

Annual Air Quality Monitoring Report 1999

Report No. 00/78

**T Aberkane
Air Quality Officer**

December 2000

Report No. U00/78

58 Kilmore Street
P O Box 345
CHRISTCHURCH
Phone: (03) 365 3828
Fax: (03) 365 3194



75 Church Street
P O Box 550
TIMARU
Phone: (03) 688 9069
Fax: (03) 688 9067

Executive summary

Continuous ambient air quality monitoring is conducted at a number of sites in the Canterbury Region. In 1999 these sites included two in St Albans (Packer St and Coles PI), Hornby, Opawa and Sumner in Christchurch, a site in Timaru, a new site in Ashburton (replacing the 1998 site) and in Rangiora. The contaminants monitored at the sites included suspended particulate (i.e., particles in the air less than 10 microns in diameter and referred to as PM₁₀), carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and nitric oxide (NO). Meteorological conditions were also monitored at all sites by measuring wind speed, wind direction and temperature.

In Christchurch air pollution concentrations for all contaminants monitored are generally low during the spring, summer and early autumn months. However in late autumn and winter PM₁₀ and CO regularly exceed health guidelines because of poor dispersion of contaminants due to meteorological conditions, combined with increased emissions from domestic heating. Measured concentrations in 1999 are compared to health guidelines and previous monitoring data.

The guideline of 50 µgm⁻³ for suspended particulate (PM₁₀) was exceeded on 27 days at the St Albans Packer St monitoring site and on 31 days at the St Albans Coles PI monitoring site in 1999. At Sumner the PM₁₀ guideline was exceeded on 33 days during the period of monitoring from August to January. These were not at the same time as high pollution in the city.

Concentrations of PM₁₀ were slightly higher at Coles PI than at Packer St during the winter, but there was no significant difference in PM₁₀ concentrations between the two sites over the whole of 1999. Concentrations of NO₂ were higher at Coles PI compared to Packer St while CO, SO₂ and NO concentrations were lower.

Concentrations of PM₁₀ measured at Timaru were considerably lower than those measured at the St Albans monitoring sites. In Timaru the Environment Canterbury guideline for suspended particulate was exceeded on 32 days. In Ashburton and Rangiora PM₁₀ concentrations were lower than those measured in Christchurch and Timaru with guideline exceedences occurring on five days in Ashburton and four days in Rangiora.

The Ministry for the Environment guideline for eight hour average carbon monoxide concentrations was exceeded on 12 days at the St Albans Packer St monitoring site and on 10 days at the St Albans Coles PI monitoring site. No exceedences for carbon monoxide occurred at other sites.

Concentrations of SO₂ exceeded the ten minute average guideline on three occasions at the Hornby monitoring site in 1999. This was associated with problems at a nearby fertiliser production plant.

Concentrations of SO₂ measured at other sites and NO₂ in Christchurch were below guideline concentrations. At the Timaru monitoring site, maximum SO₂ concentrations were at approximately 60% of the guideline. At Opawa SO₂ concentrations showed little in the way of seasonal variation with maximum ten minute average concentrations at approximately 80% of the guideline in 1999. Maximum concentrations of SO₂ at Ashburton and Rangiora were at approximately 10 - 20% of the guideline.

Table of Contents

1	Introduction	9
1.1	Quality assurance	10
2	Christchurch results	11
2.1	Christchurch monitoring sites	11
2.2	Comparison to indicator categories	11
2.3	Seasonal variation of contaminants	11
2.4	Suspended particulate in Christchurch	14
2.5	Carbon monoxide in Christchurch	16
2.6	Sulphur dioxide in Christchurch	18
2.7	Nitrogen dioxide in Christchurch	20
3	Timaru results	22
3.1	Timaru monitoring sites	22
3.2	Comparison to indicator categories	22
3.3	Seasonal variation	23
3.4	Suspended particulate in Timaru	23
3.5	Carbon monoxide in Timaru	24
3.6	Sulphur dioxide in Timaru	25
4	Ashburton results	26
4.1	Ashburton monitoring sites	26
4.2	Comparison to indicator categories	26
4.3	Seasonal variation	26
4.4	Suspended particulate in Ashburton	27
4.5	Carbon monoxide in Ashburton	28
4.6	Sulphur dioxide in Ashburton	28
5	Rangiora results	29
5.1	Rangiora monitoring sites	29
5.2	Comparison to indicator categories	29
5.3	Seasonal variation	29
5.4	Suspended particulate in Rangiora	30
5.5	Carbon monoxide in Rangiora	31
5.6	Sulphur dioxide in Rangiora	31
6	Conclusions	32
7	References	32

List of Figures

Figure 1.1 Canterbury region with current air quality monitoring sites at the underlined towns.....	8
Figure 2.1 Location of Christchurch air quality monitoring sites.....	12
Figure 2.2 Comparison of monitored concentrations at Packe St in 1999 to indicator categories.....	13
Figure 2.3 Comparison of monitored concentrations at Coles Pl in 1999 to indicator categories.....	13
Figure 2.4 Comparison of monitored concentrations at Hornby in 1999 to indicator categories.....	13
Figure 2.5 Comparison of monitored concentrations at Opawa in 1999 to indicator categories.....	13
Figure 2.6 Comparison of monitored concentrations at Sumner in 1999 to indicator categories.....	13
Figure 2.7 Maximum 24 hour average PM ₁₀ concentration each month in Christchurch, 1999	14
Figure 2.8 24 hour average PM ₁₀ concentrations measured in Christchurch, winter 1999 ...	14
Figure 2.9 PM ₁₀ monitoring results for St Albans, 1988-1999	15
Figure 2.10 Variation of hour average concentrations over two days at the St Albans sites	16
Figure 2.11 24 hour average PM ₁₀ concentrations measured in Sumner and St Albans, 1999	16
Figure 2.12 Maximum eight hour average CO concentration each month in Christchurch, 1999	17
Figure 2.13 Daily maximum eight hour average CO concentrations in Christchurch, winter 1999.....	17
Figure 2.14 Daily maximum one hour average CO concentrations in Christchurch, winter 1999	17
Figure 2.15 CO monitoring results for St Albans, 1988-1999.....	18
Figure 2.16 Maximum 24 hour average SO ₂ concentration each month in Christchurch, 1999	19
Figure 2.17 Maximum 10 minute average SO ₂ in Christchurch 1988 – 1999	19
Figure 2.18 Maximum one hour average SO ₂ concentrations in Christchurch 1988 – 1999	19
Figure 2.19 Maximum 24 hour average SO ₂ concentrations in Christchurch 1988 - 1999 ...	19
Figure 2.20 Maximum one hour and 24 hour concentrations of NO ₂ each month at the St Albans sites in 1999.....	20
Figure 2.21 Maximum one hour concentrations of NO ₂ at the St Albans sites in 1999.....	20
Figure 2.22 Maximum one hour concentrations of NO at the St Albans sites in 1999	21
Figure 2.23 Annual maximum NO ₂ concentrations at the St Albans sites since 1988	21

List of Tables

Table 1.1	Summary of guidelines for ambient air quality.....	9
Table 1.2	Air quality categories used for indicators.....	9
Table 1.3	Parameters measured at ambient air quality sites in Canterbury, 1999.....	10
Table 1.4	Percentage of data available in 1999 for annual and winter periods (May to August)	10
Table 2.1	Summary of guideline exceedences for PM ₁₀ in Christchurch	14

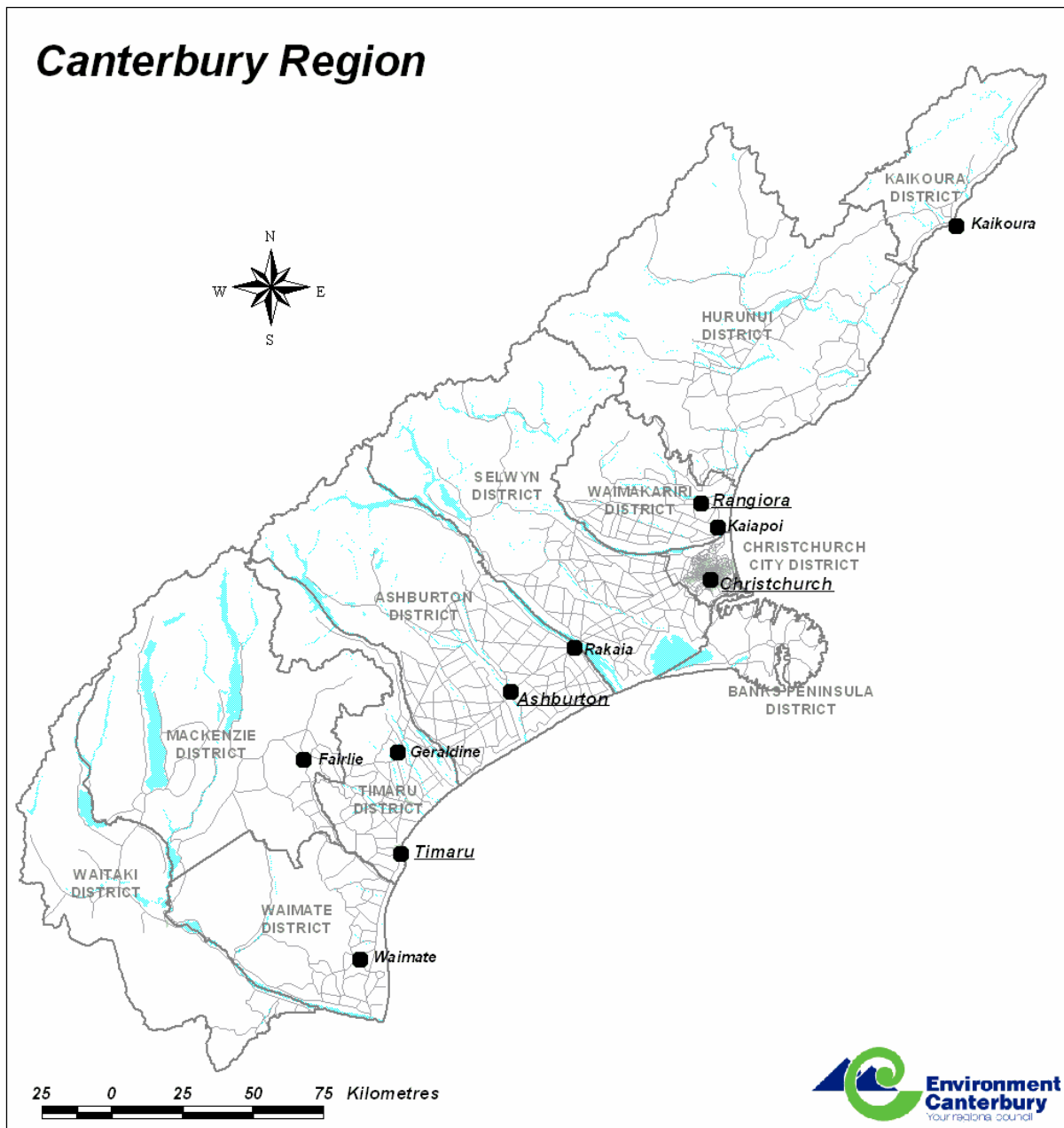


Figure 1.1 Canterbury region with current air quality monitoring sites at the underlined towns.

1 Introduction

This report details results from the ambient air quality monitoring sites in the Canterbury region for 1999. The locations of current and future monitoring sites in Canterbury are shown in figure 1.1.

The report provides a background to sites currently in operation in Christchurch, Timaru, Ashburton and Rangiora. It presents results for each contaminant at each site. Concentrations of these contaminants are compared to:

- health guidelines (table 1.1)
- categories defined by the Ministry for the Environment (table 1.2)
- monitoring data from earlier years.

The contaminants include suspended particulate (i.e., particles in the air less than 10 microns in diameter and referred to as PM₁₀), carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and

nitric oxide (NO). The monitoring sites and the contaminants and meteorological parameters measured at each are listed in table 1.3.

Hazardous pollutants have also been monitored in Christchurch and these results are the focus of other reports. The results of benzene monitoring were reported in a "Survey of benzene and other toxic organic compounds in air: July 1996 – May 1999". Monitoring for dioxins was included in a national organochlorines monitoring programme carried out by the Ministry for the Environment from June 1996 to March 1997 – "Organochlorines in New Zealand". A monitoring programme for polycyclic aromatic hydrocarbons (PAH) was conducted by Environment Canterbury between June 1999 and June 2000. A report on the results of this monitoring is in preparation. The results of monitoring for all the above contaminants indicate elevated concentrations during the winter months.

Table 1.1 Summary of guidelines for ambient air quality

	Averaging period	Concentration	Source
Particulates (PM ₁₀)	24 hour	50 µgm ⁻³	Canterbury Regional Council, 1996 * Ministry for the Environment, 1994
	Annual	40 µgm ⁻³	
Sulphur dioxide (SO ₂)	10 min	500 µgm ⁻³	Ministry for the Environment, 1994
	1 hour	350 µgm ⁻³	
	24 hour	125 µgm ⁻³	
	Annual	50 µgm ⁻³	
Carbon monoxide (CO)	1 hour	30 mgm ⁻³	Ministry for the Environment, 1994
	8 hour	10 mgm ⁻³	
Nitrogen dioxide (NO ₂)	1 hour	300 µgm ⁻³	Ministry for the Environment, 1994
	24 hour	100 µgm ⁻³	

mg = milligrams, i.e. grams/10³

µg = micrograms, i.e. grams/10⁶

*In March 1996 the CRC adopted a monitoring and reporting guideline for PM₁₀ of 50 µgm⁻³.

