Air Quality

Key Information	Why is this Useful?	What is Happening?
The number of days exceeding the PM_{10} guideline ($50\mu gm^{-3}$).	Particulate matter or smoke is the most significant element of winter air pollution in Christchurch. The number of days which exceed the guideline provides an indication of the impact ambient air quality has on amenity and residents' health.	● On average, PM_{10} has exceeded the guideline on 29 days each winter between 1988 and 1999.
Residents' problems with local air pollution.	This provides a measure of the impact of local sources of air emissions, and whether residents have problems with neighbourhood air quality.	🡻 Generally the percentage of residents who had problems with air quality decreased from 1991 to 1999.

Other Related Sections: Population Growth, Health, Weather and Climate, Land Use, Built Environment, Urban Amenity, Energy, Transportation, Businesses, Employment and Unemployment.

Air pollution can have a major impact on people and the environment. Adverse effects of air pollution include health problems ranging from lung and eye irritations from short-term exposure, to permanent respiratory and nervous system damage from long-term exposure. In addition, air pollution can damage buildings and natural environments[8].

Christchurch City is particularly susceptible to winter air pollution due to its geographic location and calm winter weather. Under these weather conditions a temperature inversion develops. Consequently, cold air and emissions are trapped under the layer of warmer air and cannot disperse as there is no wind and the inversion stops vertical dispersion.

The main sources of air pollutants in Christchurch result from combustion processes, particularly emissions from industrial, commercial and domestic activities and motor vehicles. The most common air pollutants in Christchurch are suspended particulate matter (PM_{10}), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and lead. Of these PM_{10} (from smoke) is considered to be the biggest problem in Christchurch.

Residents rank air quality as one of the most important environmental issues in the City. The 1999 Annual Survey of Residents found that air quality was perceived to be the second most important environmental issue in the City. A self-completed survey in The Press newspaper conducted by Canterbury Dialogues[9] found that air quality was the number one issue in Canterbury.

Pressures on Air Quality

The Canterbury Regional Council (CRC) has carried out two recent investigations into factors that influence Christchurch's air quality. An air shed study examined the relationship between meteorological conditions and air quality. Secondly, an emissions inventory investigated the relative contribution various activities have on winter air quality.

Air Shed Study[10]

The Regional Council initiated an air shed study for Christchurch during 1994 and 1995. Analysis of data from the first phase of the study has identified the following meteorological conditions that influence the concentration and dispersion of air pollutants:

- Strong inversions are shown to develop overnight in the winter, trapping atmospheric pollutants in a shallow layer (typically less than 100 metres above the ground). During sunny mornings solar heating is able to destroy the inversion within a few hours, establish vertical mixing and decrease surface air pollution concentrations.
- Wind speed during the night often shows wave-like patterns, sometimes resulting in strong downward mixing of fresh air from aloft, and the decline of air pollution concentrations for short periods at ground level.
- Clean, cold air draining down the slopes of the Port Hills and from the Canterbury Plains has been observed to interact with air over Christchurch trapped by temperature inversions, to produce marked fluctuations in observed air pollution concentrations.

These localised phenomena have implications for both air quality in various areas and the movement of pollution from one part of the City to the other.

Christchurch Inventory of Total Emissions[11]

An emission inventory for urban Christchurch was undertaken by the Regional Council between June 1995 and June 1996. The objective was to identify and compare the relative contribution of emissions from industry, domestic fires and motor vehicles to the winter air quality. It also aimed to establish a baseline for emissions from different sectors for the purpose of monitoring future trends in emissions.

[8] More information on the health effects of air pollution can be found at http://www.crc.govt.nz/crchome/gis&database/airpol/guidelines.htm

[9] Canterbury Dialogues is an independent charitable trust. For more information see: http://www.canterburydialogues.org.nz/

[10] Canterbury Regional Council, Regional Environmental Report 1995/96.

[11] Canterbury Regional Council, Christchurch Inventory of Total Emissions Report R97/7.

The Christchurch inventory focused on emissions relating to a typical winter's day, reflecting the part of the year with significant air quality problems.

The emission inventory revealed that::

- Seventy eight per cent of Christchurch householders use electricity or gas (or both) as a method of home heating.
- Approximately 44 per cent of householders use a wood or coal burning appliance as their main method of home heating. Of these, approximately 62 per cent use woodburners, 30 per cent use open fires, and 8 per cent use enclosed coal-burning appliances or incinerators.
- Eighty two per cent of particulate emissions (PM_{10}) to the air on a typical winter's day result from domestic solid fuel heating.
- Motor vehicles are responsible for 90 per cent of nitrogen oxide (NO_x) emissions, 65 - 70 per cent of carbon monoxide (CO) and volatile organic compounds (VOC) emissions, and 60 per cent of carbon dioxide (CO_2) emissions.
- Fifty per cent of sulphur oxide (SO_x) emissions are from industry, compared with a third from home heating.
- Peak times for emissions over the study area were 4pm to 10pm for PM_{10}, CO, SO_x, VOC and CO_2 and 10am and 4pm for NO_x.
- Lowest emission times over the study area were 6am to 10am for PM_{10} and 10pm to 6am for CO, NO_x, SO_x, VOC and CO_2.

