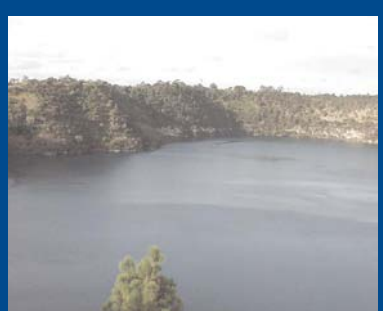
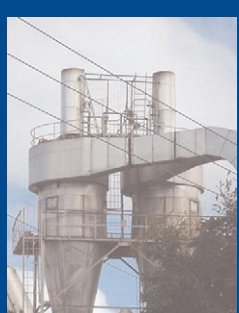
Ambient Air Quality Monitoring

Mount Gambier

September 2001–August 2002



Government of South Australia

South Australia

EPA

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GLOSSARY

24-hour average	the average concentration for a 24-hour period
Ambient air	generally, the atmosphere; usually refers to the troposphere
Annual arithmetic mean	the numerical average of the data for the year
Chemiluminescence	visible light produced by chemical reaction
Drainage flow	movement of dense mass of air down a slope
Exceedance	an incident of the concentration of a pollutant in ambient air being higher than the NEPM
Fluorescence	the production of light in response to application of radiant energy such as ultraviolet rays
Photomultiplier	a device that converts light into an electrical current, amplifying it in the process
Primary pollutant	direct emission from the source into the ambient air
Quality assurance	measures for maintaining quality in all aspects of monitoring e.g. training, maintaining written records
Quality control	activities to enhance precision and accuracy of the monitoring e.g. calibration, repair and servicing, maintenance of logs
Secondary pollutant	formed from a chemical reaction of other contaminants already present in the atmosphere from natural or anthropogenic releases
Synoptic pattern	large scale weather pattern
Troposphere	lowest layer of the earth's atmosphere and site of all our weather
Ultraviolet	light just beyond the violet end of the visible electromagnetic spectrum

ABBREVIATIONS

$\mu g/m^3$	micrograms per cubic metre
μm	micrometre
Ambient Air Quality NEPM	*National Environment Protection (Ambient Air Quality) Measure*
CO	carbon monoxide
EPA	Environment Protection Authority
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPI	National Pollutant Inventory
O_3	ozone
PM_{10}	particles in the air of less than 10 μm in diameter
ppb	parts per billion by volume
ppm	parts per million by volume
SO_2	sulfur dioxide
TEOM	tapered element oscillating microbalance
VOC	volatile organic compounds

SUMMARY

The Environment Protection Authority (EPA) has conducted an air quality monitoring campaign in the Mount Gambier region to identify and measure the concentration of compounds believed to present the greatest concern to public health in the area.

During the period September 2001–August 2002, the EPA collected air quality data from the Frew Park monitoring site in the Mount Gambier region in order to monitor ambient air quality at a representative site within the city. In conjunction with this, a mobile air monitoring unit was used to conduct two short-term—or hotspot—monitoring programs in the vicinity of the wood processing plants during the winter of 2002. This report summarises measurements from Frew Park for the period September 2001–August 2002 and two hotspot sites for June–August 2002.

The report presents hourly gaseous ambient air quality data for Frew Park and the east and west hotspot sites for sulphur dioxide, carbon monoxide, oxides of nitrogen and ozone. PM_{10} (particles less than 10 μm in diameter) data from a TEOM sampler is reported for 24-hour periods, and the report includes data for two volatile organic compounds, benzene and formaldehyde, from the hotspot sampling campaigns.

This report finds that:

- concentrations of all gaseous air quality parameters monitored in the Frew Park and two hotspot monitoring sites were below the *National Environment Protection (Ambient Air Quality) Measure* standard
- three PM_{10} exceedances were noted at the Frew Park monitoring site, using the CSIRO method of temperature adjustment, all in winter; one-day averages for PM_{10} particles were within the range 4.5–81 μg/m^3 and averaged 17.25 μg/m^3 over the monitoring period
- two PM_{10} exceedances were noted during the sampling campaign at the hotspot west site; one-day averages for PM_{10} particles were between 8.5 and 65 μg/m^3, and averaged 22.6 μg/m^3 over the monitoring period
- although benzene levels did not exceed the UK health guideline (no Australian guidelines or standards are available for benzene), ongoing monitoring and assessment of benzene, and possibly other volatile organic compounds such as formaldehyde, is recommended

This monitoring data provides sufficient evidence to suggest that further assessment of PM_{10} in the Mount Gambier area, including the contribution from regional sources, is required. A desktop study should be undertaken to identify other potentially hazardous substances which may be produced by industry in the area.

INTRODUCTION

Between September 2001 and August 2002, the Environment Protection Authority (EPA) collected air quality data in the Mount Gambier area to identify and measure the concentration of compounds believed to present the greatest concern to public health in those areas.

Continuous monitoring during the period at Frew Park monitoring site (i.e. central Mount Gambier) was complemented by two short-term 'hotspot' monitoring programs in the vicinity of wood processing plants during June–August 2002 (Figure 1). This report summarises measurements from all three sites.

The report covers air quality status for pollutants that have standards listed in the *National Environment Protection (Ambient Air Quality) Measure* (Ambient Air Quality NEPM) (Table 1) and some non-NEPM pollutants. Non-NEPM pollutants do not currently have NEPM standards (see below).

Table 1 Standards and goals listed in the Ambient Air Quality NEPM

Pollutant	Averaging period	Maximum concentration	Goal within 10 years—maximum allowable exceedances
Carbon monoxide (CO)	8 hour	9.00 ppm	1 day a year
Nitrogen dioxide (NO_2)	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	none
Photochemical oxidants (as ozone)	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year
Sulfur dioxide (SO_2)	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	none
Lead	1 year	0.5 μg/m³	none
PM_{10}	1 day	50 μg/m³	5 days a year

Suspended particulates (i.e. particles in the air of less than 10 μm[1] in diameter (PM_{10})), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3) were measured continuously at Frew Park and at the two hotspots. Carbon monoxide (CO) was also monitored at the hotspots (Table 2).

The hotspot monitoring aimed to assess localised impacts from industrial sources in the Mount Gambier region. It sampled benzene, formaldehyde, toluene and naphthalene. The results for toluene and naphthalene, however, were considered to be unreliable due to possible interference by other organic compounds[2] and are therefore not summarised in this report.

Details about monitoring methods and instrument techniques and models are listed in Appendix 1, metadata for the ambient and hotspot monitoring stations is presented in Appendix 2. Monitoring results are summarised in Appendix 3.

[1] A micrometre (1 μm) is one-millionth of a metre; a human hair is about 70 μm in diameter.
[2] The exact cause of the interference is still unknown and EPA laboratory staff are investigating.