Table 1.2 Air quality categories used for indicators (Ministry for the Environment, 1997)

Category	Maximum measured value	Comment
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
Good	between 10% and 33% of the guideline	peak measurements in this range are unlikely to impact air quality
Acceptable	between 33% and 66% of the guideline	a broad category, where maximum values might be of concern in some sensitive locations but generally at a level which does not warrant dramatic action
Alert	between 66% and 100% of the guideline	a warning level, which can lead to exceedences if trends are not curbed
Action	more than 100% of the guideline	exceedences of the guideline are a cause for concern and warrant action if they occur on a regular basis

Annual Air Quality Monitoring Report, 1999

Table 1.3 Parameters measured at ambient air quality sites in Canterbury, 1999

Parameters measured	Ashburton	Hornby	Opawa	Rangiora	St Albans Packe St	St Albans Coles PI	Sumner	Timaru
PM ₁₀	✓		✓	✓	✓	✓	✓	✓
SO ₂	✓	✓	✓	✓	✓	✓		✓
CO	✓	✓		✓	✓	✓		✓
NO ₂					✓	✓		
NO					✓	✓		
Wind speed	@6m	@6m	@6m	@6m	@10m	@10m	@6m	@6m
Wind direction	@6m	@6m	@6m	@6m	@10m	@10m	@6m	@6m
Temperature	@ 3m		@ 3m	@ 3m	@1m & @10m	@1m & @10m	@ 3m	@ 3m
Relative humidity					@10m	@10m		
Light scattering					✓			

Table 1.4 Percentage of data available in 1999 for annual and winter periods (May to August)

		Ashburton	Hornby	Opawa	Rangiora	St Albans Coles PI	St Albans Packe St	Sumner	Timaru
PM ₁₀	Annual	98%	-	47%	85%	99%	97%	49%	99%
	Winter	100%	-	49%	100%	99%	99%	46%	99%
SO ₂	Annual	67%	97%	48%	91%	83%	93%	-	98%
	Winter	33%	97%	47%	97%	56%	97%	-	98%
CO	Annual	83%	96%	-	84%	87%	98%	-	83%
	Winter	67%	89%	-	67%	84%	99%	-	63%
NO ₂	Annual	-	-	-	-	88%	89%	-	-
	Winter	-	-	-	-	96%	92%	-	-

1.1 Quality assurance

All monitoring sites, except St Albans Packe St, were operated by Environment Canterbury in 1999. Operation includes maintenance of the site, calibration of monitoring equipment and provision of quality assured data. Sites were operated in accordance with procedures specified in Environment Canterbury's Quality Assurance Procedures Manual for Ambient Air Quality Monitoring¹.

The manual states that "site operation and office procedures shall be conducted to minimise data loss. A minimum requirement of 95% of the total possible number of observations for each parameter measured over a year is desirable, in particular for the winter months." Data must also be credible and long periods of data may be deleted after prolonged fault finding.

Data loss has occurred in 1999 because of instrument malfunction. All CO analysers operated by Environment Canterbury have had different faults in 1999, mostly during

¹This manual is available on the air quality page of Environment Canterbury's website at www.ecan.govt.nz under "What we do"

the winter months. Valves clogged by particulate have been a problem for SO₂ analysers in the monitoring sites at St Albans Coles PI and at Ashburton. The air conditioner failed at Rangiora in February resulting in some loss of data for all instruments and a fault developed in the instrument measuring particulate at this site, requiring a replacement part.

The Opawa monitoring site was in operation for half the year only and was then moved to Sumner for the second half of the year. Monitoring of PM₁₀ was not conducted at the Hornby monitoring site in 1999.

Overall, the percentage of data available, compared to the total possible number of observations for each parameter at each site, is indicated in table 1.4, for all of 1999 and for the critical winter months, May to August. Where greater than 25% of data over the year is lost, no calculation of a representative average value for that year can be made.

The St Albans Packe St monitoring site was operated by the Institute of Environmental Science and Research Limited (ESR) in 1999, on behalf of the Ministry for the Environment. Data were supplied on a

monthly basis and averaging performed according to Environment Canterbury standards. Environment Canterbury also had direct access to raw data on a daily basis via modem.

With changing management of the St Albans Packe St site over the years, quality of the data is not consistent. For the years from 1988 to 1993 little is known of the instruments used and the maintenance and calibrations performed. Data from this period are reported, but care should be taken in drawing conclusions from them.

2 Christchurch results

2.1 Christchurch monitoring sites

Christchurch's primary air quality monitoring site is located in St Albans. This site was established by the former Department of Health in 1988. The Ministry of Health continued to operate this monitoring site as part of its contribution to an international air quality monitoring programme Global Environmental Monitoring Systems (GEMS). In 1999 the Ministry for the Environment took over this responsibility.

The land this site is on is being redeveloped. In anticipation of the change in land use Environment Canterbury established a similar site in St Albans in 1998 about one kilometre from the historical site. A comparison is made in this report of data measured at the historic site (Packe St) and at the new site (Coles PI).

Monitoring sites were established in 1995 in the residential areas of Hornby (at the South Hornby School) and Beckenham (at the Christchurch City Council Service Centre). Use of the Beckenham site was discontinued in March 1997. In July 1996 a monitoring site was established at Opawa in a residential area (Mary McLean Place), adjacent to a large industrial area. This site was discontinued in June 1999. An investigation into air pollution in Sumner was undertaken between July 1999 and January 2000. The location of these sites is shown in figure 2.1.

2.2 Comparison to indicator categories

Figures 2.2 to 2.6 show how monitoring at the Christchurch sites in 1999 compare to indicator categories. These figures represent concentrations over the entire

year, except for those at the Opawa and Sumner monitoring sites. For most contaminants concentrations are excellent or good, being less than 33% of the guidelines. Suspended particulate concentrations reached the action category at all sites where it was measured. The maximum eight hour CO concentrations at the St Albans monitoring sites are in this category also.

2.3 Seasonal variation of contaminants

Over a year most contaminants at Canterbury sites show a seasonal variation with maximum concentrations measured in the winter and minimum concentrations in the summer. During winter meteorological conditions are such that dispersion of contaminants is frequently poor compared to other seasons. Emissions from the domestic home heating sector also increase during this period. The combined effect of the additional emissions and poor dispersion is an increase in contaminant concentrations during the winter.

The frequency and extent of high pollution episodes during the winter are largely dependent on weather patterns during these months. Elevated pollution concentrations are generally associated with still and frosty nights as the temperature inversion, which occurs under these conditions, restricts the dispersion of contaminants.

In 1999 the months of May, June and the first part of July were warmer and sunnier than average for these months in Christchurch². Clear sunny days were frequently followed by polluted nights and the number of polluted nights was about average for a Christchurch winter. July weather was cloudier with more rainfall than normal and high concentrations of air pollution did not occur in these conditions. August 1999 was average with respect to weather and air pollution for this time of year. The sequence of southerlies followed by clear weather continued through into September with high air pollution concentrations through until September 4, 1999. The fluctuation shown in the figures that follow are a reflection of these weather patterns.

² Weather information from *Meteorological Society of New Zealand Newsletter Nos 77-78*

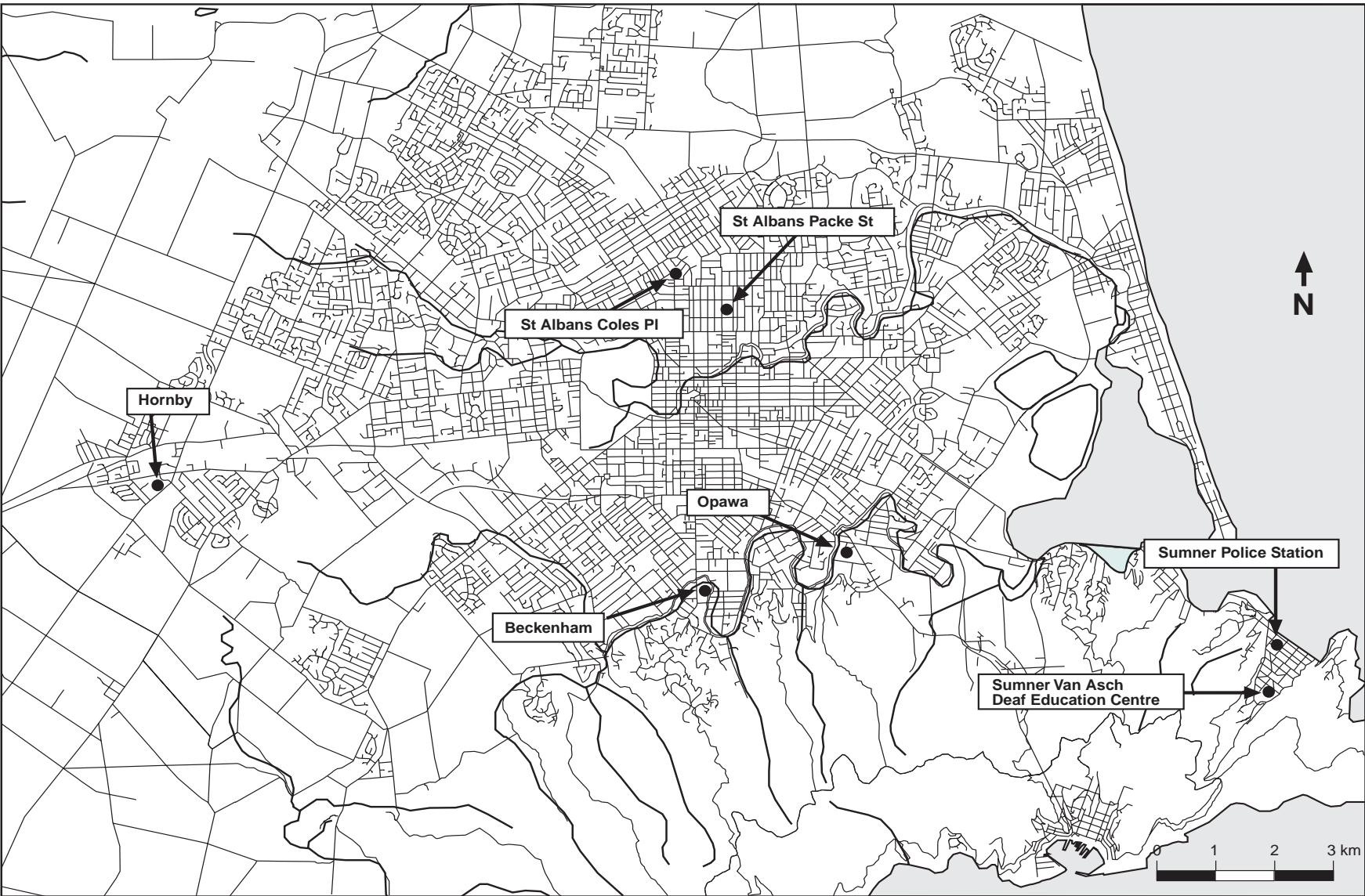


Figure 2.1 Location of Christchurch air quality monitoring sites

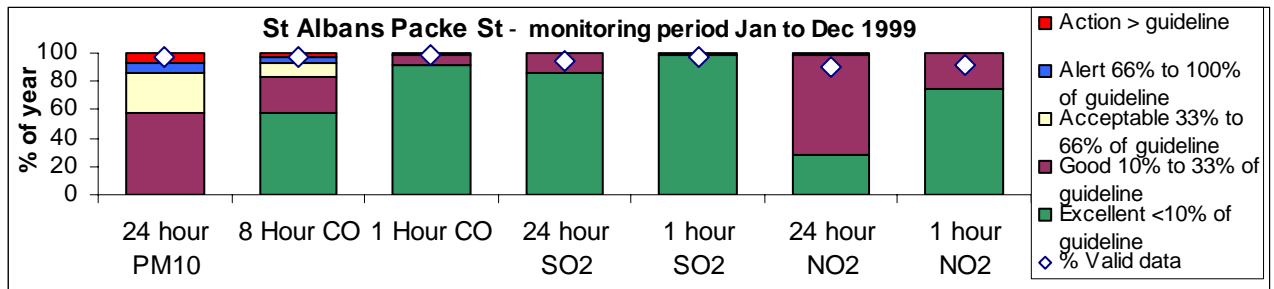


Figure 2.2 Comparison of monitored concentrations at Packe St in 1999 to indicator categories

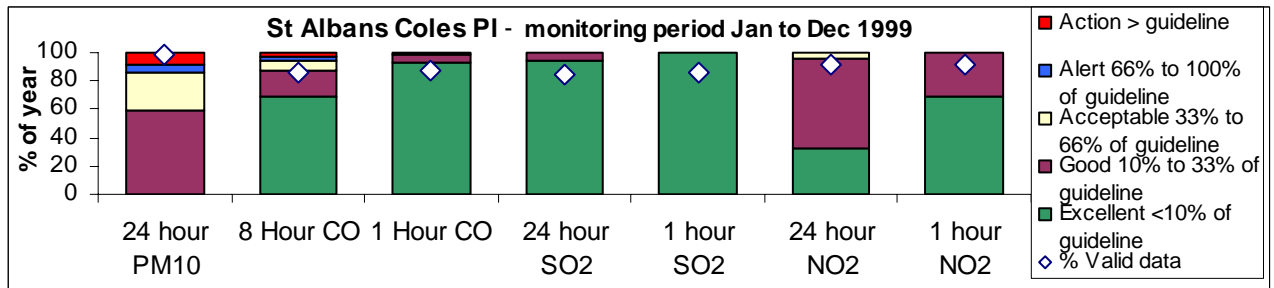


Figure 2.3 Comparison of monitored concentrations at Coles PI in 1999 to indicator categories

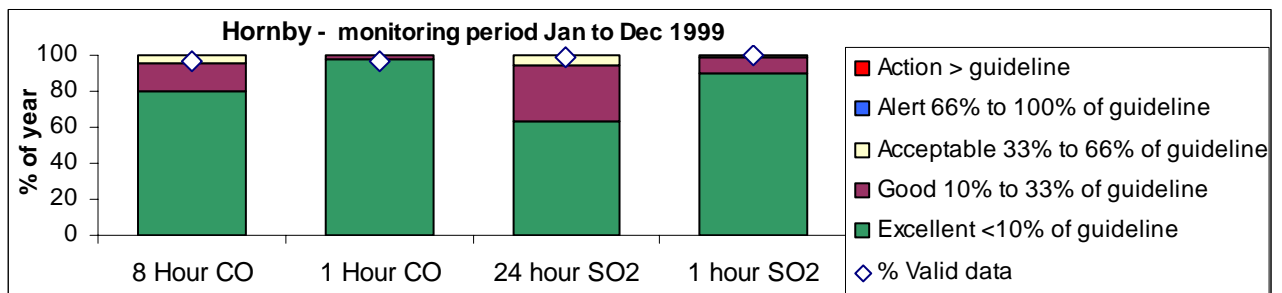


Figure 2.4 Comparison of monitored concentrations at Hornby in 1999 to indicator categories

