Ministry for the Environment

GEMS Air Monitoring Program
Annual Report 2002

Prepared for
Ministry for the Environment

By
Laboratory Services - Air Quality Department

March 2003
AQ004

GEMS AIR MONITORING PROGRAM
ANNUAL REPORT

A report for
Ministry for the Environment

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14 March 2003

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1 INTRODUCTION

The World Health Organisation (WHO) reports on global environmental standards and current environmental quality. Environmental quality is reported under the Global Environmental Monitoring System (GEMS). The data collected is sent to the WHO GEMS program, and in return, the New Zealand Ministry of Health (MoH) receives information from the WHO. The New Zealand Ministry for the Environment (MfE) has a Memorandum of Understanding with the MoH for administration of the GEMS program and supply of data to WHO.

The MfE's Air Quality Management Program aims to support and assist in the maintenance of air quality in parts of New Zealand that enjoy clean air, and improve air quality in places where it has deteriorated. As part of this program, the MfE is supporting the operation of ambient air quality monitoring sites in Auckland and Christchurch.

The GEMS ambient air quality sites are the longest running sites in New Zealand, and as such are very important in discerning trends in pollution, beyond the variation caused by annual climate variations. The Auckland sites are located at Penrose and Mt Eden. Monitoring has been performed at the Penrose Clinic since 1964 and at Gavin Street since 1989. At Mt Eden, the monitoring was started in 1982.

The Christchurch site was at St Albans (Packe Street) for most of 2002, but moved to a new site in Burnside in November 2002. Data for November and December 2002 will be reported from Environment Canterbury's site at St Albans (Coles Place). Data in 2003 will be reported from Burnside and from St Albans (Coles Place). Monitoring has been performed at St Albans since 1989.

The site details and locations are given in Section 4.

This report presents the results for ambient air quality monitoring in Auckland and Christchurch in the year 2002. Monitoring and reporting is undertaken by Watercare Services Ltd, and data is reported to MfE and WHO as part of the GEMS program.

2 CONTAMINANTS MONITORED

2.1 Particulate Matter

Particulate matter refers to numerous substances that exist in the atmosphere. It is a somewhat complex category, encompassing a wide range of chemically and physically diverse substances. Particulate matter includes all solid and aerosol matter that exists in ambient conditions.

Particulate matter has been divided into several categories, based upon the potential health or environmental effect. The main categories are described briefly below.

2.1.1 Total Suspended Particulate (TSP)

TSP consists of all particles which range in size from 20 μm diameter downwards. Particles larger than 20 μm are too large to remain airborne for extended periods, and thus are categorised as deposited particulate.

TSP is sufficiently small to be inhaled, however, the larger particles (10 – 20 μm) are readily filtered out in the nasal cavity. Particles 10 μm and less can be drawn into the respiratory system. TSP has an effect on both aesthetic and health quality of the ambient air.

2.1.2 Inhalable Particulate (PM_{10})

As described above, particles with a diameter of 10 μm or less can be inhaled into the respiratory system. The main effect of inhalable particulate is on human health.

Current research is recognising the division into finer fractions, including PM_5 and $PM_{2.5}$, which may penetrate beyond the bronchial tubes and deep into the aveoli. These fractions are commonly referred to as fine particulate.

The MfE Ambient Air Quality Guidelines (AAQG) (2002) includes a guideline value of 50 $\mu g/m^3$ for PM_{10}, and a monitoring value for $PM_{2.5}$ of 25 $\mu g/m^3$, 24 hour average. However, current monitoring does not differentiate into PM_{10} and $PM_{2.5}$, and all inhalable fractions are measured within the PM_{10} category.

2.2 Lead

Motor vehicle emissions are the major source of lead. Historically, lead was included in petrol as a catalyst for combustion, but has been removed from fuel supplies since 1996. Consequently, atmospheric concentrations of lead have dropped markedly. Lead is present in the atmosphere in its elemental form.

Lead can cause harm to many human tissues and organs, and especially the nervous system, the kidneys and the cardiovascular system. Young children may be particularly vulnerable to exposures at moderately low levels in the environment.

2.3 Sulphur Dioxide

Sulphur dioxide is an acidic gas with a pungent odour, which is mainly produced by the burning of fossil fuels. The gas is quite corrosive and can cause damage to building and other materials. It can have significant effects on the human respiratory system as well.

2.4 Carbon Monoxide

This colourless, odourless, toxic gas is formed as a product of incomplete combustion in the burning of fossil fuels. The main sources in most urban parts of New Zealand are motor vehicle exhaust emissions, and as such elevated levels are mainly found in areas of significant traffic congestion, particularly at busy intersections on inner-city streets. Carbon monoxide acts on humans by displacing oxygen from the blood. Prolonged exposure at moderate levels can lead to symptoms such as headaches and dizziness, while at high levels it can lead to loss of consciousness and even death. At the lower levels typically encountered in urban areas, carbon monoxide measurements can serve as a useful indicator for objectionable levels of vehicle exhaust fumes.

2.5 Nitrogen Oxides

Nitrogen oxides incorporates several species that exist in the atmosphere, which are collectively referred to as NO_x. The two main oxides are nitrogen dioxide (NO_2), and the monoxide form nitric oxide (NO). The main health effects of the oxides of nitrogen are due to NO_2, which is a respiratory irritant. Nitric oxide is believed to be quite harmless at the levels normally encountered in urban air, but may oxidise to NO_2 in the atmosphere.

Nitrogen oxides are formed in most combustion processes by oxidation of the nitrogen present in the atmosphere. Nitric oxide is the predominant primary product but this can then be oxidised to nitrogen dioxide in ambient air. As with carbon monoxide, motor vehicles are the major source of the NO_x in most urban parts of the country. Power stations and other large combustion units may be produce localised sources.

NO_x is also an important air pollutant because of its role in photochemical smog. NO_2 is a reddish brown gas, and has synergistic effects with other pollutants such as SO_2 and particulate.

2.6 Volatile Organic Compounds

Hazardous air contaminants are comprised of a wide range of potentially airborne chemicals with toxic or carcinogenic properties. Contaminants may be present in gaseous, aerosol or particulate forms. There are thousands of chemicals which could be regarded as a hazardous air contaminant. To rationalise air quality guidelines, the MfE compiled a list of priority contaminants, based on a review of international literature. This list of priority hazardous air contaminants was in the MfE review of AAQG (MfE 2000). Volatile organic compounds (VOC) included in the revised 2002 air quality guidelines were benzene, 1,3-butadiene, and benzo(a)pyrene.

3 AMBIENT AIR QUALITY GUIDELINES

The MfE has released revised ambient air quality guidelines (AAQG) in May 2002. The criteria for inclusion in the revised guidelines was the effect of a contaminant on human health. MfE guidelines for the contaminants monitored are given in Table 1.

TSP greater than 10 microns in diameter does not have a guideline value in the Ministry for the Environment's AAQG, as it does not have a recognised effect on human health. The criteria applied to TSP is 60 µg/m^3, (7 day average), previously applied by the Department of Health. This has been superseded by the MfE's Ambient Air Quality Guidelines, but is useful for analysing the results of the monitoring data.

Table 1: Ambient Air Quality Guidelines and Regional Targets

Contaminant	MfE AAQG 2002	Other AAQG	Averaging Period
Total Suspended Particulate		60 µg/m^3 (DoH)	7 day average
Fine particulate (PM_{10})	20 µg/m^3		Annual
	50 µg/m^3	50 µg/m^3 (ARC & E.Can)	24 hour average
Sulphur dioxide	120 µg/m^3		24 hour average
	350 µg/m^3		1 hour average
Carbon monoxide	10 mg/m^3		8 hour average
	30 mg/m^3		1 hour average
Nitrogen dioxide	100 µg/m^3		24 hour average
	200 µg/m^3		1 hour average
Lead	0.2 µg/m^3		3 month average
Benzene Year 2000 Year 2010	 10 µg/m^3 3.6 µg/m^3		 Annual Annual
1,3-Butadiene	2.4 µg/m^3		Annual

3.1 New Zealand Environmental Performance Indicators

The MfE has acknowledged that recent and on-going research has resulted in the need for revisions of AAQG. MfE is addressing this in part with the review of the AAQG, but also it has promulgated some Environmental Performance Indicators (EPI) for air quality.

The MfE notes that AAQG should not be seen as a limit to pollute up to, but rather should be considered as minimum requirements for air quality. The Resource Management Act (1991) requires the quality of the environment to be maintained or enhanced. In order to provide guidance on when enhancement should be required, the MfE has provided EPI, as set out in Table 2. These indicators can act as both indicators of poor air quality, and goals which policy can work towards achieving.

Table 2: Environmental Performance Indicators for Air

Category	Maximum Measured Value	Comment
Action	Exceeds guideline	Completely unacceptable by national and international standards
Alert	Between 66 % and 100 % of the guideline	Warning level, which can lead to guidelines being exceeded in trends are not curbed
Acceptable	Between 33 % and 66 % of the guideline	A broad category, where maximum values might be of concern in some sensitive locations, but are generally at a level which does not warrant dramatic action
Good	Between 10 % and 33 % of the guideline	Peak measurements in this range are unlikely to affect air quality
Excellent	Less than 10% of the guideline	Of little concern. If maximum values are less than a tenth of the guideline, average values are likely to be much less
Not Assessed		Insufficient monitoring data to assess this category

4 MONITORING SITES

4.1 Site Description

Site descriptions and location maps are given in Appendix A. A brief description of each site is given below. To accommodate site changes, all sites are being renamed with an alphanumeric identifier. Both old and new site numbers are given below.

4.1.1 Penrose (ACI), Auckland, Site AKL003 (old Site 4:19)

This site was relocated in January 2001 from the roof of the Occupational Health Clinic into the carpark of ACI Glass. The new ACI site is immediately adjacent to the original site, but provides improved security and access. Monitoring conditions are also improved, as tall buildings had been constructed behind the original site, and the new site has increased the distance away from these.

This site is representative of industrial activity and is west of the Southern Motorway. The site is located within the ACI Glass car park, approximately 8 metres east of Great South Rd.

4.1.2 Penrose, Auckland, Site AKL009 (old Site 4:23)

This is also an industrial site, and monitors NO_x from industry and traffic. The monitor is located at the electricity substation in Gavin St, approximately 50 metres east of the motorway.

Meteorological variables measured at the site are wind speed and wind direction.

4.1.3 Mt Eden, Auckland, Site AKL002 (old Site 4:65)

This site is representative of a residential location. The monitors and samplers are located at the rear of the Mt Eden Science Centre site, on the corner of Mt Eden Road and Kelly Street.

Meteorological variables measured at the site are wind speed and wind direction.

The Mt Eden site was been relocated in February 2001 to another location within the overall site. The move was necessitated by the sale of part of the Science Centre. Data for 2001 and 2002 is from the new location.

4.1.4 St Albans, Christchurch, Site CAN001 (old Site 16:67)

This site is representative of a residential location within an older area of Christchurch. The monitor is located on Madras Street, 30 m to the east of a busy arterial route.

Meteorological variables measured at the site are temperature, humidity, wind speed and wind direction.

This site was decommissioned in November 2002. Data from St Albans for November and December 2002 has been reported from the Environment Canterbury site at Coles Place. In future, data from Coles Place will be reported for the St Albans area. TSP will be monitored at Coles Place.

4.1.5 Burnside, Christchurch, Site CAN002

The site is located behind an electricity substation on Greers Road, Christchurch. The monitors are located within a grassed paddock, which is surrounded on four sides by residential dwellings.

Meteorological variables measured at the site are temperature, humidity, wind speed and wind direction.

This site is representative of a residential area in the north west section of Christchurch. Houses in the area are heated by solid fuel, but are generally younger than St Albans, with a mixture of solid fuel burners and open fires.

4.2 Contaminants Monitored at Individual Sites

The full suite of contaminants is not monitored at each site. The contaminants monitored, by site, are listed in Table 3 below.

Table 3: Monitoring Sites and Contaminants Monitored

Site	TSP	PM_{10}	SO_2	CO	NO	NO_2	VOC	Lead
Mt Eden, Auckland site 4:65	✓				✓	✓	✓	✓
Penrose (ACI), Auckland: site 4:19	✓		✓					✓
Penrose, Auckland site 4:23					✓	✓	✓	
St Albans, Christchurch (to Nov 2002)	✓	✓	✓	✓	✓	✓	✓	✓
Burnside, Christchurch (Dec 2002)		✓	✓	✓	✓	✓	✓	

5 METHODS

5.1 Quality Assurance

Watercare Services Ltd holds IANZ accreditation for the operation of its laboratory. The Watercare Services Ltd Air Quality Department is taking steps to include its air quality methods in the IANZ accreditation.