Air Quality Trends

The Canterbury Regional Council undertakes extensive air quality monitoring within Christchurch. Suspended particulate matter (PM_{10}), sulphur dioxide, nitrogen oxide, nitrogen dioxide and carbon monoxide have been monitored at a site in St Albans since 1988. Wind speed, wind direction and air temperature at ground level and at three metres are also measured. In addition, some monitoring of visibility and humidity has been carried out at this site.

In 1995 three additional monitoring sites were established in residential areas in Hornby and Beckenham, and in a residential area adjacent to a large industrial area in Opawa. The Beckenham site was discontinued in 1997. Not all pollutants are monitored at each site.

In general, air quality varies throughout the day. The lowest pollutant concentrations occur around midday, while peaks in pollutant concentrations generally occur in the evenings from 8pm to midnight. Concentrations reduce to low levels during the early morning and peak again with morning traffic. Most pollution peaks occur during the winter months. The exception is SO_2 concentrations at Hornby where effects of SO_2, influenced by industrial activity, can occur throughout the year.

Table 2.8 Summary of the Ministry for the Environment Guidelines for Ambient Air Quality

	Average Period	Concentration
Particulates* (PM_{10})	24 hours	120 µg/m^3
	24 hours	50µg/m^3
Sulphur dioxide	10 min	500 µg/m^3
	1 hour	350 µg/m^3
	24 hours	125 µg/m^3
	Annual	50 µg/m^3
Carbon monoxide	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Nitrogen dioxide	1 hour	300 µg/m^3
	24 hours	100 µg/m^3
Lead	3 months	0.5-1.0 µg/m^3
Ozone	1 hour	150 µg/m^3
	8 hour	100 µg/m^3

mg = milligrams, i.e grams/10^3
µg = micrograms, i.e grams/10^6

1. Ambient air quality is air quality in a general area, i.e away from the influence of a specific contaminant discharge.

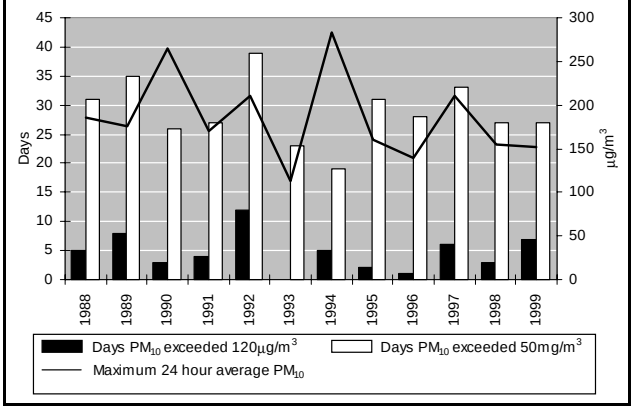
* In March 1996 the Canterbury Regional Council adopted a monitoring and reporting guideline for PM_{10} of 50µg/m^3.

Source: Ministry for the Environment and Canterbury Regional Council.

Suspended Particulate Matter (PM_{10})

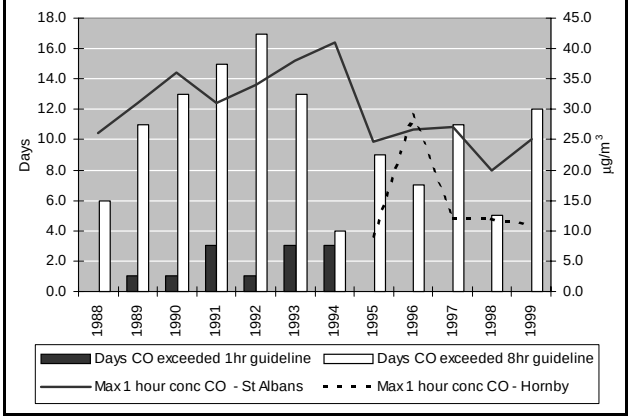
The Canterbury Regional Council 24-hour guideline for PM_{10} concentrations (50µgm^{-3}) has been exceeded every year since 1988 (Figure 2.8). The number of days which exceeded the guideline varied from 19 to 39 days per year for the period, with the average number of excessive concentrations being 29 days. This is equivalent to having one month a year with air quality that is hazardous to people's health. Maximum 24-hour concentrations of PM_{10} averaged 185 µgm^{-3} during the 1988 to 1999 period, which is three and a half times greater than the CRC guideline and well above the Ministry for the Environment's 120 µgm^{-3} guideline. As winter air quality is controlled by the weather, variation between years can be quite large, making it difficult to distinguish whether a trend exists or not.

