GEMS/AMIS Air Quality Monitoring Programme Annual Report 2004

Prepared for the Ministry for the Environment

by

Laboratory Services – Air Quality Group

April 2005

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Published in September 2005 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10-362, Wellington, New Zealand

ISBN: 0-478-25912-3
ME number: 680

This document is available on the Ministry for the Environment's website:
www.mfe.govt.nz

Ministry for the Environment
Manatū Mō Te Taiao

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1 Summary

Air pollutants arise from a number of different sources. Fine particles (PM_{10}) arise from stationary and mobile combustion sources, principally domestic heating, industrial processes and vehicle emissions (as well as natural processes such as soil erosion and sea salt). Sulphur dioxide is produced from the burning of fossil fuels, particularly coal and oil. Carbon monoxide is a product of incomplete combustion of carbon containing fuels, especially from motor vehicles. Volatile organic compounds (VOCs) are organic chemicals, such as hydrocarbons, that are closely tied to vehicle emissions and many industrial processes. Historically, lead was a petrol additive but since the significant reduction of lead in petrol from 1996, levels have declined in New Zealand.

The (Global Environmental Monitoring System) GEMS monitoring sites were established to measure key air pollutants associated with adverse effects on people's health and wellbeing. This report presents the 2004 data set for the GEMS sites in Auckland and Christchurch, New Zealand. The GEMS sites include some of the longest running air quality monitoring sites in New Zealand. Various air quality monitoring has been undertaken at the Gavin Street, Penrose site in Auckland since 1964. These sites were established to determine the effect of policies for air quality management and are important for recording trends in pollution level trends in New Zealand. The GEMS sites have provided continuity in monitoring data for Auckland and Christchurch, and a snapshot of air quality for two of New Zealand's largest cities.

The two Auckland monitoring sites include a site dominated by residential and vehicle emissions (Kowhai Intermediate School, Kingsland) and a site representative of vehicle and industrial emissions (Gavin Street, Penrose). This report also includes data from the Kelly Street, Mt Eden site which was decommissioned and replaced by Kowhai in October 2004 after seven months parallel monitoring. The Greers Road, Burnside site in Christchurch is located within a residential area and represents emissions from domestic properties. The other Christchurch site (Cole's Place, St Albans) is also in a residential area and measures additional pollutants.

Five ambient air quality standards for carbon monoxide, nitrogen dioxide, ozone, PM_{10} and sulphur dioxide were promulgated in October 2004. These standards are the minimum requirements that outdoor air quality must meet to guarantee a set level of protection for human health and the environment. The ambient standards are based on existing ambient air quality guidelines. Guideline levels for pollutants (and averaging periods) not covered by the standards still apply.

The monitoring for carbon monoxide undertaken at Burnside, Christchurch showed concentrations were below the air quality 1-hour standard and 8-hour guideline during 2004. The nitrogen dioxide air quality 1-hour standard and 24-hour guideline was not exceeded at any site during 2004. Neither site in Auckland or Christchurch experienced exceedences of the sulphur dioxide air quality 1-hour standard and 24-hour guideline. There were no exceedences of the 24-hour fine particles air quality standard at Kelly Street (Mt Eden), Gavin Street (Penrose) or Kowhai Intermediate (Kingsland) during 2004. However, at Greers Road, Burnside, there were 25 exceedences of the 24-hour standard, mainly during the winter months from July to August 2004. These exceedences are likely to have resulted from the combination of home heating emissions and meteorological conditions such as temperature inversions. At all sites the six month concentrations of VOCs as benzene were below the guideline value of 3.6 $\mu g/m^3$ to be achieved by 2010.

The continuous monitors performed well with data capture rates (instrument availability including calibration data) of well over 90% for all sites. Valid NO_2 data (excluding calibrations and other invalid results) from the Burnside site was just below 90% due to communication difficulties with the instrument and an air conditioning failure. Unfortunately, the filters used for lead analysis were misplaced in storage and have been unavailable for lead analysis.

2 Introduction

This report presents the annual data set for 2004 for ambient air quality monitoring in Auckland and Christchurch, New Zealand. The monitoring is conducted by Watercare Services Ltd, on behalf of the Ministry for the Environment (MfE).

The Ministry for the Environment has a Memorandum of Understanding with the New Zealand Ministry of Health to collect and supply air quality monitoring data to the World Health Organization (WHO) from three sites – two in Auckland and one in Christchurch.

This data has historically formed New Zealand’s contribution to WHO’s Global Environmental Monitoring System / Air Pollution Programme (GEMS/AIR) which began in 1973.[1]

In 1996 WHO developed the Air Management Information System (AMIS) the successor to GEMS/AIR. The objective of AMIS is to transfer information on air pollutant concentrations and air quality management between countries. Nationally it aims to support and assist in the maintenance of air quality in parts of New Zealand that enjoy clean air and to improve air quality where it has deteriorated.

As a result, data from the AMIS programme is used by the Ministry for the Environment to support and enhance ambient air quality monitoring and management in Auckland and Christchurch. In fact the GEMS/AMIS ambient air quality sites are the longest running sites in New Zealand and as such are very important in identifying local long term trends in air pollution.

The Auckland sites are located in the industrial area of Penrose to the southeast of the city centre and in Mt Eden and Kingsland, both of which are older residential areas just south of the city centre. Air quality monitoring has been performed in Penrose since 1964 and at Mt Eden since 1982. In October 2004 the Mt Eden site was decommissioned pending redevelopment of the site. However, a replacement site was commissioned in April 2004 providing seven months of parallel monitoring data.

Between 1989 and 2002 monitoring was undertaken in Christchurch at a site located in the older residential area of St Albans just north of the city centre. Due to impending redevelopment of this site the monitoring station was relocated in November 2002 to a site in Burnside/ Bishopdale, is a newer residential area to the northwest of the city centre.

This report includes graphical and statistical presentations of the data as well as any data collection issues that may have arisen during the monitoring period.

The Auckland Regional Council has kindly provided permission to use data from their monitoring instruments (Gavin Street Penrose and Kelly Street Mt Eden) for inclusion in this report.

All data in this report has been completely validated. Quality assurance checks have been carried out to ensure that invalid and calibration data is not reported.

1 Schwela DH. 1999. Public health and the air management information system (AMIS). *Epidemiology* 10(5): 647–55.

3 Air Pollutants Monitored

3.1 Particulate matter

Particulate matter is an air pollutant that is associated with a variety of health and environmental effects.

Sources of particulates vary widely from location to location and reflect the wide range of emission sources of particulate concentrations in New Zealand. Typical sources include:

- fine particulates that result from fuel combustion such as those associated with road vehicles, power generation, industrial processes, domestic heating appliances, etc
- particulates formed by chemical reactions in the atmosphere. These comprise largely of sulphates and nitrates
- coarse particulates from a wide range of sources, including re-suspended dusts from road vehicles, construction works, mineral extraction processes, wind-blown dusts and soils, sea salt, and biological particles such as pollen.

There are a variety of measures which can be used to determine the different health and environmental effects of particulate matter. As part of the GEMS/AMIS programme two particle size fractions are monitored:

- fine particulates (PM_{10})
- total suspended particulates (TSP).

3.1.1 Fine particulates (PM_{10})

As described above, particles with a diameter of 10 μm or less can be inhaled into the respiratory system. The main effect is on human health. The coarser fraction of airborne particles (2.5 μm to 10 μm) is deposited in the trachea bronchial region, where asthma attacks are triggered.

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.

3.1.2 Total suspended particulate (TSP)

TSP consists of all particles which range in size from 50 μm diameter downwards. Particles larger than 50 μm are too large to remain airborne for extended periods and thus form deposited particulate.

TSP is sufficiently small to be inhaled, however, the larger particles (10–50 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.

3.2 Lead

Lead is present in the atmosphere in its elemental form and one of the principle sources has been motor vehicle emissions. Historically, lead was included in petrol as a catalyst for combustion but has been removed from fuel supplies since 1996.

As a result atmospheric concentrations of lead have dropped markedly since this time and, to reflect this, in October 2000 monitoring of lead was reduced from monthly samples to samples taken over a three-month period during the winter (June–August) only.

3.3 Sulphur dioxide

Sulphur dioxide is an acidic gas with a pungent odour. It is mainly produced by the burning of fossil fuels. The gas is quite corrosive and can cause damage to buildings and other materials.

It can also have significant effects on the human respiratory system. Inhalation of high ambient concentrations of sulphur dioxide can cause stimulation of the nerves in the air passages, resulting in a reflex cough, irritation and chest tightness.

In addition, sulphur dioxide can also cause narrowing of the air passages, particularly in people suffering from asthma and chronic lung disease. These people frequently have narrowed airways, and any further restriction will have a disproportionately large effect compared to people with uncompromised respiratory systems.

3.4 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 parts of New Zealand are motor vehicle exhaust emissions, and 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 of objectionable levels of vehicle exhaust fumes.

3.5 Nitrogen oxides

Nitrogen oxides incorporates several species that exist in the atmosphere, collectively referred to as NO_x. The two main oxides are nitrogen dioxide (NO_2) which is of concern due to its potential to cause health effects, and the monoxide form nitric oxide (NO) which is less toxic 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, as indicated, this can then be oxidised to nitrogen dioxide in ambient air. Emissions from motor vehicles are the major source of the NO_x in most parts of the country, although power stations and other large combustion units may be significant localised sources as well.

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.

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.

3.6 Volatile organic compounds

Volatile organic compounds are chemicals that easily evaporate at room temperature. The term ‘organic’ indicates that the compounds contain carbon.

To rationalise air quality guidelines, the Ministry for the Environment has compiled a list of priority contaminants based on a review of international literature. The priority list includes the volatile organic compounds (VOC) benzene and 1,3-butadiene and provides ambient air quality guidelines for these contaminants (MfE 2002).

4 Ambient Air Quality Guidelines and Standards

The Ministry for the Environment has promulgated national environmental standards for air quality. These standards were released in October 2004, and for several major contaminants they replaced the Ambient Air Quality Guidelines 2002. Both the national environmental standards and the Ambient Air Quality Guidelines are set to protect human health. The national environmental standards allow a number of exceedences per year but must be complied with by 1 September 2005. Ministry for the Environment guidelines for the various air pollutants monitored as part of the GEMS/AMIS programme are given in Table 1.

Total suspended particulate (TSP) does not have a guideline value in the Ministry for the Environment's Ambient Air Quality Guidelines as it does not have a recognised effect on human health. The criteria applied to TSP is 60 µg/m^3 (seven-day average) previously applied by the Ministry of Health. This has been superseded by the Ministry's Ambient Air Quality Guidelines but is useful for analysing the results of the monitoring data.

Table 1: National environmental standards, guidelines and regional targets

Air pollutant	National environmental standards 2004	Ministry for the Environment Ambient Air Quality Guidelines 2002 and other	Averaging period	National environmental standards permissible excess
Carbon monoxide	10 mg/m^3		8-hour average	One 8-hour period in a 12-month period
		30 mg/m^3	1-hour average	
Nitrogen dioxide		100 µg/m^3	24-hour average	
	200 µg/m^3		1-hour average	9 hours in a 12-month period
Sulphur dioxide		120 µg/m^3	24-hour average	
	350 µg/m^3		1-hour average	9 hours in a 12-month period
	570 µg/m^3		1-hour average	Not to be exceeded at any time
Benzene				
– Year 2000		10 µg/m^3	Annual average	
– Year 2010		3.6 µg/m^3	Annual average	
1,3-Butadiene		2.4 µg/m^3	Annual average	
Fine particulate (PM_{10})		20 µg/m^3	Annual average	
	50 µg/m^3		24-hour average	One 24-hour period in a 12-month period
Total suspended particulate (TSP)		60 µg/m^3 (MoH)	7-day average	
Lead		0.2 µg/m^3	3-month average	

5 Monitoring Sites

5.1 Site descriptions

A brief description of the monitoring sites in the GEMS/AMIS air quality monitoring programme is given below. This includes the three Auckland sites at Gavin Street in Penrose. Kelly Street in Mt Eden and Kowhai Intermediate in Kingsland, as well as the two sites in Christchurch at Greers Road in Burnside and Coles Place in St Albans.

5.1.1 MfE Kelly Street, Mt Eden, Auckland – site AKL002

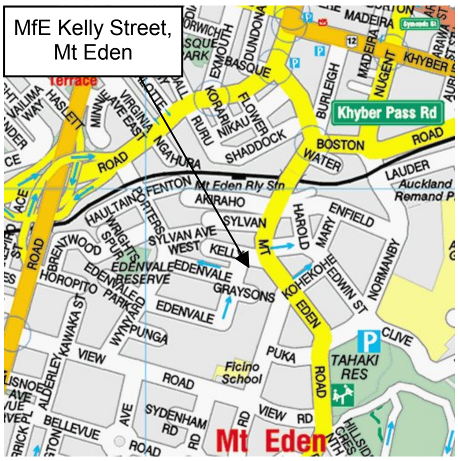
Site name	MfE Kelly Street, Mt Eden	**Site ID**	AKL002
Address	Ex-ESR Site, Kelly Street, Mt Eden, Auckland	**Site class**	Residential – peak

Description

This site is located within the grounds of the former ESR Mt Eden Science Centre off Kelly Street. Historically there has been a lot of local vegetation around the site, which is surrounded by residential properties on three sides and is within 30 metres of the busy Mt Eden Road which runs north to south past the site. It is representative of emissions arising from road vehicles as well as domestic properties in the older inner-city area of Mt Eden which lies to the south of Auckland city centre. About 200 metres to the south-east of the site is the actual Mt Eden, an extinct volcanic cone, which can have a localised impact on meteorological conditions. Due to impending redevelopment of this site, parallel monitoring between this site and a replacement site was undertaken during 2004. All monitoring has now been re-located to the new site at Kowhai Intermediate School in Kingsland which is about 500 metres to the west of the current site.

Pollutants monitored	**CO** N	**NO_2** Y	**SO_2** N	**VOCs** Y
	PM_{10} N	**TSP** Y	**Lead** Y	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**Relative humidity** Y	
	Temperature (5 m) Y	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map



Photograph

5.1.2 MfE Kowhai, Auckland – site AKL073

Site name	MfE Kowhai, Kingsland	**Site ID**	AKL073
Address	Kowhai Intermediate School, Sandringham Road, Auckland	**Site class**	Residential – peak

Description

This site is located within the grounds of Kowhai Intermediate School. It is surrounded by residential properties on three sides as well as the school buildings which lie about 100 metres to the east. The busy New North Road is approximately 100 metres to the north of the site whilst Sandringham Road runs northwest to southeast past the site and Eden Park rugby ground which is within 300 metres to the southeast of the site. It is representative of emissions arising from road vehicles as well as domestic properties in the older inner-city area of Kingsland which lies to the south of Auckland city centre. This is a new site, commissioned in 2004, designed to replace the neighbouring Kelly Street site in Mt Eden which is due to be redeveloped. The new Kowhai site lies about 500 metres to the west of the Kelly Street and both sites have the same 'Residential – Peak' classification. During 2004 a period of parallel monitoring between the two sites was undertaken before all monitoring was relocated to the new Kowhai site in October 2004.

Pollutants monitored	**CO** N	**NO_2** Y	**SO_2** N	**VOCs** Y
	PM_{10} Y	**TSP** Y	**Lead** Y	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**Relative humidity** Y	
	Temperature (5 m) Y	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map

Photograph

5.1.3 MfE Gavin Street, Penrose, Auckland – site AKL009

Site name	MfE Gavin Street, Penrose	**Site ID**	AKL009
Address	Transpower, Gavin Street, Penrose, Auckland	**Site class**	Industrial – dense / traffic – peak

Description

This site is located within the grounds of the Transpower NZ Ltd electrical sub-station on Gavin Street. It is representative of road vehicle and industrial emissions in the Penrose area which lies to the southeast of Auckland city centre and is also approximately 50 metres northeast of the southern motorway. There are residential properties immediately to the northeast of the site. During 2003 parallel monitoring was undertaken between this site and the neighbouring ACI site on the Great South Road in Penrose with a view to consolidating all monitoring at the Gavin Street site early in 2004.