The sites are operated by Watercare Services Ltd. Operation includes maintenance of the site, calibration of monitoring equipment, and provision of quality assured data.

Quality Assurance (QA) procedures are undertaken in accordance with MfE guidelines. Data is corrected for instrument and method calibrations, missing data is annotated, and summary statistics of data are recorded as part of data processing and QA.

5.2 Analytical Methods

5.2.1 Particulate Matter

TSP is collected by drawing air through a filter giving a measure of the total quantity of particles suspended in the air. The method used is a scaled down version of the standard high-volume sampler (Department of Health sampler) and is Air Quality Test Method T101.

PM_{10} is monitored at St Albans continuously using a Beta Attenuation analyser. The analyser is covered by Australian Standard AS 3580.9.6 and US EPA ‘equivalent’ method.

5.2.2 Lead

Lead is measured by chemical analysis of the samples collected in the monitoring of suspended particulate according to Air Quality Test Method T102. Lead monitoring has been reduced to winter (Jun-Jul-Aug) monitoring only.

5.2.3 Sulphur Dioxide

Sulphur dioxide is monitored continuously at Penrose and St Albans using a UV fluorescence analyser according to Air Quality Test Method T202 (ref AS 3580.4.1-1990).

5.2.4 Carbon Monoxide

Carbon monoxide is monitored continuously using a non-dispersive infra-red analyser according to Air Quality Test Method T200 (ref AS 2695-1984).

5.2.5 Nitrogen Oxides

NO_x is monitored continuously using a chemiluminescence analyser according to Air Quality Test Method T201 (ref AS 3580.5.1-1993).

5.2.6 Volatile Organic Compounds

VOC are monitored using passive sampling badges (3M badges), exposed for a 3 month period. VOC are adsorbed onto an activated carbon filter, and desorbed and analysed using gas chromotagraphy/mass spectrometry (GC/MS), according to Air Quality Test Method T114 (ref NIOSH Method 1500 & 1501). Duplicate badges were exposed at each site to verify individual results.

Determination of 1,3-butadiene over a three month exposure period is not reliable. Investigations have determined that samples are unstable when held above -4°C (OSHA Method 54, NIOSH Method 1024), with significant desorption occurring. Technical information supplied with 3M badges reports a 10% loss of 1,3-butadiene over 3 weeks' storage at room temperature. Due to the potential for error over a three month exposure period, 1,3-butadiene has not been analysed and reported.

6 RESULTS AND DISCUSSION

6.1 Site Performance and QA

Site performance in 2002 was mixed. A lot of instruments were operating unreliably and faulting. Data logging software also caused data loss through jamming up and stopping recording. Instrument faults are being rectified through improved maintenance schedules and replacement. Data logger software and hardware is being replaced with specialised equipment and software. Site performance is therefore expected to be much better in 2003. The overall site performance is recorded in Table 4.

Table 4: Percentage Valid Data

Contaminant	Site	Percentage Valid Data (ann. avg.)	Reasons for low valid data (<90%)
TSP	Mt Eden	100 %	
TSP	Penrose	79 %	Instrument required major repair
TSP	St Albans	82 %	Site relocation
PM_{10}	St Albans	79 %	Instrument fault – tape jammed Technician fault – tape incorrectly installed
SO_2	Penrose	77 %	Data logger lockup Instrument fault
SO_2	St Albans	68 %	Instrument fault Site relocation
CO	St Albans	84 %	Instrument fault Site relocation
NO_x	Mt Eden	86 %	Instrument fault Data logger lockup
NO_x	Penrose	94 %	Instrument fault Data logger lockup
NO_x	St Albans	58%	Instrument fault Site relocation
Lead	Mt Eden	100 %	
Lead	Penrose	10 %	Instrument required major repair
Lead	St Albans	100 %	
VOC	Mt Eden	100 %	
VOC	Penrose	100 %	
VOC	St Albans	100 %	

6.2 Site Assessment and EPI Categories

The performance of different sites was determined by calculating the Environmental Performance Indicators (EPI) for the whole year, according to MfE (1997) against the ambient air quality guidelines (2002). The EPI's were determined for contaminants which were monitored and listed in the MfE AAQG (2002), and therefore excluded TSP.

Results are presented in Figure 1 (Mt Eden), Figure 2 (Penrose) and Figure 3 (St Albans). At this time, then new Christchurch Burnside site has less than one months' full data, and was therefore not considered to be representative. Future reports will include Burnside, and St Albans data from Environment Canterbury's Coles Place site.

EPI's for lead are calculated from each of three months' monitoring (June, July and August). At Penrose, lead data was only obtained for one month due to instrument failure. Therefore, an EPI has not been calculated for Penrose because of insufficient data

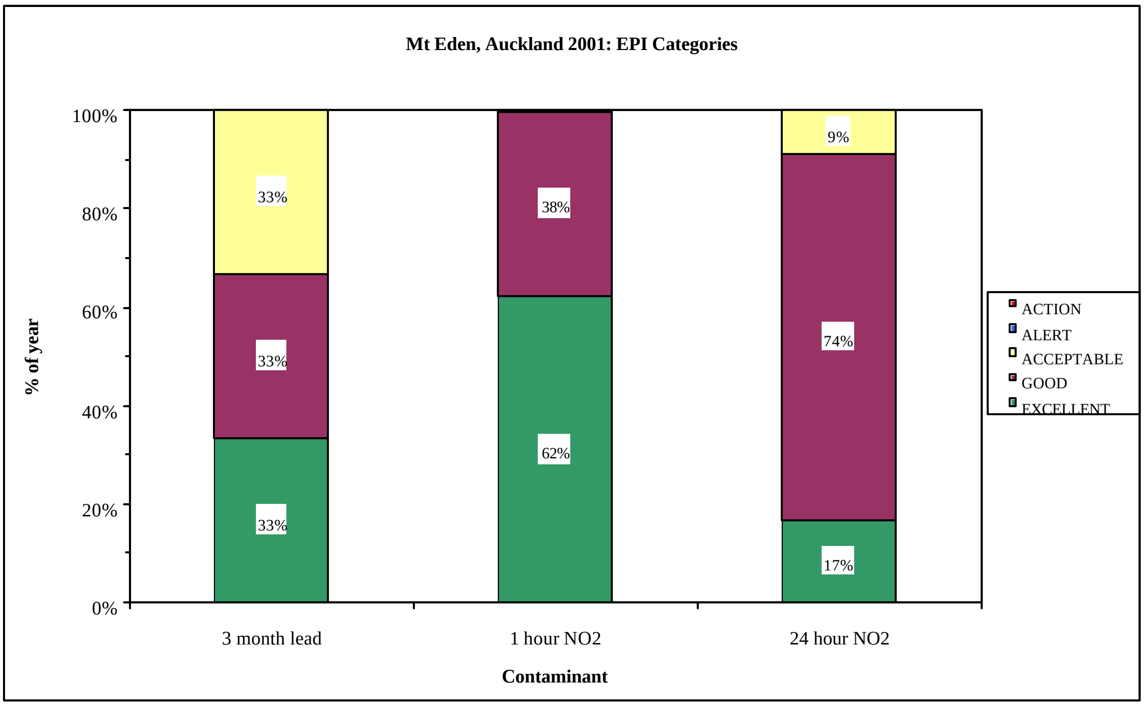

Figure 1: Comparison of monitored contaminants at Mt Eden to EPI

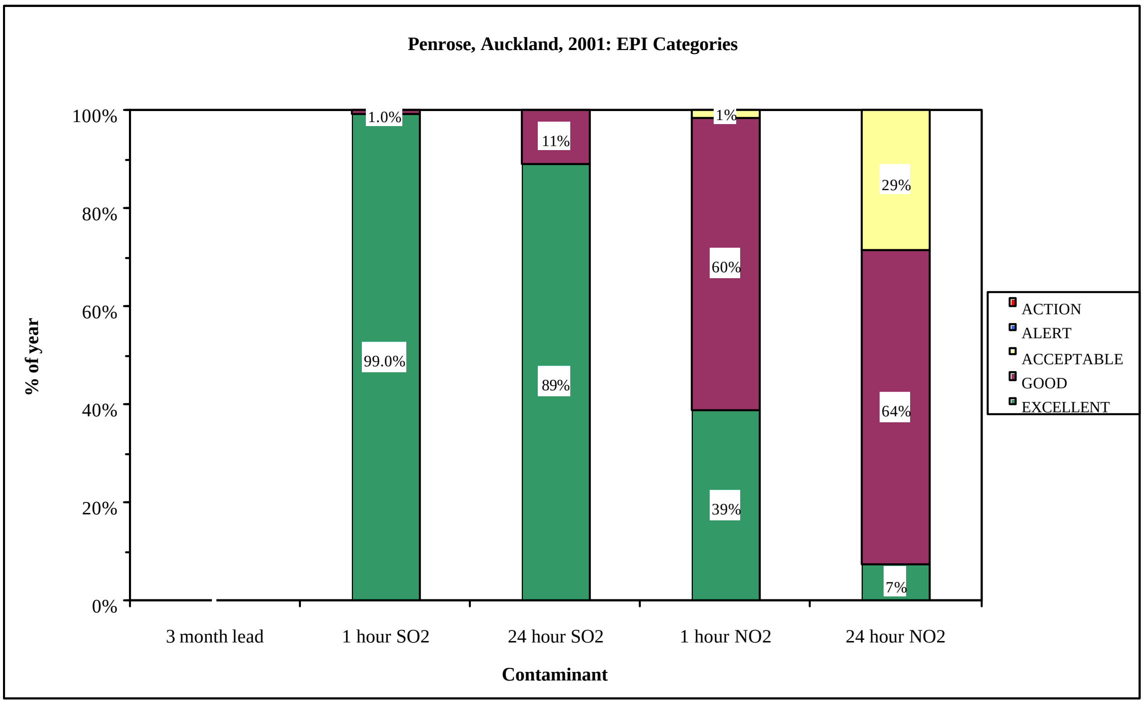

Figure 2: Comparison of monitored contaminants at Penrose to EPI

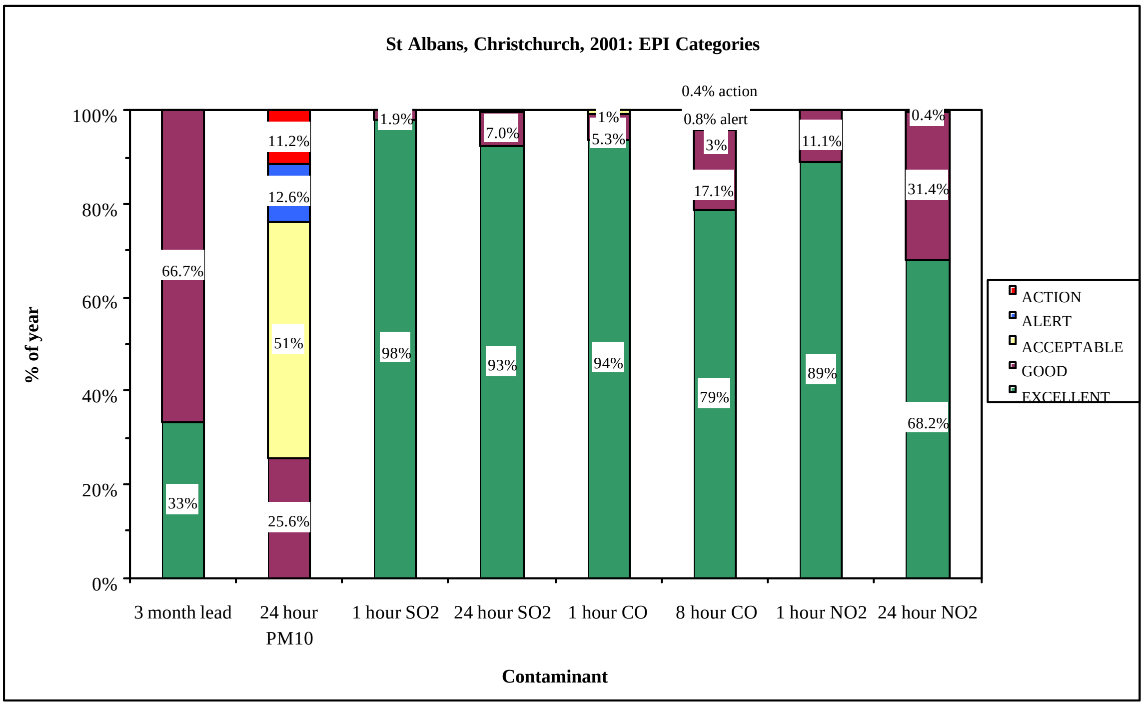

Figure 3: Comparison of monitored contaminants at St Albans to EPI

6.3 Particulate Matter

6.3.1 Total Suspended Particulate (TSP)

TSP is recorded as 7 day averages. Summary statistics are presented in Table 5, and results for 2002 are shown in Figure 4.