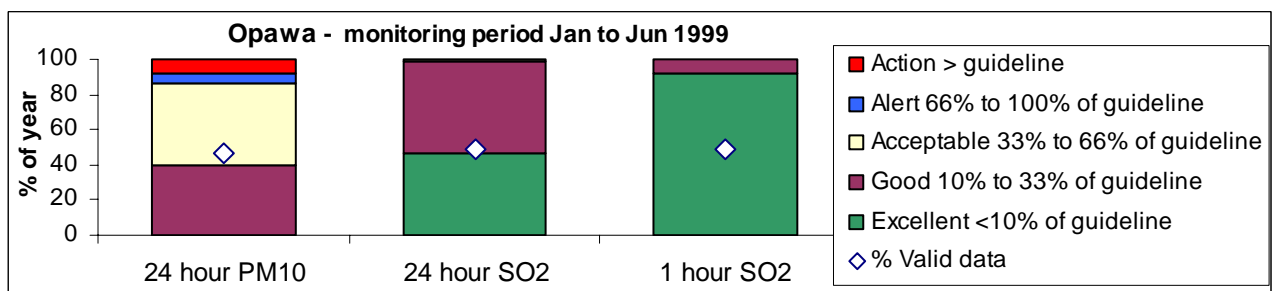


Figure 2.5 Comparison of monitored concentrations at Opawa in 1999 to indicator categories

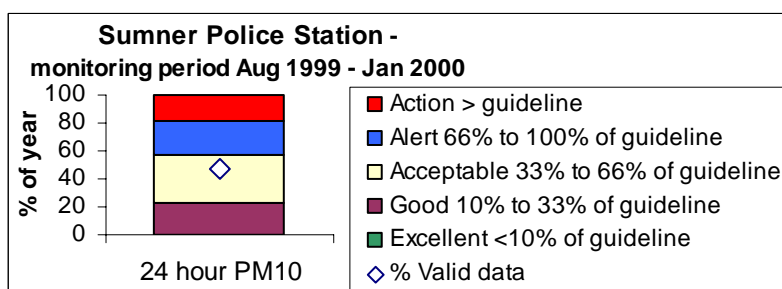


Figure 2.6 Comparison of monitored concentrations at Sumner in 1999 to indicator categories

2.4 Suspended particulate in Christchurch

The maximum 24 hour average PM₁₀ measured each month in 1999, is shown in figure 2.7. The variation over the year is indicated in this figure with highest concentrations for most sites during the winter months. The daily results of monitoring during the winter at the St Albans Packe St, St Albans Coles PI and Opawa monitoring sites are illustrated in figure 2.8 which also shows the Environment Canterbury guideline of 50 µgm⁻³ for 24 hour average PM₁₀ concentrations. The number of exceedences of the Environment Canterbury guideline at these sites each month is summarised in table 2.1. The total number of days of exceedences at Packe St was 27 days and at Coles PI 31 days. For the period of monitoring at Sumner there were a total of 33 days exceeding the guideline.

On most days of guideline exceedences the levels recorded at the St Albans monitoring sites were about 30 to 50% higher than those recorded at the Opawa site. Variations in emissions, proximity to sources and different meteorological conditions could account for the variation between these sites.

The days when PM₁₀ concentrations exceeded the guideline at the St Albans sites were spread over the winter months from May to September. Figure 2.8 shows how close the concentrations were on a particular day. Concentrations at Coles PI were slightly higher than those at Packe St about two thirds of the time. There were four days when this difference resulted in a guideline exceedence at Coles PI, but not at Packe St. The maximum PM₁₀ concentration at Coles PI occurred in June and the maximum at Packe St occurred in July.

A Wilcoxon signed rank test performed on the data over the entire year for the two St Albans sites indicates there was no difference between daily PM₁₀ concentrations. However when the data are limited to the winter period there was a significant difference; 98% of this is explained by the regression equation:

$$y = 1.02x + 1.31 \quad r^2 = 0.98$$

where y = daily PM₁₀ from 9am at Coles PI and x = daily PM₁₀ from 9am at Packe St.

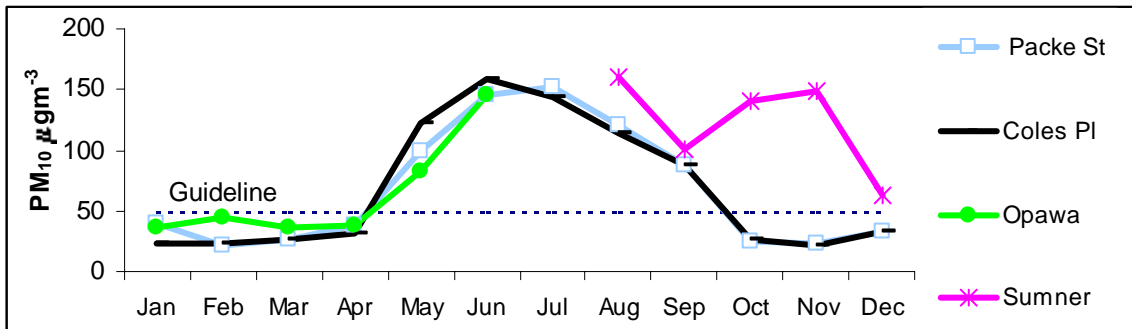


Figure 2.7 Maximum 24 hour average PM₁₀ concentration each month in Christchurch, 1999

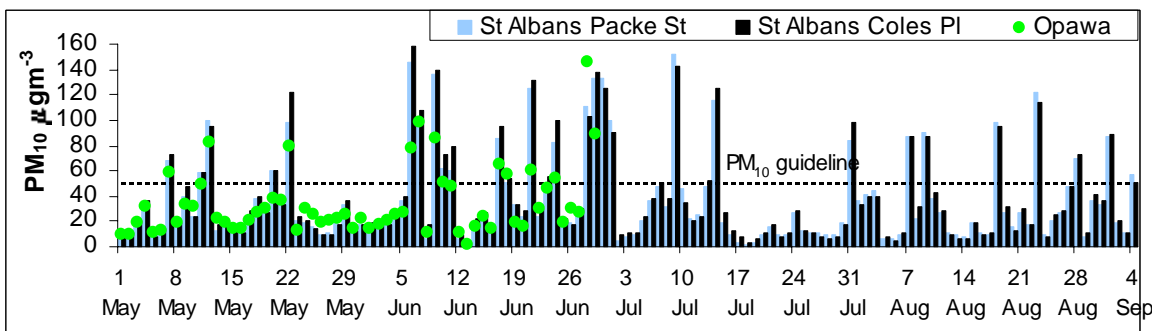


Figure 2.8 24 hour average PM₁₀ concentrations measured in Christchurch, winter 1999

Table 2.1 Summary of guideline exceedences for PM₁₀ in Christchurch

Annual Air Quality Monitoring Report, 1999

	St Albans Packe St	St Albans Coles PI	Opawa	Sumner
May 1999	5	5	3	
June 1999	11	13	10	
July 1999	4	6		0
August 1999	5	5		4
September 1999	2	2		5
October 1999	0	0		8
November 1999	0	0		10
December 1999	0	0		2
January 2000	0	0		4
Total number of days exceeded PM₁₀ guideline	27	31	13	33
Maximum 24 hour average PM₁₀ concentration (µgm⁻³)	152	158	146	160

The maximum 24 hour average PM₁₀ concentration measured at the St Albans monitoring sites and the number of days the guidelines were exceeded each year since 1988 are shown in figure 2.9. Coles PI data have been estimated using the regression equation for the years 1988 to 1998. Overall, no particular trend is evident in pollution concentrations over the period of monitoring.

The variation of PM₁₀ concentrations over a day is shown in figure 2.10. These are hour averages from 9am which are then combined to provide a 24 hour average to be compared to the guideline. The maximum hour concentrations shown in this figure are similar for the two dates, yet result in very different 24 hour averages. This is because of differences in the length of time over which the high concentrations occurred.

The PM₁₀ data reported for all sites are from Tapered Element Oscillating Microbalance (TEOM) monitors, with an operating temperature of 40°C. A Beta Gauge Automated Particle Sampler (BG) also collected PM₁₀ at the St Albans Packe St site. Concentrations of PM₁₀ differ between these two instruments; the Beta Gauge results are about 30% higher than those from the TEOM. The relationship between the two methods collocated at St Albans Packe St is described by the regression equation:

$$\text{TEOM} = 0.68 * \text{BG} + 1.18 \quad r^2=0.95$$

where TEOM are the 24 hour average PM₁₀ concentrations from the TEOM method (at 40°) and BG are the 24 hour average PM₁₀ concentrations from the beta gauge method.

Comparison of these methods of measurement is the focus of another report (Foster, 1998).

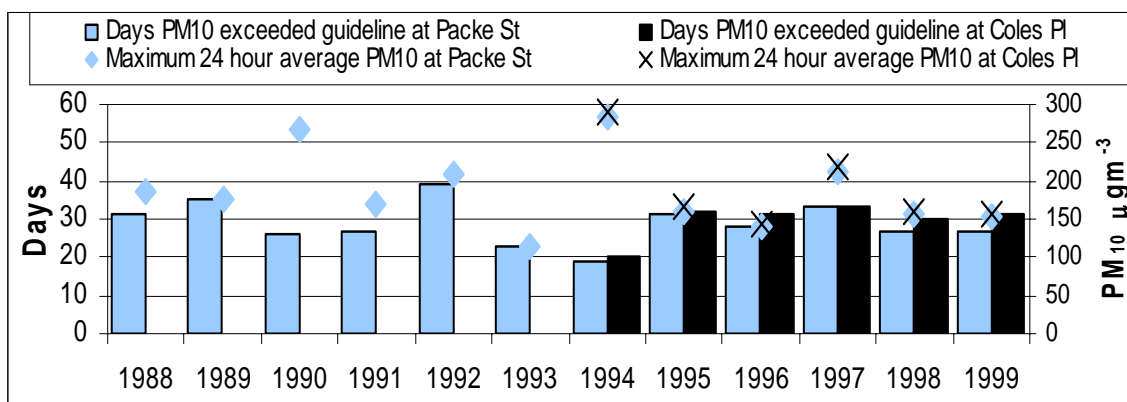


Figure 2.9 PM₁₀ monitoring results for St Albans, 1988-1999

Values shown for the years 1988, 1989, 1993 and 1994 may be less than actually occurred because of missing data. Coles PI data from 1994 to 1998 are derived from Packe St data. Data prior to this have not been estimated owing to greater uncertainty in data quality.

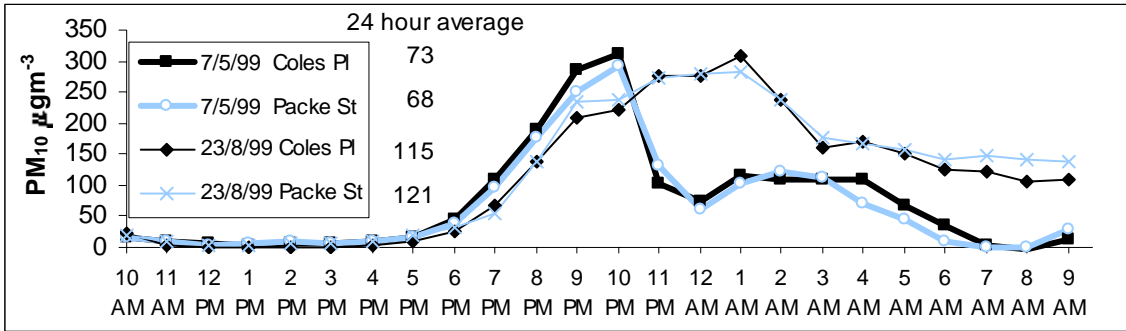


Figure 2.10 Variation of hour average concentrations over two days at the St Albans sites

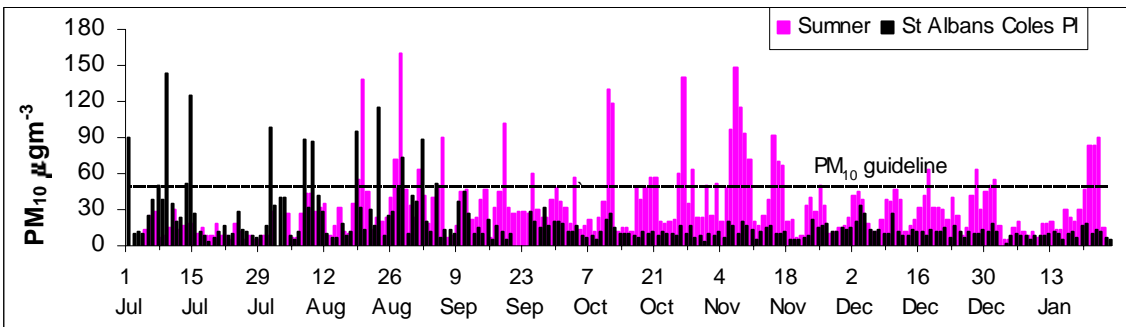


Figure 2.11 24 hour average PM₁₀ concentrations measured in Sumner and St Albans, 1999

2.4.1 Suspended particulate in Sumner

Initially monitoring of PM₁₀ was conducted at the Van Asch Deaf Education Centre in Sumner (figure 2.1). Concentrations of PM₁₀ measured at this site did not exceed the guideline, with a maximum 24 hour average in July of 30 µg m⁻³. However examination of the local meteorology indicated that this site, at the top of a valley, was not suitable for measuring pollution in Sumner. This is because on nights with potential for air pollution, winds moved from the hills towards the sea and only emissions from further up the valley were being measured. In August the monitoring site was moved to the Police Station which is near the shopping centre and closer to the sea.

Exceedences of the PM₁₀ guideline occurred at this site during every month, until monitoring stopped in January 2000 (table 2.1). Concentrations of PM₁₀ at this site were not elevated at the same time as concentrations at St Albans (figure 2.11). Sumner has a separate airshed from the city because the hills separate it from other suburbs.

2.5 Carbon monoxide in Christchurch

The maximum eight hour average CO concentrations measured each month in 1999, are shown in figure 2.12. The variation over the year is illustrated in this figure with highest concentrations during the winter months. Daily maximum CO concentrations at the St Albans and Hornby monitoring sites are shown in Figures 2.13 and 2.14 compared with the eight hour average guideline of 10 mgm⁻³ and the one hour average guideline of 30 mgm⁻³. The CO concentrations vary according to the weather patterns in a similar way to the PM₁₀ concentrations.