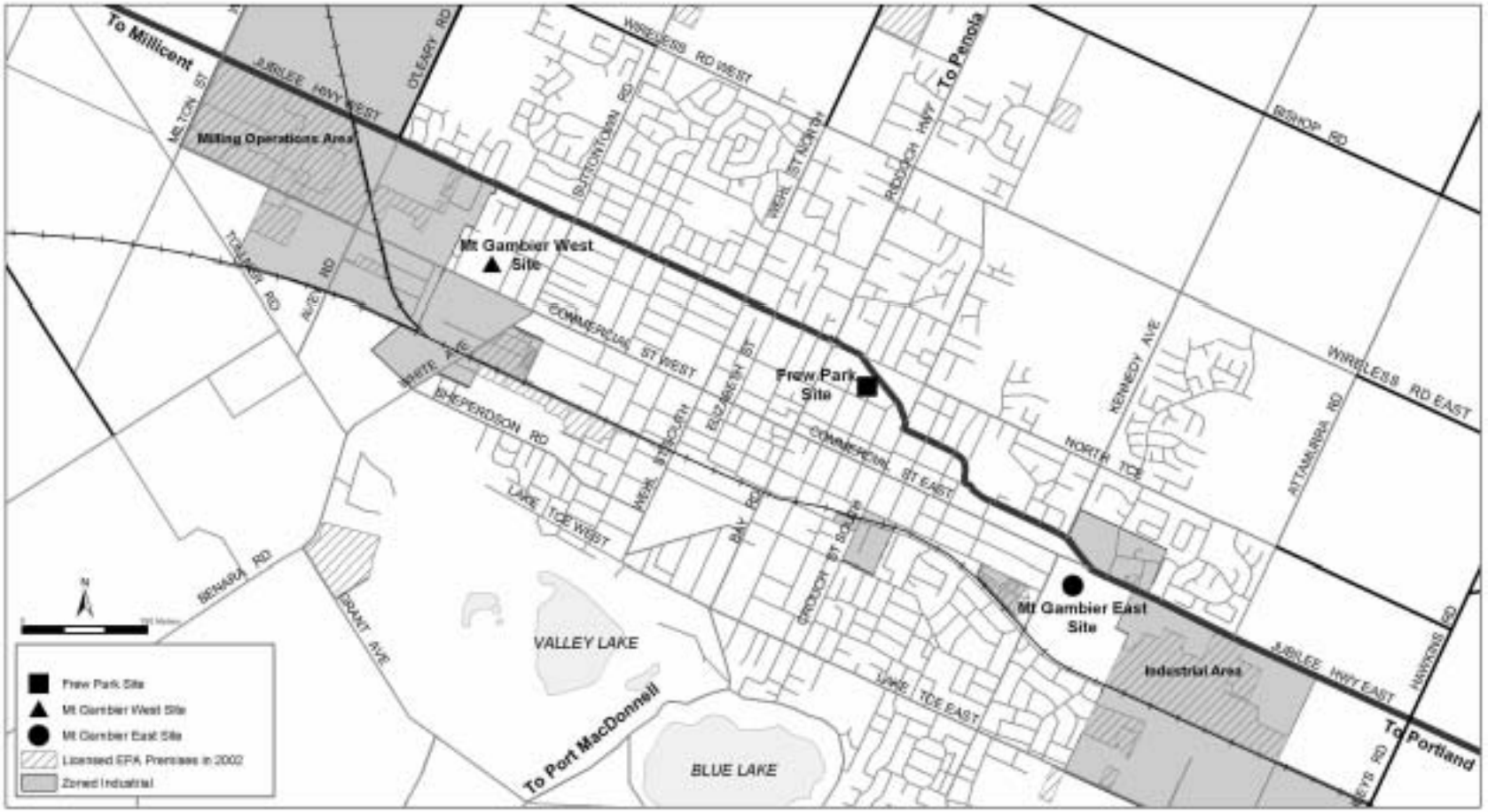


Figure 1 Mount Gambier's road network and the location of the EPA monitoring sites. The shaded areas are EPA licensed locations.

Table 2 Pollutants measured in the Mount Gambier area

Monitoring site	Monitoring period	NEPM pollutants		Non-NEPM pollutants—hourly ($\mu g/m^3$)
		Gaseous hourly (ppm)	Particulate matter hourly ($\mu g/m^3$)	
Frew Park	September 2001–August 2002	SO_2 NO_2 O_3	PM_{10}	—
Mount Gambier east	19 June 2002–29 July 2002	SO_2 NO_2 O_3 CO	PM_{10}	benzene, formaldehyde
Mount Gambier west	30 July 2002–31 August 2002	SO_2 NO_2 O_3 CO	PM_{10}	benzene, formaldehyde

Ambient air quality monitoring and NEPM standards

Ambient air quality refers to the quality of surrounding outdoor air and is broadly representative of the air quality of an area. The EPA conducts ambient monitoring at a number of permanent sites in and around Adelaide, and assesses the results to determine trends of urban air quality over time.

The EPA also conducts 'hotspot' ambient air monitoring in South Australia's regional cities, using transportable monitoring stations. The mobile air monitoring unit (hotspot van) provides added flexibility to carry out measurements at many locations for short periods of time to investigate local pollution and determine whether a permanent station is required.

Each criterion pollutant has a promulgated Ambient Air Quality NEPM standard which is periodically reviewed by National Environment Protection Council (NEPC). The NEPM standard defines a limit for the ambient concentration of airborne contaminants and is established to protect public health and welfare. Each pollutant is defined from scientific studies of the health effects produced by various exposures to specific pollutants. NEPM objectives have traditionally been the benchmark against which South Australia assesses the impact of anthropogenic activities on air quality and ensures the current air quality is maintained at a reasonable level. Ambient air quality standards cover relatively few air pollutants. For example, no NEPM standards exist for nitric oxide, total suspended particulates or air toxics[3] such as benzene and formaldehyde.

The EPA air quality program uses monitoring data to:

- assess air quality in light of established public health and welfare standards and, in particular, determine the relationship of the pollutant concentrations at a sampling site to the NEPM
- help identify measures that may reduce the pollutant concentrations and bring problem areas within the NEPM, preventing future problems in other areas
- provide background information for assessing licence applications and new industrial development proposals.

[3] New NEPM criteria for air toxics are in the process of development.

STUDY AREA—MOUNT GAMBIER

Geography of the Mount Gambier region

The South East region of South Australia consists of an area 65 km north–south, 65 km east–west, and includes two towns, Mount Gambier and Millicent. The Mount Gambier (population 23,656) airshed covers an area 15 km north–south and 15 km east–west; the Millicent (population 4639) airshed area, about 50 km north-west of Mount Gambier, is 5 km north-south and 10 km east-west.

The city of Mount Gambier (37° 50′ S, 140° 45′ E) is South Australia's second largest urban centre and is situated 460 km south-east of Adelaide. Built on the lower slopes of the extinct volcano from which it takes its name, it is the commercial centre for the largest softwood pine plantation in Australia (Figure 2).

Figure 2 Logs from the plantation forest, stored and ready for processing

The area surrounding Mount Gambier is primarily rural, with farming, horticulture, dairying, viticulture, and forests. The region is bordered to the north and east by farmlands and forests, and to the south and west by coastal geography. Figure 3 describes Mount Gambier's generally undulating elevation. The volcanic hills of Blue Lake and Valley Lake rise to 170 m, while rest of the land ranges 30–60 m above sea level. The area's topography is a significant factor in the build up of pollutants that can result in poor air quality under certain meteorological conditions.