MfE AAQG do not include a guideline for TSP. The guideline used for TSP is the DoH guideline of 60 µg/m^3. In the year 2002, the guideline was not exceeded at Mt Eden or Penrose on any occasion. There were three exceedances at the St Albans site, occurring in June and July (Table 5).

Table 5: Statistics for TSP Monitoring 2002

	Mt Eden	Penrose	St Albans
Maximum Value (µg/m^3)	25	36	82
No. of Exceedances (>60 µg/m^3)	Nil	Nil	3
Exceedance Date & Time			6/6/02 70 µg/m^3 11/7/02 68 µg/m^3 25/7/02 82 µg/m^3

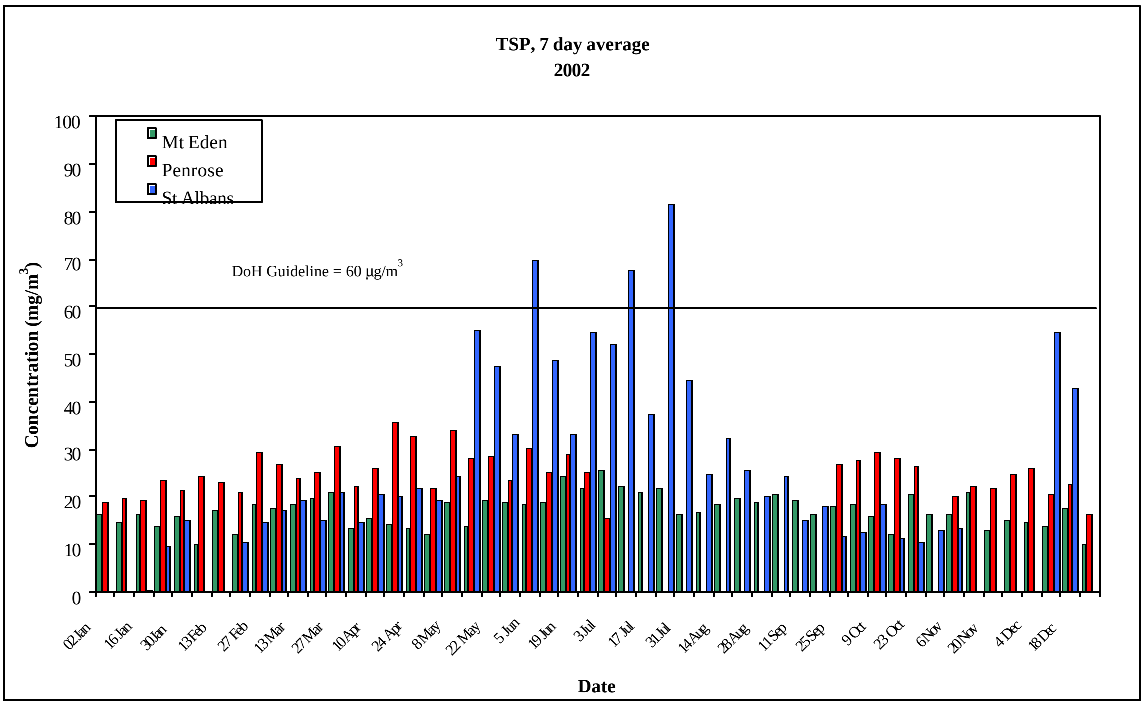

Figure 4: TSP 7 day average 2002 (all sites)

Monitoring of TSP commenced at Mt Eden in 1983, and results since records began are shown in Figure 5. The TSP monitoring at Mt Eden in 2002 shows a variable but low TSP concentration, ranging from 10 – 25 µg/m^3, 7 day average. There is a seasonal trend, with concentrations being higher during the winter months. Historic monitoring since 1983 shows the maximum annual peak and annual average is declining. The DOH guideline has only been exceeded on one occasion since monitoring began.

At Penrose, there were no exceedances in the 2002 monitoring year. A portion of winter monitoring was missed due to equipment requiring repair. Concentrations ranged from 15 – 36 µg/m^3, and appear to be higher in the winter. Monitoring commenced at Penrose in 1964, and results are shown in Figure 6. Historic data shows a clear seasonal trend, with elevated concentrations occurring in winter. A significant decrease in ambient TSP occurred in the mid to late 1980's, and since that time both the average TSP and the peaks have typically been below guidelines.

TSP monitoring in 2002 at St Albans shows the typical distinct seasonal pattern for this site, with ambient TSP concentrations being elevated through the winter months, and the guideline being exceeded on three occasions. Monitoring commenced at this site in 1989, and the guideline is exceeded on several occasions every winter (Figure 7). Concentrations appeared to be lower than in 2001, but similar to the previous 4 years. Results suggest average winter TSP concentrations are similar from year to year

