GEMS/AMIS Air Quality Monitoring Programme Annual Report 2005

Prepared by
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Laboratory Services Air Quality Department
New Zealand Accredited Laboratory

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Published in June 2006 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10-362, Wellington, New Zealand

ISBN: 0-478-25984-0
ME number: 749

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

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1 Summary

This report contains the 2005 annual ambient air quality dataset measured from two sites in Auckland and one site in Christchurch. These sites form New Zealand's contribution to the global environmental monitoring system (GEMS).

The GEMS monitoring sites were established to measure key air pollutants associated with adverse effects on people's health and well-being. The GEMS sites include some of the longest- running air quality monitoring sites in New Zealand. For example, various air quality monitoring has been undertaken at the Gavin Street, Penrose site in Auckland since 1964. These sites were established to determine the effects of policies for air quality management and are important for recording trends in pollution levels in New Zealand. The GEMS sites have provided long-term continuity in monitoring data for Auckland and Christchurch and provide an important 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). The Greers Road, Burnside site in Christchurch is located within a residential area and represents emissions from domestic properties.

Air pollutants arise from a number of different sources. Particulate matter (PM_{10}) arises 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.

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.

For most of the time, air pollutants at all sites during 2005 were below the standards. However, there were times when these standards were exceeded. One exceedance of the nitrogen dioxide 1-hour standard at Gavin Street, Penrose was found to be caused by local construction works where machinery was operating several metres from the monitoring site. The ambient air standard for NO_2 makes allowance for nine 1-hour exceedances per year before the standard is breached. At Greers Road, Burnside, there were 18 exceedances of the 24-hour standard for PM_{10}, mainly during the winter months from June to August 2005. These exceedances were most likely caused by home heating emissions. The standard allows for one exceedance of the PM_{10} 24-hour threshold per year.

2 Introduction

This report presents the 2005 ambient air quality data set for Auckland and Christchurch, New Zealand. The monitoring is conducted by Watercare Services Ltd, on behalf of the Ministry for the Environment (the Ministry, MfE).

The Ministry has a Memorandum of Understanding with the New Zealand Ministry of Health (MoH) 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 the WHO's global environmental monitoring system/air pollution programme (GEMS/AIR) which began in 1973.[1]

In 1996, the 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. It also 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 in places where it has deteriorated.

As a result, monitoring from the AMIS programme is used by the Ministry 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, which is 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 between 1982 and 2004. In October 2004, the Mt Eden site was decommissioned pending redevelopment of the site and replaced by the Kingsland site at Kowhai Intermediate School.

Between 1989 and 2002, monitoring was undertaken in Christchurch at a site located in the older residential area of St Albans which is 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 which is a newer residential area to the northwest of the city centre.

Environment Canterbury provided sampling services for gravimetric and passive monitoring methods at the two Christchurch sites (Coles Place, St Albans and Greers Road, Burnside).

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.

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.

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[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 can be a significant air pollutant that is associated with a variety of health and environmental effects.

Sources of particulates vary widely from location to location reflecting the diverse range of emission sources that contribute to particulate concentrations in New Zealand. Typical sources can include:

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

There are a variety of measurements that 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 diametre of 10 μm or less can be inhaled into the respiratory system and affect human health. The coarser fraction of airborne particles (2.5 to 10 μm) are 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 pollutant, encompassing a wide range of chemically and physically diverse substances. Particulate matter includes all solids and aerosols that exist in ambient conditions.

3.1.2 Total suspended particulates (TSP)

TSP consists of all particles that range in size up to 50 μm in diametre. 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 affects both the aesthetic and health quality of the ambient air.

3.2 Lead

Lead is a toxic metal emitted into the air both from motor vehicles that use leaded fuel and some industries. Since lead was removed from fuel in 1996, concentrations of lead in the air have dropped markedly. In October 2000, monitoring of lead was reduced from monthly samples to samples taken over a three-month period during winter only (June – August).

3.3 Sulphur dioxide

Sulphur dioxide is an acidic gas with a pungent odour which is mainly produced by the burning of fossil fuels. The gas is quite corrosive and can cause damage to 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, as such, elevated levels are mainly found in areas of significant traffic congestion, particularly at busy intersections on inner-city streets.

Carbon monoxide acts on humans by displacing oxygen from the blood. Prolonged exposure at moderate levels can lead to symptoms such as headaches and dizziness, while at high levels it can lead to loss of consciousness and even death. At the lower levels typically encountered in urban areas, carbon monoxide measurements can serve as a useful indicator for objectionable levels of vehicle exhaust fumes.

3.5 Nitrogen oxides

Nitrogen oxides incorporates several species that exist in the atmosphere which are collectively referred to as NO_x. The two main oxides are nitrogen dioxide (NO_2), 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 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

In October 2004, the Ministry for the Environment introduced the National Environmental Standards (NES) for Air Quality. The NES includes five standards for ambient (outdoor) air quality. These and other New Zealand guidelines are described in Table 1 below.

The criteria applied to TSP, 60 µg/m^3 (seven-day average), was previously applied by the Ministry of Health. This has been superseded by the Ministry for the Environment'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[2]

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	30 mg/m^3	8-hour average 1-hour average	One 8-hour period in a 12-month period
Nitrogen dioxide	200 µg/m^3	100 µg/m^3	24-hour average 1-hour average	9 hours in a 12-month period
Sulphur dioxide	350 µg/m^3 570 µg/m^3	120 µg/m^3	24-hour average 1-hour average 1-hour average	9 hours in a 12-month period Not to be exceeded at any time
Benzene – Year 2000 – Year 2010		 10 µg/m^3 3.6 µg/m^3	 Annual average Annual average	
1,3-Butadiene		2.4 µg/m^3	Annual average	
Fine particulate (PM_{10})	50 µg/m^3	20 µg/m^3 50 µg/m^3 (ARC and ECAN)	Annual average 24-hour average	One 24-hour period in a 12-month period
Total suspended particulates (TSP)		60 µg/m^3 (DoH)[2]	7-day average	
Lead		0.2 µg/m^3	3-month average	

[2] See http://www.mfe.govt.nz/laws/standards/air-quality-standards.html

5 Monitoring Sites

5.1 Site descriptions

A brief description of all the monitoring sites in the GEMS/AMIS air quality monitoring programme is given below. This includes the two Auckland sites – at Gavin Street, Penrose and Kowhai Intermediate School, Kingsland – and two sites in Christchurch – at Greers Road, Burnside and Coles Place, St Albans. (Note: at Coles Place only TSP and lead are monitored by the Ministry for the Environment.)

5.1.1 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 while Sandringham Road runs northwest to southeast past the site and Eden Park rugby ground is within 300 metres to the southeast of the site. The site 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, and 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	**RH** Y	
	Temperature (6 m) Y	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map

Photograph

5.1.2 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 substation 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** N	**NO_2** Y	**SO_2** Y	**VOCs** Y
	PM_{10} Y	**TSP** Y	**Lead** Y	
Meteorological parameters monitored	**Wind speed** Y	**Wind direction** Y	**RH** Y	
	Temperature (6 m) Y	**Temperature (10 m)** N	**Temperature (2 m)** N	

Location map

Photograph