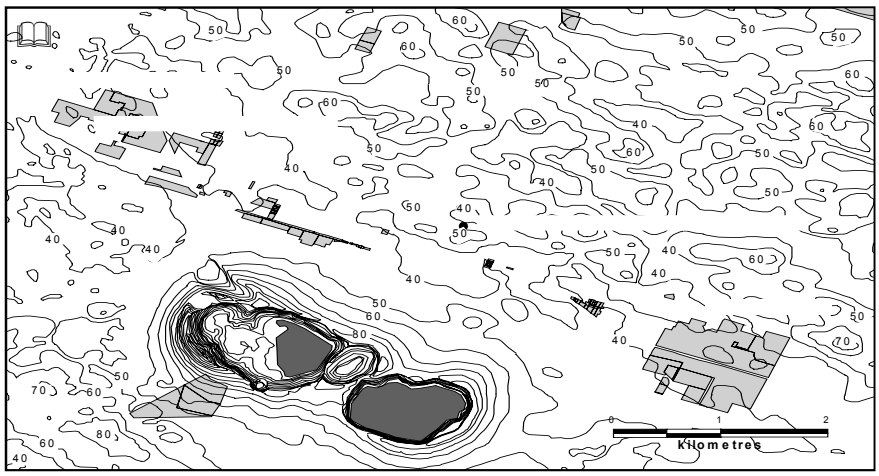


Figure 3 Mount Gambier area at 10 m contour intervals

Climate of the Mount Gambier area

Mount Gambier is classified as the cooler end of a Mediterranean-type climate with summer day temperatures of 16–42°C (the latter being very rare). Most rains occur May–October and average about 700 mm (28 inches) per year. Winters are generally cold and wet with temperatures ranging from –2°C to 20°C. A long-term climatological summary for the Mount Gambier region is provided in Table 3.

Table 3 Climatological information for Mount Gambier, South Australia

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean daily maximum temperature (°C)	25.1	25.1	23.0	19.3	16.0	13.8	13.1	14.0	15.7	17.8	20.1	22.7
Mean daily minimum temperature (°C)	11.0	11.6	10.4	8.6	7.3	5.7	5.1	5.4	6.2	7.1	8.2	9.9
Mean rainfall (mm)	26.2	25.3	35.3	56.0	72.9	81.9	100	92.3	72.5	62.4	46.2	36.9
Days with rain (at least 0.1 mm)	8.5	7.8	10.9	14.3	18.1	19.2	21.5	21.1	19	17.1	13.6	12
Mean daily sunshine duration (hours)	9.0	8.7	6.8	5.3	4.3	4.0	4.3	5.2	5.5	6.8	7.4	8.0

Source: Bureau of Meteorology, SA; weather station at 37.7S, 140.8E, altitude: 63 m; data collection period: 1941–2001

The winds are predominantly southerlies, ranging from south-easterly to south-westerly for about 50% of the year; north to north-westerlies are recorded approximately 35% of the year. Appendix 4 shows surface wind roses for the period 1941–2003 at Mount Gambier aerodrome (centre of rose). The rose arms point to the direction from which the wind is blowing as a percentage of the sampling period.

The two times of daily wind observations coincide with the two major contributing factors to the daily wind regime. The 0900 (Central Standard Time, as are all following times) records tend to emphasise the synoptic pattern, whereas the 1500 records tend to reflect the surface generated effects (e.g. sea breezes) superimposed on the basic synoptic situation. A comparison of the wind speed pattern (Appendix 4) shows that the highest percentage of calms (i.e. wind speed less than 1 m/s) tend to occur in autumn.

During the summer months (i.e. December, January, February) high pressure cells move eastward along the subtropical high pressure ridge to the north of the region. These systems produce a predominance of south-easterly and southerly winds, as illustrated by January 0900 in Appendix 4. In contrast, the 1500 data shows a general strengthening of the southerlies.

During the winter months (i.e. June, July, August) the synoptic pattern produces predominantly northerly winds. The 1500 data shows a reduction in the northerly winds and a general strengthening of the westerlies. At both observation hours there is a difference in the observed percentage of calm, with 18% occurrence at 0900 compared to 5% at 1500.

The presence of Mount Gambier, an extinct volcano, produces some local drainage flows from the east. Nocturnal (night-time) drainage winds begin when air adjacent to a sloping surface cools and becomes more dense than the free air at the same elevation. Common drainage flows dictate local air transport and determine the spatial distribution of nocturnal minimum temperatures.

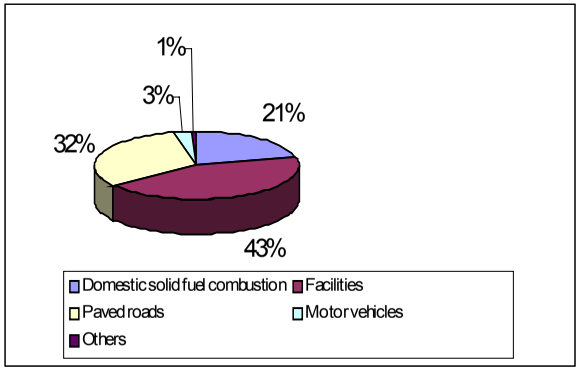
Emissions in the region

The National Pollutant Inventory (NPI[4]) for 2001–02 identifies six registered industrial sites emitting various pollutants within the Mount Gambier area, most in the west of the city. Major industries in the Mount Gambier airshed include timber, dairy products, horticulture and wool. The large wood processing industry in the area may contribute to the particle concentrations in the region.

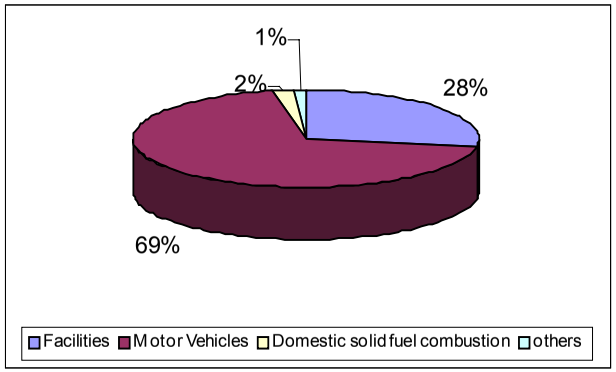
A summary of the emission sources for NEPM and non-NEPM pollutants in Mount Gambier is illustrated in Figure 4. As indicated, the majority of PM_{10} emissions are primary emissions from point source fuel combustion—usually dust particles from industrial sources (43%). Domestic solid fuel combustion constitutes 21% of the total PM_{10} emissions, while natural sources like paved roads contribute 32%.

Motor vehicle fuel combustion is a significant source category contributing to NO_2 (69%) and CO (48%), while industrial combustion sources constitute the highest contribution (85%) of SO_2.