Pollutants monitored	**CO**	**NO_2**	**SO_2**	**VOCs**
	N	Y	Y	Y
	PM_{10}	**TSP**	**Lead**	
	N	N	N	
Meteorological parameters monitored	**Wind speed**	**Wind direction**	**Relative humidity**	
	Y	Y	Y	
	Temperature (5 m)	**Temperature (10 m)**	**Temperature (2 m)**	
	Y	N	N	

Location map

Photograph

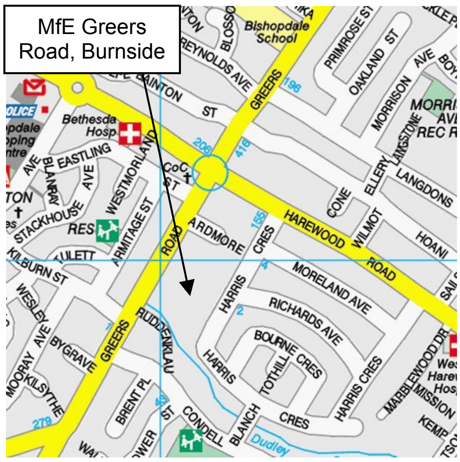
5.1.4 MfE Greers Road, Burnside, Christchurch – site CAN002

Site name	MfE Greers Road, Burnside	**Site ID**	CAN002
Address	Transpower, Greers Road, Burnside, Christchurch	**Site class**	Residential – neighbourhood

Description

This site is located in a paddock to the rear of the Transpower NZ Limited electrical substation on Greers Road and is surrounded by residential properties on four sides. It is representative of emissions arising from domestic properties in the newer suburban areas of Burnside and Bishopdale which lie to the northwest of Christchurch city centre.

Pollutants monitored	**CO** Y	**NO_2** Y	**SO_2** Y	**VOCs** Y
	PM_{10} Y	**TSP** N	**Lead** N	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**Relative humidity** Y	
	Temperature (5 m) N	**Temperature (10 m)** Y	**Temperature (2 m)** Y	

Location map	**Photograph**
	

5.1.5 MfE Coles Place, St Albans, Christchurch – site CAN003

<table>
<tr><td>Site name</td><td>MfE Coles Place, St Albans</td><td>Site ID</td><td colspan="2">CAN003</td></tr>
<tr><td>Address</td><td>Coles Place, St Albans, Christchurch</td><td>Site class</td><td colspan="2">Residential – neighbourhood</td></tr>
<tr><td colspan="5">Description
This site is operated by Environment Canterbury and is located on an area of public open space at the end of Coles Place. It is surrounded by residential properties on four sides. It is representative of emissions arising from domestic properties in the older suburban area of St Albans which lies to the north of Christchurch city centre.</td></tr>
<tr><td rowspan="2">Pollutants monitored</td><td>CO
N</td><td>NO_2
N</td><td>SO_2
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<tr><td rowspan="2">Meteorological parameters monitored</td><td>Wind speed
N</td><td>Wind direction
N</td><td>Relative humidity
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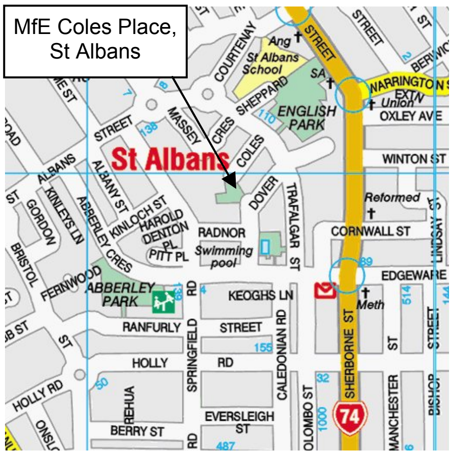
</td><td colspan="3">Photograph
</td></tr>
</table>

5.2 Air pollutants monitored at GEMS/AMIS sites

An overview of the air pollutants monitored at each site, as part of the GEMS/AMIS programme, is given in Table 2 below.

Table 2: Air pollutants monitored at GEMS/AMIS sites

Site	CO	NO_2	SO_2	VOC	PM_{10}	TSP	Lead*
Kelly Street, Mt Eden, Auckland AKL002		✓		✓	✓	✓	✓
Kowhai Intermediate, Kingsland AKL073N		✓		✓	✓	✓	✓
Transpower, Gavin Street, Penrose, Auckland AKL009		✓	✓	✓	✓		
Greers Road, Burnside, Christchurch CAN002	✓	✓	✓	✓	✓		
Coles Place, St Albans, Christchurch CAN003				✓		✓	✓

Note:

* Lead is monitored in the months of June, July and August only.

6 Methods

6.1 Quality assurance

All monitoring services are undertaken by Watercare Services Ltd in accordance with the Ministry for Environment's *Good Practice Guide for Air Quality Monitoring and Data Management* and wherever applicable the appropriate Australian/New Zealand and US EPA monitoring methods.

Watercare Laboratory Services is accredited by IANZ (International Accreditation New Zealand) and since October 2003 has held accreditation for the following methods:

- Australian Standard AS 3580.7.1 – 1992 'Method 7.1: Determination of Carbon Monoxide – Direct Reading Instrumental Method'.
- Australian Standard AS 3580.5.1 – 1993 'Method 5.1: Determination of Oxides of Nitrogen – Chemiluminescence Method'.
- Australian Standard AS 3580.4.1 – 1990 'Method 4.1: Determination of Sulphur Dioxide – Direct Reading Instrumental Method'.
- US EPA Method 40, Part 50, Appendix J 'Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere'.

As part of the GEMS/AMIS programme, Watercare Laboratory Services provides the following monitoring services:

- Instrument operation, calibration and maintenance. This includes the use of automatic daily calibration systems for all continuous ambient gas monitors ensuring that the requirements of the relevant Australian Standards for weekly calibration of continuous analysers.
- Site maintenance as well as, when necessary, commissioning new sites and decommissioning old sites.
- Data logging, polling, checking, rescaling, validation, ratification and reporting. This encompasses the entire data quality assurance process ensuring that the final dataset reported is fit for the purpose of the GEMS/AMIS programme.

6.2 Analytical methods

6.2.1 Carbon monoxide

Measurements are made in accordance with AS 3580.7.1 – 1992 'Determination of Carbon Monoxide – Direct Reading Instrumental Method'. The performance of the instruments are checked using an automatic calibration system ensuring compliance with the method which requires instrumentation to be calibrated on a weekly basis.

The instruments themselves are infra red absorption gas analysers which continuously measure carbon monoxide. This allows data to be analysed and reported over a variety of average periods including 10 minutes, 24 hours and one year.

6.2.2 Nitrogen oxides

Measurements are made in accordance with AS 3580.5.1 – 1993 'Determination of Oxides of Nitrogen – Chemiluminescence Method'. The performance of the instruments are checked using an automatic calibration system ensuring compliance with the method which requires instrumentation to be calibrated on a weekly basis.

The instruments themselves are chemiluminescence gas analysers which continuously measure nitrogen oxides. This allows data to be analysed and reported over a variety of average periods including 10 minutes, 24 hours and one year.

6.2.3 Sulphur dioxide

Measurements are made in accordance with AS 3580.4.1 – 1990 'Determination of Sulphur Dioxide – Direct Reading Instrumental Method'. The performance of the instruments are checked using an automatic calibration system ensuring compliance with the method which requires instrumentation to be calibrated on a weekly basis.

The instruments themselves are UV fluorescence gas analysers which continuously measure sulphur dioxide. This allows data to be analysed and reported over a variety of average periods including 10 minutes, 24 hours and one year.

6.2.4 Volatile organic compounds

VOCs are measured each quarter (January–March, April–June, July–September and October–December) in accordance with Watercare's Air Quality Group Test Method T114 (ref NIOSH Methods 1500 and 1501).

VOC samples are taken using passive (3M) sampling badges which are exposed for a three-month period. The VOCs diffuse on to the badges which are coated with activated carbon. Following exposure the samples are forwarded to AgriQuality who extract the VOCs using carbon disulphide and analyse them using GC-MS.

Note: 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 three 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.

6.2.5 Particulate matter (PM_{10})

Measurements are made in accordance with the US EPA Equivalent Method for measuring PM_{10} EQPM-1102-150 'Thermo Andersen Series FH62-C14 Continuous PM_{10} Ambient Particulate Monitor'. This method was designated as an Equivalent Method by the US EPA in accordance with 40 CFR Part 53 on 11 December 2002.

The Thermo Andersen FH62-C14 is fitted with a size-selective PM_{10} head and measures particle mass as it accumulates during sampling. As a result the instrument is able to record and output real-time measurements of PM_{10} data which allows measurements to be reported over a variety of average periods, including; 10 minutes, 24 hours and one year. The inlet temperature of all beta-gauges operated by the Ministry for the Environment is 40°C.

6.2.6 Particulate matter (TSP)

Measurements of TSP are made in accordance with Watercare's Air Quality Group Test Method T101. It is a gravimetric method of measuring particulates and is modelled upon the High Volume sampler method. The technique has been used to provide TSP data at existing GEM/ AMIS sites since 1982.

The equipment used to measure TSP is quite basic and involves ambient air being pulled through a glass fibre filter by a pump with a gas meter being used to measure the air volume drawn through the filter. The filter is weighed before and after sampling. The TSP concentration is determined from the weight of particulates collected and the air volume sampled.

6.2.7 Lead

Lead is sampled during the winter months, June–August, using the same instrumentation used to measure TSP according to Watercare's Air Quality Group Test Method T101. This is a gravimetric technique used to measure particulates and is modelled upon the high volume sampler method. The technique has been used to provide TSP data at existing GEM's sites since 1987.

Analysis of lead is performed according to Watercare Laboratory Services according to US EPA Methods 3051 and 200.7. This involves taking a composite of the weekly TSP filters exposed during each winter month and digesting them all, using mixed acid digestion, into a single sample. This sample is then analysed for lead using the technique of Inductively Coupled Plasma Optical Emisssions Spectrometry (ICP-OES). The concentration of lead sampled during the month is then determined from the amount of lead detected and the total volume of air sampled during the respective month.

7 Results and Discussion

7.1 Site performance and quality assurance

The continuous monitors performed well during 2004. All sites having data capture rates well over 90%.

Monitoring at Kowhai Intermediate, Kingsland commenced in April 2004. Statistics below are taken from 8 April 2004, the date from which all instruments at Kowhai Intermediate, Kingsland were monitoring successfully.

Valid NO_2 data from the Greers Road, Burnside site was below 90% due to:

- communication difficulties with the instrument (between 31 March and 9 April 2004)
- an air conditioning failure. Monitoring was shut down during the period 13–21 September 2004 while a new air conditioning unit was installed
- Kelly Street, Mt Eden was decommissioned 26 October 2004 following almost seven months of parallel monitoring with Kowhai Intermediate, Kingsland between 8 April and 26 October 2004.

Overall site performance is shown in Table 3 below. This is based on 10-minute averages for continuously monitored data. Percent data capture is the percent of total instrument availability and includes down time for calibration and routine maintenance. Percent valid data is defined as the percent valid data following quality assurance (eg, invalidation of data resulting from calibrations, routine maintenance, spurious data, and excessively negative data).

Table 3: Percentage valid and capture data, January–December 2004

Analyte	Site	Percentage valid data (V) and percentage data capture (C)																									
		January		February		March		April		May		June		July		August		September		October		November		December		Annual	
		V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C
CO	Burnside	94.2	99.4	92.7	98.1	92.3	99.4	93.4	99.4	84.6	92.2	90.6	95.2	96.9	99.7	95.8	99.5	67.9	75.8	93.1	99.1	91.6	99.7	98.0	99.6	**90.2**	**96.4**
NO_2	Mt Eden	93.2	97.0	95.9	99.4	96.1	100	95.8	99.2	95.7	99.2	95.5	99.0	95.5	99.0	81.7	85.2	96.4	99.1	95.3	98.6	N/A	N/A	96.3	98.9	**94.3**	**97.7**
NO_2	Penrose	87.6	93.6	92.5	95.9	92.2	95.8	92.6	96.1	95.5	98.9	95.4	99.5	95.2	98.3	94.8	97.2	96.4	100	96.1	99.1	91.5	99.6	92.6	99.2	**95.1**	**97.8**
NO_2	Burnside	92.0	99.4	92.7	98.1	83.6	99.4	69.8	75.9	93.8	99.1	93.9	100	97.2	99.5	96.5	98.5	67.9	75.8	93.2	97.3	91.5	99.7	96.4	99.6	**89.5**	**95.2**
NO_2	Kowhai	N/A	N/A	N/A	N/A	N/A	N/A	92.9	95.1	86.2	86.2	94.4	97.0	93.6	96.3	95.9	98.7	96.9	99.7	96.2	99.4	96.8	99.6	96.4	99.8	**94.2**	**96.9**
SO_2	Penrose	87.6	93.7	92.7	96.2	92.3	95.7	92.4	95.9	96.1	99.5	96.3	99.4	95.4	98.5	93.3	96.9	95.8	100	94.1	99.3	90.3	99.6	93.2	99.6	**94.8**	**97.8**
SO_2	Burnside	94.1	99.5	92.7	98.1	92.3	99.4	93.6	99.4	96.8	99.1	94.8	100	96.5	99.8	96.6	99.5	68.0	75.8	93.7	99.1	92.0	99.7	97.2	99.6	**92.6**	**97.4**
PM_{10}	Burnside	96.9	99.4	92.6	98.1	95.9	99.3	93.2	99.3	94.6	99.1	95.8	100	97.2	99.8	95.0	99.5	69.6	75.4	99.0	99.3	99.5	99.7	98.9	99.5	**94.2**	**97.4**
PM_{10}	Kowhai	N/A	N/A	N/A	N/A	N/A	N/A	78.0	100	87.8	100	97.4	100	94.8	100	97.5	100	98.4	100	98.7	99.6	97.9	99.0	98.8	99.1	**94.3**	**99.7**
PM_{10}	Mt Eden	98.8	100	99.3	100	99.8	100	98.9	100	98.5	100	98.7	100	98.7	100	74.4	100	98.3	100	98.1	99.2	N/A	N/A	98.4	98.9	**96.5**	**99.8**
PM_{10}	Penrose	98.7	100	99.1	100	99.4	100	98.7	100	98.5	100	98.4	100	98.6	100	96.1	100	97.6	100	98.5	100	98.9	99.6	98.9	99.2	**98.4**	**99.9**
VOC	Mt Eden	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**	**100**
VOC	Penrose	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**	**100**
VOC	Burnside	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**	**100**
VOC	St Albans	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**	**100**
TSP	Mt Eden	0	0	0	0	60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	0	0	0	**63**	**63**
TSP	St Albans	0	0	0	0	100	100	100	100	100	100	100	100	80	80	100	100	100	100	100	100	100	100	100	100	**82**	**82**
TSP	Penrose	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**	**100**
TSP	Kowhai	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	50	50	100	100	100	100	**96**	**96**
Lead	Mt Eden	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Lead	Kowhai	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Lead	St Albans	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**

7.2 Carbon monoxide (CO) 2004

CO was monitored at Greers Road, Burnside. One hour and 8-hour averages have been calculated from 10-minute averages recorded by the instruments.

The maximum results and their dates are described in the following table.

Site	1-hour maximum (mg/m^3)	99.9 percentile 1-hour (mg/m^3)	8-hour maximum (mg/m^3)	99.9 percentile 8-hour (mg/m^3)
Greers Road, Burnside	8.4 (26 June – 24:00)	7.2	6.2 (27 June – 04:00)	5.5

Results are given in Figures 4 to 7.

Concentrations of CO at Greers Road, Burnside were below the ambient air quality 1-hour guideline (30 mg/m^3) and 8-hour national environmental standard (10 mg/m^3) during 2004.

7.3 Nitrogen oxides (NO_2 and NO) 2004

Oxides of nitrogen were monitored at Kelly Street, Mt Eden; Gavin Street, Penrose; Kowhai Intermediate, Kingsland; and Greers Road, Burnside. One hour and 24-hour averages have been calculated from 10-minute averages recorded by the instruments.

The maximums for NO_2 and their dates for each site are described in the following table.

Site	1-hour maximum (µg/m^3)	99.9 percentile 1-hour (µg/m^3)	24-hour maximum (µg/m^3)	99.5 percentile 8-hour (µg/m^3)
Kelly Street, Mt Eden	66.2 (14 October 09:00)	61.9	41.2 (15 July)	40.6
Gavin Street, Penrose	98.8 (20 July 09:00)	71.6	51.6 (31 August)	49.2
Kowhai Intermediate School, Kingsland	69.1 (27 July 08:00)	62.6	42.2 (5 August)	38.5
Greers Road, Burnside	76.8 (9 July 10:00)	64.3	37.2 (28 June)	36.4

Nitrogen dioxide results are presented in Figures 8 to 13 (Kelly Street), 14 to 17 (Kowhai), 18 to 23 (Gavin Street), and 24 to 29 (Burnside).

There were no exceedences of the NO_2 ambient air quality 1-hour standard (200 µg/m^3) or the 24-hour guideline (100 µg/m^3) during 2004 at any site in Auckland or Christchurch.

7.4 Sulphur dioxide (SO_2) 2004

Sulphur dioxide was monitored at Gavin Street, Penrose and Greers Road, Burnside. One hour and 24-hour averages have been calculated from 10-minute averages recorded by the instruments. ACI monitoring was discontinued in January 2004.