Fig 2.8 Number of Days PM_{10} Guidelines are Exceeded – St Albans



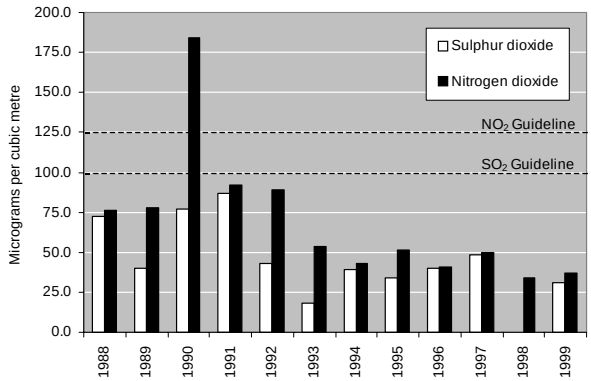
Source: Canterbury Regional Council.

Fig 2.9 CO Monitoring Results for St Albans, April to September 1988 to 1999



Source: Canterbury Regional Council.

Fig 2.10 Max 24 hr average SO_2 and NO_2 - St Albans, April to September 1988 to 1999



Source: Canterbury Regional Council.

On most high pollution nights, levels recorded at the St Albans monitoring site were higher than those recorded at other sites. Variations in emissions and proximity to sources could account for some of the differences between sites. The areas of non-residential open space near Hornby and to a lesser extent Opawa could also explain some of the variation between these sites and the residential site in St Albans[12].

Carbon Monoxide (CO)

Concentrations of carbon monoxide have exceeded the eight-hour guideline during each year since 1988. The St Albans site averages 10 days a year with CO concentrations greater than the 10 μgm^{-3} guideline (Figure 2.9). Between 1995 and 1999, one-hour concentrations of CO did not exceed the one-hour guideline of 30 μgm^{-3}.

Carbon monoxide is also monitored at Hornby. The maximum one-hour concentrations are shown on Figure 2.9. Generally, maximum concentrations of CO at Hornby were around half those recorded at St Albans. As a result CO concentrations at Hornby exceeded the guidelines on fewer days than at St Albans.

Sulphur Dioxide (SO_2)

The maximum annual 24-hour average concentration of sulphur dioxide at the St Albans monitoring site was consistently lower than the relevant guideline between 1988 and 1999 (Table 2.9 and Figure 2.10). Concentrations of SO_2 measured at the St Albans site show seasonal variations, with higher concentrations occurring during the winter period. Maximum concentrations at Hornby can occur throughout the year, with minimum concentrations during the period from early December to mid-February. This is likely to be due to the industrial nature of the area and the impact of SO_2 emissions from nearby industries.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide levels showed a decreasing trend between 1988 and 1999 (Figure 2.10), except for a peak in 1990 when the 24-hour guideline of 100μgm^{-3} was exceeded with an annual 24 hour maximum of 184μgm^{-3}. This was over twice as high as any other record and is probably the result of a single one-off event.

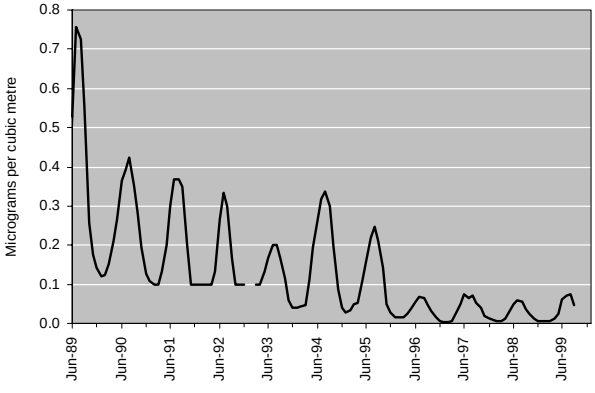
Lead Monitoring

Figure 2.11 shows the lead concentration for the period 1989 to 1999 at the St Albans site. There was a noticeable decrease in lead concentrations over this period, reflecting the change to unleaded fuel in motor vehicles. As a result, the lead guideline of 0.5-1.0μgm^{-3} (three-monthly average) was not been exceeded at the St Albans site after the winter of 1989. After January 1996 the lead concentrations remained below 0.1μgm^{-3} compared with the guideline of 0.5 to 1.0μgm^{-3}.