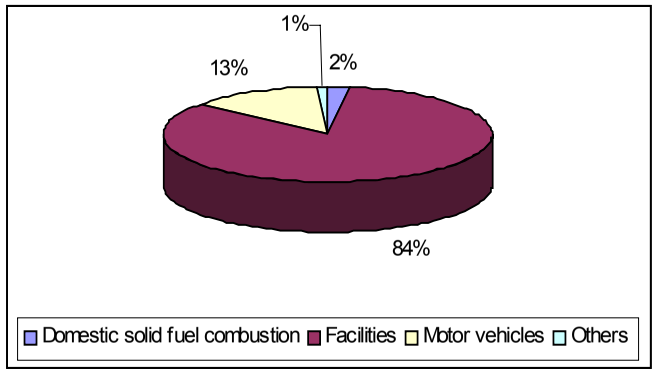
[4] The NPI holds emission data reported by industrial facilities and aggregated emission data collected by participating jurisdictions.



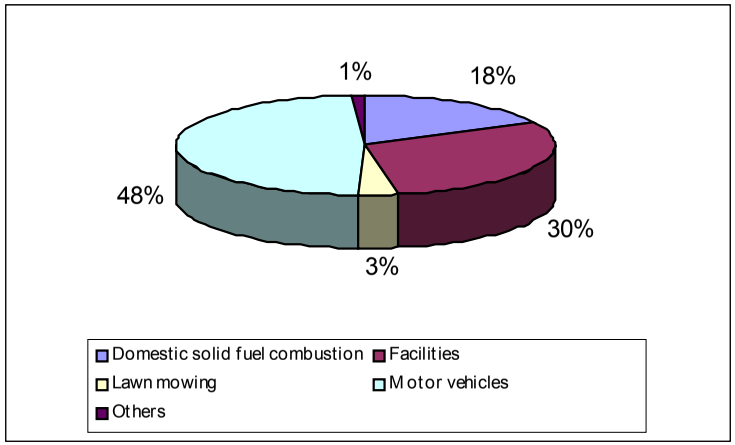
(a) PM_{10}



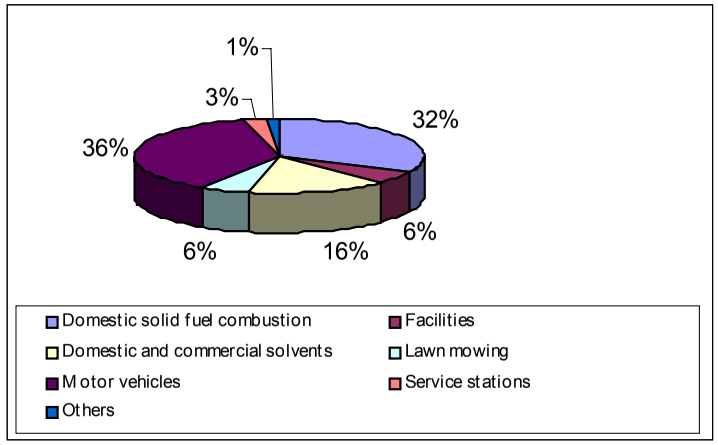
(b) NO_x



(c) SO_2



(d) CO



(e) Total VOCs

Figure 4 Annual inventory estimates from the NPI for the Mount Gambier Region. Emissions have been represented to two significant figures (Source: EPA 2001a).

Air pollution from wood manufacturing in Mount Gambier

The wood processing industry is the largest manufacturing industry in Mount Gambier. For industrial purposes, wood is classified into two types: hardwoods (e.g. *Eucalyptus*) and softwoods (e.g. pine). In Mount Gambier, pine is the most abundant softwood species processed in sawmills and chip mills. The two main milling operations are Green Triangle Forest Products and Carter Holt Harvey, Jubilee Highway. The city is also home to a number of small manufacturing industries.

Major wood manufacturing processes are debarking, sawing, sanding, milling, chipping and drying. Apart from particle chip drying operations, sanding and sawing produce fine airborne dust particles. The high moisture content in fresh wood makes it less likely to be airborne than dry wood, which produces more dust during processing.

The main air quality concerns about wood processing plants relate to dust, wood-fired boiler and wood-chip dryer emissions (particulate and volatile organic compounds), and odour.

Carter Holt Harvey Wood Products Australia Pty Ltd operates two panel board mills (White Avenue and Lakeside) in Mount Gambier that dry wood particles and burn waste timber for heat generation. Air emission stacks from the wood chip dryers at Carter Holt Harvey (White Avenue) are shown in Figure 5. The twin 'Bison' model dryer stacks are in front of the single 'Buttner' model dryer stack in the photograph. The two wood chip dryers operate by heating the wood chips in a rotating drum, reducing the moisture level of the wood chips to allow for the production of particle board products. The air emission control systems at this site are cyclones.

Figure 5 Smokey air emission stacks associated with the wood chip dryers at the Carter Holt Harvey, White Avenue site

Two other mills in Mount Gambier undertake wood processing, burning waste wood to produce heat for on-site use.

Particle board (chipboard) is made of small wood particles and a binder—usually a synthetic resin. Wood is mechanically chipped and then reconstituted using a synthetic resin adhesive. A variety of resins and bonding agents are used in the manufacture of chipboard.

The chemicals used at Mount Gambier mills typically include resins and adhesives such as urea formaldehyde, oils (fuel and lubrication), solvents and wood treatment chemicals (copper chrome arsenate and creosote).

Other sources of air pollution

Other human-induced sources of air pollution in the region include burning of forestry waste (Figure 6), stubble and residential wood. Back-yard burning, which is legally prohibited in and around metropolitan Adelaide, is still in practice in some parts of the Mount Gambier area. These sources can have a cumulative effect on the region's air quality in general and especially particulate levels under unfavourable meteorological conditions.

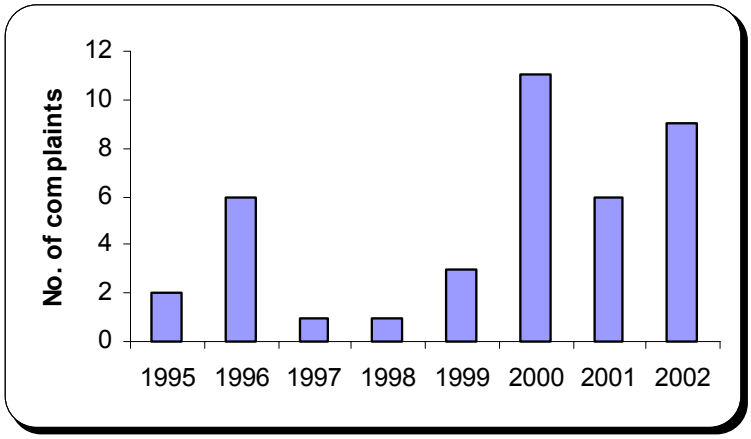
Figure 6 Plantation forest compartment after being logged; vegetative waste within these compartments is also burnt.

Under some weather conditions, the city can also receive SO_2 and associated organic emissions from a pulp and paper facility at Millicent.