In the 1999 winter, carbon monoxide concentrations exceeded the eight hour guideline on 12 days at St Albans Packe St monitoring site and on 10 days at the St Albans Coles PI monitoring site. Data at Coles PI were not available from mid August; however it is unlikely further exceedences of the guideline would have occurred during this time. There were no exceedences of the one hour guideline measured at any site, though the maximum at the St Albans monitoring sites did reach the alert category.

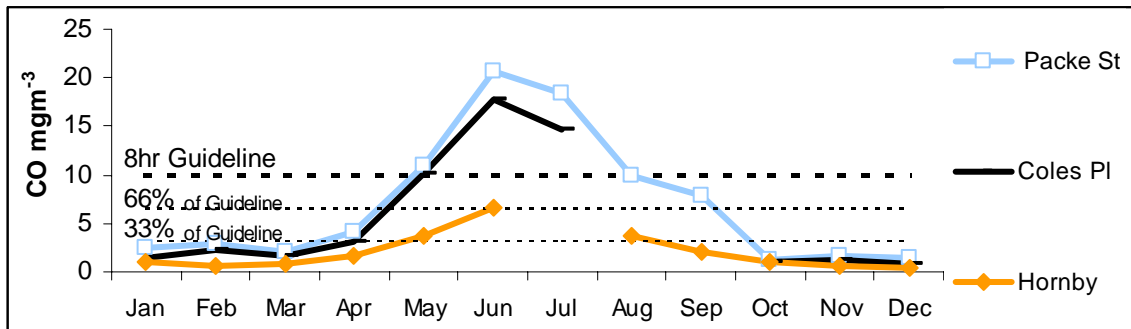


Figure 2.12 Maximum eight hour average CO concentration each month in Christchurch, 1999

In general concentrations of CO were slightly higher at Packe St compared to Coles PI. This may be due to the relative proximity of the road at the Packe St monitoring site. For eight hour average concentrations the relationship is described by the regression equation:

$$y = 0.90x - 0.10 \quad r^2 = 0.98$$

where y is eight hour average CO at Coles PI and x is eight hour average CO at Packe St

For one hour average concentrations the regression equation is:

$$y = 0.89x - 0.06 \quad r^2 = 0.95$$

where y is one hour average CO at Coles PI and x is one hour average CO at Packe St

The number of exceedences of the CO guidelines at the St Albans monitoring sites during 1999, compared to exceedences for the years 1988 – 1998, are shown in figure 2.15. Coles PI data have been estimated using the regression equations for the years 1988 to 1998.

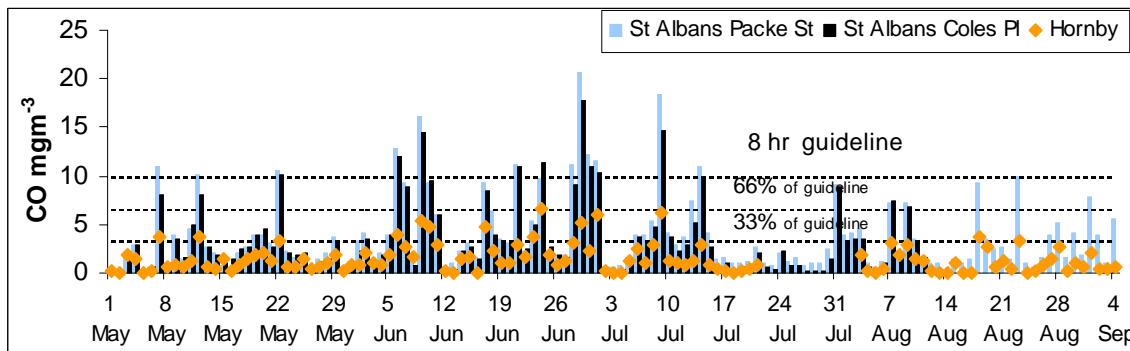


Figure 2.13 Daily maximum eight hour average CO concentrations in Christchurch, winter 1999

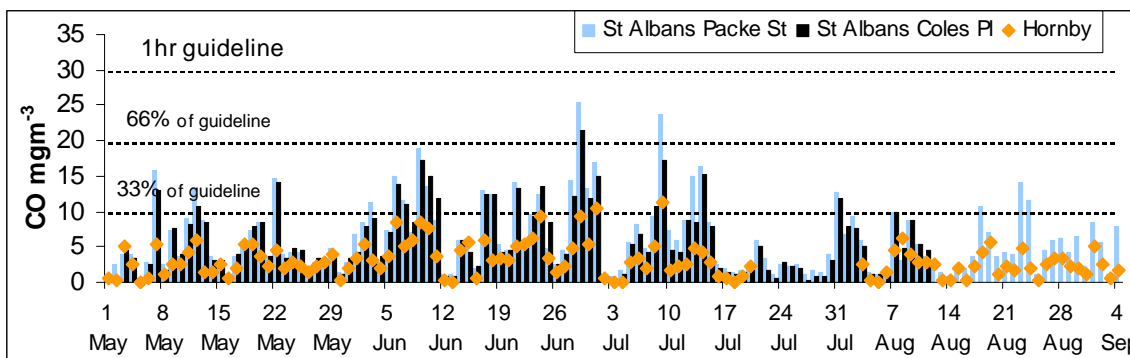


Figure 2.14 Daily maximum one hour average CO concentrations in Christchurch, winter 1999

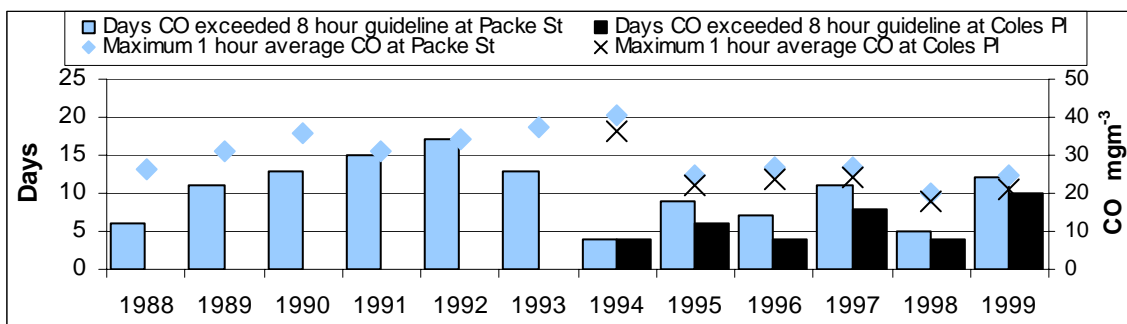


Figure 2.15 CO monitoring results for St Albans, 1988-1999

Values shown for the years 1988 and 1991 may be less than actually occurred because of missing data. Coles PI data from 1994 to 1998 are derived from Packe St data. Data prior to this have not been estimated owing to greater uncertainty in data quality.

2.6 Sulphur dioxide in Christchurch

Maximum one hour average SO₂ concentrations measured at Christchurch sites each month in 1999, are shown in figure 2.16. Concentrations of SO₂ measured at the St Albans monitoring sites show seasonal variations, with higher concentrations occurring during the winter period. At the Opawa and Hornby monitoring sites maximum concentrations can occur throughout the year. This is likely to be because of the industrial nature of these areas and the impact of SO₂ emissions from nearby industries.

There are health guidelines for three averaging periods for SO₂. Figures 2.17 to 2.19 show how maximum SO₂ concentrations measured at the Christchurch sites compare to the 10 minute average, one hour average, and 24 hour average guidelines. Coles PI data have been estimated using regression equations for the years 1988 to 1998.

There were three days when SO₂ concentrations exceeded the 10 minute average guideline at the Hornby monitoring site in 1999. This has not occurred before at this site. The first exceedence was on February 16, when the maximum 10 minute

average was 613 µgm⁻³. A fire broke out in the sulphur melting system of a nearby fertiliser production plant on this day. The other occasions were in October when concentrations peaked at 532 µgm⁻³ on Oct 1 and at 922 µgm⁻³ on Oct 19. Faults occurred at the same fertiliser plant during this month.

Concentrations of SO₂ measured at the Packe St monitoring site were higher than those measured at Coles PI. The relationship between SO₂ concentrations may be described by one of the following regression equations:

$$y = 0.71x + 4.11 \quad r^2 = 0.67$$

where y is 10 min average SO₂ at Coles PI and x is 10 min average SO₂ at Packe St

$$y = 0.71x + 2.26 \quad r^2 = 0.76$$

where y is one hour average SO₂ at Coles PI and x is one hour average SO₂ at Packe St

$$y = 0.64x + 0.80 \quad r^2 = 0.66$$

where y is 24 hour average SO₂ from 9am at Coles PI and x is 24 hour average SO₂ from 9am at Packe St.

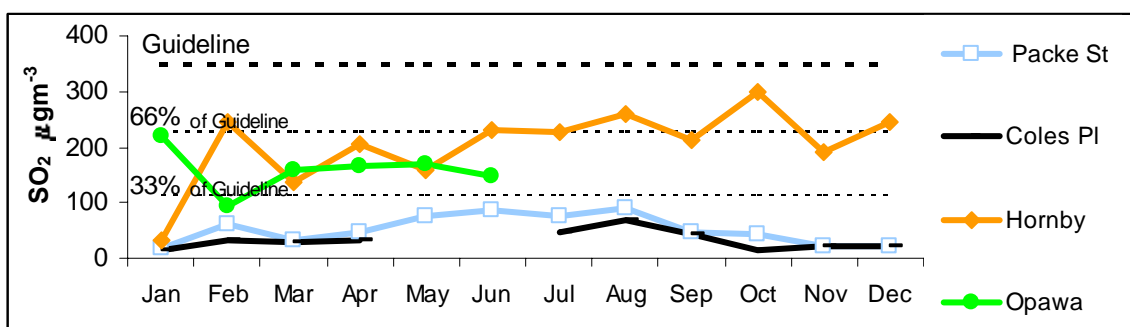


Figure 2.16 Maximum 24 hour average SO₂ concentration each month in Christchurch, 1999

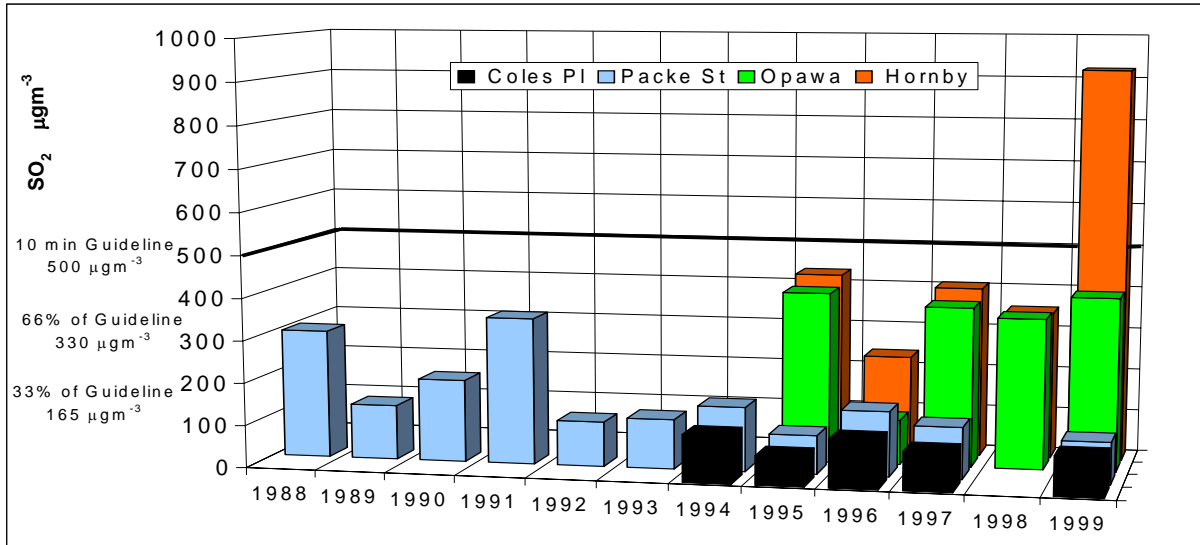


Figure 2.17 Maximum 10 minute average SO₂ in Christchurch 1988 – 1999

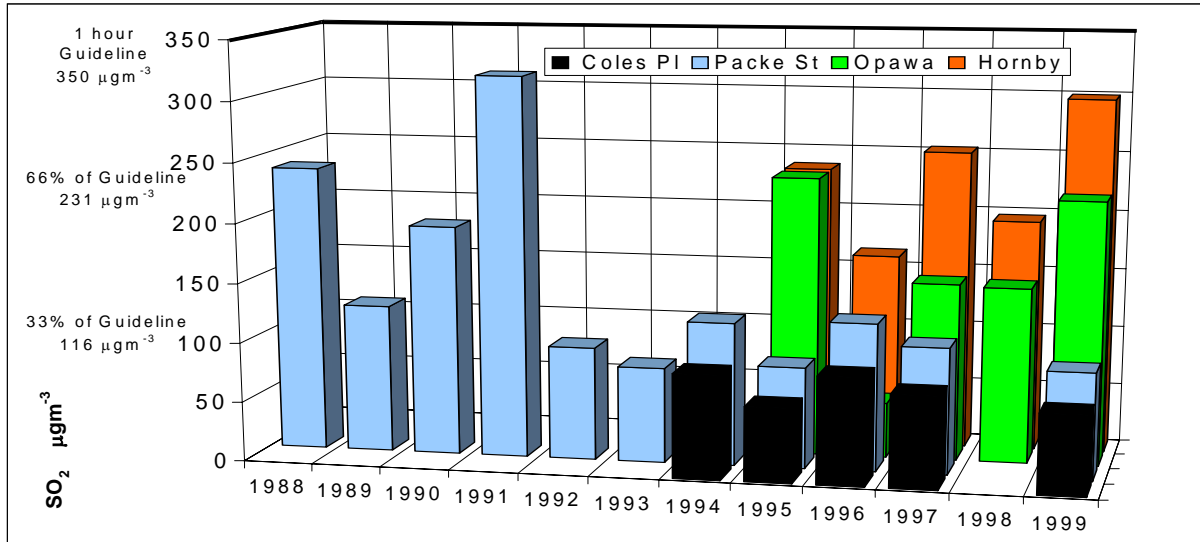


Figure 2.18 Maximum one hour average SO₂ concentrations in Christchurch 1988 – 1999