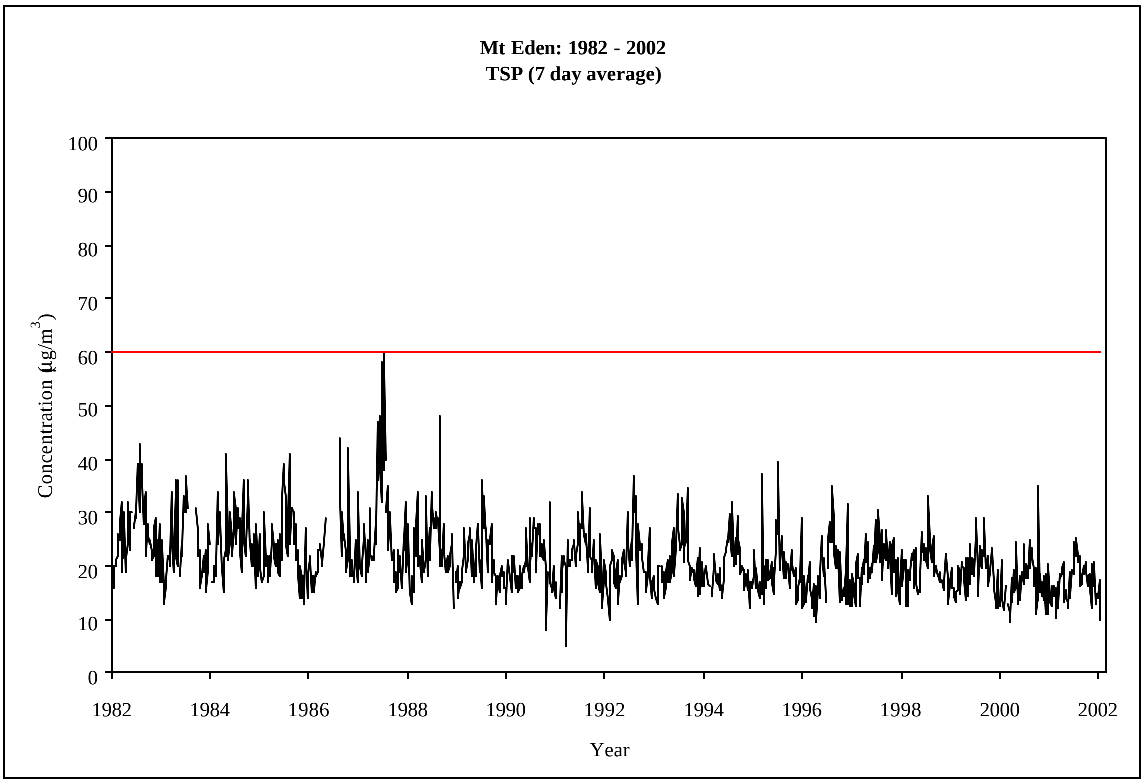

Figure 5: Mt Eden TSP, 7 day average 1983 - 2002

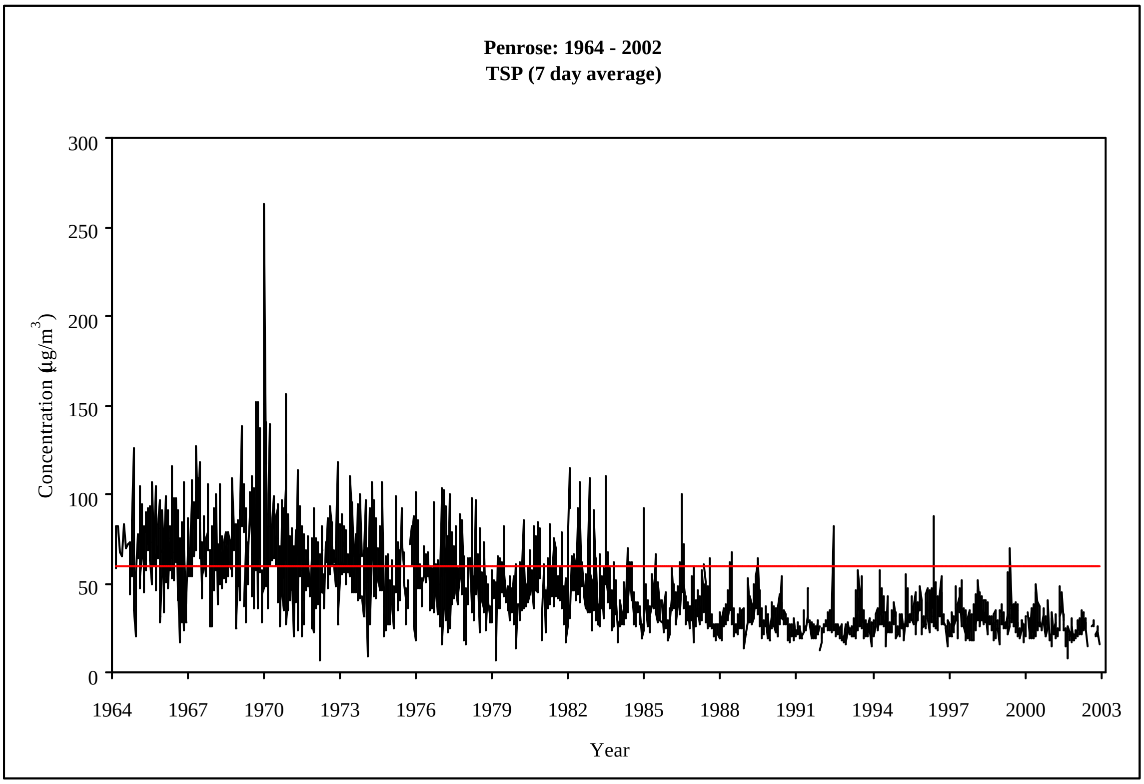

Figure 6: Penrose TSP, 7 day average 1964 – 2002

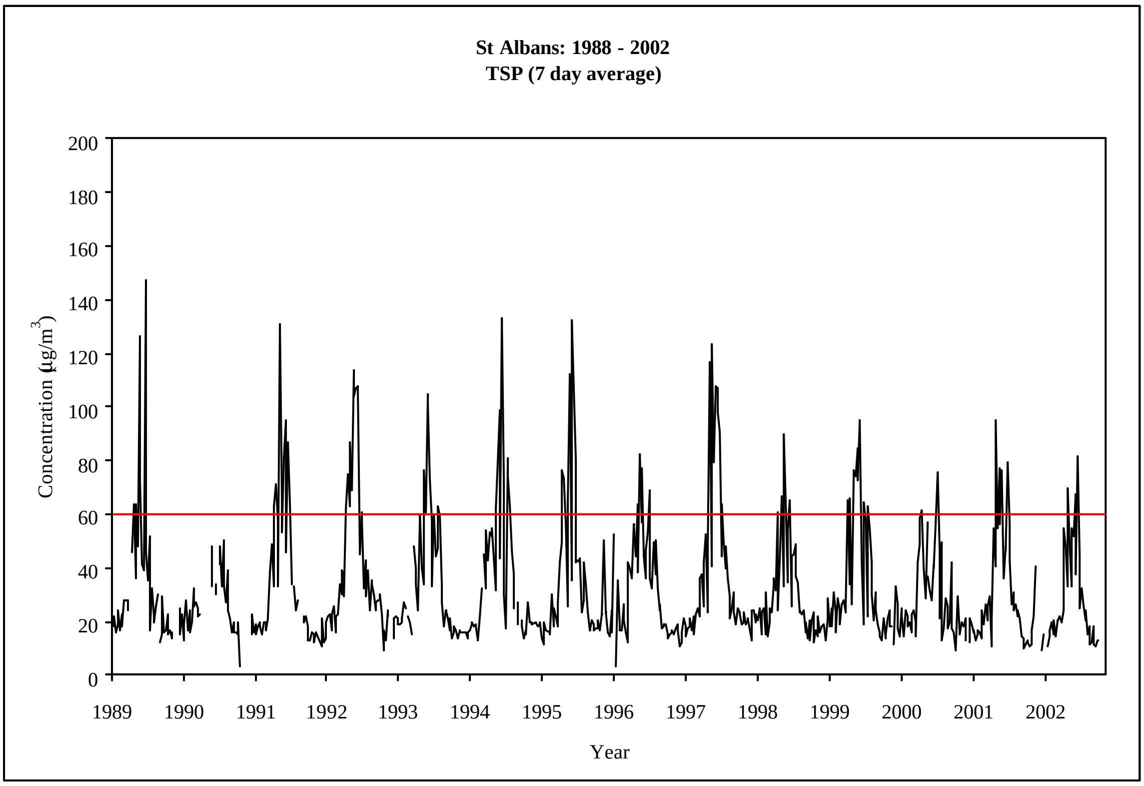

Figure 7: St Albans TSP, 7 Day average 1989 – 2002

6.3.2 Inhalable Particulate (PM_{10})

Only one site, St Albans, Christchurch, monitors ambient PM_{10}. Monitoring is undertaken using a Beta gauge. Particulate matter data for St Albans for January to December 2002 was obtained from Environment Canterbury's air monitoring site at Coles Place. Environment Canterbury use a TEOM to determine particulate, and a correction factor was applied to the TEOM data to compare it with the Beta gauge.

The Beta gauge malfunctioned in February 2001. The instrument manufacturer has ceased operation, and due to difficulty sourcing equipment and information the Beta gauge was not repaired until October 2001. It operated from October 2001 until June 2002, when another fault stopped operation. During the second repair, an operator fault was also was found. Following the June 2002 repair, Beta gauge results have correlated well with Environment Canterbury TEOM results. Beta gauge data prior to June 2002 has been invalidated, as it correlated very poorly with the Coles Place TEOM.

Results for St Albans terminated in November 2002, with the decommissioning of the Madras Street site. Data for 2003 will comprise of St Albans data from Environment Canterbury's site, and Burnside data from the MfE site.

Environment Canterbury provided PM_{10} data from its TEOM monitor at St Albans for the period Feb 2001 to Dec 2001, when the MfE Beta Gauge was out of operation. The following points are noted:

- Environment Canterbury calculates its 24 hour fixed average from 9am to 9 am. This is at variance with MfE reporting, which calculates the 24 hour fixed average from midnight to midnight. Therefore, Environment Canterbury provided 10 minute data, which was used to calculate the 24 hour average for the midnight to midnight period.

- The TEOM sampler is known to provide lower PM_{10} concentrations than other methods, due to the use of a heated air inlet. The data was adjusted to represent Beta Gauge results using the following equation, which was derived by Environment Canterbury from co-located equipment:

$$\text{Beta gauge} = 1.4 \times \text{TEOM} + 0.06$$

- Environment Canterbury uses a different averaging period (9am to 9am). Due to the difference in averaging times, and the use of a conversion factor from TEOM to Beta gauge results, the Environment Canterbury statistics and reported exceedances may differ from those reported here.

Table 6: Statistics for PM_{10} monitoring, 2002

	St Albans
Maximum ($\mu g/m^3$, 24 hour average)	216
99.5 percentile ($\mu g/m^3$, 24 hour average)	159
Number of Exceedances (>50 $\mu g/m^3$)	34

The results for 2002 are given shown in Figure 8, data for the last 5 years in Figure 9. The annual average data, for the earliest available data to 2002 is illustrated in Figure 10. Summary statistics for PM_{10}, calculated from reported data, are given in
Table 6. Exceedance dates and values are given in Table 7.

Ambient PM_{10} concentrations exceeded the MfE's ambient air quality guideline of 50 $\mu g/m^3$ on 34 occasions in 2002. Exceedances occurred between May and October.

Table 7: PM_{10} Exceedance of AAQG 2002

Exceedance Date	St Albans Exceedance Value ($\mu g/m^3$)
11/05/02	51
12/05/02	54
16/05/02	74
17/05/02	74
23/05/02	104
31/05/02	95
2/06/02	104
3/06/02	76
4/06/02	57
5/06/02	105
6/06/02	84
8/06/02	60
11/06/02	96
20/06/02	59
23/06/02	57
26/06/02	104
27/06/02	90
3/07/02	101
4/07/02	167
5/07/02	152
8/07/02	80
9/07/02	97
10/07/02	74
18/07/02	75
20/07/02	146
21/07/02	216
29/07/02	61
1/08/02	59
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23/08/02	55
15/10/02	55
17/10/02	50

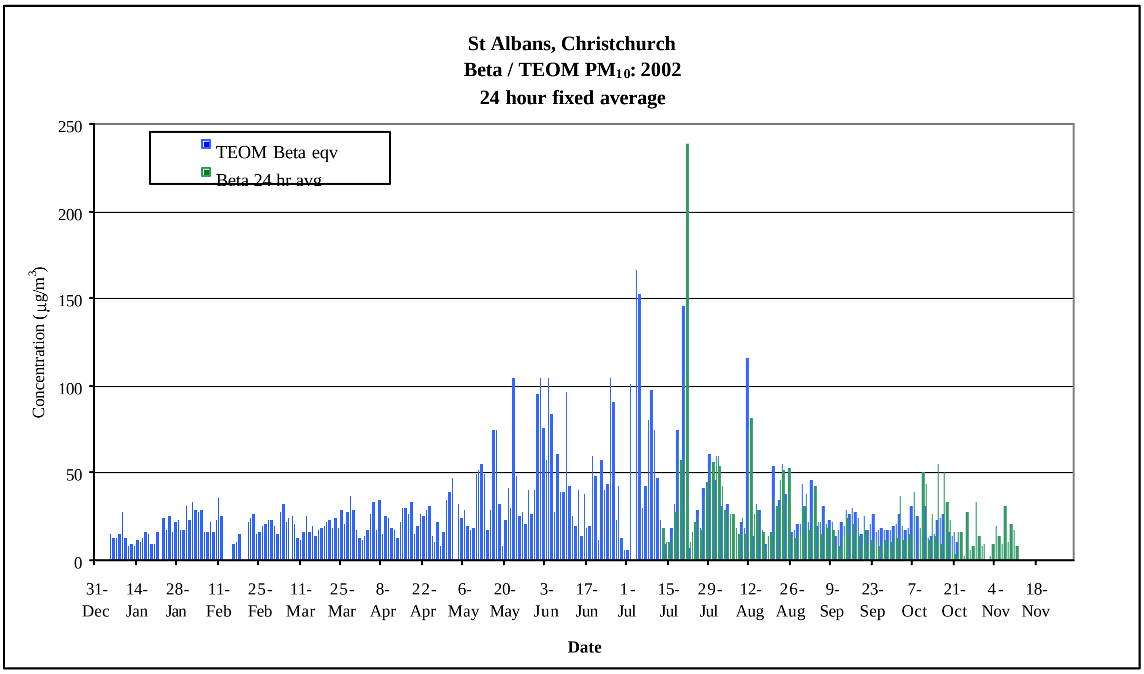

Figure 8: PM_{10} **24 hour average 2002 (St Albans only)**

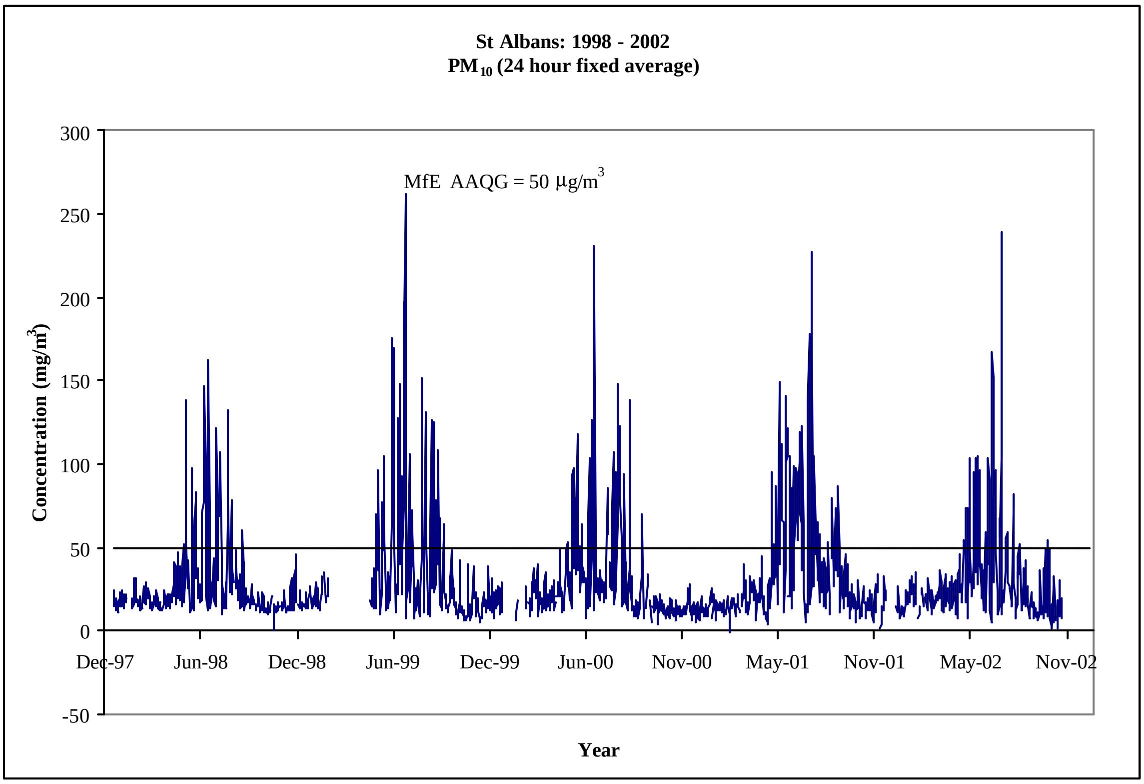

Figure 9: PM_{10} **24 hour average 1998 – 2002 (St Albans)**

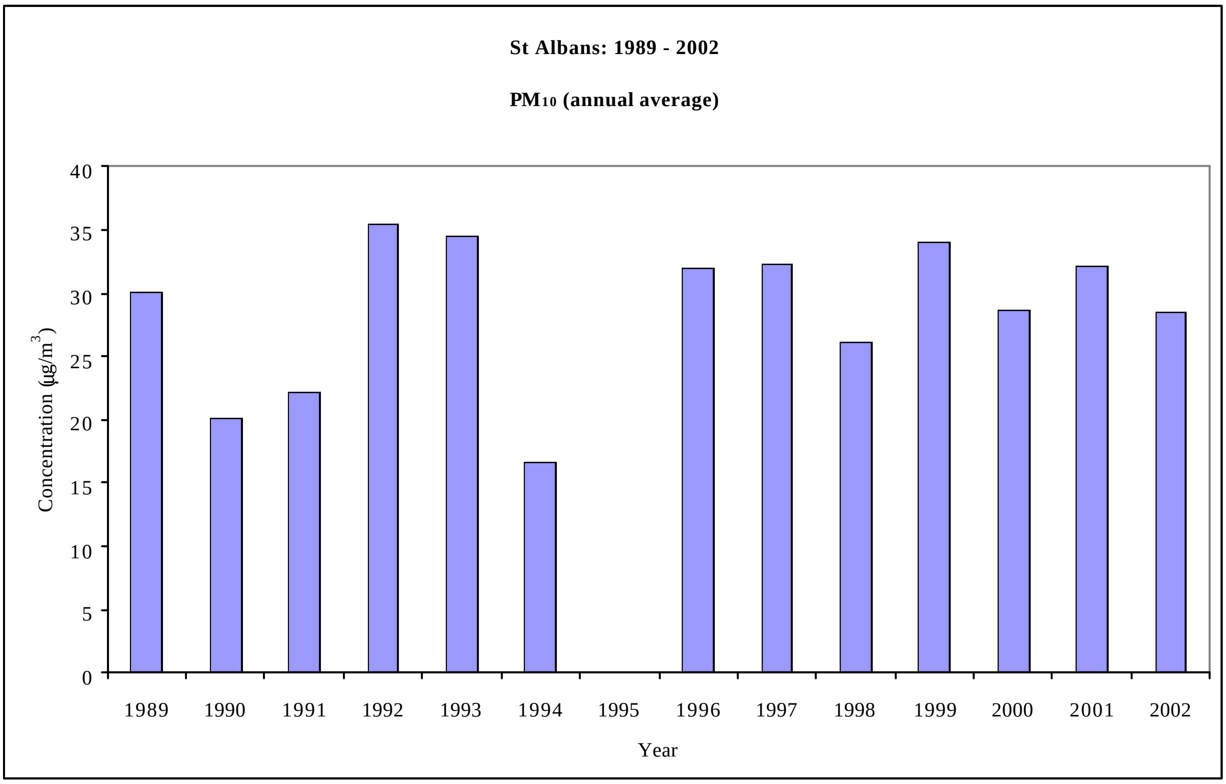

Figure 10: PM_{10} Annual Average from Commencement of Monitoring

6.4 Lead

Lead results are recorded as 1-month averages and presented as 3-month moving averages. The results for the last 5 years are shown in Figure 11. Summary statistics for lead monitoring are given in Table 6. The proposed AAQG is 0.2 g/m^3, 3 month average.