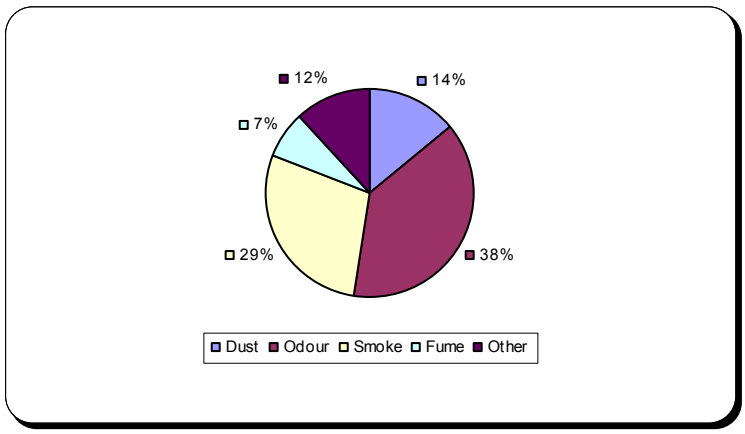
Air quality complaints in the Mount Gambier region

Figure 7a shows complaints received by the EPA from the Mount Gambier area over the period 1995–2002. Complaints are in general increasing. As indicated in Figure 7b, the highest percentage (38%) of the complaints are related to odour nuisances. Odour is probably one of the most noticeable air pollutants; it is particularly important because of its subjective nature and the difficulties encountered in its proper assessment.

EPA records also show that more than 50% of air quality complaints were likely to be caused by wood processing.



(a) No. of registered air quality complaints



(b) Nature of air quality complaints

Figure 7 Number and nature of air quality complaints in the Mount Gambier region (1995–2002)

AIR QUALITY DATA

Sampling sites

Frew Park

The monitoring site at Frew Park (Figure 1) was in the centre of Mount Gambier, between industrial regions to the east and west of the city. The monitoring station was situated in a residential area to investigate the combined impact of industry, motor vehicles and domestic air pollution sources on residential areas. The monitoring site was surrounded by houses, with higher densities to the south and east. Jubilee Highway was about 100 m to the north of the monitoring station.

The site was relatively open and exposed so that general weather conditions (meteorology) could be easily measured without being overly influenced by local obstructions (buildings) or local winds driven by the higher topography of the Blue and Valley lakes. Monitoring covered at least 12 months to ensure that seasonal variation in meteorology was accounted for in air pollution assessment.

Hotspot monitoring sites

The Mount Gambier eastern hotspot monitoring station was located 400 m from a timber processing plant (Carter Holt Harvey, Jubilee Highway East) to the east-south-east. The monitoring station was bounded on the north by Jubilee Highway, a heavy traffic road; on the west by Pick Avenue, another heavy vehicle road to Portland in Victoria; and on the south by residential premises.

The western hotspot monitoring site was located at the SA Water complex on Commercial Street West, with the major industrial sources Carter Holt Harvey and Green Triangle Forest Products to the south and north-west respectively. An additional potential air pollution source to the south was a truck re-fuelling depot. Residential areas were to the north and east of the site.

The sampling sites were selected primarily to measure the potential impact from the wood manufacturing plants. However, other industrial, residential and vehicular sources of air pollution in the Mount Gambier region or nearby areas like Millicent may also contribute to the measured concentration of pollutants due to short- and long-range air transport.

Air quality data collection and analysis process

The EPA is committed to ensuring the collection of high quality environmental data through the development and implementation of extensive quality assurance and quality control procedures. This goal is accomplished by the EPA through a series of measures which include periodic calibrations, record keeping of monitoring processes and maintenance, use of reference or equivalent monitoring methods, and the use of standard methodologies to achieve comparable and representative results.

The EPA laboratories are responsible for operating and maintaining air quality instrumentation for ambient air monitoring. Samples of each pollutant are collected using the sampling techniques described in Appendix 1. Methods are strictly governed by operation or instruction manuals and applicable quality assurance procedures.

Data handling

To perform the data analysis in this report, monthly or annual means were not calculated unless at least 50% of the hourly observations were available for the period concerned. Furthermore, the annual mean was not calculated unless monthly means were reported for at least two months in each quarter. The 8-hour and 24-hour running means were not calculated unless 75% of the hourly observations were available. A summary of statistics for the three monitoring sites is shown in Appendix 3.

RESULTS

Formaldehyde (CH_2O)

Sources

Formaldehyde is both a primary and secondary pollutant. It is used in glues, wood products, preservatives, permanent press fabrics, paper product coatings and certain insulation materials. It is also released by incomplete combustion of fuels in motor vehicles, cigarette smoking, and burning wood (formaldehyde is a natural ingredient of wood), kerosene and natural gas. Conventional wood manufacturing in Mount Gambier uses formaldehyde resin as the glue to hold the fibres of the chipboard together. This could lead to incremental emissions over a long period of time.

Formaldehyde is also produced in large quantities by natural events such as forest or bush fires.

Health impacts

When formaldehyde is present in the air at levels at or above 0.1 ppm, acute health effects can occur. These include chest tightness and wheezing, skin rashes and other sensory irritations.

WHO guideline

The World Health Organization's (2000) guideline is 100 μg/m^3 (0.08 ppm) measured as a 30-minute average.

Monitoring results

Mount Gambier east

Thirty-minute averages for formaldehyde were within the range of 0–53.4 μg/m^3, with an average for the entire sampling period of 30.1 μg/m^3 (Figure 8). These results are well below the WHO guideline of 100 μg/m^3 measured as a 30-minute average.

Mount Gambier west

The average measurement for the one-month study at Mount Gambier west was 27 μg/m^3. The 30-minute averages for formaldehyde were within the range of 2.2–62.3 μg/m^3 (Figure 9). The results are below the WHO guideline.

Comparison of formaldehyde concentration with background levels in Adelaide

A comparison of formaldehyde concentrations from the two hotspot sites with levels measured in Adelaide at similar industrial and high traffic hotspots (Table 4) shows quite high relative levels at the Mount Gambier sites. This suggests some input from nearby point sources (i.e. wood industry).

Table 4 Comparative levels of formaldehyde in Adelaide and hotspot monitoring sites

	Hotspot east	Hotspot west	Adelaide
Range	0–53.4 μg/m^3 (0–0.043 ppm)	2.2–62.3 μg/m^3 (0.0017–0.05 ppm)	0.008–0.019 ppm
Mean	30.1 μg/m^3 (0.024 ppm)	27 μg/m^3 (0.022 ppm)	

The concentration of formaldehyde may contribute to the odour complaints in the area. Health problems such as sensory irritation are not expected below 0.08 ppm measured over 30 minutes. However, according to DHS, formaldehyde is considered to be a potential carcinogen and human exposure to this substance should be kept as low as possible.