The maximums for SO_2 and their dates for each site are described in the following table.

Site	1-hour maximum ($\mu g/m^3$)	99.9 percentile 1-hour ($\mu g/m^3$)	24-hour maximum ($\mu g/m^3$)	99.5 percentile 8-hour ($\mu g/m^3$)
Gavin Street, Penrose	40.1 (3 March 10:00)	33.1	13.9 (29 September)	12.5
Greers Road, Burnside	32.7 (3 November 08:00)	27.8	17.1 (21 July)	15.5

Results for Gavin Street, Penrose are shown in Figures 30 and 31and Greers Road, Burnside are shown in Figures 32 and 33. There were no exceedences of the SO_2 ambient air quality 1-hour standard (350 $\mu g/m^3$) or the 24-hour guideline (125 $\mu g/m^3$) during 2004 at any site.

7.5 Volatile organic compounds (VOC) January–December 2004

Monitoring of VOCs were conducted at four sites: Kelly Street, Mt Eden; Gavin Street, Penrose; Greers Road, Burnside; and Coles Place, Christchurch. VOC monitoring utilises passive sampling badges exposed over a three-month period. A set of results for each 2004 quarter are shown in Tables 4 to 7. See monitoring method in section 4.

The benzene 2000 annual average guideline is 10 $\mu g/m^3$. The 2010 guideline is 3.6 $\mu g/m^3$. The 2004 six-month and 12-month averages are described in the table below.

Site	Six-month average (January–June 2004) benzene ($\mu g/m^3$)	2004 annual average benzene ($\mu g/m^3$)
Coles Place, St Albans	2.5	2.7
Greers Road, Burnside	2.6	2.3
Gavin Street, Penrose	2.4	2.2
Kelly Street, Mt Eden[1]	3.4	3.0
Kowhai Intermediate School, Kingsland[2]	N/A	2.3

Note:

1 VOC monitoring at Kelly Street Mt Eden was decommissioned 26 October 2004. Results for October to December 2004 were not reported due to short sample period.

2 VOC monitoring at Kowhai began 16 July 2004.

Table 4: VOC results (January–March 2004)

January February March 2004 Analyte	Limit of detection (μg/m³)	Results (μg/m³)			
		Burnside	Coles Place	Gavin Street	Mt Eden
Target VOCs	ND				
Ethanol	ND				
Isopropyl alcohol	ND				
Acetone	ND				
Pentane	ND				
Dichloromethane	ND				
Butan-2-one	ND				
Hexane	0.5	0.8	0.6	0.9	0.7
Ethyl acetate	ND			0.7	
Trichloromethane	ND				
1,1,1-trichoroethane	ND				
n-butanol	ND				
Benzene	2.2	1.8	1.2	1.9	1.4
2-methylhexane	0.5			0.5	
2,3-dimethylpentane	ND				
Heptane	0.5		0.6		
Trichloroethene	ND				
Propyl acetate	0.5			0.8	
Methylcyclohexane	ND				
4-methylpentan-2-one	ND				
Toluene	ND				
Octane	ND				
Tetrachloroethene	ND				
Butyl acetate	ND				
Ethylbenzene	0.6	0.8		1.2	0.8
m+p-xylene	0.6	2.8	1.8	3.7	2.9
Styrene	ND				
o-xylene	0.6	1.0	0.6	1.3	1.0
Nonane	0.6				
Alpha pinene	0.7			0.7	
Propylbenzene	ND				
1,3,5-trimethylbenzene	ND				
Beta pinene	0.7			0.8	
Decane	0.7			1.2	
1,2,4-trimethylbenzene	0.6	1.3	0.7	1.2	1.1
Limonene	ND				
Undecane	0.5			1.1	
Dodecane	0.6			0.6	
Tetradecane	ND				

Table 5: VOC results (April–June 2004)

April May June 2004 Analyte	Limit of detection (μg/m³)	Results (μg/m³)			
		Burnside	Coles Place	Gavin Street	Mt Eden
Target VOCs					
Ethanol	ND				
Isopropyl alcohol	ND				
Acetone	ND				
Pentane	2.7	3.3	3.7	2.8	4.3
Dichloromethane	ND				
Butan-2-one	ND				
Hexane	0.6	1.2	1.3	1.5	2.7
Ethyl acetate	ND				
Trichloromethane	ND				
1,1,1-trichoroethane	ND				
n-butanol	ND				
Benzene	2.6	3.3	3.7	2.8	5.3
2-methylhexane	0.7	0.7	0.8	0.8	1.5
2,3-dimethylpentane	ND				
Heptane	0.7	0.7	1.0	0.8	1.3
Trichloroethene	ND				
Propyl acetate	ND				
Methylcyclohexane	ND				
4-methylpentan-2-one	ND				
Toluene	ND				
Octane	ND				
Tetrachloroethene	ND				
Butyl acetate	ND				
Ethylbenzene	0.7	1.1	1.1	1.5	2.7
m+p-xylene	0.7	3.9	4.0	5.6	10.6
Styrene	ND				
o-xylene	0.7	1.5	1.5	1.9	3.6
Nonane	ND				
Alpha pinene	0.9			0.7	
Propylbenzene	ND				
1,3,5-trimethylbenzene	0.7	0.7		0.7	1.5
Beta pinene	0.9		1.2	0.8	
Decane	0.9			1.1	
1,2,4-trimethylbenzene	0.7	1.9	1.8	1.9	3.9
Limonene	ND				
Undecane	0.6			0.6	
Dodecane	ND				
Tetradecane	ND				

Table 6: VOC results (July–September 2004)

July August September 2004 Analyte	Limit of detection ($\mu g/m^3$)	Results ($\mu g/m^3$)				
		Coles Place AM4729	Burnside AM4768	Gavin Street AR1405	Kowhai AM4720	Mt Eden AM4766
Target VOCs						
Ethanol	ND					
Isopropyl alcohol	2.0			2.6		
Acetone	ND					
Pentane	2.2	3.0	2.4	3.2	2.7	
Dichloromethane	2.1				6.2	6.2
Butan-2-one	ND					
Hexane	0.5	2.2	2.6	6.8	5.7	4.9
Ethyl acetate	ND					
Trichloromethane	ND					
1,1,1-trichoroethane	ND					
n-butanol	ND					
Benzene	0.3	4.7	3.6	3.0	3.3	2.3
2-methylhexane	0.5	0.8	0.6			
2,3-dimethylpentane	ND					
Heptane	0.5	0.8	0.8	0.7	0.7	
Trichloroethene	0.5	0.7	0.7			
Propyl acetate	0.5				1.4	
Methylcyclohexane	ND					
4-methylpentan-2-one	ND					
Toluene	ND					
Octane	0.3	9.8	7.5	9.2	10.1	7.2
Tetrachloroethene	ND					
Butyl acetate	ND					
Ethylbenzene	ND					
m+p-xylene	0.3	1.4	1.0	1.3	1.2	0.9
Styrene	0.3	5.0	3.5	4.5	4.8	3.5
o-xylene	ND					
Nonane	0.3	2.0	1.4	1.7	1.7	1.3
Alpha pinene	0.6	0.6				
Propylbenzene	ND					
1,3,5-trimethylbenzene	ND					
Beta pinene	ND					
Decane	ND					
1,2,4-trimethylbenzene	0.6			1.0		
Limonene	0.6	2.0	1.4	1.5	1.7	1.7
Undecane	ND					
Dodecane	0.7			1.5		
Tetradecane	ND					

Note: VOC monitoring commenced at Kowhai on 16 July 2004.

Table 7: VOC results (October–December 2004)

October November December 2004 Analyte	Limit of detection (μg/m^3)	Results (μg/m^3)			
		Coles Place DZ5816	Burnside DZ5818	Gavin Street DZ4464	Kowhai DZ4491
Target VOCs					
Ethanol	ND				
Isopropyl alcohol	ND				
Acetone	ND				
Pentane	ND				
Dichloromethane	ND				
Butan-2-one	ND				
Hexane	0.5	0.6	0.7	0.7	0.8
Ethyl acetate	ND				
Trichloromethane	ND				
1,1,1-trichoroethane	ND				
n-butanol	ND				
Benzene	0.3	0.9	0.8	1.2	1.4
2-methylhexane	ND				
2,3-dimethylpentane	ND				
Heptane	ND				
Trichloroethene	ND				
Propyl acetate	ND				
Methylcyclohexane	0.6			0.7	
4-methylpentan-2-one	ND				
Toluene	ND				
Octane	0.3	3.4	2.7	5.0	5.5
Tetrachloroethene	ND				
Butyl acetate	ND				
Ethylbenzene	ND				
m+p-xylene	0.3	0.4	0.3	0.6	0.6
Styrene	0.3	1.3	1.1	2.0	2.1
o-xylene	ND				
Nonane	0.3	0.5	0.4	0.7	0.8
Alpha pinene	ND				
Propylbenzene	ND				
1,3,5-trimethylbenzene	ND				
Beta pinene	ND				
Decane	ND				
1,2,4-trimethylbenzene	0.6			0.8	
Limonene	0.6	0.5		0.8	0.8
Undecane	ND				
Dodecane	0.8			1.3	
Tetradecane	0.7			0.6	

Note: Mt Eden site decommissioned 26 October 2004 therefore no results have been reported for this quarter.

7.6 PM_{10} 2004

PM_{10} is recorded at Greers Road, Burnside, using a Thermo FH62-C14 Beta Gauge. PM_{10} results measured by Auckland Regional Council at Gavin Street, Penrose and Kelly Street, Mt Eden sites, also using Thermo FH62-C14 Beta Gauges, are also included in this report. Twenty-four-hour averages have been calculated from 10-minute averages recorded by the instruments. All PM_{10} data is reported at 0°C and 101.3 kPa.

The maximums for PM_{10} and their dates for each site are described in the following table.

Site	24-hour maximum (μg/m^3)	99.5 percentile 24-hour (μg/m^3)
Kelly Street, Mt Eden	31.3 (22 February)	29.9
Gavin Street, Penrose	39.1 (4 July)	38.6
Kowhai Intermediate, Kingsland	42.2 (5 August)	40.5
Greers Road, Burnside	98.4 (9 July)	88.6

There were no exceedences of the ambient air quality standard (50 μg/m^3) at Kelly Street, Mt Eden, Gavin Street, Penrose or Kowhai Intermediate, Kingsland during the 12-month period.

At Greers Road, Burnside, there were 25 exceedences of the 24-hour standard. Each exceedence and the date is listed in Table 8 below. Charts describing 24-hour averaged data for 2004 for each site are shown in Figures 34 to 35 (Kelly Street), 36 (Kowhai), 37 to 38 (Gavin Street), and 39 and 40 (Burnside). As there were exceedences at the Christchurch site, more data analysis was carried out as shown in Figures 41 to 47. All exceedences occurred over the winter period, a time when wood and other solid fuel burning is widely used to heat homes. As reported by Environment Canterbury, cold winter conditions strongly influence air pollution in the region. May 2004 was described as cloudy, rainy and windy compared with previous years. These conditions are less likely to cause air pollution and resulted in only two exceedences near the end of the month. June and July 2004 experienced more settled weather conditions and much higher particulate concentrations. A total of 22 exceedences occurred during this two-month period. Only one exceedence was recorded in August 2004.

Table 8: Greers Road, Burnside PM_{10} exceedences of the daily NES 2004

Date	Burnside PM_{10} ($\mu g/m^3$)
26 May 2004	54.7
30 May 2004	53.6
08 June 2004	54.4
09 June 2004	59.8
10 June 2004	62.9
11 June 2004	64.9
14 June 2004	68.6
23 June 2004	50.4
24 June 2004	68.5
26 June 2004	64.6
27 June 2004	53.9
29 June 2004	53.8
01 July 2004	63.4
04 July 2004	51.9
05 July 2004	77.0
06 July 2004	71.0
09 July 2004	98.4
10 July 2004	57.5
11 July 2004	91.1
12 July 2004	70.9
20 July 2004	87.9
21 July 2004	79.1
23 July 2004	51.1
31 July 2004	66.4
01 August 2004	62.3

Note : National environmental standard for PM10 = 50 $\mu g/m^3$.

7.7 Total suspended particulates (TSP) 2004

TSP is measured as a seven-day average from Kelly Street, Mt Eden, Gavin Street, Penrose, Kowhai Intermediate, Kingsland and Coles Place, St Albans. Maximum results are shown in the table below.

Site	Maximum seven-day average ($\mu g/m^3$)
Kelly Street, Mt Eden	26
Gavin Street	43
Kowhai Intermediate, Kingsland	28
Coles Place, St Albans	42

Notes: TSP monitoring began at Kowhai Intermediate School on 5 April 2004. TSP monitoring at Kelly Street, Mt Eden finished on 27 October 2004.

There were no exceedences of the Ministry of Health guideline of 60 $\mu g/m^3$ at any site. The data from each site is described in Figures 1 and 2 below.

Figure 1: TSP seven-day average (Auckland sites)

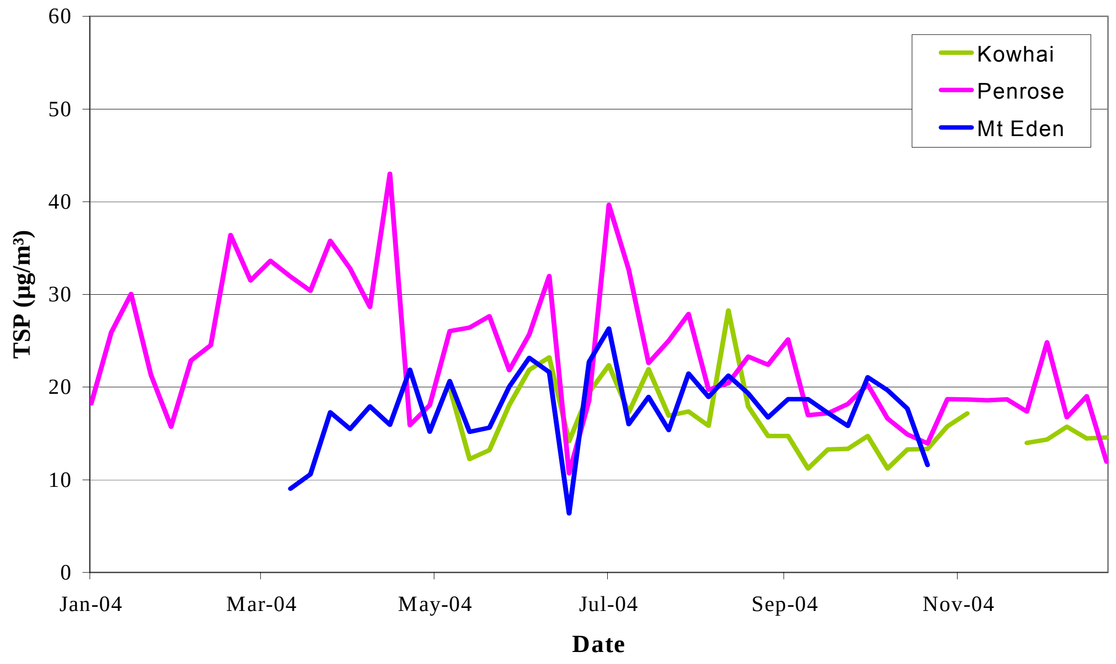
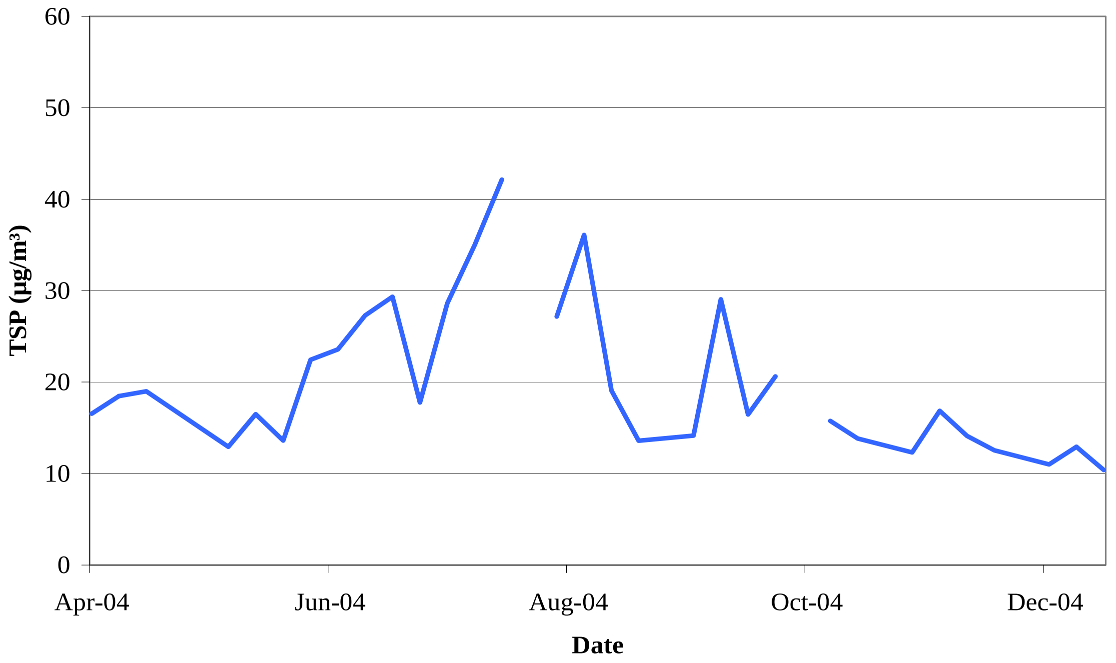


Figure 2: TSP seven-day average (Christchurch site)



7.8 Lead (Pb) June–August 2004

Regrettably, TSP filters used for lead analysis were misplaced in storage following TSP measurements and have been unavailable for lead analysis. Subsequent to their removal, and before the filters were logged into the laboratory, there was a staff change and the filters were misplaced. A corrective action request was raised as a consequence and the subsequent investigation identified the following actions to prevent the recurrence of such an event in future:

- procedures for filter storage will be documented in Watercare's quality assurance system
- filters intended for further analysis will be stored as per the above filter storage procedure until analysis is required
- better training will be provided to staff during the hand over period of projects.