Ambient concentrations of lead have fallen steadily since the removal of lead from petrol in 1996. Contract requirements have changed and lead analysis is now only undertaken on winter samples as a 3-monthly average. The statistics in Table 8 are based on June to August 2002 data only.

Results for 2002 are comparable to earlier years. The existing AAQG of 0.5 µg/m^3 3 month average, and the proposed AAQG of 0.2 µg/m^3 3 month average, was not breached at any site on any occasion. Monthly and 3-monthly concentrations were very similar at all sites, 0.01 – 0.05 µg/m^3.

Table 8: Statistics for Lead Monitoring in 2002

6.4.1.1.1 Statistics for Lead Monitoring			
Site	**Maximum monthly average (µg/m³)**	**No. of Execeedences (>0.2 µg/m³)**	**Valid data (%)**
Mt Eden	0.023	Nil	100%
Penrose	0.009	Nil	20%
St Albans	0.061	Nil	100%

Note: Lead analysis is now only undertaken on winter samples as a 3-monthly average. The above statistics are based on June to August 2002 data only.

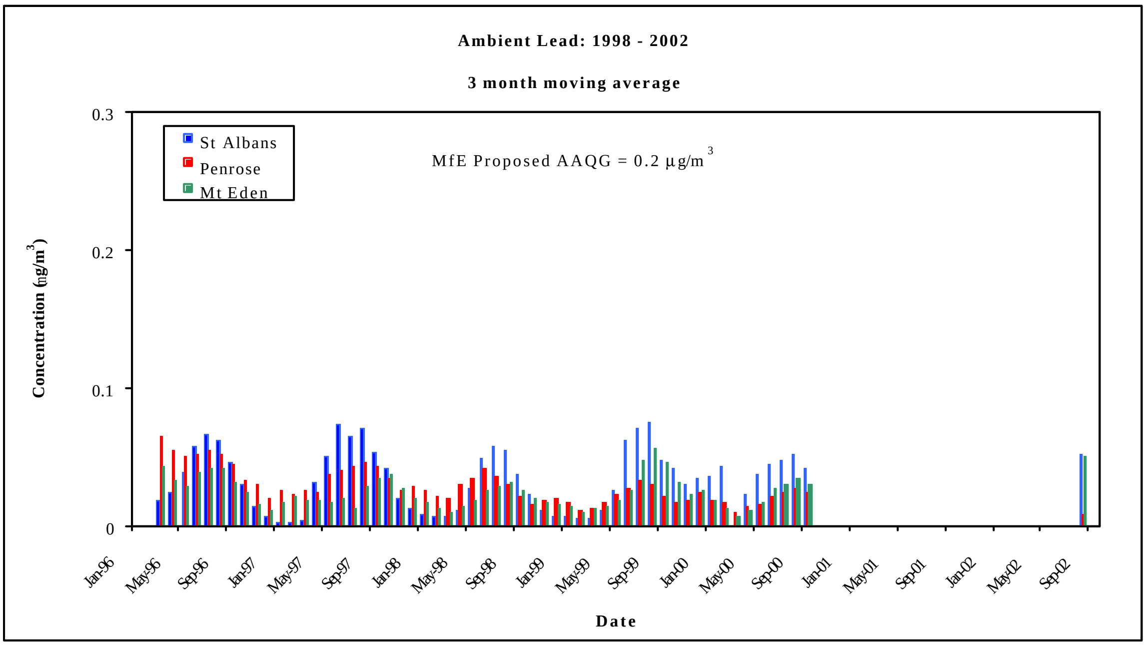

Figure 11: Lead 3-month moving average 1997 – 2002 (all sites)

6.5 Sulphur Dioxide

Current MfE AAQG has values for 1 hour and 24 hour SO_2 averages. The 1 hour AAQG is 350 µg/m³, and the 24 hour average is 120 µg/m³.

Summary results for SO_2 monitoring in 2002 are presented in Figure 12 (St Albans and Penrose 1 hour monthly maximum and average) and Figure 13 (St Albans and Penrose 24 hour monthly maximum and average). Full results for the year 2002 are presented in Appendix B. Monitoring at Penrose changed in January 2002 from wet chemistry to continuous instrumental monitoring. Therefore, results of historic 24 hour data at Penrose are not directly comparable to 2002 data.

Summary statistics are presented in Table 9.

Table 9: Summary Statistics for Sulphur Dioxide Monitoring in 2002

	Penrose	St Albans
Maximum (1 hr average)	48.0	72.5
99.9 %ile (1 hr average)	27.3	57.7
No. of Exceedances (>350 µg/m³)	Nil	Nil
Maximum (24 hr average)	14.7	34.1
99.5 %ile (24 hr average)	13.6	25.3
No of Exceedances (>120 µg/m³)	Nil	Nil

Guidelines were not exceeded at either St Albans or Penrose on any occasion. The maximum 1 hour and 24 hour concentrations were within the 'good' air quality range, according to EPI.

At St Albans, concentrations were slightly higher in winter. The maximum monthly 1 hour averages ranged from 7 – 72 µg/m³, and the 24 hour averages ranged from 4 – 34 µg/m³.

Penrose had slightly higher SO_2 concentrations than St Albans throughout the year. However, concentrations are still low relative to guidelines. The maximum monthly 1 hour averages ranged from 3 – 85 µg/m³, and the 24 hour averages ranged from 3 – 18 µg/m³. At both sites, there is some evidence of a seasonal trend, with concentrations being low in summer and higher in winter.

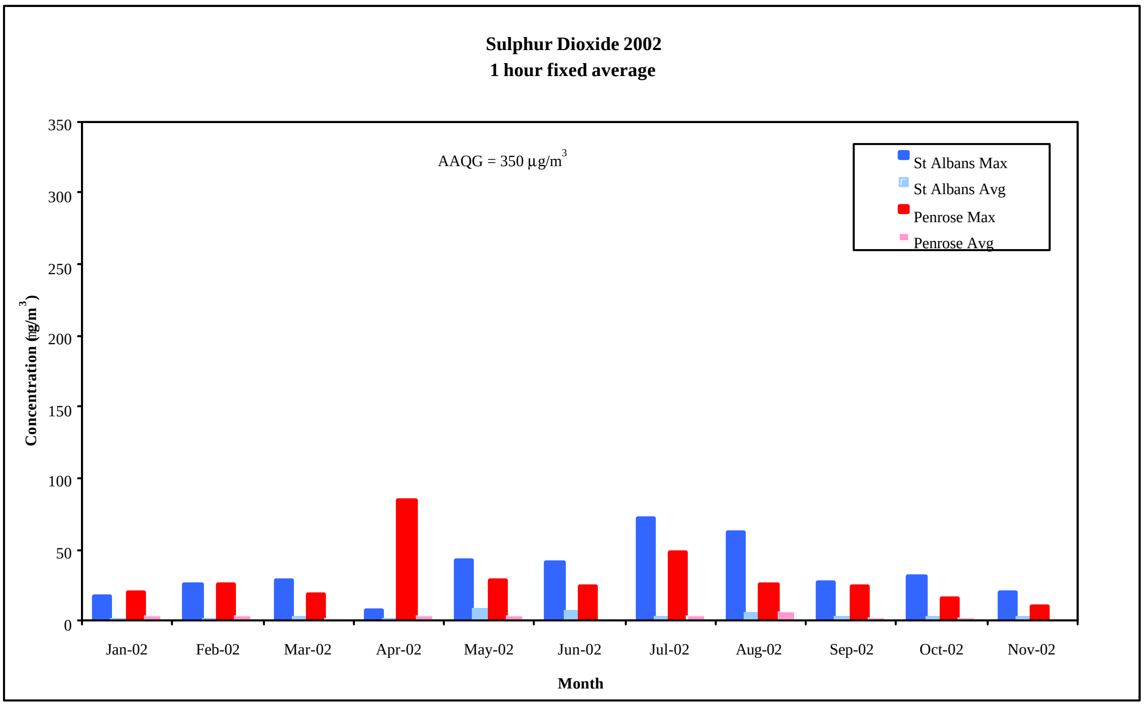

Figure 12: SO_2 monthly average and maximum values (1 hour average)

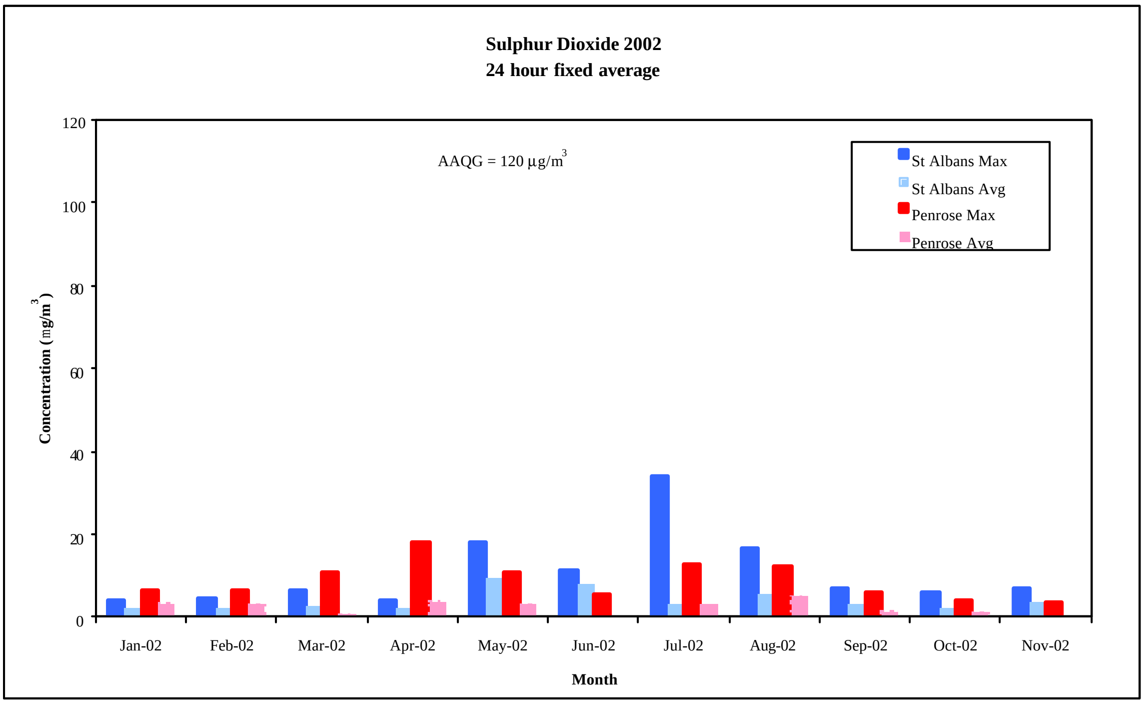

Figure 13: SO_2 monthly average and maximum values (24 hour average)