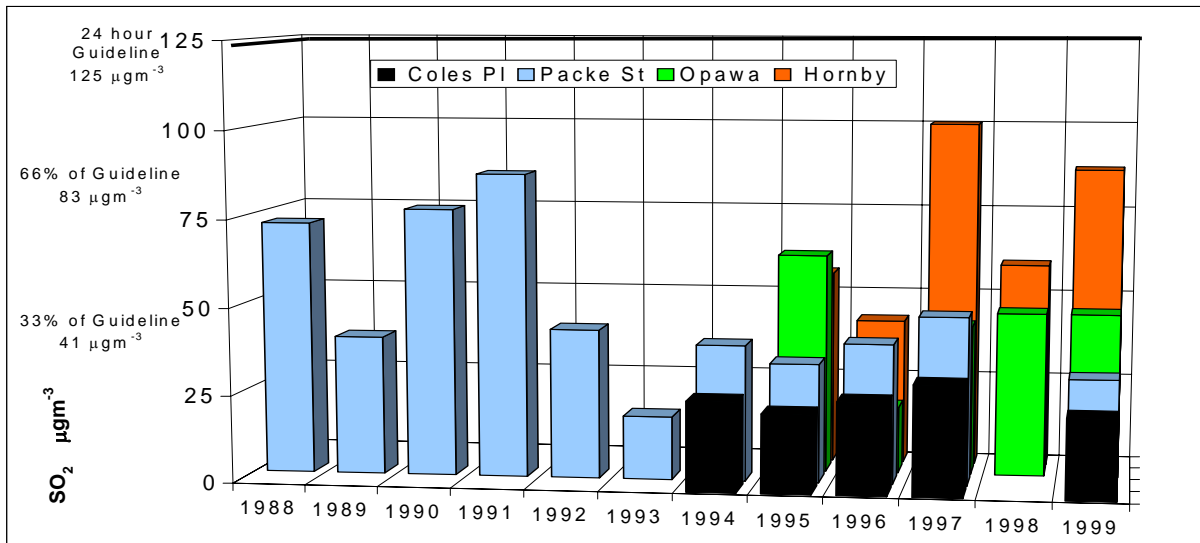


Figure 2.19 Maximum 24 hour average SO₂ concentrations in Christchurch 1988 - 1999

Values shown for the years 1988, 1991, 1993 and 1995 at St Albans, 1995 at Hornby, 1995, 1996 and 1999 at Opawa may be less than actually occurred because of missing data. Coles PI data from 1994 to 1998 are derived from Packe St data. Data prior to this have not been estimated owing to greater uncertainty in data quality.

2.7 Nitrogen dioxide in Christchurch

The maximum one hour and 24 hour NO₂ concentrations each month in 1999 are shown in figure 2.20. These concentrations show a seasonal variation with the maxima measured in the winter months.

While there is no guideline concentration for NO, this contaminant is monitored because of its potential for conversion to NO₂ in the lower atmosphere. The one hour average concentrations of NO and NO₂ for the 1999 winter at both St Albans sites are shown in figures 2.21 and 2.22 and are consistently below the NO₂ guidelines.

The maximum concentrations of NO₂ measured at the St Albans monitoring sites each year since 1988 are shown in figure 2.23. On only one occasion in 1990 have the guidelines been exceeded. Coles PI data have been estimated using the regression equation for the years 1988 to 1998.

Concentrations of NO₂ measured at the Packe St monitoring site were lower than those measured at Coles PI. The relationship between NO₂ concentrations may be explained by one of the following regression equations:

$$y = 1.24x - 1.70 \quad r^2 = 0.69$$

where y is 24 hour average NO₂ from 9am at Coles PI and x is 24 hour average NO₂ from 9am at Packe St.

$$y = 1.16x + 0.91 \quad r^2 = 0.64$$

where y is one hour average NO₂ at Coles PI and x is one hour average NO₂ at Packe St.

The NO₂ one hour average guideline has been revised by the World Health Organisation to 200 µgm⁻³ and is also under review by the Ministry for the Environment in New Zealand. Historically there have been six times that one hour average concentrations have exceeded 200 µgm⁻³ at the Packe St and the years in which these occurred are shown in figure 2.23.

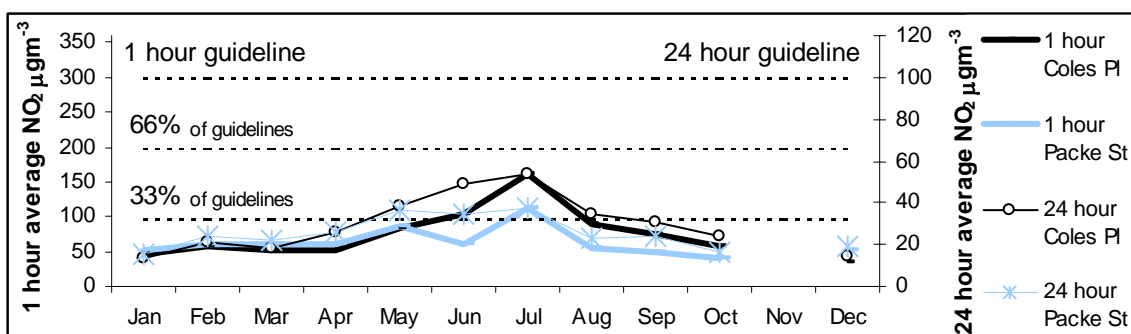


Figure 2.20 Maximum one hour and 24 hour concentrations of NO₂ each month at the St Albans sites in 1999

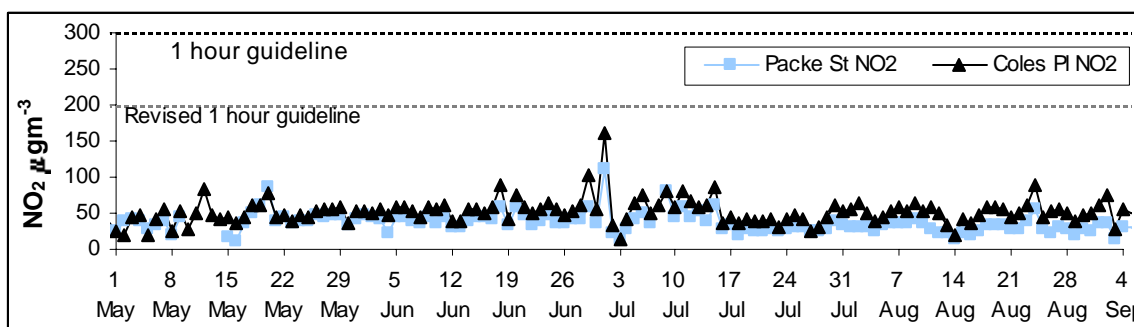


Figure 2.21 Maximum one hour concentrations of NO₂ at the St Albans sites in 1999

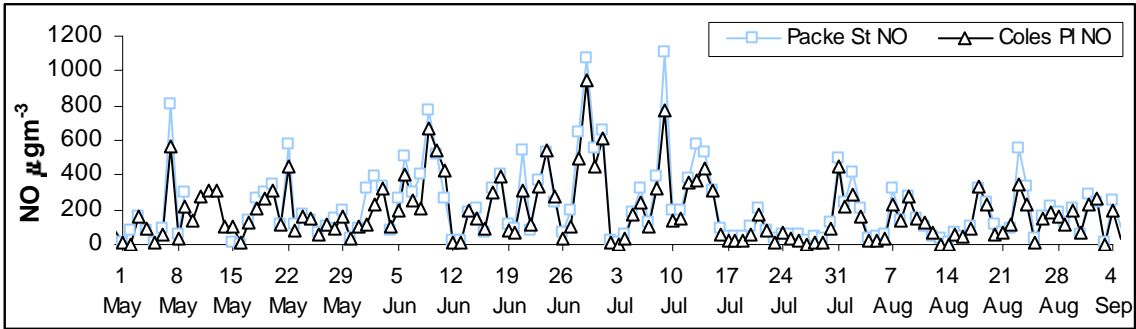


Figure 2.22 Maximum one hour concentrations of NO at the St Albans sites in 1999

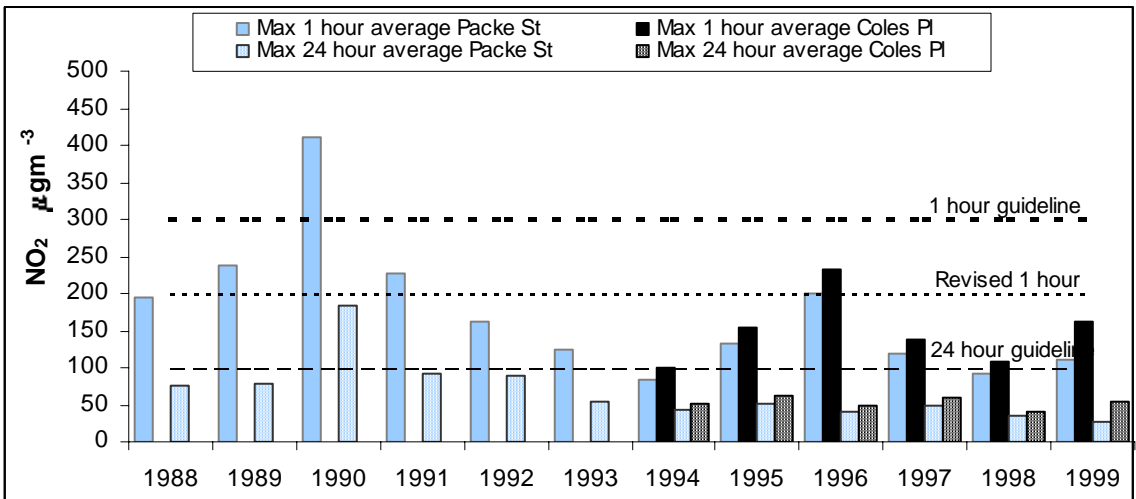


Figure 2.23 Annual maximum NO₂ concentrations at the St Albans sites since 1988

Values shown for the years 1988, 1992, 1993 and 1994 may be less than actually occurred because of missing data. Coles PI data from 1994 to 1998 are derived from Packe St data. Data prior to this have not been estimated owing to greater uncertainty in data quality.

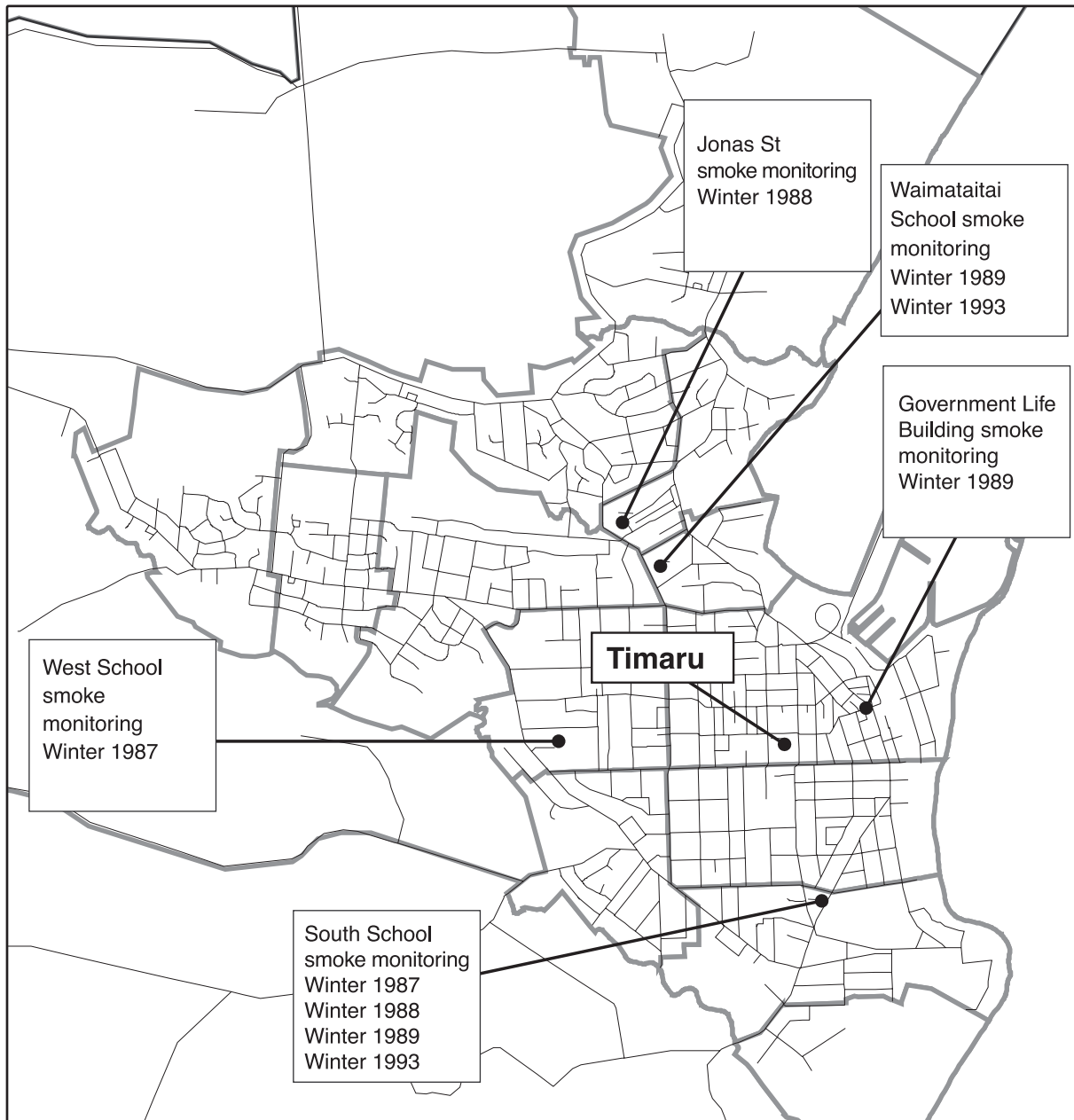


Figure 3.1: Location of Timaru air quality monitoring sites

3 Timaru results

3.1 Timaru monitoring sites

In January 1997 Environment Canterbury established an air quality monitoring site in Timaru at the Timaru Main School. This site was selected, as for Christchurch sites, as a representative, rather than a worst case, ambient air quality monitoring site. The area to the east of the site is the main commercial area and also includes some industries. To the west of the monitoring site are residential areas. Previously smoke monitoring had

been carried out between 1987 and 1989, and in 1993, at various sites in Timaru. The location of these sites is shown in figure 3.1.