Figure 3: MFE Burnside CO 1-hour fixed average January–December 2004

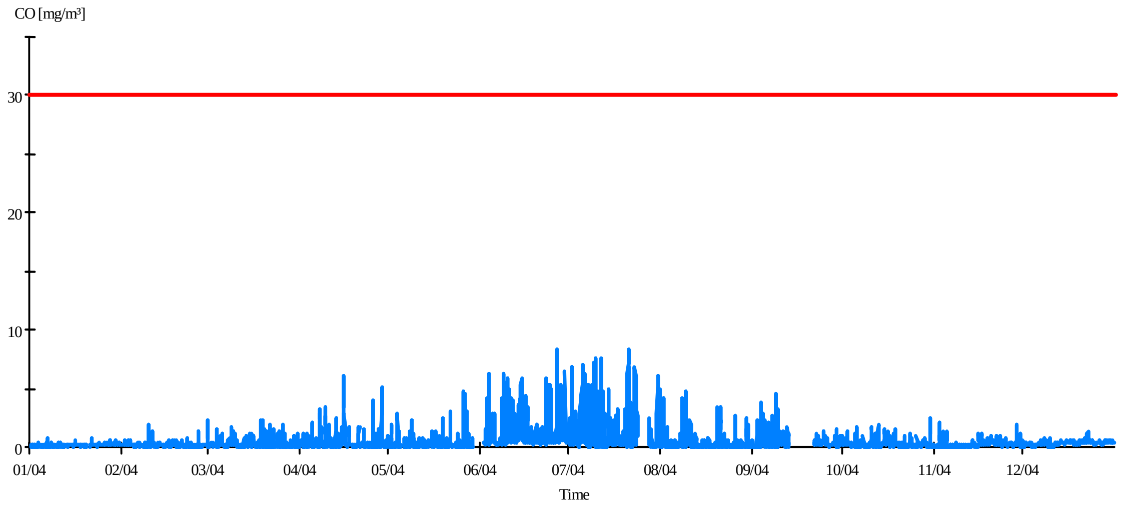


Figure 4: MFE Burnside CO 1-hour fixed average 1 January 2003–31 December 2004

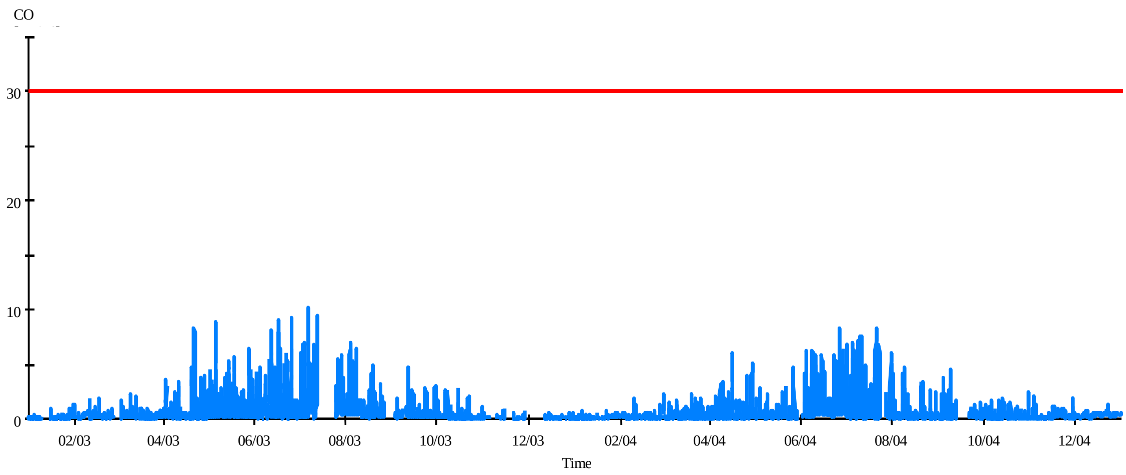


Figure 5: MFE Burnside CO 8-hour rolling average January–December 2004

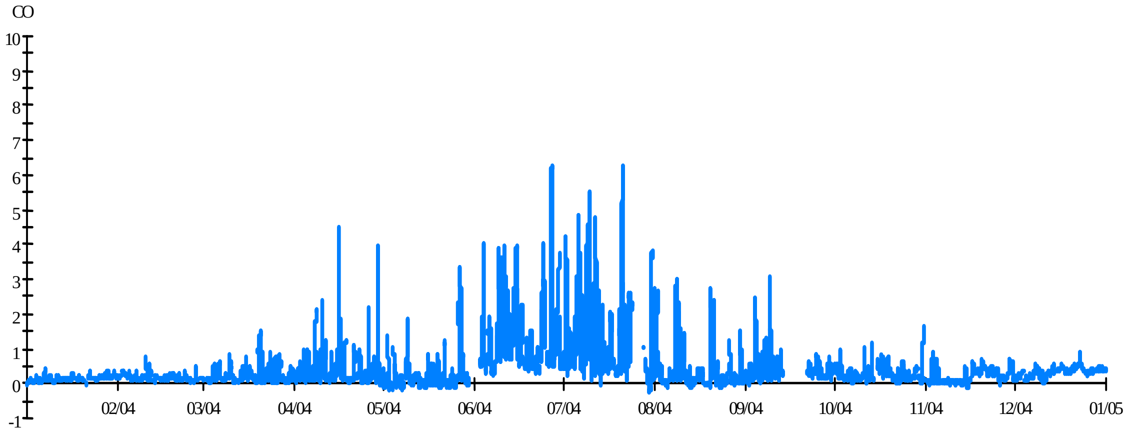


Figure 6: MFE Burnside CO 8-hour rolling average 1 January 2003–31 December 2004

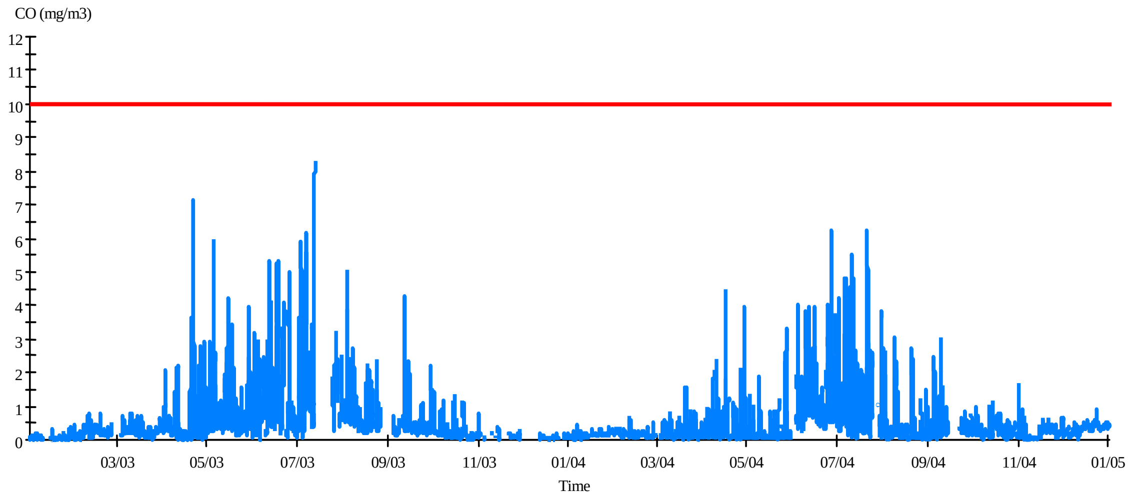


Figure 7: MFE Kelly Street NO_2 1-hour fixed average January–December 2004

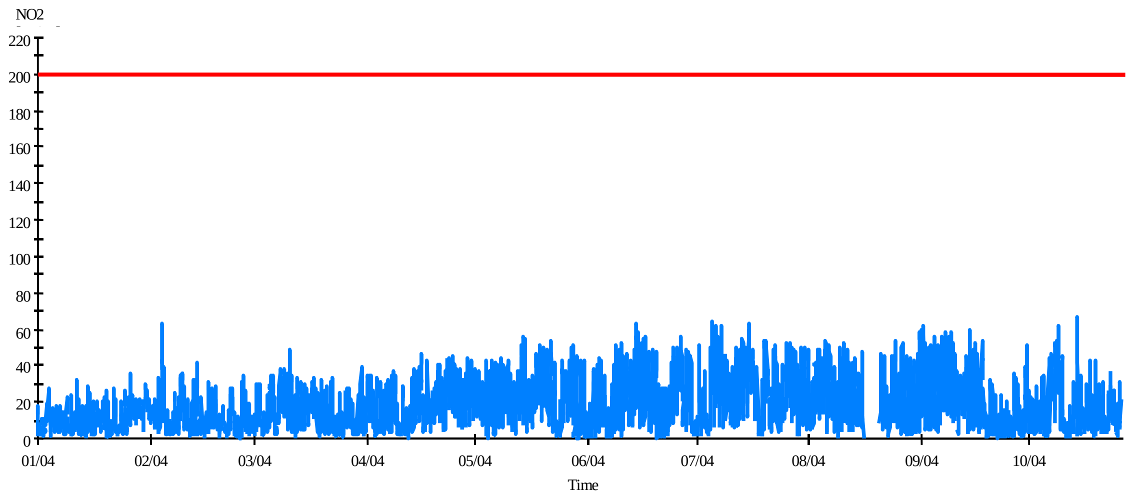


Figure 8: MFE Kelly Street NO_2 1-hour fixed average 1 January 1997–31 December 2004

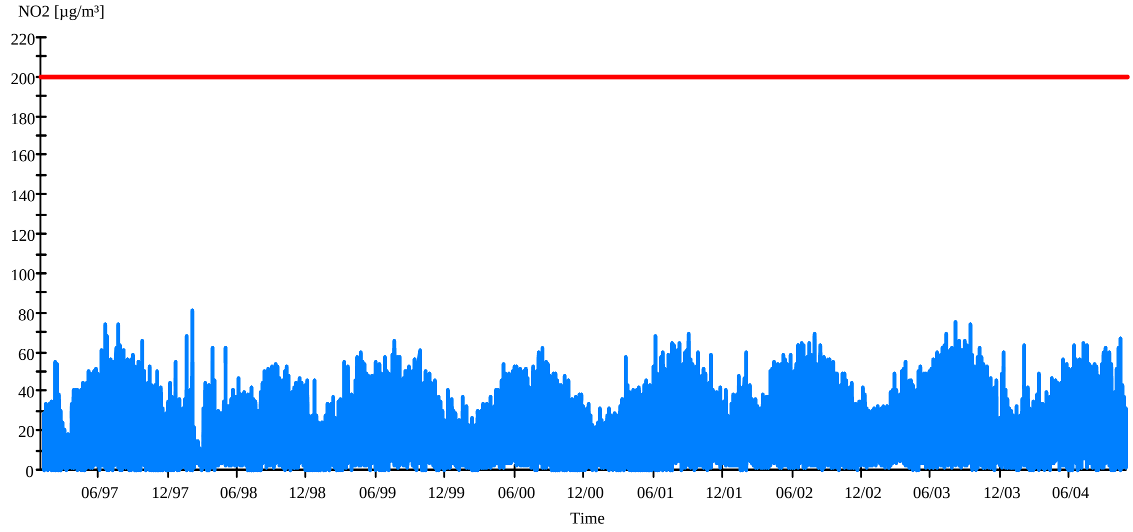


Figure 9: MFE Kelly Street NO_2 24-hour fixed average January–December 2004

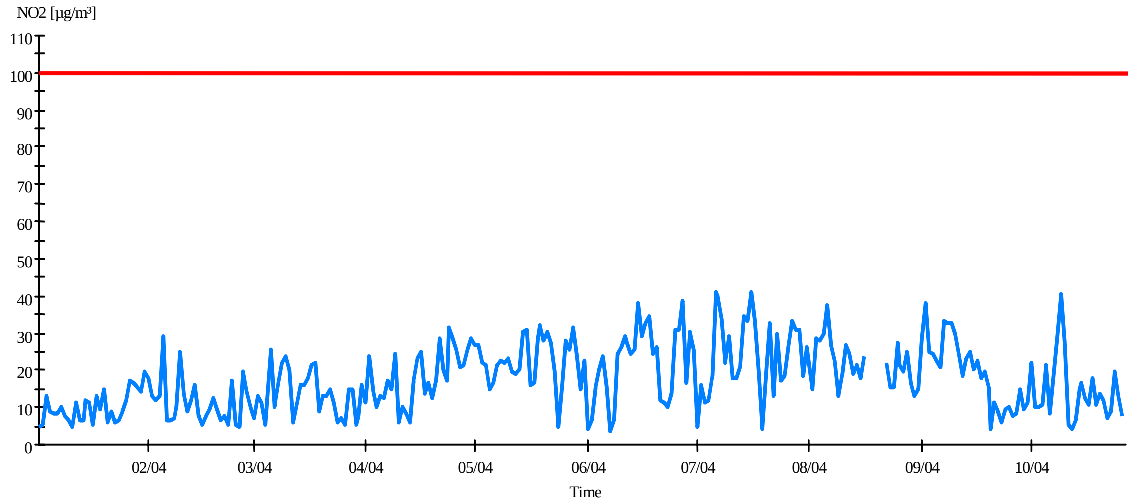


Figure 10: MFE Kelly Street NO_2 24-hour fixed average 1 January 1997–31 December 2004

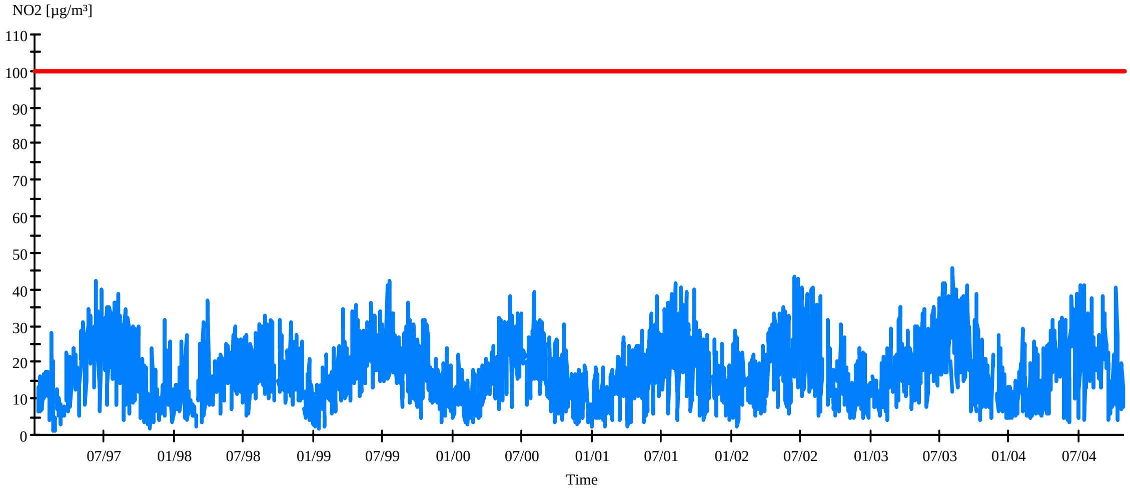


Figure 11: MFE Kelly Street NO_2 and NO 1-hour fixed average January–December 2004