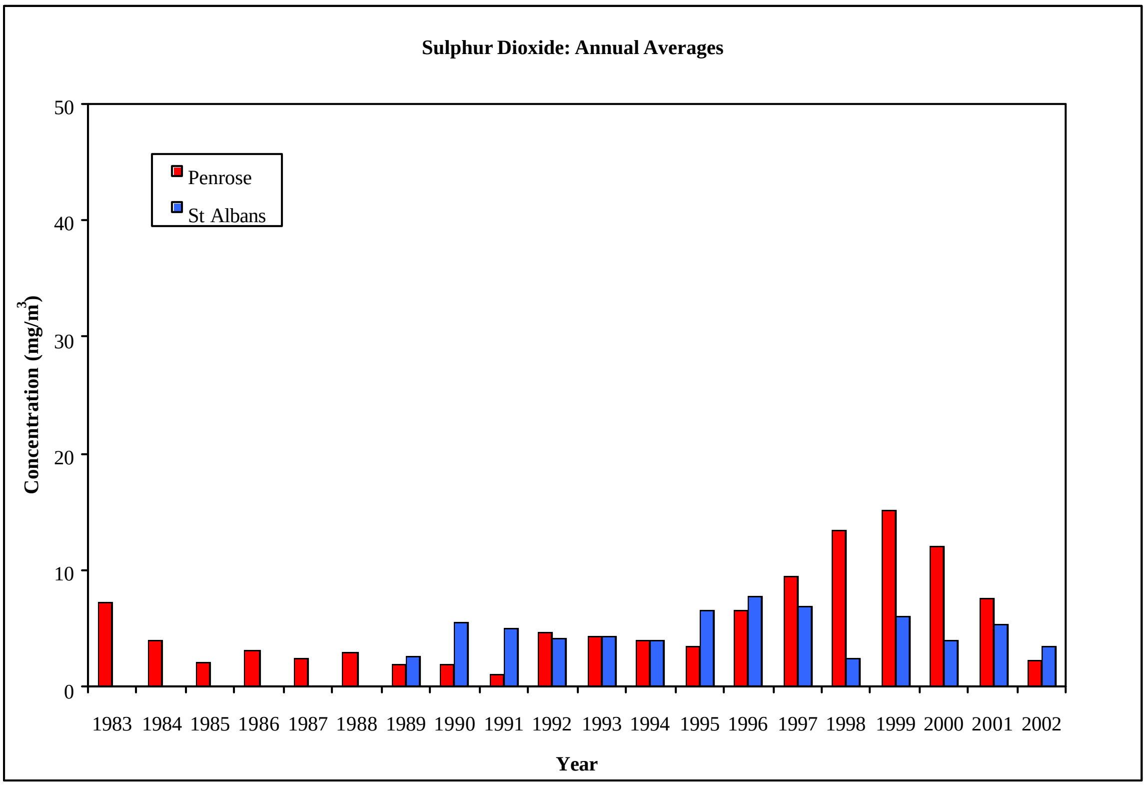

Figure 14: SO_2 annual average 1975 - 2002

6.6 Carbon Monoxide

CO is monitored at the St Albans site only. Carbon monoxide output from the continuous monitor is recorded as 10-minute averages. The 1-hour (fixed) averages have been calculated from this 10-minute data. The 8-hour moving averages have been calculated from the 1-hour averages. Summary statistics are presented in Table 10. The maximum and average monthly 1 hour averages for 2002 are given in Figure 15, and maximum and average monthly 8 hour averages are given in Figure 16. Full results for the period 1997 to 2002 are presented in Appendix C.

The MfE AAQG for CO, 1 hour average, was not exceeded at any time in the year 2002.

There were 27 exceedances of the 8 hour AAQG of 10 mg/m^3 in 2002 (Table 11). The maximum concentration for the year was 24 mg/m^3. In 2002, the number of breaches and frequency were relatively high compared to other years.

Ambient CO concentrations showed a seasonal trend, being higher from May to August. This trend is also apparent in earlier years.

Table 10: Summary Statistics for Carbon Monoxide Monitoring in 2002

	St Albans
Maximum (1 hr average)	24.4
99.9 %ile (1 hr average)	16.6
No. of Exceedances (>30 mg/m^3)	Nil
Maximum (8 hr average)	15.8
99.5 %ile (8 hr average)	14.6
No of Exceedances (>10 mg/m^3)	27*

* Number of exceedances is reported according to MfE Good Practice Guide, with each hour of exceedance recorded as an individual exceedance. Exceedances occurred on 3 days – refer Table below.

Table 11: CO (8 hr average) Exceedance of AAQG 2002

Date and Time	St Albans Exceedance Value (mg/m^3)
22/05/02 23:00	10.4
23/05/02 00:00	12.5
23/05/02 01:00	14.2
23/05/02 02:00	15.3
23/05/02 03:00	15.0
23/05/02 04:00	14.1
23/05/02 05:00	12.3
23/05/02 06:00	10.2
4/07/02 01:00	10.8
4/07/02 02:00	12.0
4/07/02 03:00	12.6
4/07/02 04:00	12.6
4/07/02 05:00	12.4
4/07/02 06:00	11.8
4/07/02 07:00	10.7
20/07/02 00:00	10.1
20/07/02 01:00	12.0
20/07/02 02:00	13.7
20/07/02 03:00	14.8
20/07/02 04:00	15.5
20/07/02 05:00	15.8
20/07/02 06:00	15.8
20/07/02 07:00	15.5
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20/07/02 09:00	13.3
20/07/02 10:00	11.7
20/07/02 11:00	10.4

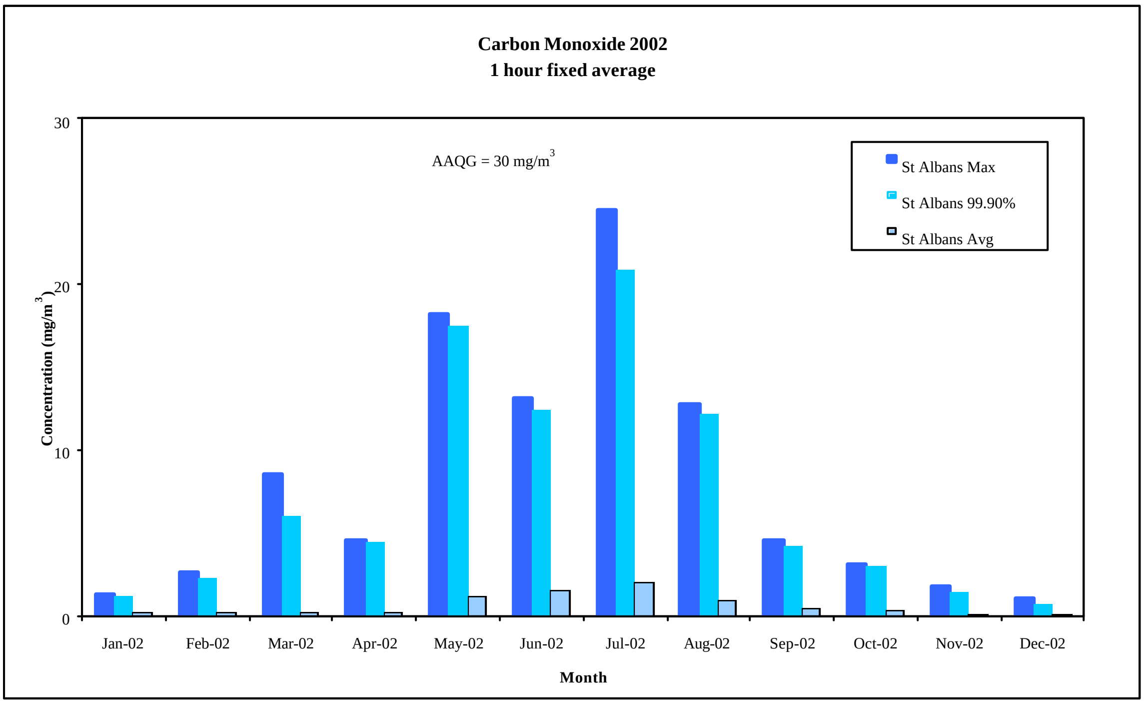

Figure 15: CO monthly average and maximums (1hr average) 2002

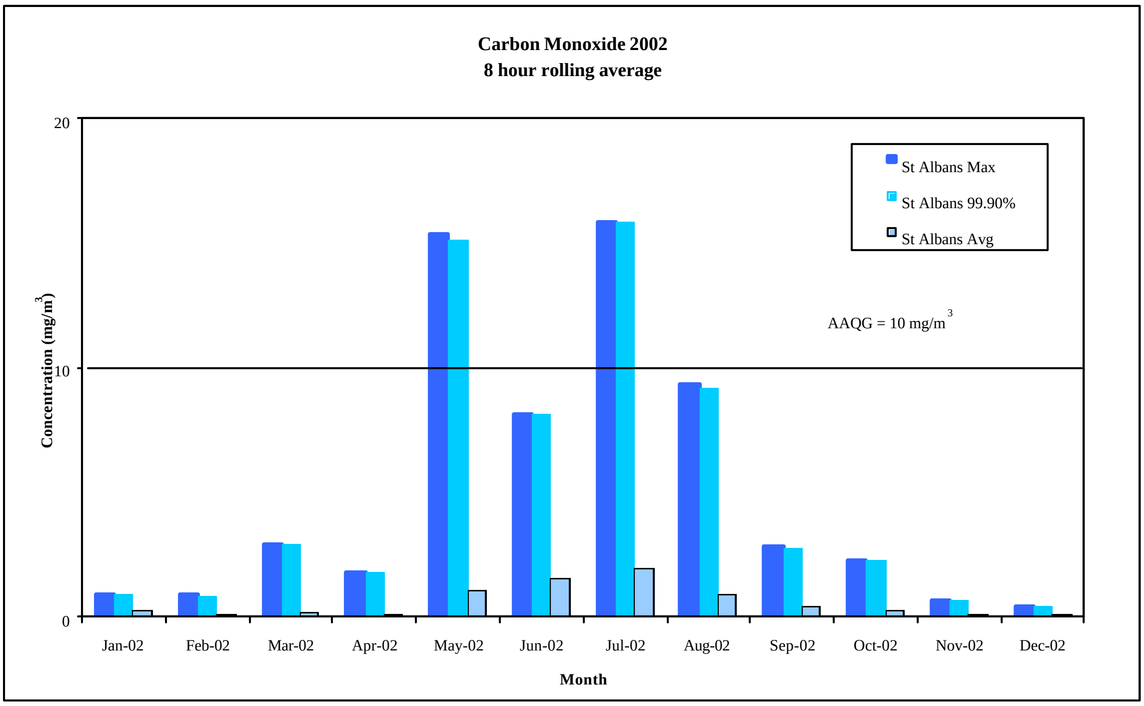

Figure 16: CO monthly average and maximums (8 hr average) 2002

6.7 Nitrogen Monoxide and Nitrogen Dioxide

Oxides of nitrogen are monitored at three sites. Output from the continuous monitors are recorded as 10-minute averages. The 1-hour and 24-hour averages for nitrogen dioxide and nitric oxide have been calculated from the 10 minute data.

Summary statistics for NO_2 for all sites, 1 hour and 24 hour averaging period, are given in Table 12. The maximum monthly NO_2 concentrations, 1 hour average, are presented in Figure 17. The maximum monthly NO_2 concentrations, 24 hour average, are presented in Figure 18. All nitrogen dioxide concentrations, 1 hour average and 24 hour average, since 1998, are presented in Appendix E.

Table 12: Summary Statistics for NOx Monitoring in 2002

	Mt Eden	Penrose	St Albans
Maximum (1 hr average)	74.1	123.9	117.0
99.9 %ile (1 hr average)	67.9	85.3	59.5
No. of Exceedances (>200 $\mu g/m^3$)	Nil	Nil	Nil
Maximum (24 hr average)	46.7	63.5	34.0
99.5 %ile (24 hr average)	44.3	61.3	31.9
No of Exceedances (>100 $\mu g/m^3$)	Nil	Nil	Nil

In 2002, there were no exceedances of ambient air quality guidelines for NO_2 at any sites.