3.2 Comparison to indicator categories

Figure 3.2 shows how monitoring in Timaru in 1999 compares to indicator categories. This figure represents concentrations over the entire year. For most contaminants concentrations are excellent or good, being less than 33% of the guidelines. Suspended particulate concentrations reach the action category at this site.

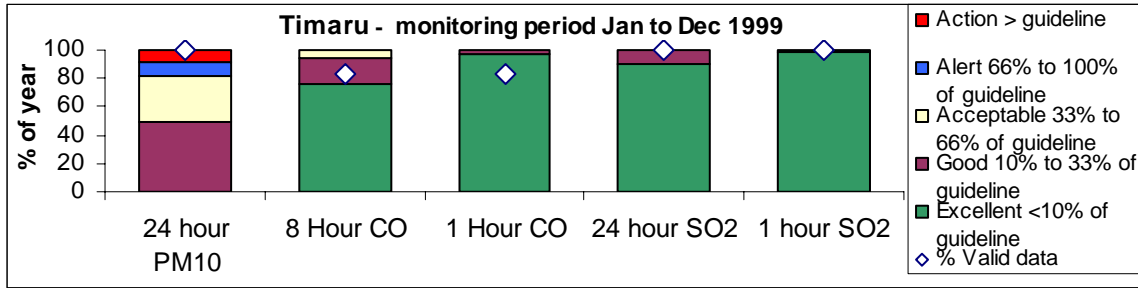


Figure 3.2: Comparison of monitored concentrations at Timaru in 1999 to indicator categories

3.3 Seasonal variation

Figure 3.3 shows the maximum concentrations for 24 hour average PM₁₀, one hour average SO₂, and eight hour average CO each month over the year. The PM₁₀ and CO show a seasonal variation with the highest concentrations occurring during the winter months. The highest concentration of SO₂ in 1999 occurred in October and is described in more detail in section 3.6.

in 1987, 1998, 1989 and 1993. The maximum 24 hour average smoke concentrations measured during these years are shown in figure 3.4 along with the maximum 24 hour PM₁₀ concentrations recorded each year since 1997.

In general, Timaru experiences similar weather patterns to Christchurch. These patterns are reflected in the air pollution concentrations in figure 3.5, which shows daily concentrations of PM₁₀ and the maximum eight hour CO concentration each day.

3.4 Suspended particulate in Timaru

Suspended particulate (PM₁₀) has been measured in Timaru since 1997. Prior to this smoke monitoring had been carried out

These weather/pollution patterns are similar to patterns in Christchurch, though on

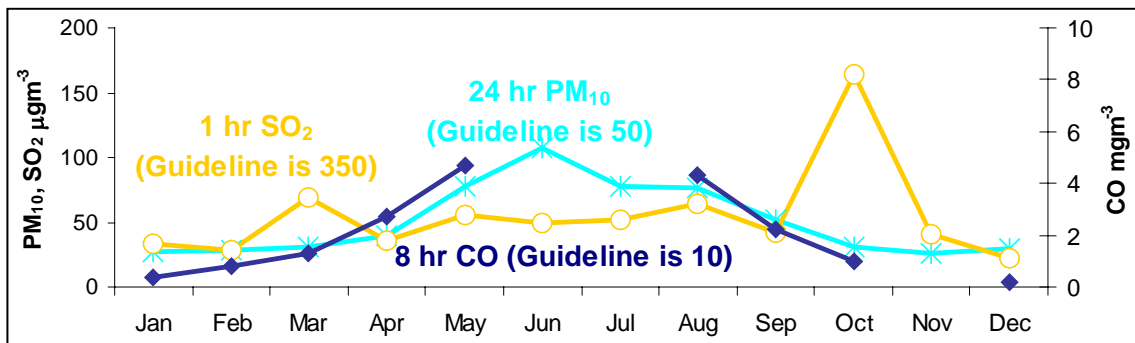


Figure 3.3: Maximum concentrations each month in Timaru in 1999

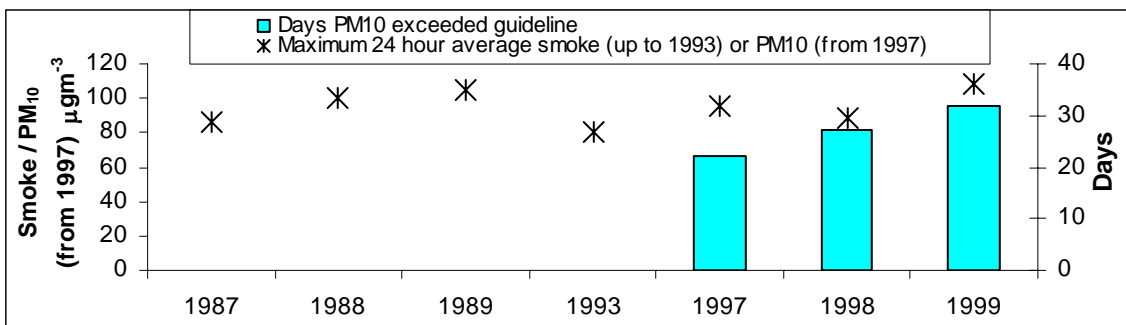


Figure 3.4: Maximum 24 hour smoke and PM₁₀ concentrations measured at Timaru

Values shown for the years 1987, 1988, 1989 and 1993 may be lower than actually occurred because of missing data.

occasions Timaru may have calm conditions

while a fresh sea breeze is blowing in Christchurch. These conditions can result in exceedences of the guideline in Timaru, but not in Christchurch.

In 1999 Timaru had 32 days with PM₁₀ guideline exceedences, with the maximum 24 hour PM₁₀ concentration of 108 µgm⁻³. This was similar to the number of days measured at the St Albans sites in Christchurch. Figure 3.6 shows how the spread of the high concentrations differs at the sites in 1999. Most high pollution days in Timaru were in the range from 50 to 70 µgm⁻³, while most high pollution days in St Albans were greater than 70 µgm⁻³. Although the number of exceedences was similar in Timaru the concentrations were lower than at St Albans, Christchurch.

Over a day hourly average PM₁₀ concentrations in Timaru have a similar pattern to those in Christchurch, with the peak in the evening period. This pattern is dependent on the meteorological conditions.

3.5 Carbon monoxide in Timaru

Carbon monoxide data are unavailable for the period from mid June to mid July because of instrument problems. Figure 3.5

shows the maximum eight hour average CO concentrations for each day of valid data. This figure also shows the 24 hour average PM₁₀ concentrations. There is a good relationship between the PM₁₀ and CO concentrations and figure 3.5 indicates that the highest eight hour average probably occurred on June 11 with a concentration of 7 mgm⁻³ at the same time as the maximum 24 hour PM₁₀ concentration. One hour average CO concentrations were also likely to be highest on this day with a concentration of 11 mgm⁻³. Given these highest concentrations, it is unlikely that there were any exceedences of the CO guidelines (10 mgm⁻³ for the eight hour average and 30 mgm⁻³ for the one hour average) during this monitoring period.

Table 3.1 shows how these maximum concentrations compare to monitoring results in previous years. The eight hour average CO of 7 mgm⁻³ measured on June 11 is higher than concentrations measured in other years and comes into the Alert category at more than 66% of the 10 mgm⁻³ guideline. It is likely that this is the only occasion in 1999 when CO concentrations were this high in Timaru.

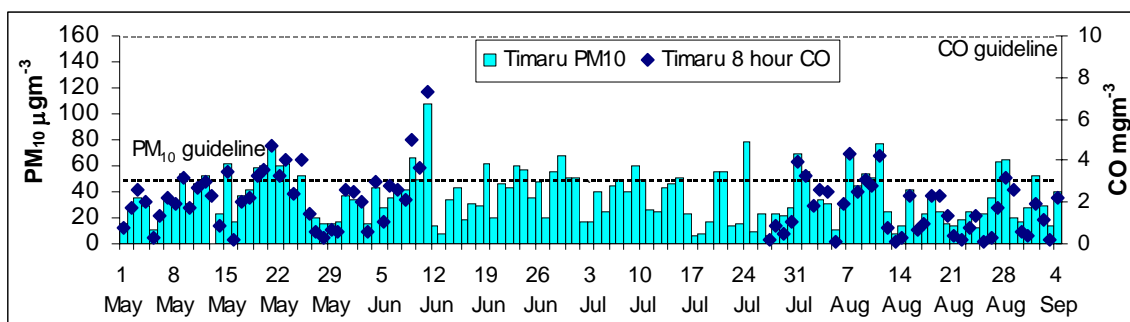


Figure 3.5: 24 hour average PM₁₀ concentrations and eight hour average CO concentrations measured at Timaru, winter 1999

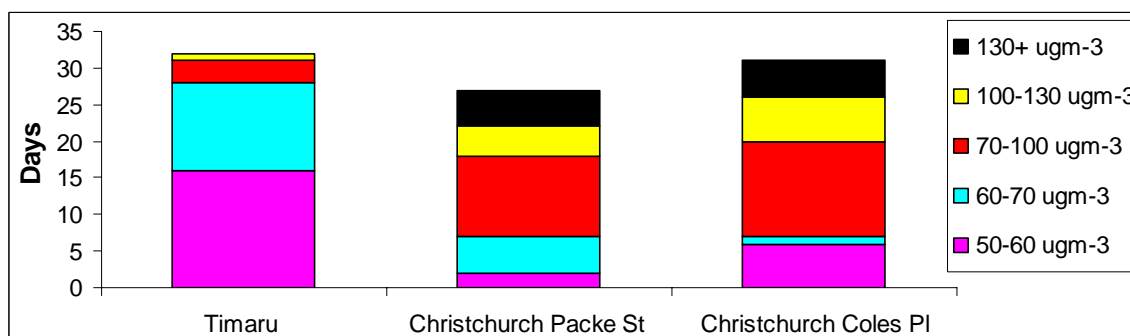


Figure 3.6: Number of days PM₁₀ concentrations at various levels in Timaru and Christchurch, 1999

Table 3.1: Summary of maximum concentrations for CO

Maximum CO concentration (mgm ⁻³)			
	1 hour average	8 hour average	Period monitored
Timaru	7	5	8/7/97–31/12/97
Timaru	9	5	1/1/98–31/12/98
Timaru	11	7	1/1/99–31/12/99
MfE Guideline concentration	30	10	

3.6 Sulphur dioxide in Timaru

Sulphur dioxide concentrations measured in Timaru during 1999 were well below guidelines (figure 3.2). In general SO₂ concentrations were similar in 1999 to those in 1998 (figure 3.7).

There were two days in October that had higher hourly and 10 minute average concentrations than any other days monitored (figure 3.4). The maximum ten minute concentrations on these days were 308 and 194 µgm⁻³. In 1998 the maximum

was 161 µgm⁻³. These high concentrations occurred during the late morning and afternoon period with light northeasterly winds. As the high periods on these days were for about five hours only, when averaged over the 24 hour period they became less significant. These days can be seen in figure 3.7, which shows the 24 hour average SO₂ concentrations since monitoring began in mid 1997.

Figure 3.7 shows a seasonal variation with higher concentrations in the winter periods compared to those in the summer periods. Aberkane (1998) suggested that the highest SO₂ concentrations in Timaru occurred when the wind direction was from the east. High concentrations during the evening and morning were typically associated with westerly winds. It was concluded that the high daytime concentrations were likely to arise as a result of emissions from industrial activities³ in the city centre and port, whereas evening and morning concentrations were more likely to come from domestic heating. Concentrations in 1998 and 1999 showed similar patterns.