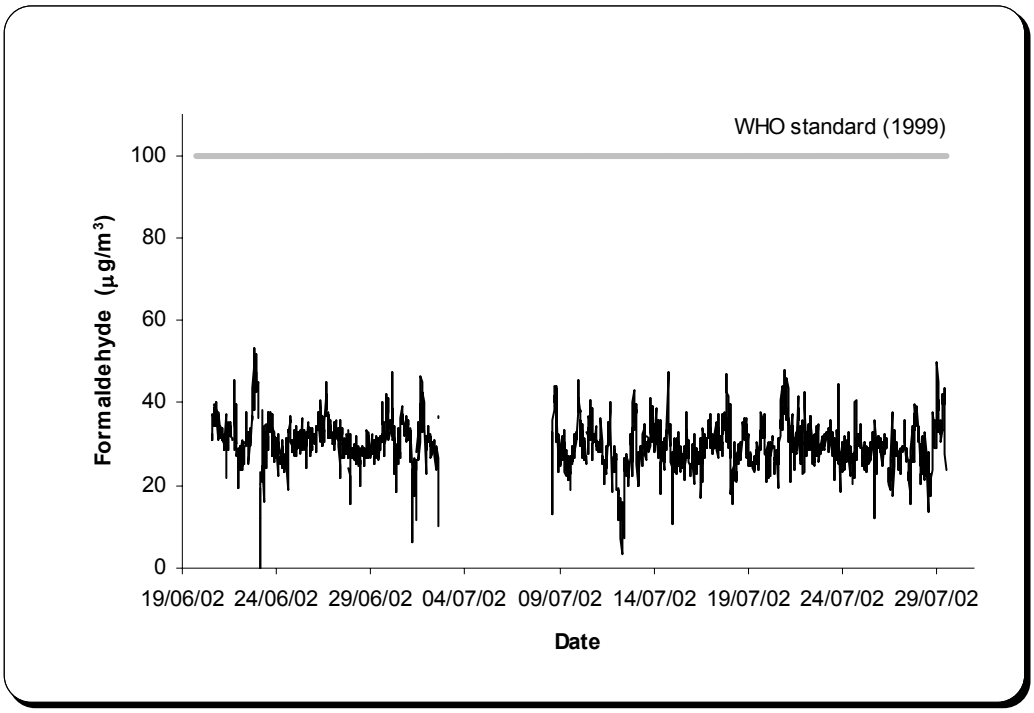


Figure 8 Thirty-minute formaldehyde concentrations at Mount Gambier east hotspot

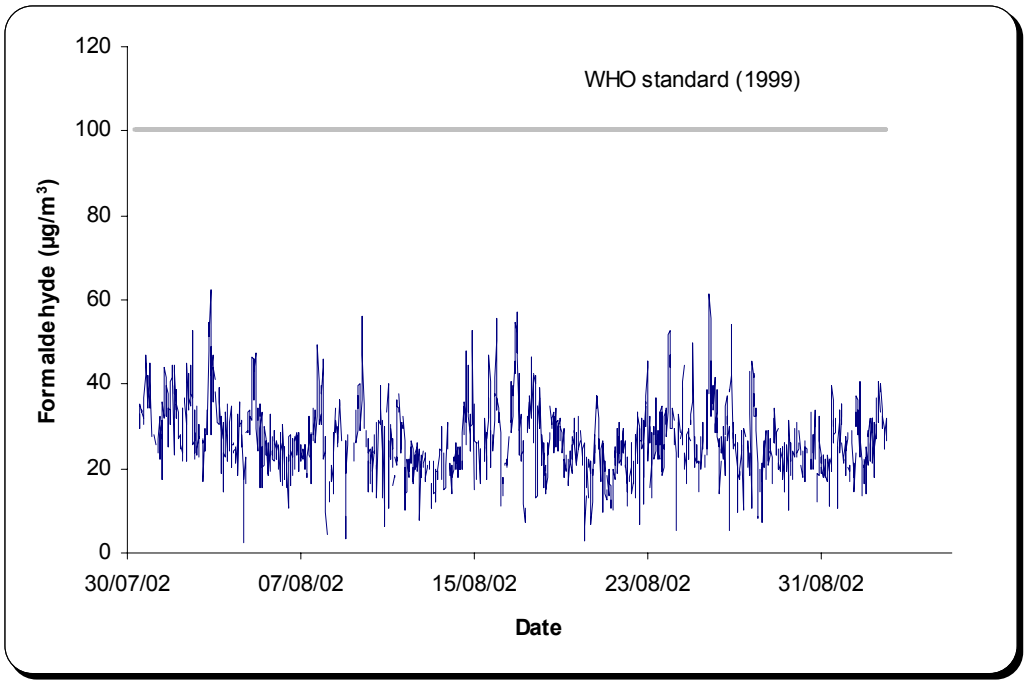


Figure 9 Thirty-minute formaldehyde concentrations at Mount Gambier west hotspot

Benzene (C_6H_6)

Sources

Benzene is a primary pollutant, with emissions largely attributed to vehicular traffic; domestic fuel combustion may contribute during the cold part of the year. Fuel combustion, motor vehicle exhaust, industrial solvents and tobacco smoke account for 50% of public exposure. Emissions from vehicular combustion depend on the benzene content of the fuel as well as engine type.

Commitments to improve fuel quality standards, motor vehicle emission controls and improved engine technologies are expected to result in decreased benzene levels throughout Australia (Best 2000). Improved VOC emission control technology on new motor vehicles plus the effect of reduced petrol benzene levels will also help reduce ambient benzene levels.

Health impacts

Benzene is a known carcinogen and exposure to high ambient levels of the compound represents a significant health risk. Because of its carcinogenicity, no safe level has been specified for ambient air concentrations of benzene and at present there is no ambient standard for benzene in Australia.

UK air quality guideline

The UK air quality guideline (Department of the Environment, Transport and the Regions 1994) for benzene is 16 μg/m^3 (0.005 ppm measured as an annual average).

Monitoring results

Mount Gambier east

One-hour averages for benzene were within the range 0–24.5 μg/m^3, with an average for the entire sampling period of 6.7 μg/m^3 (Figure 10). Comparable levels are measured in other Australian cities (Department of Environment Protection 2000).

Mount Gambier west

Average one-hour benzene concentrations measured at Mount Gambier west ranged from 0 to 46 μg/m^3 during this one-month study (Figure 11). The average concentration for the sampling period was 11.5 μg/m^3.

The one-month mean benzene concentration of 11.5 μg/m^3 can be taken as an annual average by assuming that no seasonal variation occurs since industry operates all year around. More data is needed to test this assumption, given the fact that the monthly mean concentration is close (72%) to the recommended annual average of 16 μg/m^3.

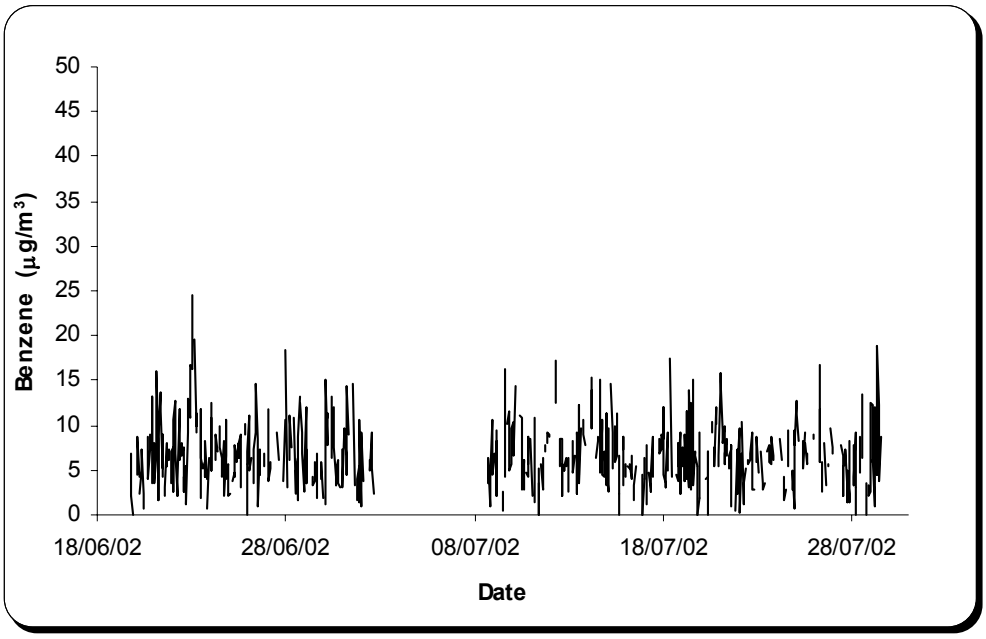


Figure 10 One-hour benzene concentrations at Mount Gambier east hotspot
(Note: gap in data due to instrument malfunction)