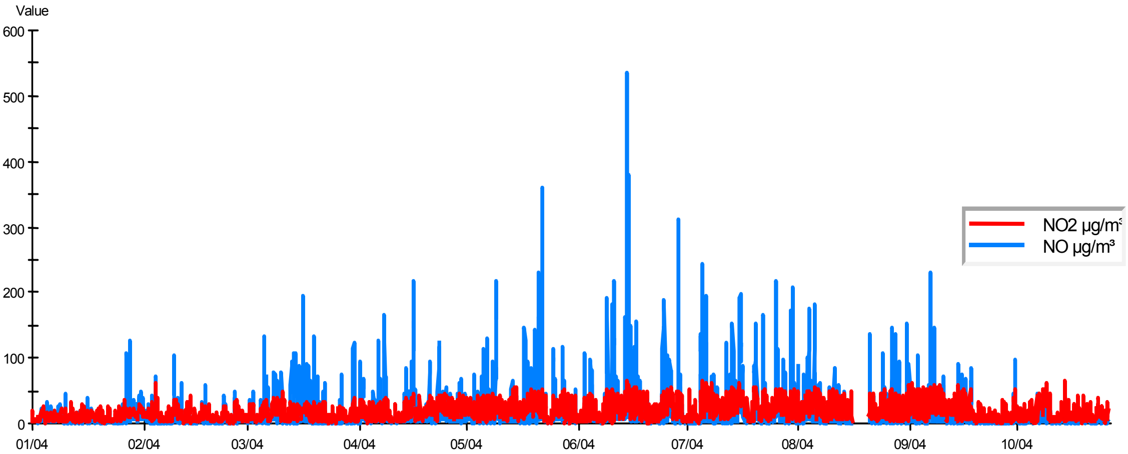


Figure 12: MFE Kelly Street NO_2 and NO 24-hour fixed average January–December 2004

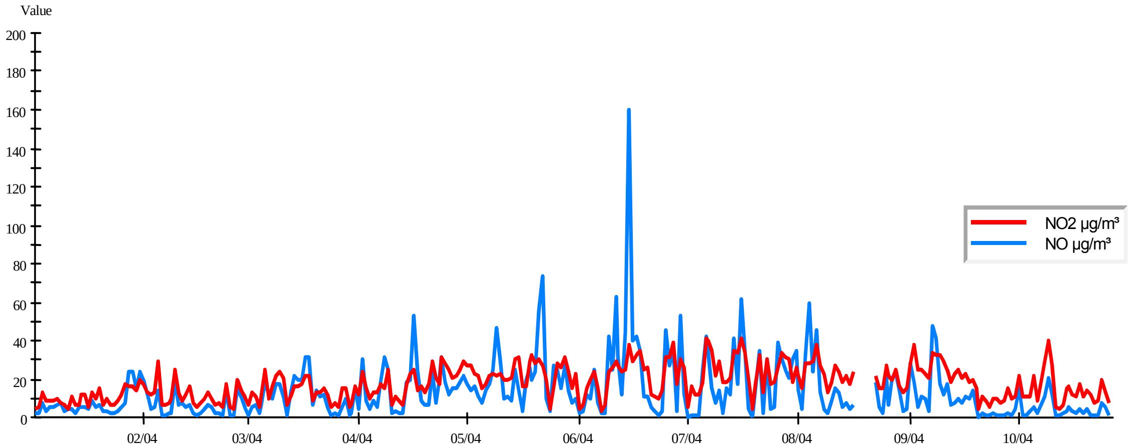


Figure 13: MFE Kowhai NO_2 1-hour fixed average January–December 2004

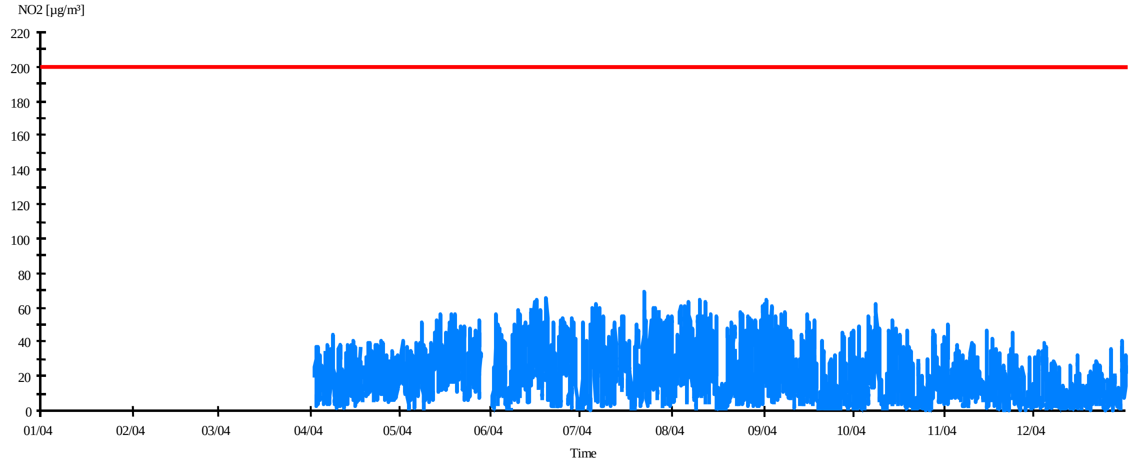


Figure 14: MFE Kowhai NO_2 24-hour fixed average January–December 2004

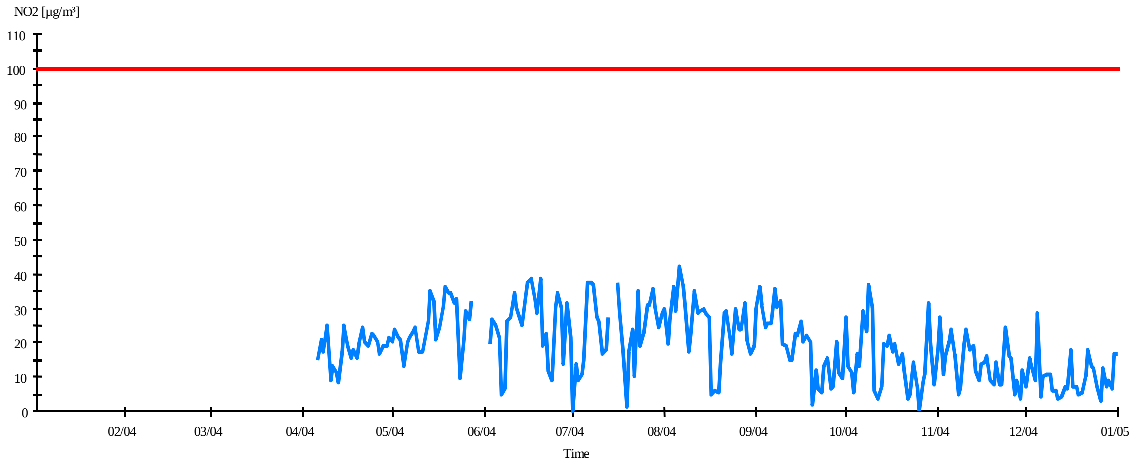


Figure 15: MFE Kowhai NO_2 and NO 1-hour fixed average January–December 2004

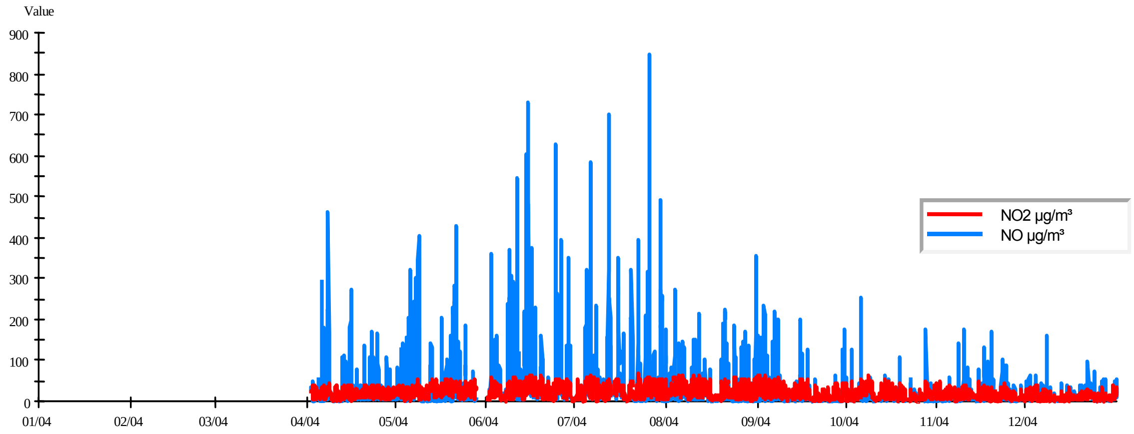


Figure 16: MFE Kowhai NO_2 and NO 24-hour fixed average January–December 2004

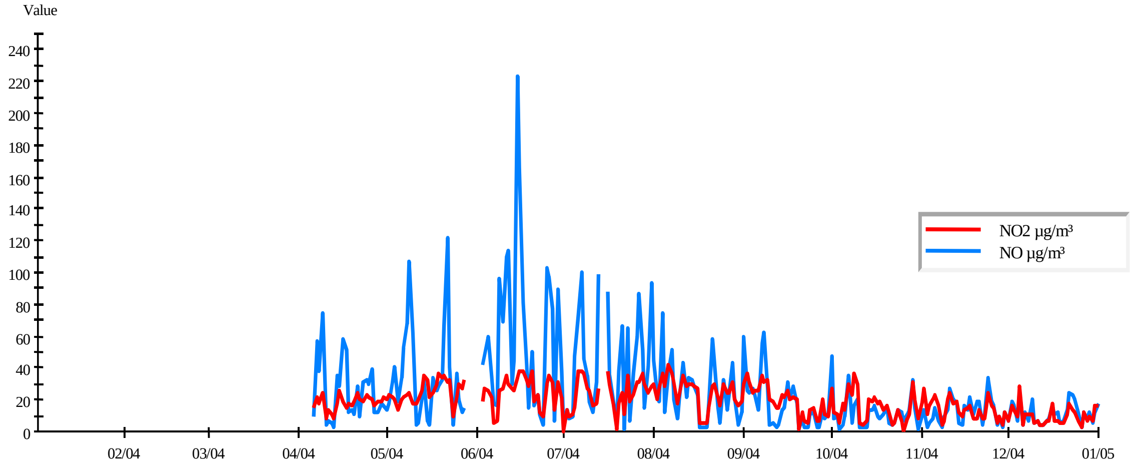


Figure 17: MFE Gavin Street NO_2 1-hour fixed average January–December 2004

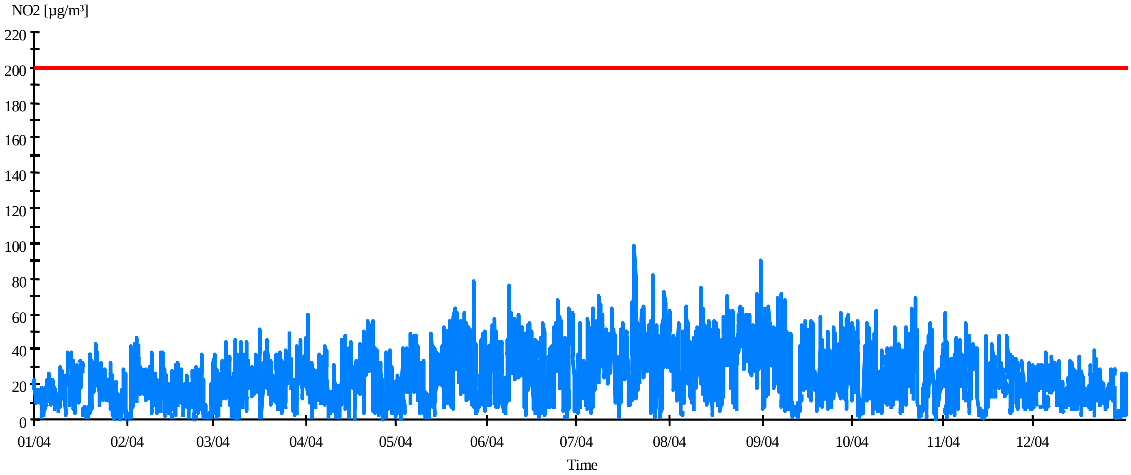


Figure 18: MFE Gavin Street NO_2 1-hour fixed average 1 January 1997–31 December 2004

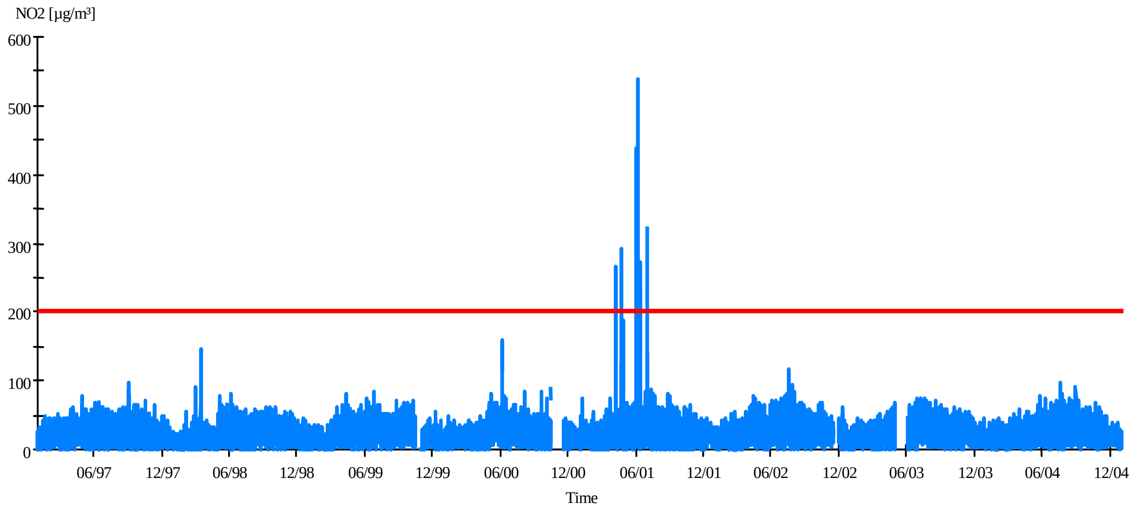


Figure 19: MFE Gavin Street NO_2 24-hour fixed average January–December 2004

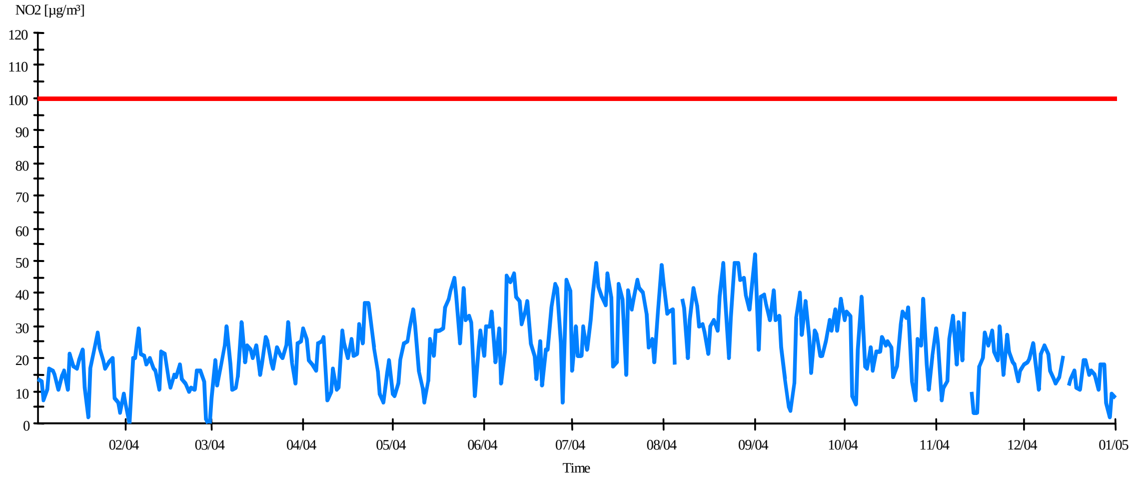


Figure 20: MFE Gavin Street NO_2 24-hour fixed average 1 January 1997–31 December 2004