The maximum value at Mt Eden was 74 $\mu g/m^3$, 1 hour average. This is 37% of the proposed AAQG (200 $\mu g/m^3$). Air quality with respect to NO_2 in Mt Eden on occasions is only acceptable, but most of the time is good to excellent, according to Ministry for the Environment's EPI's (Figure 1).

There is a slight seasonal pattern of NO_2 for Mt Eden, which is more evident in the 24 hour averages than in the 1 hour averages. Summer months appear to have slightly lower NO_2 concentrations, with higher concentrations in the winter months. This pattern is similar to other years.

Maximum values for 1997 and 1998 were in the order of 80 – 100 $\mu g/m^3$. In 1999 to 2002, maximum values have dropped to 70 – 80 $\mu g/m^3$. Whilst this is a reduction, it is considered to be too early to conclude a real downward trend is occurring. Given the small magnitude of the change and the relatively short time frame, the observed variability could be caused by variations in weather patterns.

The maximum value at Penrose in 2002 was 124 $\mu g/m^3$, 1 hour fixed average. Air quality at Penrose is in the good to acceptable category, according to Ministry for the Environment's EPI's (Figure 2). The seasonal pattern at Penrose distinctly shows higher concentrations in winter.

The maximum value St Albans was 117 $\mu g/m^3$, 1 hour average. There were major instrument problems at St Albans in 2002, and the apparently low concentrations through the winter months may be an artefact of instrument performance. However, review of instrument performance records does not indicate any basis on which data should be adjusted or invalidated. Concentrations are generally higher in winter at this site. Overall concentrations for 2002 are similar to 1998 - 2000, and are lower than 1997 and 2001.

Monitoring results over a 24 hour averaging period at all sites are more suggestive of a seasonal trend, with concentrations being lower over the summer (Figure 18). These results also show Penrose has the highest NO_2 concentrations. Averages over the last 5 years confirms that the summer concentrations are lower, but does not suggest any annual trend of concentrations increasing or decreasing over time.

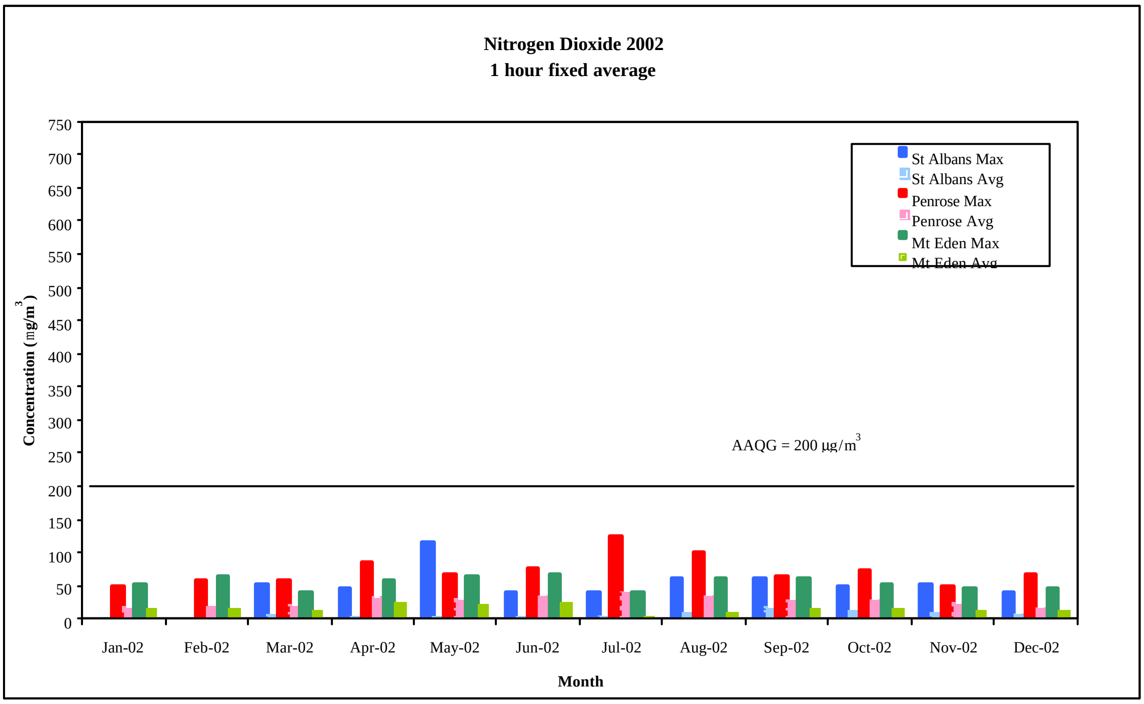

Figure 17: NO_2 monthly average and maximums (1 hr avg) 2002

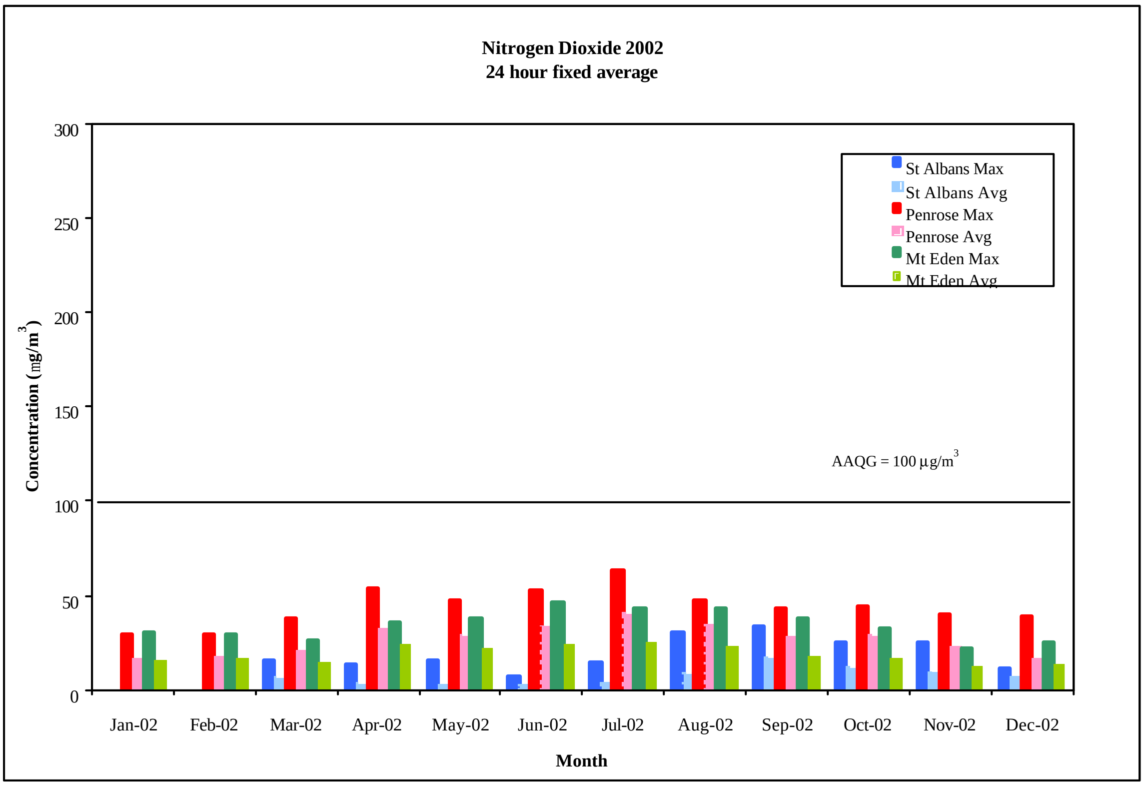

Figure 18: NO_2 monthly average and maximums (24 hr avg) 2002

6.7.1 Nitrogen Monoxide and Nitrogen Dioxide

The concentration of NO and NO_2 has been presented graphically for each site. One hour averages are presented in Figure 19 (Mt Eden), Figure 20 (Penrose) and Figure 21 (St Albans), and 24 hour averages are presented in Figure 22 (Mt Eden), Figure 23 (Penrose) and Figure 24 (St Albans).

Much of the NO and NO_2 in the atmosphere is produced from combustion processes. This can include internal combustion engines (vehicle engines), external combustion (stationary boilers and fuel burners) and home heating. Predominantly, NO is discharged (85 – 90% total NOx in discharge is NO), and is oxidised to NO_2 in the atmosphere. Therefore, the relative percentages of each species can provide an indication of the proximity of a monitoring station to the NOx source.

Total NOx and NO at all sites shows a consistent seasonal pattern, with there being significantly higher concentrations during the winter. This could be caused by a combination of increased space heating causing higher NOx emissions, and winter meteorology reducing dispersion.

At Mt Eden, most NOx is present as NO_2. This suggests that the point of emission is some distance from the monitoring site. In this predominantly residential area, the major source of ambient NOx is expected to be traffic emissions.

At Penrose, there is significantly more NO relative to NOx. Potential sources at this location are industrial boilers, and traffic emissions. It is suggested that if traffic were the major source, a concurrent increase in VOC could be expected. However, VOC concentrations at this site were not high relative to other sites (see Section 6.8). Therefore, it is likely that industrial emissions are the main source of NOx. High winter NO_2 concentrations indicate the effect of meteorology on ambient NOx concentrations.

At St Albans, there is significantly more NO relative to NO_2 in the winter months. St Albans is located in a residential area, but relatively close to major roads. The high winter NO concentrations may be affected by both winter meteorology, and by increased emissions from solid fuel domestic heating.