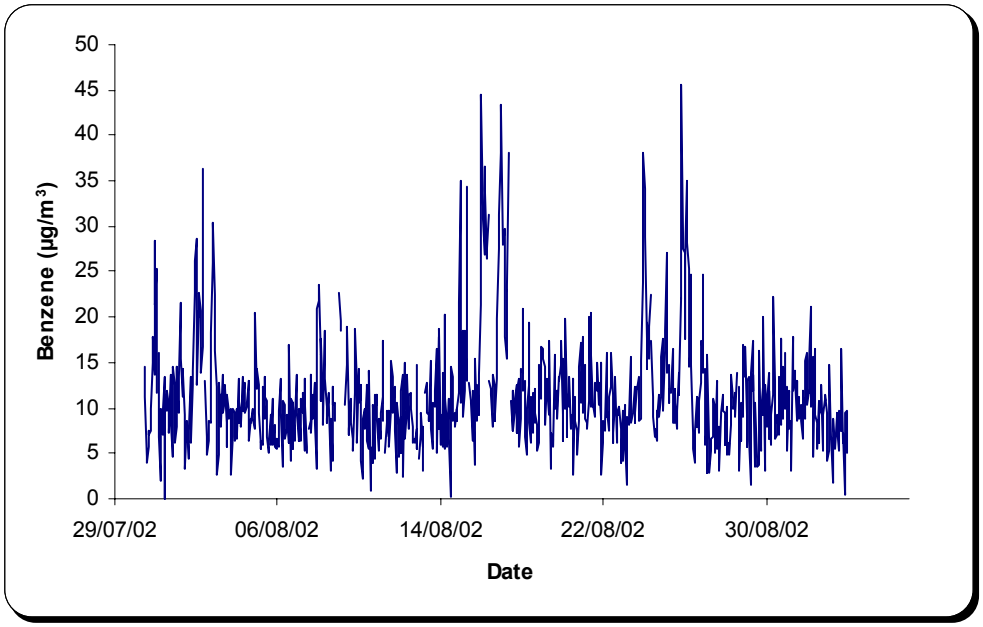


Figure 11 One-hour benzene concentrations at Mount Gambier west hotspot

Carbon monoxide (CO)

Sources

Carbon monoxide is a colourless, odourless, poisonous gas formed by incomplete combustion of fuels. Motor vehicles are the largest source of CO emissions. Other sources include incinerators, wood stoves, furnaces, and some industrial processes including steel plants, foundries, oil refining, and chemical manufacturing such as the making of lime.

Peak CO concentrations typically occur during the colder months of the year, when CO automotive emissions are greater and night-time inversion conditions are more frequent.

Health impact

The main threat to health from exposure to CO is the formation of carboxyhaemoglobin, which significantly reduces the capacity of blood to carry oxygen and deliver it to the tissues. Exposure can cause fatigue, headache and impaired judgement at moderate concentrations, while at high levels of exposure unconsciousness and death can result. People with heart diseases, angina, emphysema and other lung or cardiovascular diseases are most susceptible.

NEPM standard

The standard is an 8-hour average (as running 8-hour mean) of 9 ppm and this value should not be exceeded more than once per year.

Monitoring results

Mount Gambier east

Eight-hour averages of CO were within the range 0–2 ppm, with an average for the entire sampling period of 0.3 ppm (Figure 12). No exceedances of the 8-hour CO NEPM air quality standard were recorded during the monitoring period.

Mount Gambier west

Eight-hour averages of CO at the Mount Gambier west hotspot were within the range 0.1–4.3 ppm, with an average for the entire sampling period of 0.6 ppm (Figure 13). There were no exceedances of the 8-hour NEPM air quality standard.

Overall, concentrations of CO were slightly higher at the Mount Gambier west hotspot site than at the east hotspot site. This may be due to the relative proximity of truck movement associated with the truck refuelling point at the west hotspot monitoring site. CO concentrations may also vary according to the weather patterns in a similar way to the PM_{10} concentrations.

The Department of Human Services has advised that health impacts would not be anticipated.

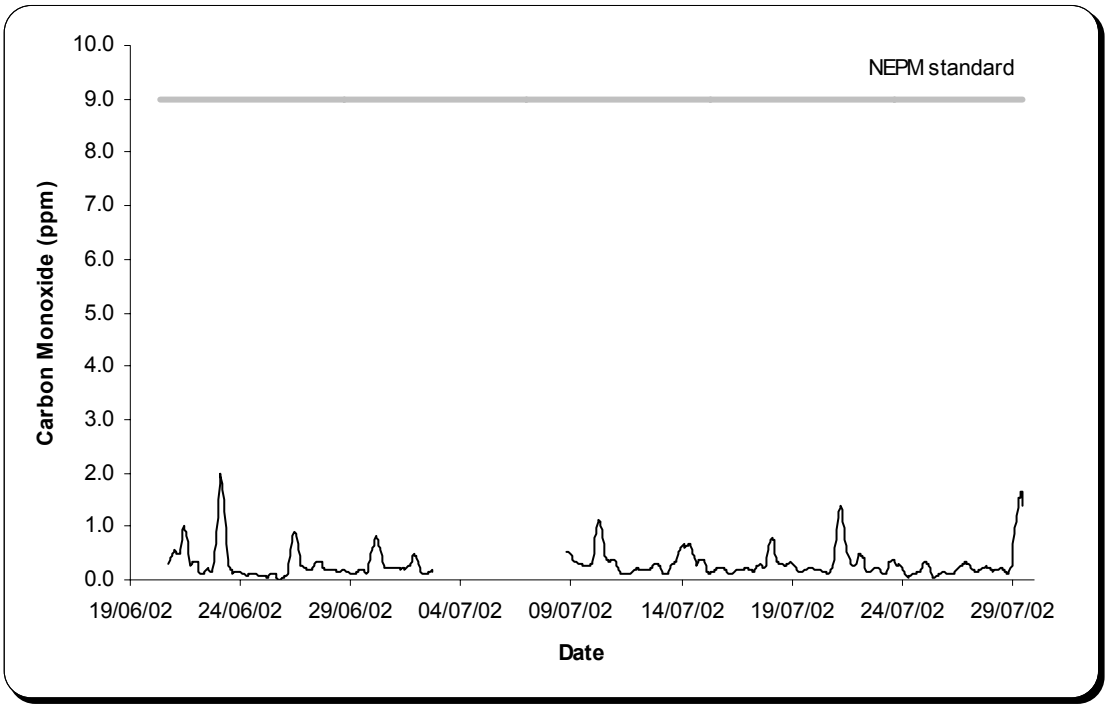


Figure 12 Eight-hour carbon monoxide concentration at Mount Gambier east hotspot (Note: gap in data due to instrument malfunction)