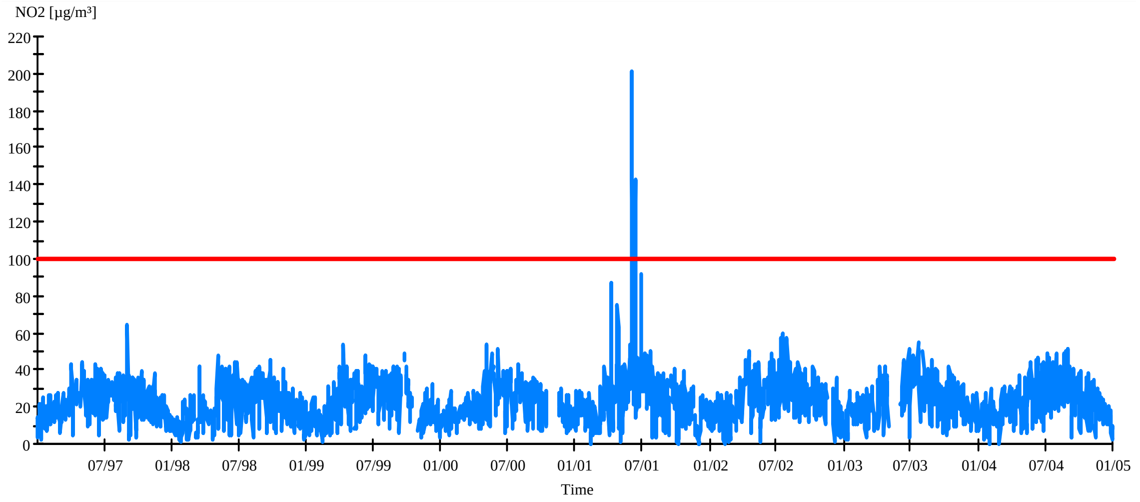


Figure 21: MFE Gavin Street NO_2 and NO 1-hour fixed average January–December 2004

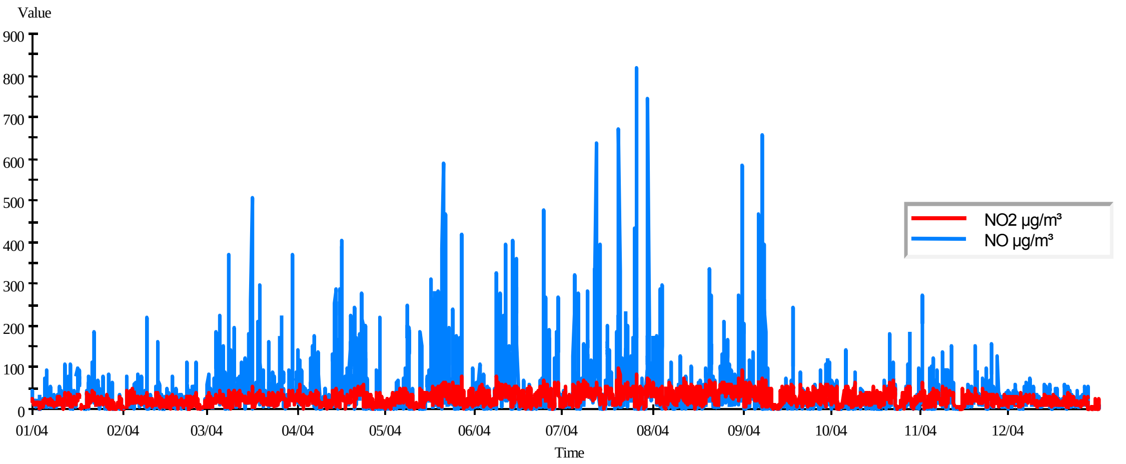


Figure 22: MFE Gavin Street NO_2 and NO 24-hour fixed average January–December 2004

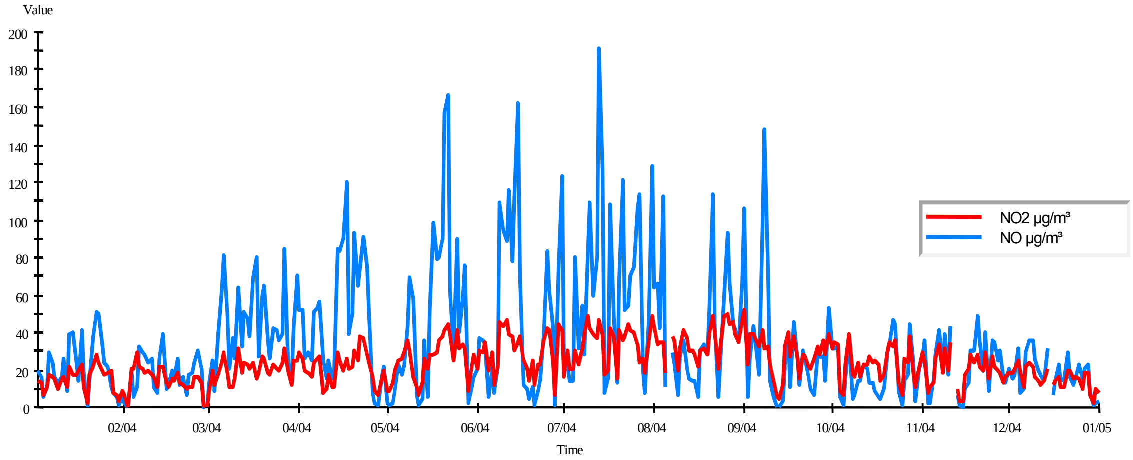


Figure 23: MFE Burnside NO_2 1-hour fixed average January–December 2004

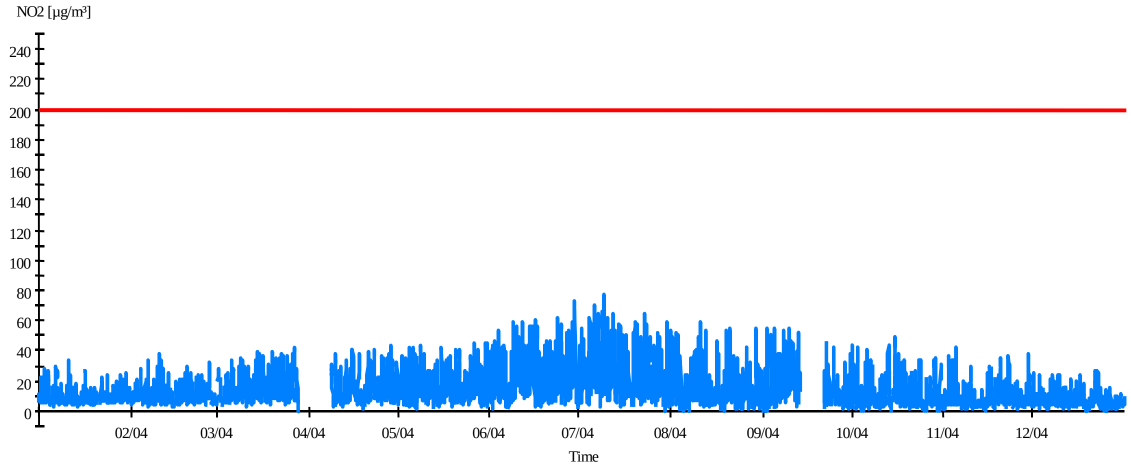


Figure 24: MFE Burnside NO_2 1-hour fixed average 1 January 2003–31 December 2004

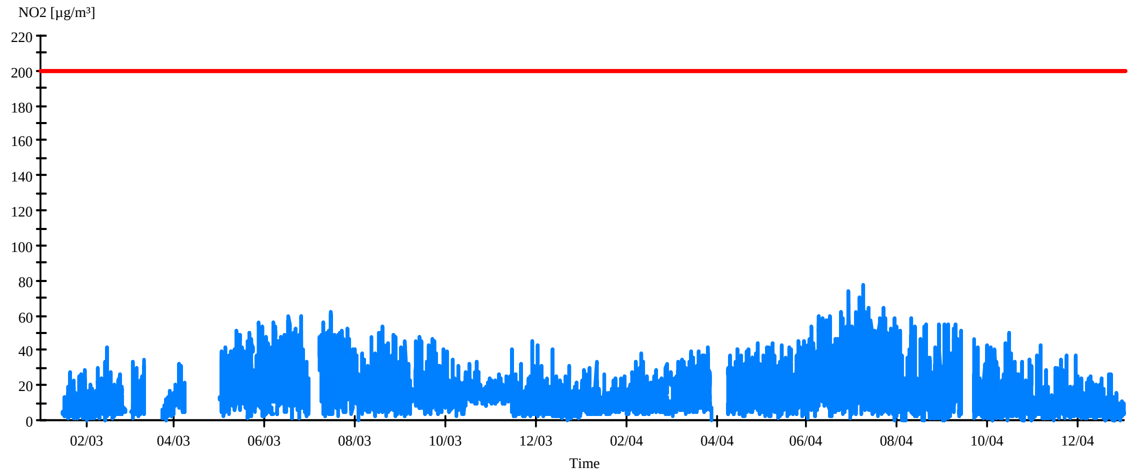


Figure 25: MFE Burnside NO_2 24-hour fixed average January–December 2004

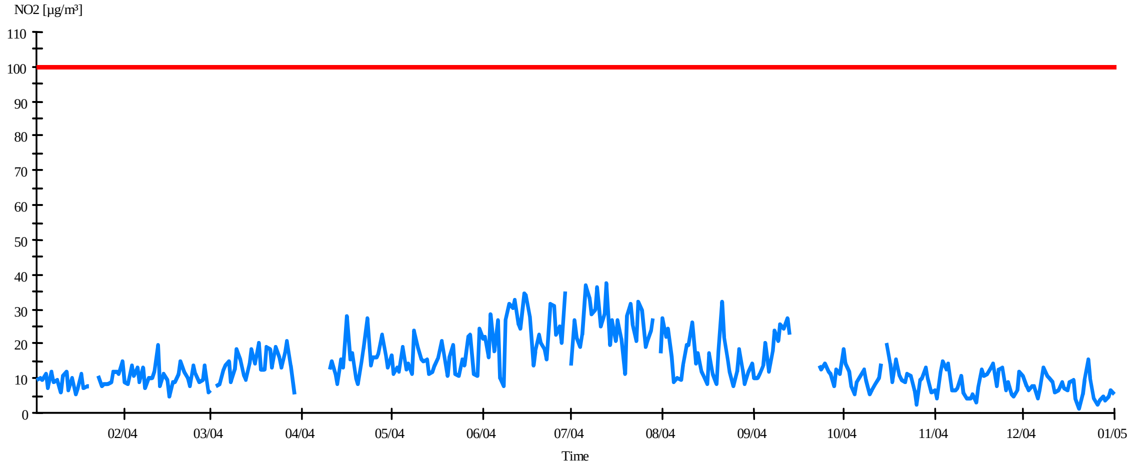


Figure 26: MFE Burnside NO_2 24-hour fixed average 1 January 2003–31 December 2004