³ includes industrial and trade processes

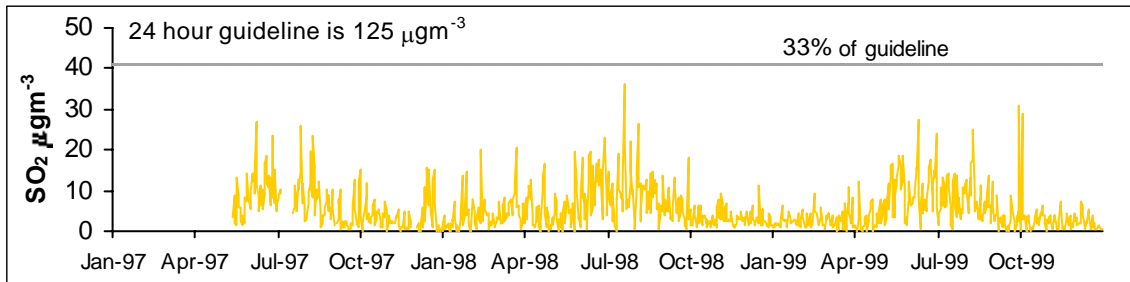


Figure 3.7: 24 hour SO₂ concentrations at Timaru 1997 –1999

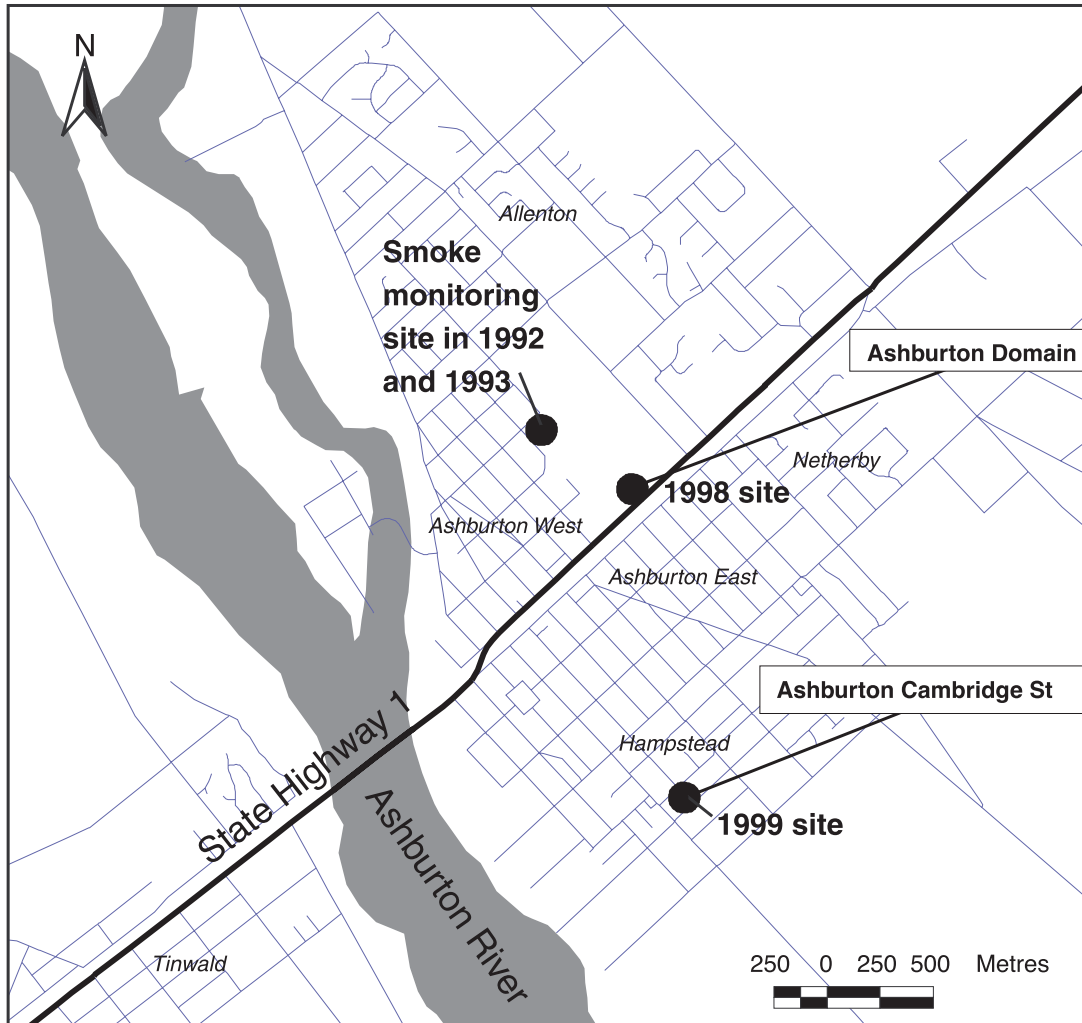


Figure 4.1: Location of Ashburton air quality monitoring sites

4 Ashburton results

4.1 Ashburton monitoring sites

In January 1998 Environment Canterbury established an air quality monitoring site in Ashburton in the Domain. Previously smoke monitoring had been carried out in a different area of the Domain as shown in figure 4.1.

In 1999 a new site in the suburb of Hampstead was established as investigations into meteorology (Chilton, 1999) have shown that airflow measured at the air quality site in the Domain in 1998 were different to air flows measured in other parts of Ashburton. This indicated that trees near to the site may have affected airflow and concentrations of contaminants monitored may not have been representative of the Ashburton urban airshed.

4.2 Comparison to indicator categories

Figure 4.2 shows how monitoring at the Ashburton site in 1999 compares to indicator categories. This figure represents concentrations from March to December. For most contaminants concentrations are excellent or good, being less than 33% of the guidelines. Suspended particulate concentrations reach the action category at this site.

4.3 Seasonal variation

Figure 4.3 shows the maximum concentrations for 24 hour average PM₁₀, one hour average SO₂, and eight hour average CO each month over the year. The PM₁₀ concentrations show a seasonal variation with the highest concentrations during the winter months. With missing data during the winter months this is not obvious in figure 4.3 for the CO and SO₂ concentrations.

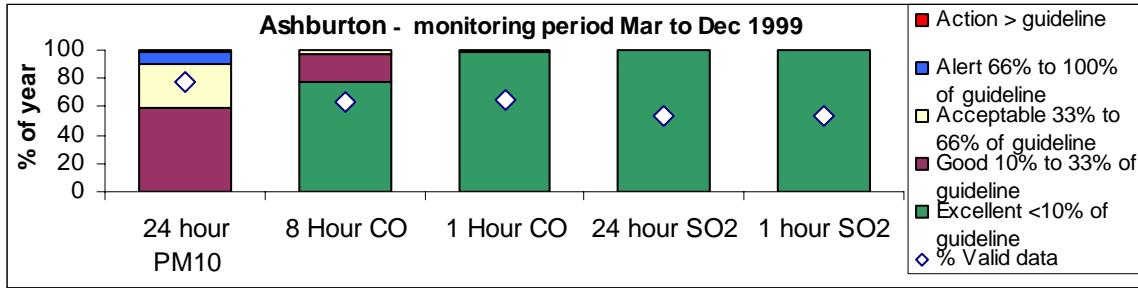


Figure 4.2: Comparison of monitored concentrations at Ashburton in 1999 to indicator categories

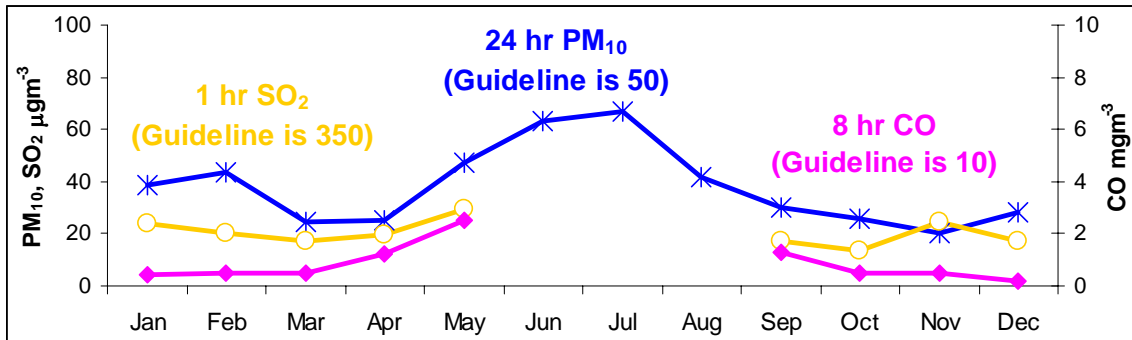


Figure 4.3: Maximum concentrations each month in Ashburton Domain for January and February and Cambridge St from March to December 1999

4.4 Suspended particulate in Ashburton

Suspended particulate (PM₁₀) has been measured in Ashburton since 1998. Prior to this smoke monitoring had been carried out in Ashburton in the Domain in the winters of 1992 and 1993. In 1992 the monitoring period was for 24 hours and in 1993 for the evening period only. Figure 4.4 shows how PM₁₀ measured since 1998 compares to smoke monitoring in 1992 and 1993. Note these measurements have been made at different sites as indicated on the map in figure 4.1.

In 1999 there were five exceedences of the PM₁₀ guideline with a maximum 24 hour average PM₁₀ concentration of 67 µgm⁻³ (figure 4.5). Data for these days are presented in more detail in figure 4.6 showing hour average PM₁₀ concentrations for the 24 hour period. This shows that concentrations rose about 5pm, peaked about 7pm and remained at elevated concentrations through until the early hours of the morning. This figure also indicates that the period of elevated concentrations differs each night, as does the maximum concentration. This variation is dependent on the meteorological conditions.

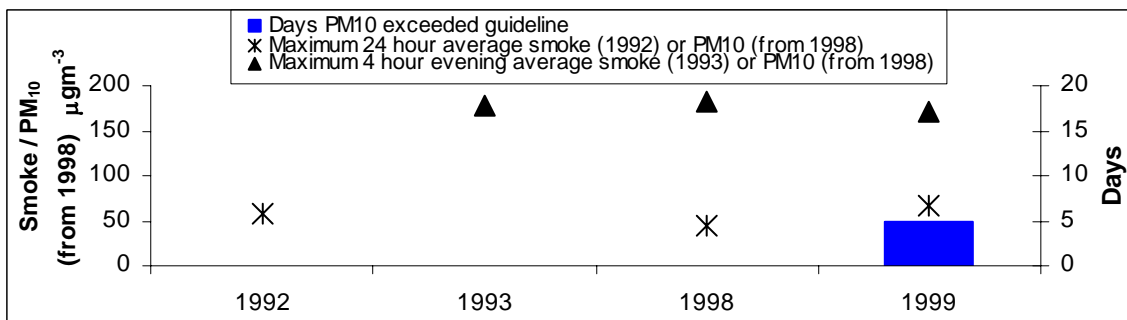


Figure 4.4: Comparison of smoke and PM₁₀ concentrations at Ashburton

Values shown for the years 1992 and 1993 may be lower than actually occurred because of missing data.

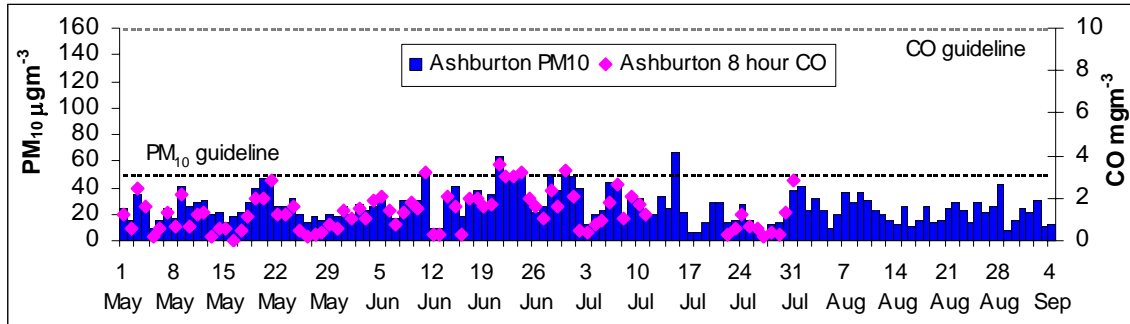


Figure 4.5: 24 hour average PM₁₀ concentrations and eight hour average CO concentrations measured at Ashburton, winter 1999

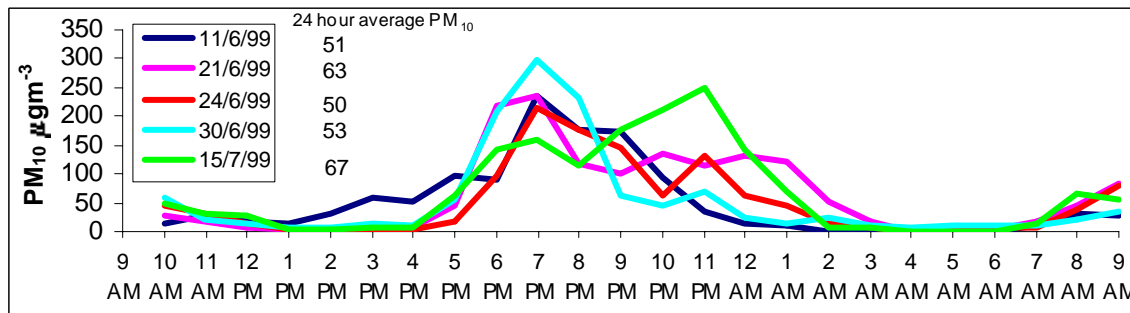


Figure 4.6: Hourly variation of PM₁₀ on days of high air pollution

Concentrations of PM₁₀ measured at Cambridge St show a seasonal pattern over a year with highest concentrations in the winter months and low concentrations during the rest of the year. This pattern is typically associated with emissions from home heating sources.

At the Domain PM₁₀ concentrations were relatively high (around 40 µgm⁻³) in the summer as well as the winter (January and February in figure 4.3). Aberkane (1999) suggested that rural burning and backyard burning along with industrial processes and wind blown dust were possible sources of these high PM₁₀ concentrations outside the winter months.

4.5 Carbon monoxide in Ashburton

Carbon monoxide data are unavailable for a period in mid July and all of August through to September 7, 1999 because of instrument problems. Figure 4.5 shows the maximum eight hour average CO concentrations for each day of valid data along with 24 hour average PM₁₀ concentrations. There is a good relationship between the PM₁₀ and CO concentrations and as indicated in figure 4.5 the highest eight hour average probably occurred on July 15 with a concentration of

about 4 mgm⁻³. This date is when the maximum 24 hour PM₁₀ concentration of 67 µgm⁻³ occurred though a CO concentration is not available on this day.

One hour average CO concentrations are unlikely to have been much higher than 10 mgm⁻³ at their maximum. This was measured on June 23. IN 1999 concentrations of CO were generally less than 10% of the guidelines (10 mgm⁻³ for the eight hour average and 30 mgm⁻³ for the one hour average) with the maximum eight hour average CO in the acceptable category at about 40% of the guideline (figure 4.2).

4.6 Sulphur dioxide in Ashburton

Data are unavailable from mid June to early September because of instrument failure. It is unknown how high maximum concentrations of SO₂ would have been during this period. Concentrations of SO₂ outside of this period were very low compared to guideline levels. These concentrations were less than 10% of the guidelines, as indicated in figure 4.2.