Carbon Monoxide Monitoring at Riccarton Road

Carbon monoxide monitoring was carried out by the Canterbury Regional Council on Riccarton Road during June and July of 1993 and from March to June in 1996. The purpose of this monitoring was to

Fig. 2.11 Lead Concentration at St Albans, 1988 – 1999 (3 month running mean)



Source: Canterbury Regional Council.

[12] Canterbury Regional Council, Annual Air Quality Monitoring Report 1998, U99/26.

Table 2.9 Summary of Winter 1999 Air Quality Monitoring at St Albans, Opawa and Hornby

Site		CO 8 hour	CO 1 hour	PM_{10} 24 hour (50 mg/m^3)	PM_{10} 24 hour (120mg/m^3)	NO_2 24 hour	SO_2 24 hour
St Albans	Days exceeding	12	0	27	7	0	0
	Max Conc.	21	25	152	152	37	31
Opawa	Days exceeding	-	-	13	1	-	0
	Max Conc.	-	-	168	168	-	47
Hornby	Days exceeding	0	0	-	-	-	0
	Max Conc.	7	11	-	-	-	67
Guidelines		10 mg/m^3	30 mg/m^3	50 mg/m^3	120 mg/m^3	100 mg/m^3	125 mg/m^3

Source: Canterbury Regional Council.

measure street level air quality that results from motor vehicle carbon monoxide emissions on a busy arterial road in urban Christchurch.

Measurements in 1996 were carried out at two monitoring sites. One was at street level on Riccarton Road, approximately 100 metres west of the Clarence Street/Riccarton Road intersection. The second site was 30 metres back from Riccarton Road and measured the impact vehicle emissions have on the surrounding area. (The 1993 site was situated close to the Clarence Street/Riccarton Road intersection.)

The eight-hour ambient air quality guideline (10mg/m^2) for carbon monoxide was exceeded at street level on 30 per cent of the 79 days monitored in 1996. The one hour ambient air quality guideline (30mg/m^2) was exceeded on 4 per cent of the days monitored. Fewer high readings were measured in 1996 than in 1993. Differences between the concentrations measured in 1996 and 1993 were likely to be due to lower wind speeds in 1993 and the different locations of the monitoring equipment. Concentrations of carbon monoxide at the site 30 metres from Riccarton Road did not exceed any of the ambient air quality guidelines.

The eight-hour guideline was more likely to be exceeded on days when vehicle numbers were greater than about 1,050 vehicles per hour and the maximum wind speed was less than 2 m/s. On days when the wind was primarily from the northerly quadrants, the minimum number of vehicles required to exceed the deadline decreased to about 900 per hour. This was due to the monitoring equipment being on the downwind side of the road.

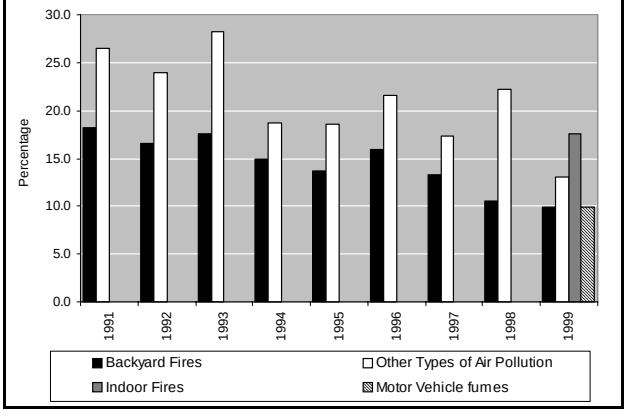
Air Pollution Complaints

The Christchurch City Council and the Canterbury Regional Council are jointly responsible for investigating complaints about the City's air quality arising from odours, fumes, dust, smoke and other problems. The City Council receives an average of 210 complaints a year.

The Regional Council's complaints register covers the whole of the Canterbury Region. However, the majority of air quality complaints are for the Christchurch City area. Between 1996 and 1998, complaints increased from 845 to 1,751 and then declined to 1,613 in 1999. Approximately 90 per cent of complaints received by the Regional Council were for odours, spray drift and industrial discharges, with the remaining complaints relating to domestic fires.

The Christchurch City Council's Annual Survey asked a representative group of residents whether they had experienced problems with air pollution. Figure 2.12 shows there has been a decrease in the percentage of those who had problems with air pollution, especially with regard to backyard fires. In 1999 the survey also asked whether indoor fires and motor vehicle fumes were a nuisance. Eighteen and 10 per cent of respondents respectively indicated these were a nuisance.

Fig 2.12 Percentage of Residents Who Have Had Problems with Air Pollution



Source: Christchurch City Council, Annual Survey of Residents.