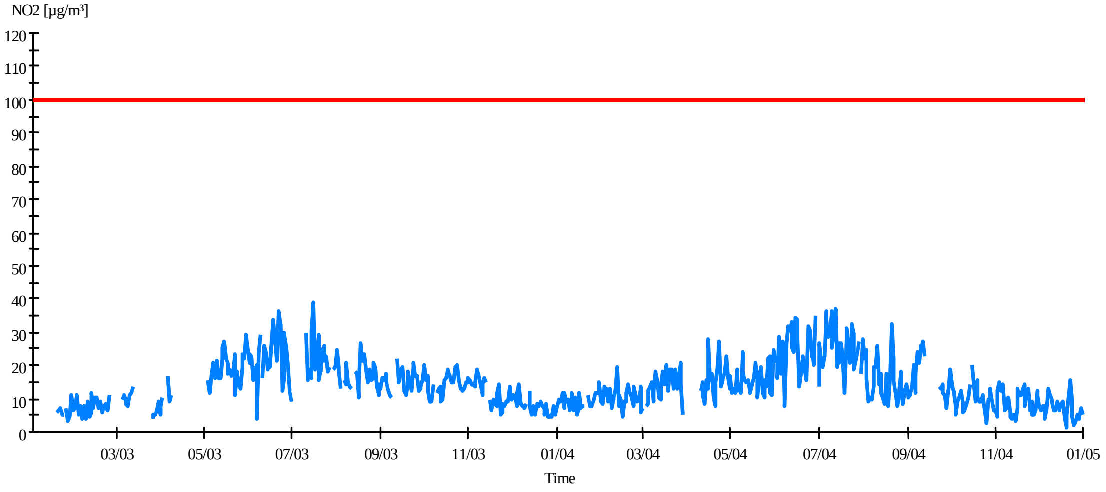


Figure 27: MFE Burnside NO_2 and NO 1-hour fixed average January–December 2004

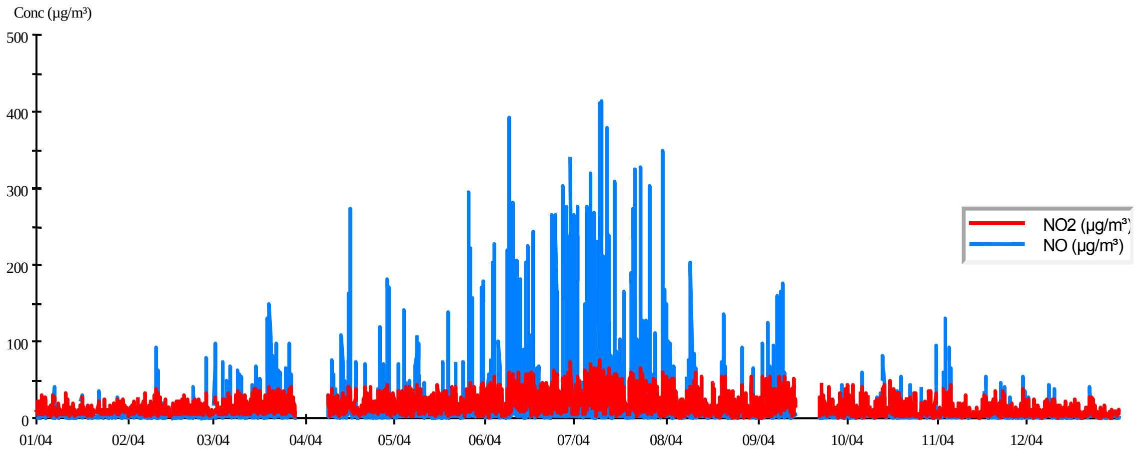


Figure 28: MFE Burnside NO_2 and NO 24-hour fixed average January–December 2004

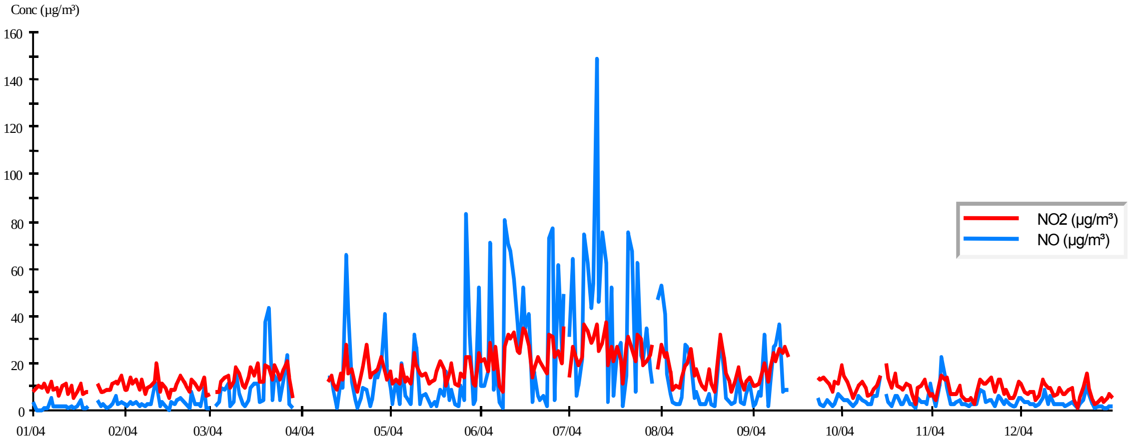


Figure 29: MFE Gavin Street SO_2 1-hour fixed average January–December 2004

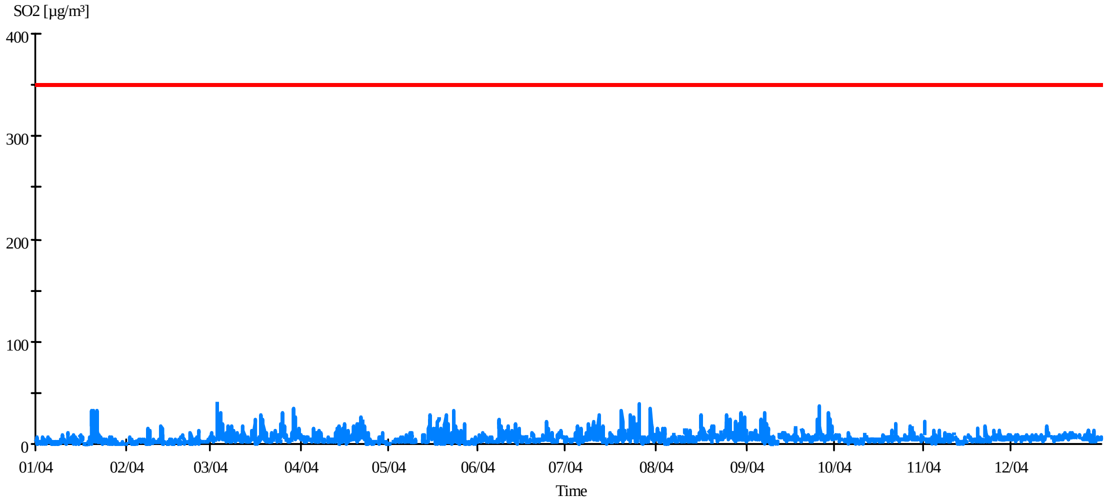


Figure 30: MFE Gavin Street SO_2 24-hour fixed average January–December 2004

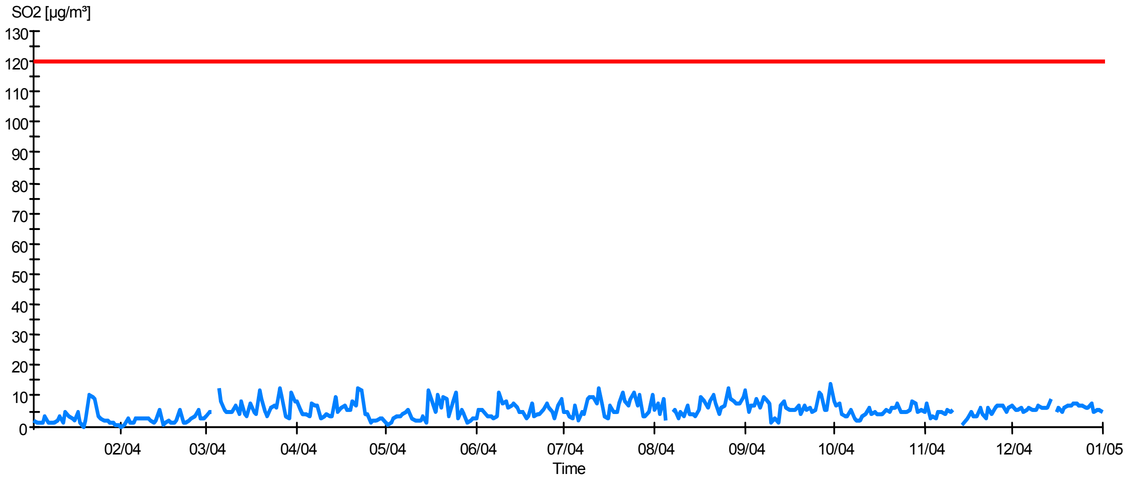


Figure 31: MFE Burnside SO_2 1-hour fixed average January–December 2004

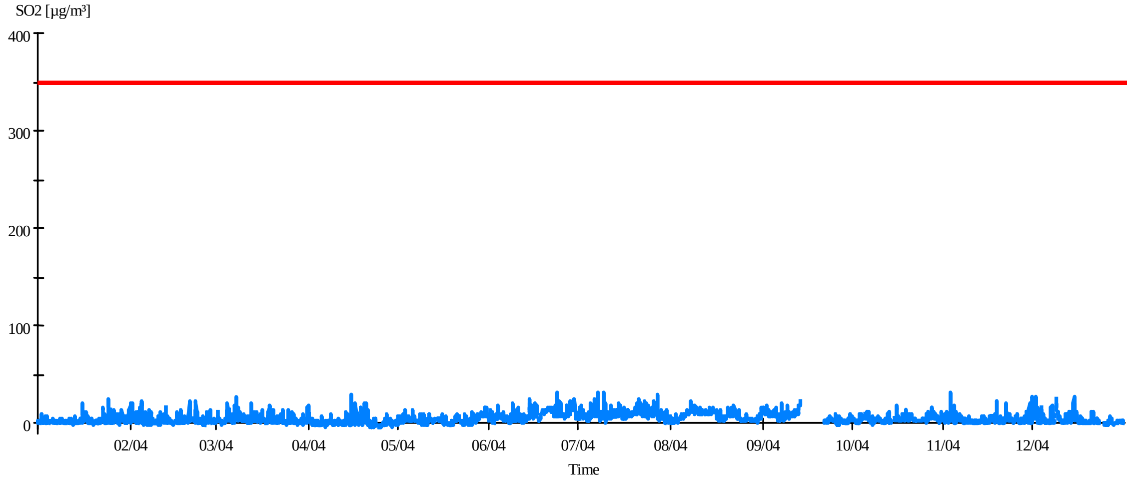


Figure 32: MFE Burnside SO_2 24-hour fixed average January–December 2004

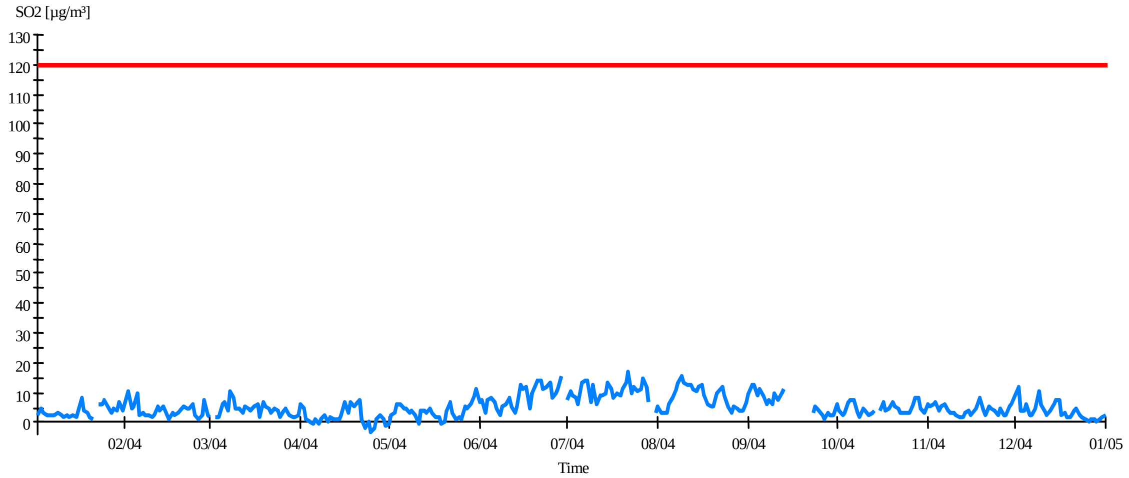


Figure 33: MFE Kelly Street PM_{10} 24-hour fixed average 1 January–26 October 2004

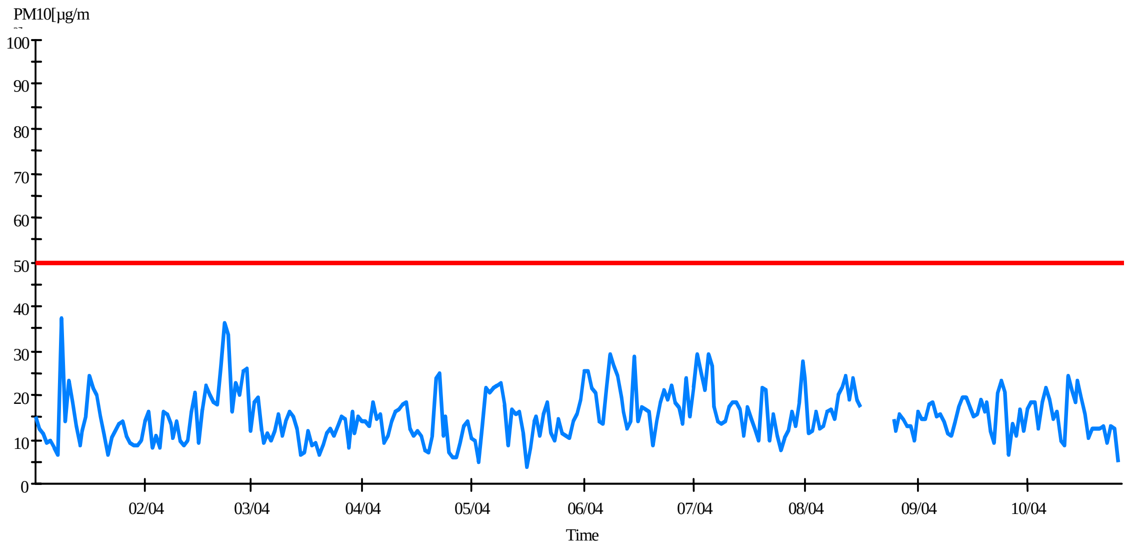


Figure 34: MFE Kelly Street PM_{10} 24-hour fixed average 1 January 2002–26 October 2004

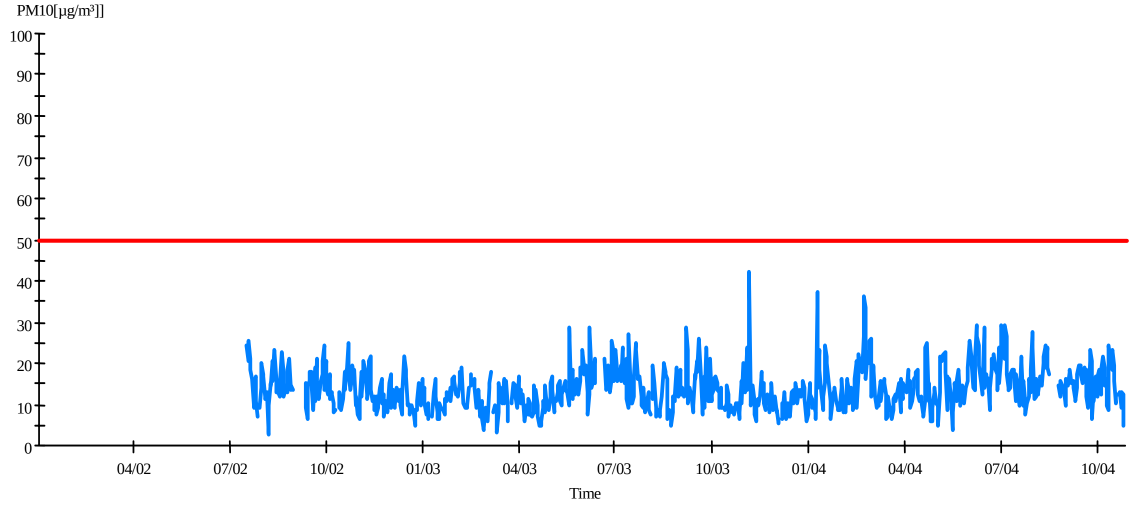


Figure 35: MFE Kowhai PM_{10} 24-hour fixed average January–December 2004

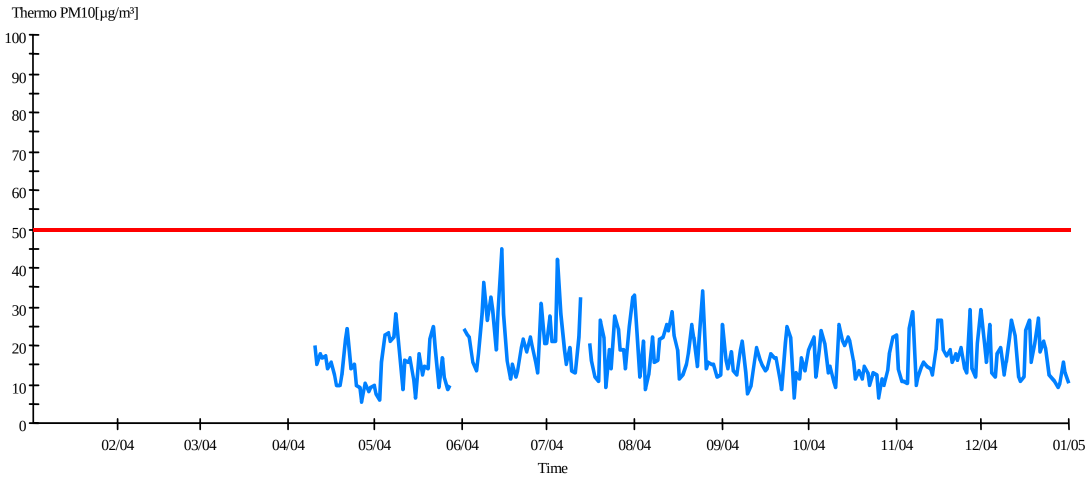


Figure 36: MFE Gavin Street PM_{10} 24-hour fixed average January–December 2004

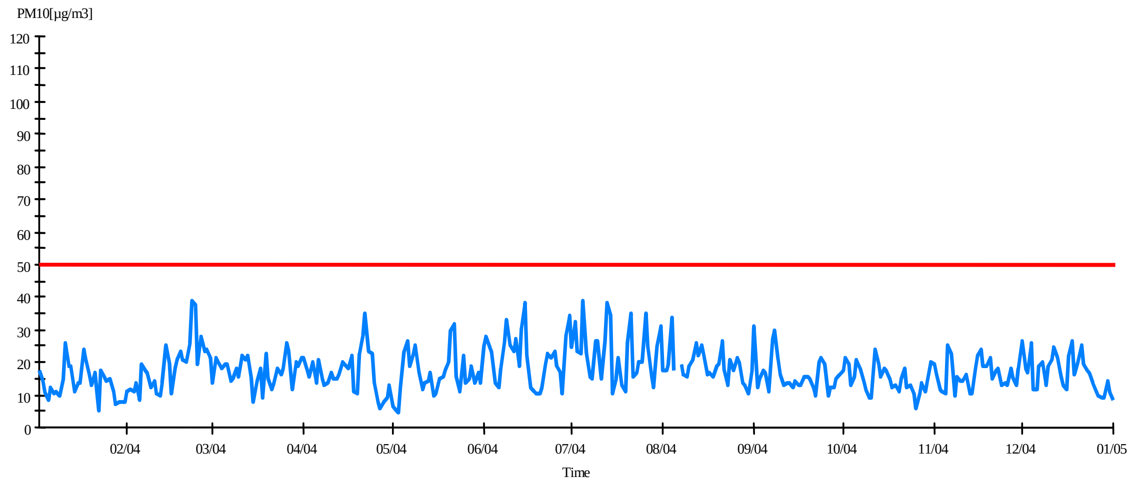


Figure 37: MFE Gavin Street PM_{10} 24-hour fixed average 1 January 2003–31 December 2004

