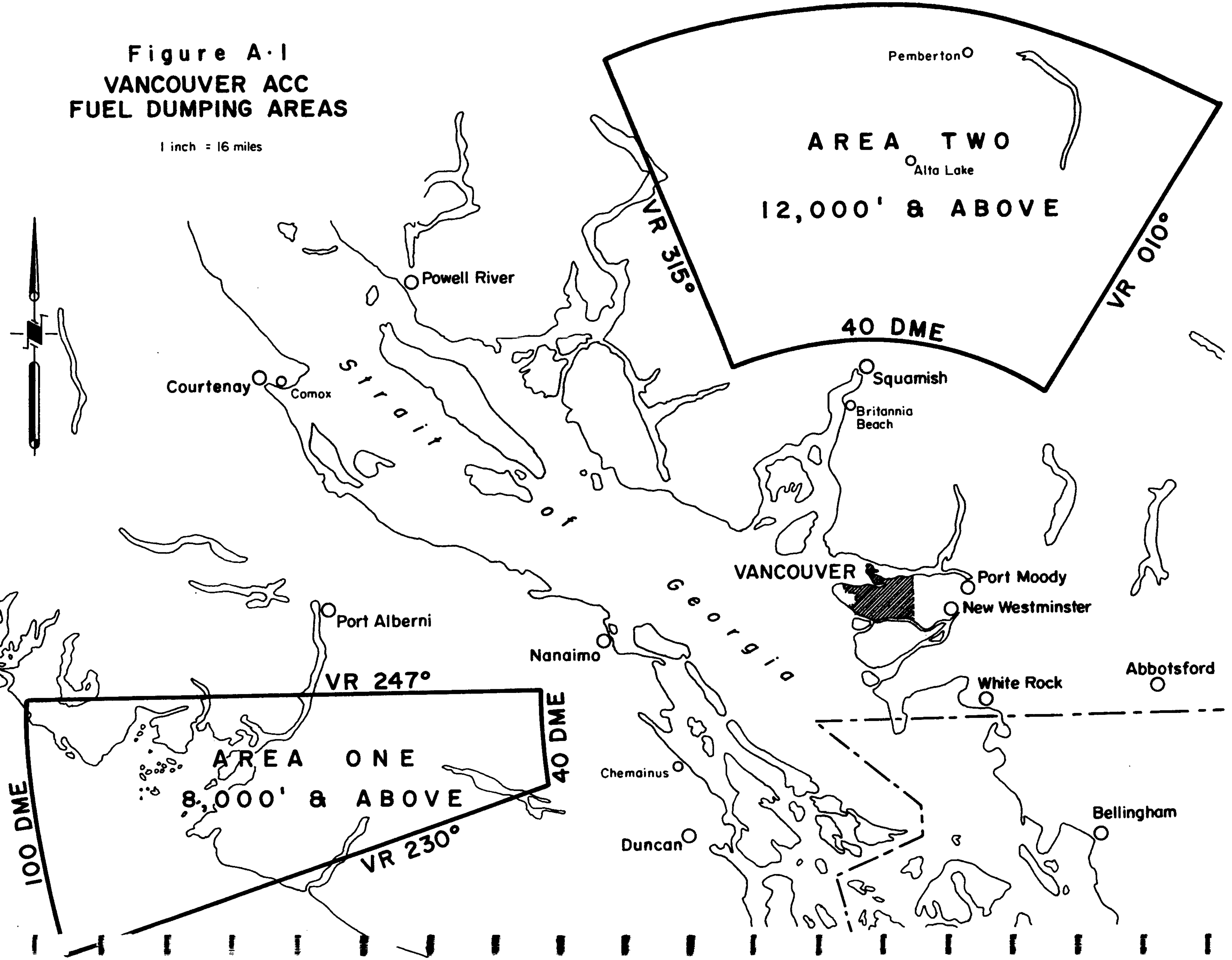
Area (2): from Vancouver 230 radial to the Vancouver 247 radial; between 40 and 100 miles D.M.E.; dumping altitude at 8,000 ft or above.

Maximum fuel discharge rates for representative commercial aircraft are tabulated as follows:

B 747	5,000 lbs fuel/min
DC 8	4,000 " " "
B 727	3,500 " " "
B 737	No emergency dump capability

Figure A·1
VANCOUVER ACC
FUEL DUMPING AREAS

1 inch = 16 miles



It is understood from discussions with representatives of Shell Canada Limited, that jet fuel, generally JP1 and JP4 is vaporized in air and will not impinge on the ground if discharged from an aircraft flying at a speed of over 200 knots and above elevation 1,000 ft. Furthermore, the very low freezing point (58°F) of jet fuel would ensure vaporization over a wide range of ambient air temperatures.

Having regard to the previously noted data on fuel discharge rates together with the preceding information, one can calculate a fuel dispersal rate for a qualitative appreciation of the operation. Assuming the minimum aircraft speed of 200 knots, typical of an aircraft in a landing mode several miles from an airport, and a maximum fuel discharge rate of 5,000 lbs/min, the fuel would be dispersed along the line of travel at the rate of approximately 3 gal/100 ft. However, an aircraft would usually be near its cruising speed during the fuel dumping mode and that would reduce considerably the worst case dispersal rate calculated here.

It is noted that the selected dumping areas that have been adopted by the Ministry of Transport are remote from major urban centers and are considered acceptable with respect to environmental considerations recognizing the paramount importance of aircraft safety and the practical necessity of having zones that are readily recognizable from aircraft instrumentation.

Prudence suggests that there is no cause for concern of fuel impingement at ground level for the relatively high altitude fuel-dumping conditions set by the Ministry of Transport at the two designated areas discussed herein.