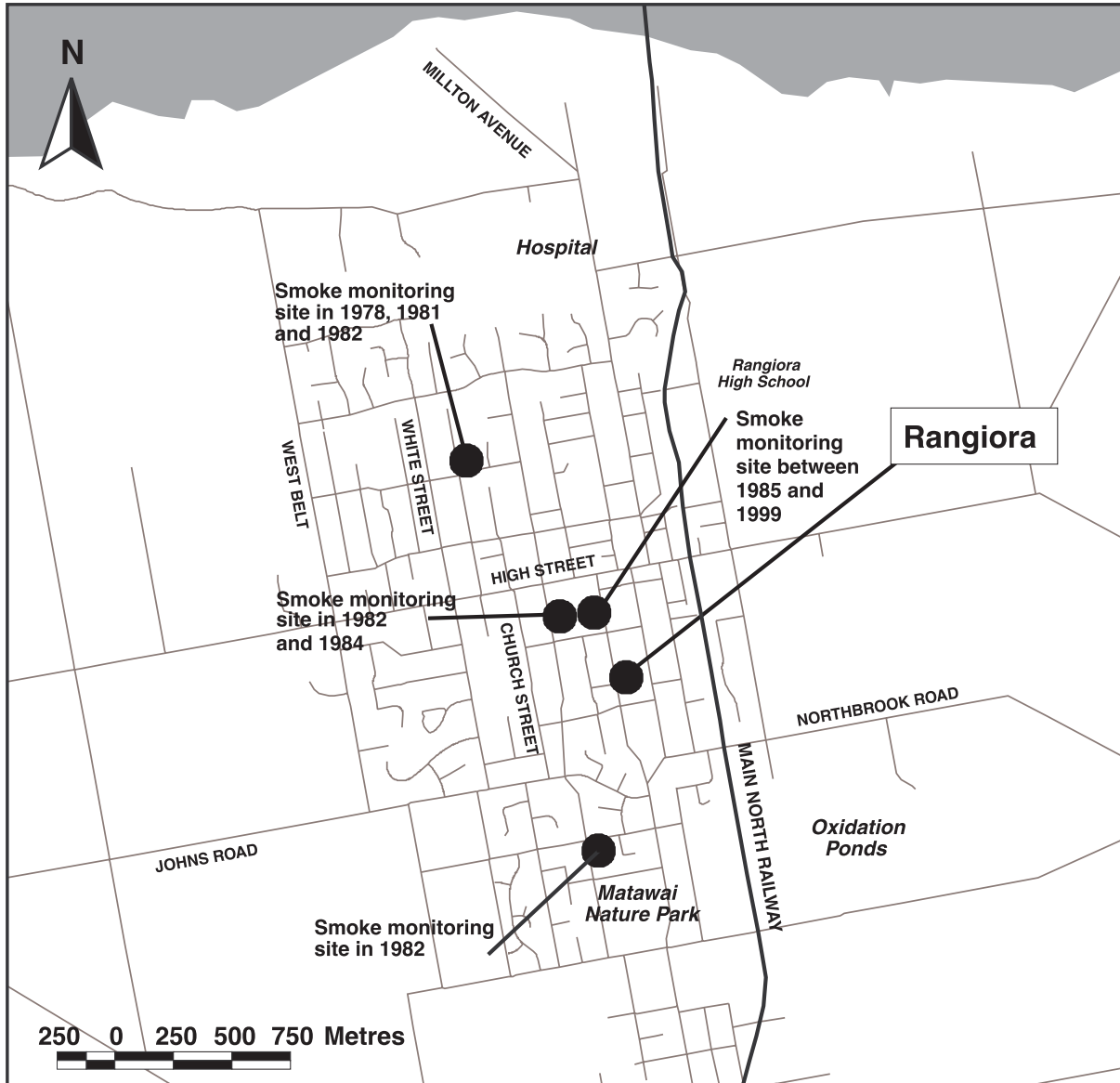


Figure 5.1: Location of Rangiora air quality monitoring sites

5 Rangiora results

5.1 Rangiora monitoring sites

In January 1999 Environment Canterbury established an air quality monitoring site in Rangiora at St Joseph's school. Smoke monitoring was carried out at various sites during earlier winters. The location of these sites is shown in figure 5.1.

5.2 Comparison to indicator categories

Figure 5.2 shows how monitoring in Rangiora in 1999 compares to indicator categories. This figure represents concentrations over

the entire year. For most contaminants concentrations are excellent or good, being less than 33% of the guidelines. Suspended particulate concentrations reach the alert category at this site.

5.3 Seasonal variation

Figure 5.3 shows the maximum concentrations for 24 hour average PM₁₀, one hour average SO₂, and eight hour average CO each month over the year. This figure shows a seasonal variation with the highest concentrations during the winter months.

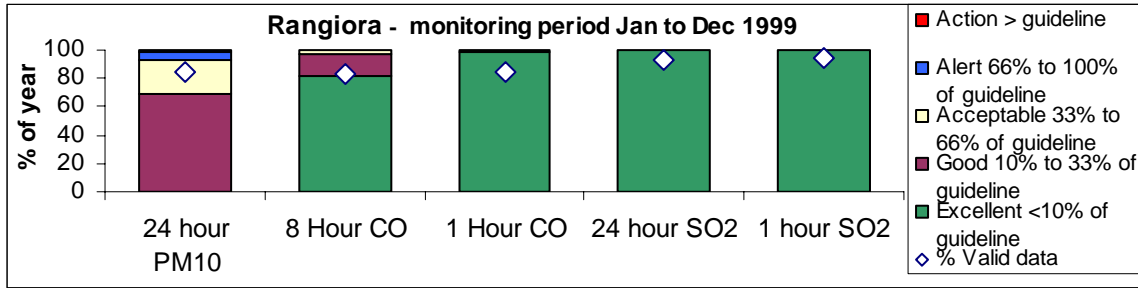


Figure 5.2: Comparison of monitored concentrations at Rangiora in 1999 to indicator categories

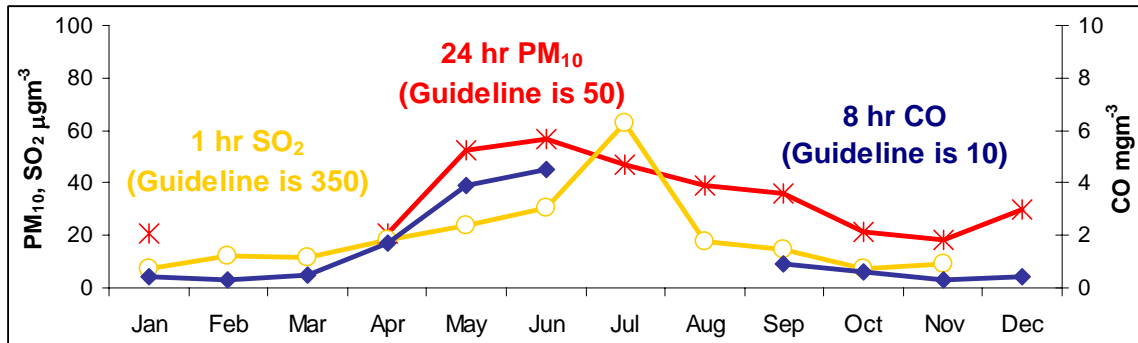


Figure 5.3: Maximum concentrations each month in Rangiora

5.4 Suspended particulate in Rangiora

Suspended particulate was measured in Rangiora in 1999. Prior to this smoke monitoring had been carried out in most winters between 1978 to 1990 at sites shown in figure 5.1. Figure 5.4 shows how PM₁₀ measured in 1999 compares to the smoke monitoring in earlier years.

In 1999 there were four exceedences of the PM₁₀ guideline with a maximum 24 hour average PM₁₀ concentration of 57 µgm⁻³

(figure 5.5). Data for these days are presented in more detail in figure 5.6 showing hour average PM₁₀ concentrations for the 24 hour period. This shows that concentrations rose about 5pm, peaked late in the evening and remained at elevated concentrations through until the early hours of the morning. This figure also indicates that the period of elevated concentrations differs each night, as does the maximum concentration. This variation is dependent on the meteorological conditions.

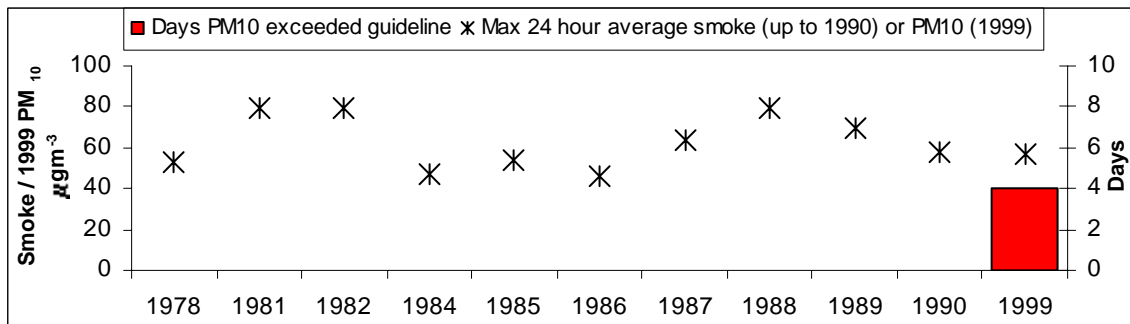


Figure 5.4: Maximum 24 hour smoke and PM₁₀ concentrations measured at Rangiora

Values shown for the years 1978 to 1990 may be lower than actually occurred because of missing data.

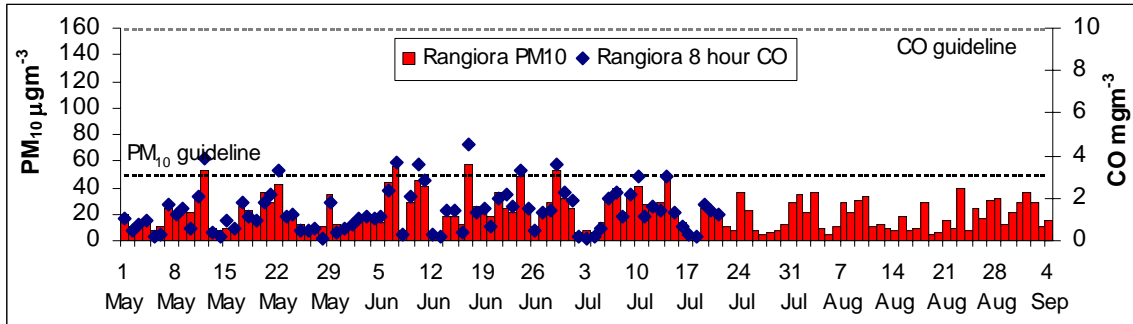


Figure 5.5: 24 hour average PM₁₀ concentrations and eight hour average CO concentrations measured at Rangiora, winter 1999

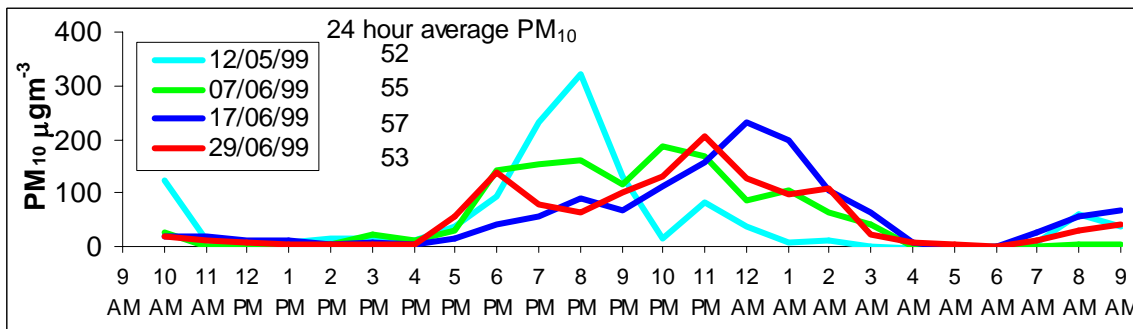


Figure 5.6: Hourly variation of PM₁₀ on days of high air pollution

5.5 Carbon monoxide in Rangiora

Carbon monoxide data are unavailable from late July to early September, 1999 because of instrument problems. Figure 5.5 shows the maximum eight hour average CO concentrations for each day of valid data, along with the 24 hour average PM₁₀ concentrations. There is a good relationship between the PM₁₀ and CO concentrations and figure 5.5 indicates that the highest eight hour average probably occurred on June 17 with a concentration of 5 mgm⁻³. This is the day when the maximum 24 hour PM₁₀ concentration of 57 µgm⁻³ occurred. The maximum measured one hour average CO concentration was 9 mgm⁻³ on May 12. This is likely to be the maximum concentration for the year. IN 1999 concentrations of CO were generally less than 10% of the guidelines (10 mgm⁻³ for the eight hour average and 30

mgm⁻³ for the one hour average) with the maximum eight hour average CO in the acceptable category at about 45% of the guideline.

5.6 Sulphur dioxide in Rangiora

Concentrations of SO₂ were very low in Rangiora compared to guidelines with most concentrations at less than 10% of the guidelines. The maximum ten minute and one hour concentrations (95 and 63 µgm⁻³) occurred on July 9 and are almost double the second highest concentrations for these averaging periods. This indicates that the concentrations on this day were atypical and may have been caused by a localised occurrence.

6 Conclusions

- (i) Environment Canterbury's guideline for suspended particulate was exceeded at all monitoring sites in 1999. There were 27 days on which the guideline was exceeded at the St Albans Packe St monitoring site and 31 days at Coles PI. In Timaru there were 32 days on which the guideline was exceeded. Ashburton and Rangiora had five and four days respectively.
- (ii) Concentrations of PM₁₀ were highest at the Christchurch monitoring sites with the maxima about three times the guideline. In Timaru concentrations of PM₁₀ were lower than in Christchurch with the maximum at about double the guideline. In Ashburton and Rangiora concentrations were much lower with the maximum in Ashburton about 35% higher than the guideline and in Rangiora about 15% higher.
- (iii) In Sumner there were 33 days when concentrations of PM₁₀ exceeded the guideline at the Police Station. These high concentrations did not occur at the same time as at the St Albans monitoring sites.
- (iv) Concentrations of SO₂ exceeded the 10 minute average guideline on 3 days at the Hornby monitoring site. No exceedences occurred at other monitoring sites.
- (v) The MfE guideline for eight hour average carbon monoxide concentrations was exceeded on 12 days at the St Albans Packe St monitoring site and 10 days at the St Albans Coles PI monitoring site. No exceedences for carbon monoxide occurred at other sites, though some data were missing because of instrument failure during the critical winter period.
- (vi) Concentrations of NO₂ measured at the St Albans sites were below guideline concentrations.
- (vii) Concentrations of PM₁₀ were slightly higher at Coles PI than at Packe St during the winter but there was no significant difference in concentrations over the whole of 1999.

Concentrations of NO₂ were higher at Coles PI compared to Packe St while CO, SO₂ and NO concentrations were lower.

7 References

- Aberkane, T.G., 1999. Annual Air Quality Monitoring Report 1998. Canterbury Regional Council Report U99(26)
- Aberkane, T.G., 1998. Annual Air Quality Monitoring Report 1997. Canterbury Regional Council Report U98(43)
- Chilton, R. 1999. Meteorological Influences on Air Pollution in a Canterbury Town. MSc Thesis in preparation.
- Foster, E. 1998 An investigation into the measurement of PM₁₀ in Christchurch. Canterbury Regional Council Report U98(69)
- Meteorological Society of New Zealand (Inc.) Newsletter 77 June 1999
- Meteorological Society of New Zealand (Inc.) Newsletter 78 September 1999
- Ministry for the Environment, 1994. Ambient Air Quality Guidelines.
- Ministry for the Environment, 1997. Environmental performance indicators (Proposals for air, fresh water and land).
- Ministry for the Environment, 1999. Organochlorines in New Zealand.
- Stevenson and Narsey for Ministry of Health, 1999. Survey of Benzene and Other Toxic Organic Compounds In Air: July 1996 – May 1999.