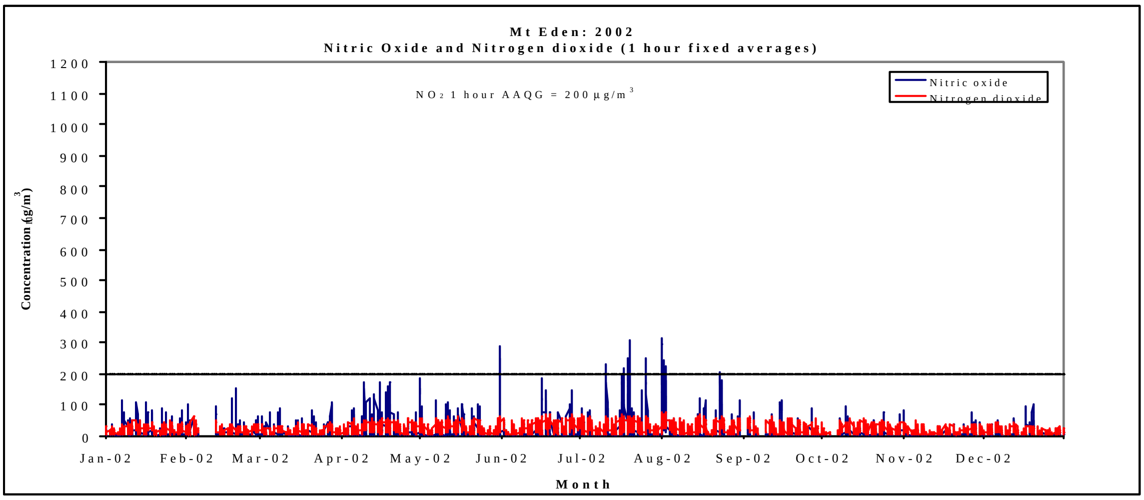

Figure 19: NO / NO_2 1 hour average 2002 at Mt Eden

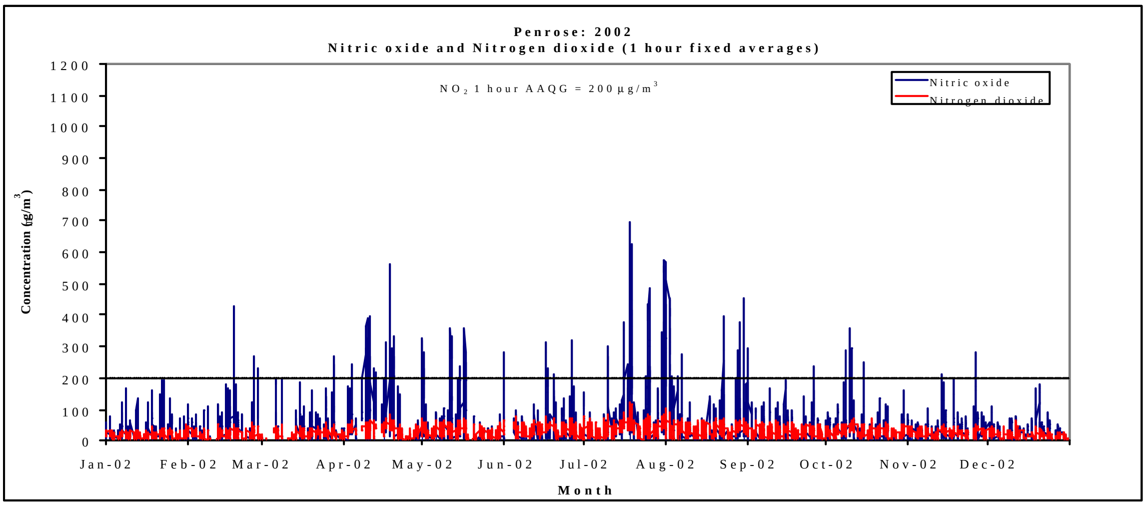

Figure 20: NO / NO_2 1 hour average 2002 at Penrose

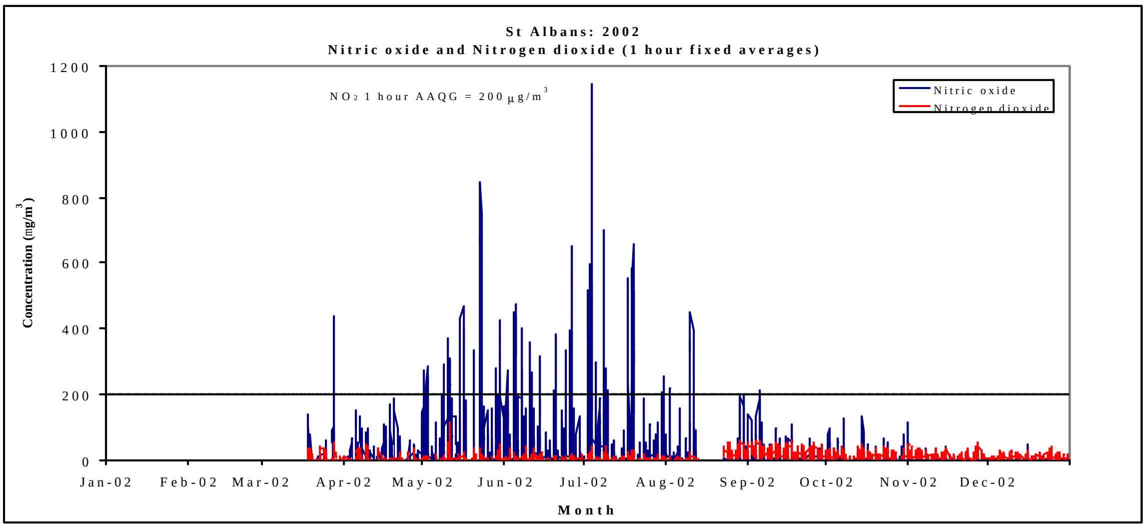

Figure 21: NO / NO_2 1 hour average 2002 at St Albans

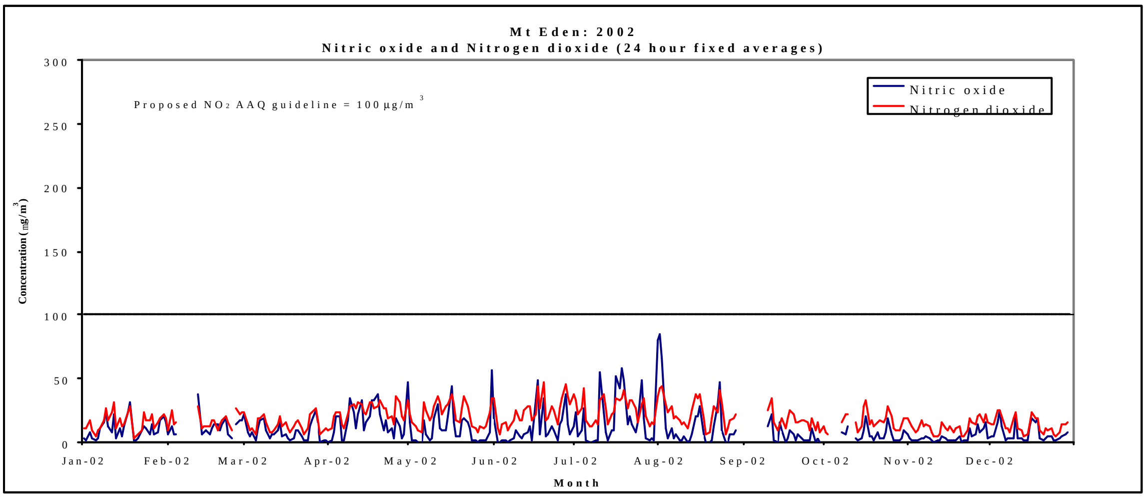

Figure 22: NO / NO_2 24 hour average 2002 at Mt Eden

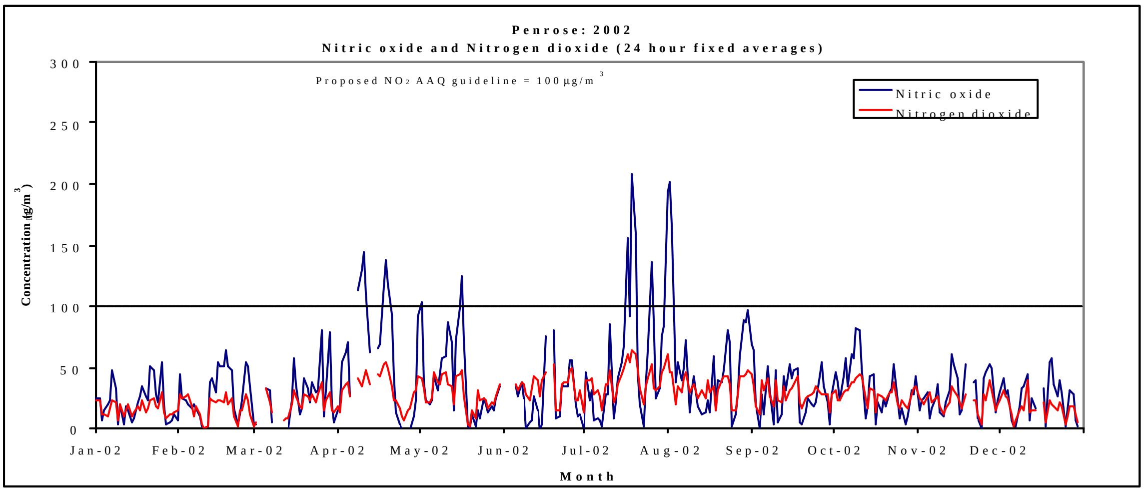

Figure 23: NO / NO_2 24 hour average 2002 at Penrose

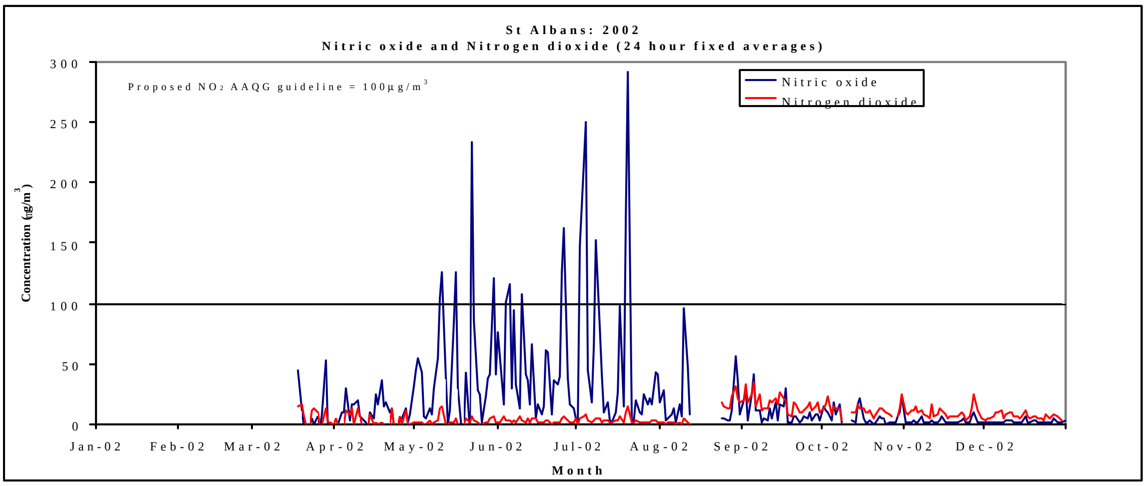

Figure 24: NO / NO_2 24 hour average 2002 at St Albans

6.8 Volatile Organic Compounds

Monitoring of VOC commenced on 01 April 2001. Passive badges were exposed for 3 month periods. The badges were analysed for a range of VOC, but only compounds which were detected in at least one sample were reported.

Of the VOC that can be collected on passive badges, only benzene is in the new AAQG. The results of monitoring of benzene is given in Figure 25. Full reports for each quarter are included in Appendix F, and laboratory analytical reports are in Appendix G.

Monitoring to date has shown that the highest concentration of benzene is generally at St Albans. However, in the Oct Nov Dec 2002 quarter, benzene monitoring was relocated to Burnside, and no benzene was detected. Benzene concentrations at St Albans were within the guideline of 10 µg/m^3 (annual average) proposed for the year 2000, but above the guideline of 3.6 µg/m^3 proposed for 2010. Benzene concentrations at both Penrose and Mt Eden were within both of the above guideline values.

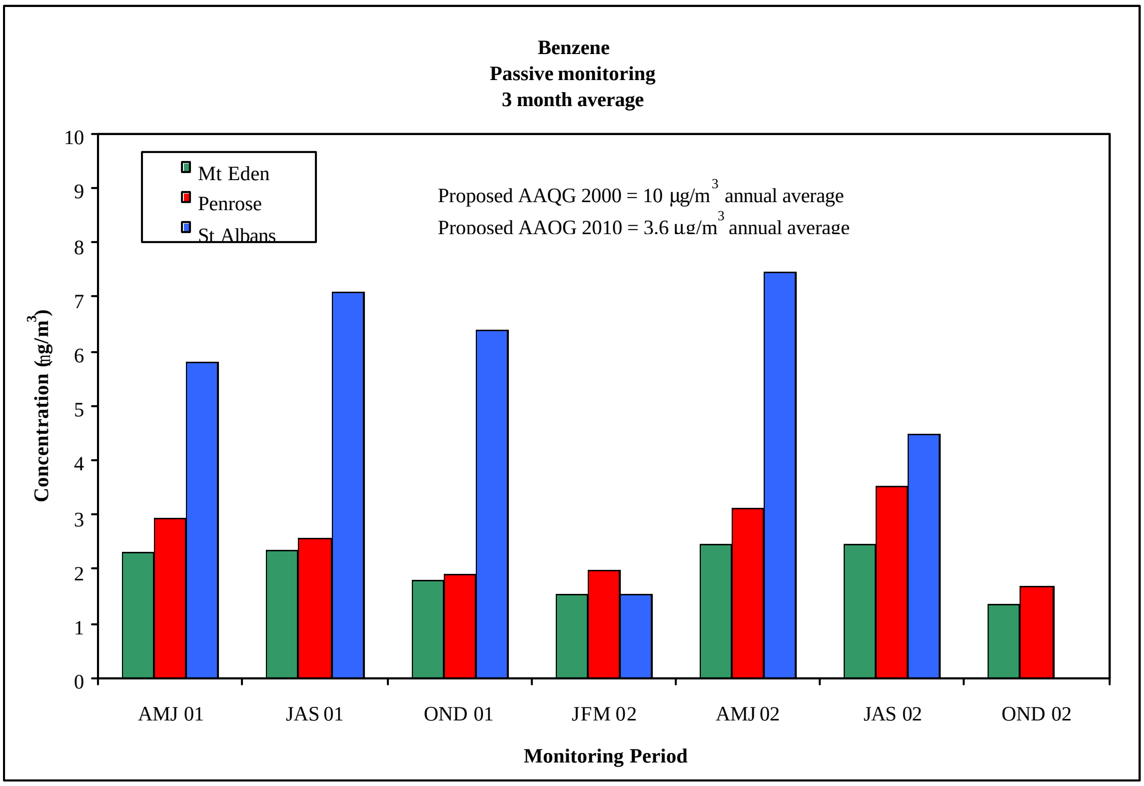

Figure 25: Benzene 3 month average 2002

7 REFERENCES

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