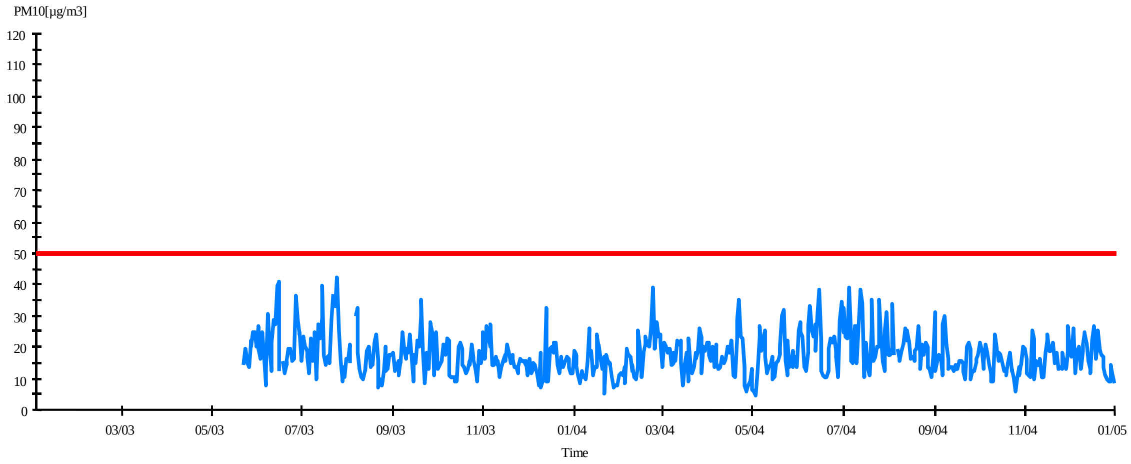


Figure 38: MFE Burnside PM_{10} 24-hour fixed average January–December 2004

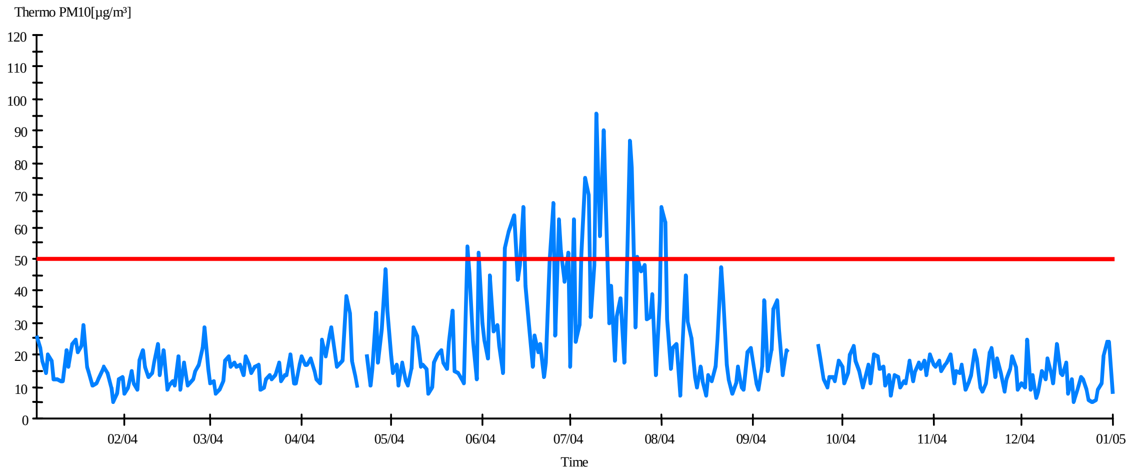
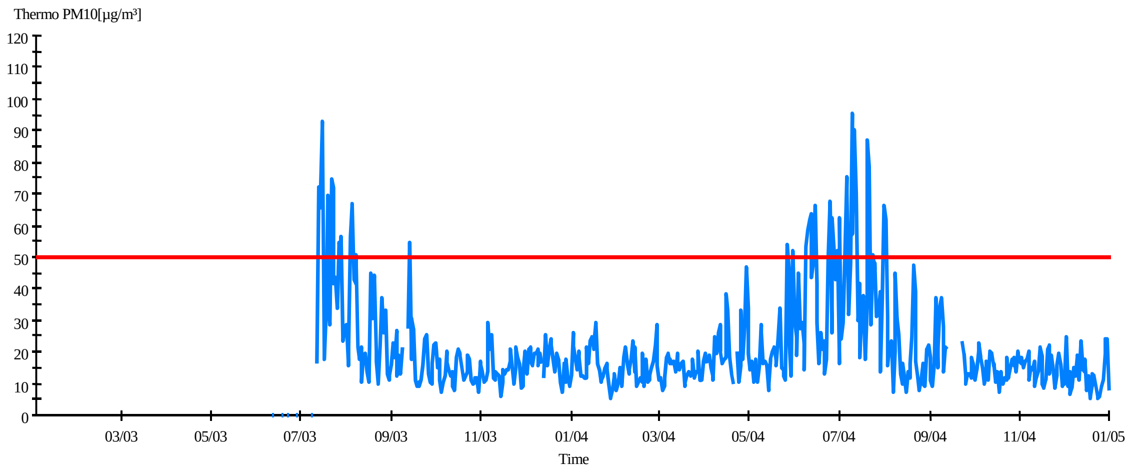


Figure 39: MFE Burnside PM_{10} 24-hour fixed average 1 January 2003–31 December 2004



7.9 Analysis of PM_{10} exceedences at Greers Road, Burnside

The following figures provide further analysis of PM_{10} exceedences at Greers Road, Burnside. Figure 40 shows a comparison of relative PM_{10} concentrations from different sites in Christchurch over the winter period May to August 2004. The Beta Gauge PM_{10} data from Greers Road, Burnside compares well with taped element oscillating microbalance (TEOM) PM_{10} data from Coles Place, St. Albans and shows that PM_{10} concentrations are consistent across the city suggesting the incidents are not directly related to very localised sources of PM_{10} but are perhaps more related to prevailing meteorological conditions such as temperature inversions.

Figure 41 provides an example of the diurnal trends in air pollution over a 48-hour period during the winter months. Figures 42 to 44 present the meteorological conditions that influence the diurnal trend. It is apparent when comparing wind speed (Figure 42) and PM_{10} concentrations (Figure 41) that low wind speeds coincide with PM_{10} peaks and conversely higher wind speeds coincide with low PM_{10} concentrations. Reduced air mixing, caused by low wind speeds, results in poor dispersion of pollution while an unstable atmosphere caused by high wind speeds is conducive to pollution dispersion.

Low temperatures, often coinciding with still atmospheric conditions, can cause temperature inversions. This can contribute to higher PM_{10} concentrations being measured as pollution is trapped at ground level. A comparison of temperatures measured at 1.5 and 10 m (Figure 43) does not indicate the presence or absence of a temperature inversion as the inversion height may be greater than 10 m, however, a diurnal trend is apparent. As the temperature drops during the evening, Christchurch residents light their heating appliances causing particle emissions to increase and PM_{10} levels to peak just before midnight. As the fires die down and the atmosphere becomes more unstable toward morning, concentrations of PM_{10} drop off.

A pollution rose for the same 48-hour period (Figure 44) describing the relationship between wind direction and PM_{10} concentrations shows no obvious pattern.

Temperature inversions occur when the ground temperature falls below the surrounding air temperature. Air in contact with the ground is cooled to a lower temperature than the air layers above it. As an inversion continues, air becomes stagnant and pollution becomes trapped in the mixing layer close to the ground.

TEOM PM_{10} data from Coles Place, St Albans has been provided courtesy of Environment Canterbury.

Figure 40: Christchurch PM_{10} comparison, beta gauge versus TEOM, 24-hour fixed average 1 May–30 August 2004

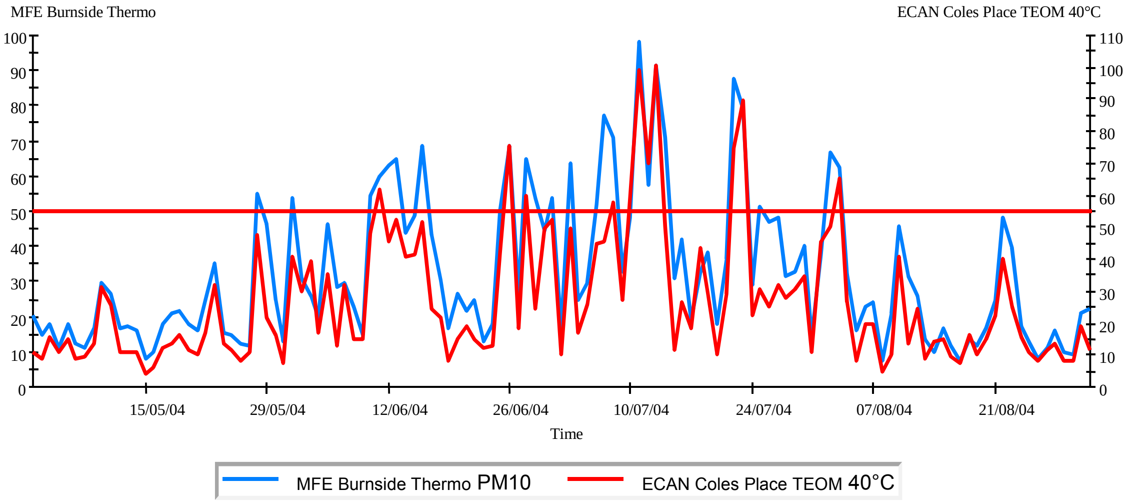


Figure 41: MFE Burnside PM_{10}, typical winter diurnal trend, 24-hour fixed average 9–10 July 2004

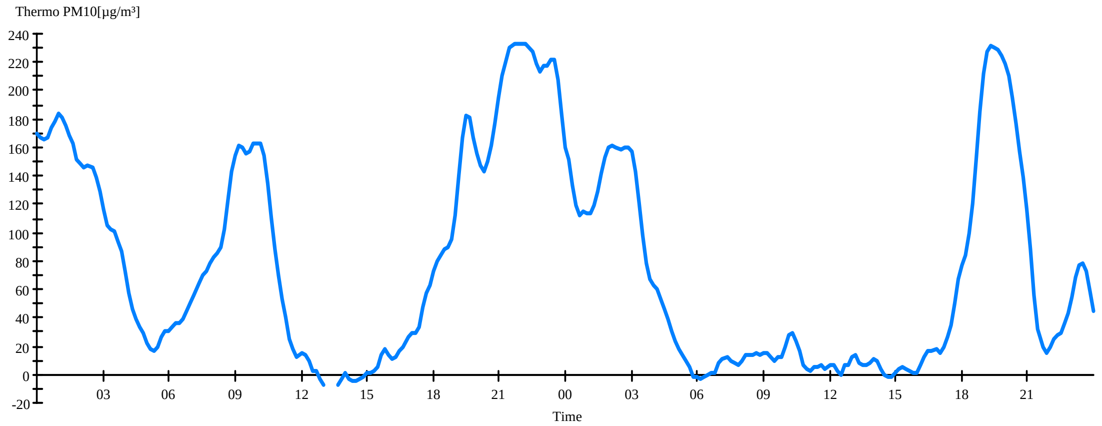


Figure 42: MFE Burnside wind speed, typical winter diurnal trend, 24-hour fixed average 9–10 July 2004

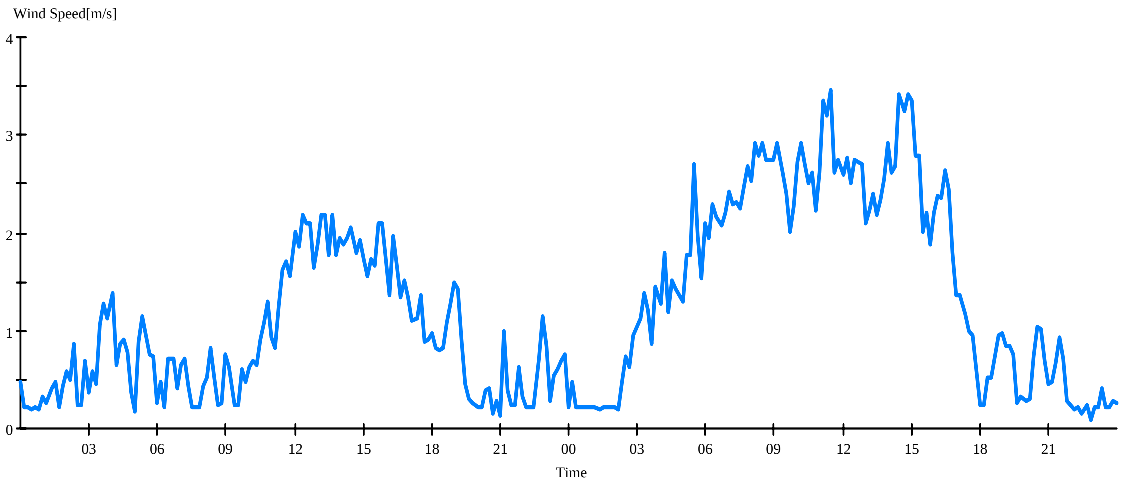


Figure 43: MFE Burnside ambient temperature, typical winter diurnal trend, 24-hour fixed average 9–10 July 2004

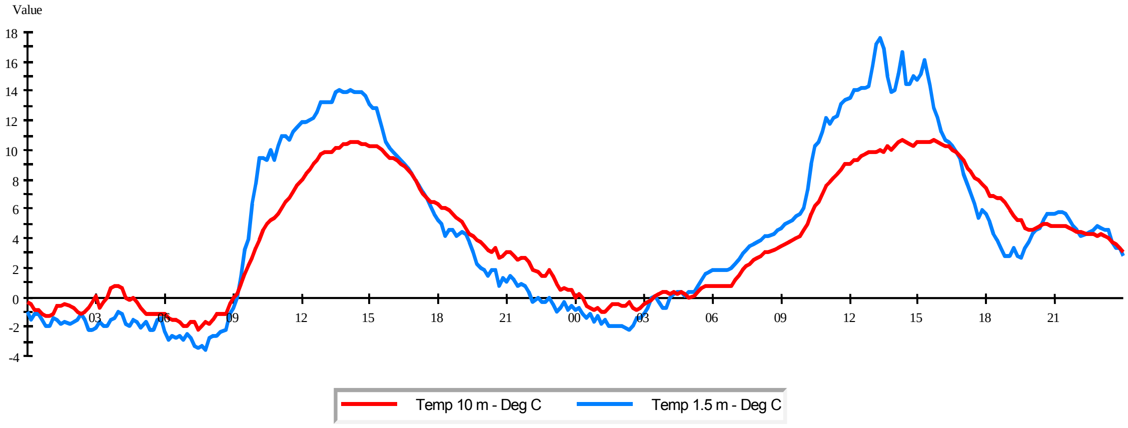


Figure 44: MFE Burnside pollution rose, 24-hour average 9–10 July 2004

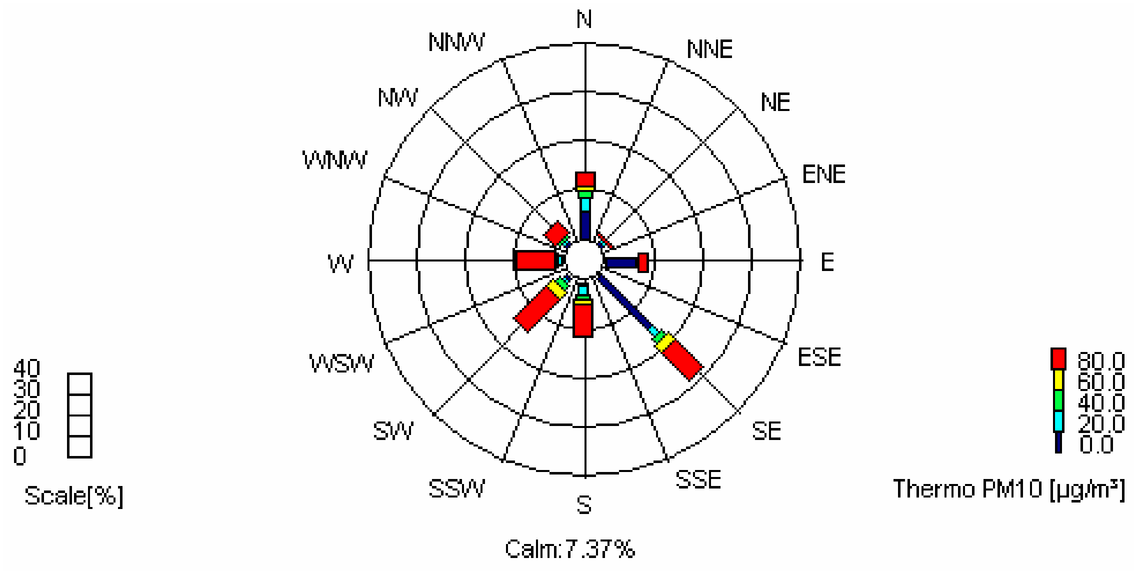


Figure 45: MFE Burnside pollution rose 24-hour average June 2004

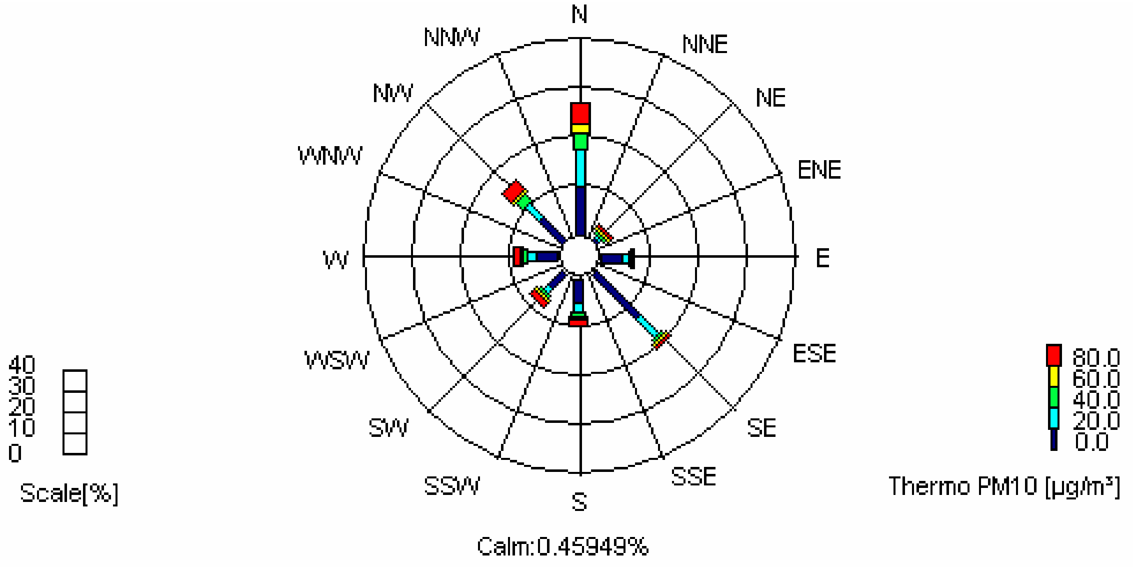


Figure 46: MFE Burnside pollution rose 24-hour average July 2004