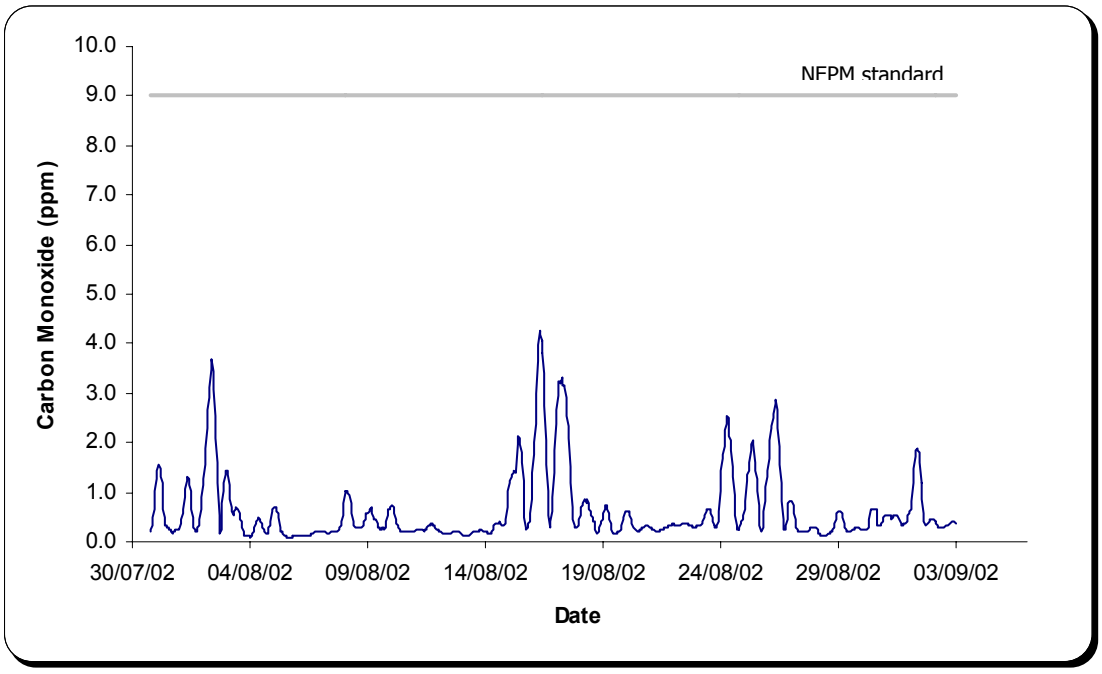


Figure 13 Eight-hour carbon monoxide concentration at Mount Gambier west hotspot

Nitrogen dioxide (NO_2)

Sources

Nitrogen dioxide (NO_2) is a reddish-brown toxic gas, part of a group of gases containing nitrogen and oxygen called oxides of nitrogen (NO_x). They are produced during the high temperature burning of fuels. Sources of NO_x include motor vehicles and stationary sources that burn fossil fuels, such as power plants, industrial boilers and building heating systems.

Health impact

Nitrogen dioxide irritates the lungs and upper respiratory system and lowers resistance to respiratory infections. It can be fatal in high concentrations. Reactions between NO_x and other compounds in the atmosphere can form nitric acid, which can contribute to the acid rain problem.

Additionally, NO_x and various other pollutants (e.g. hydrocarbons) may react in the presence of sunlight to produce photochemical oxidants. These are extremely unstable compounds which damage plants and irritate people's eyes and respiratory systems.

NEPM standard

The NEPM standard is 0.12 ppm measured as an hourly average and 0.03 ppm as an annual mean.

Monitoring results

Frew Park

Daily average concentrations for NO_2 were within the range 0–0.03 ppm and well below the NEPM air quality standard of 0.12 ppm. The average concentration for the entire sampling period (September 2001–August 2002) was 0.005 ppm, well below the annual standard of 0.03 ppm.

The Department of Human Services has advised that health impacts would not be anticipated.

Mount Gambier east

One-hour averages for NO_2 were within the range 0.001–0.039 ppm, with an average for the entire sampling period of 0.007 ppm (Figure 14). The results are well below the NEPM standard.

Mount Gambier west

The average measurement at the Mount Gambier west was 0.008 ppm during this one-month study. The hourly averages for NO_2 were within the range 0–0.032 ppm (Figure 15). The results are below the NEPM standard.

The Department of Human Services has advised that health impacts would not be anticipated.

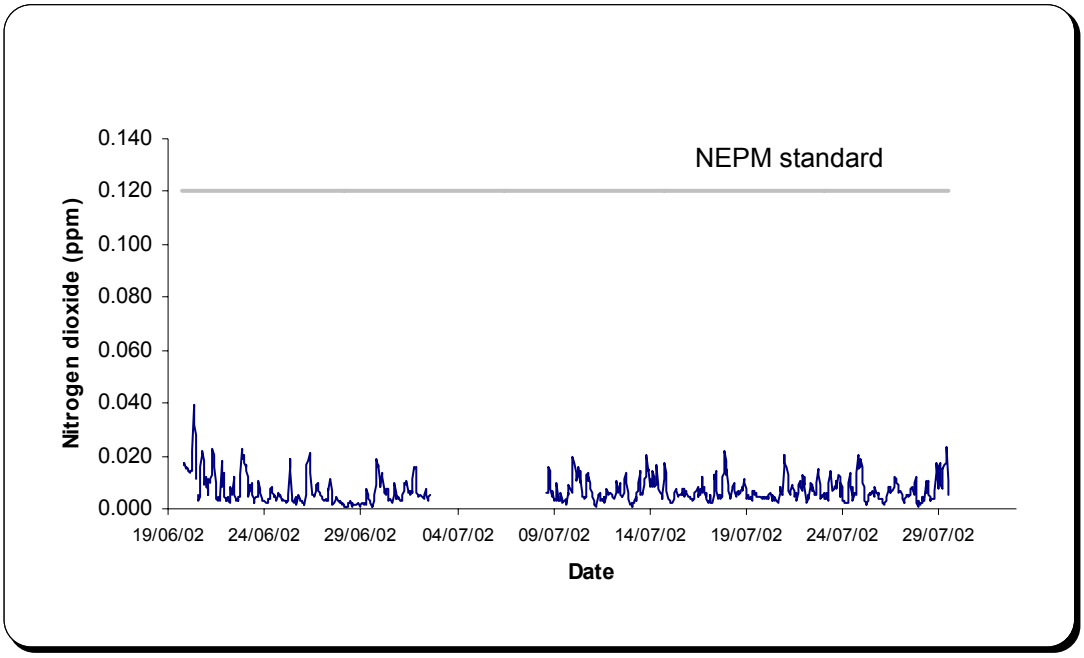


Figure 14 One-hour nitrogen dioxide concentrations at Mount Gambier east hotspot (Note: gap in data due to instrument malfunction)

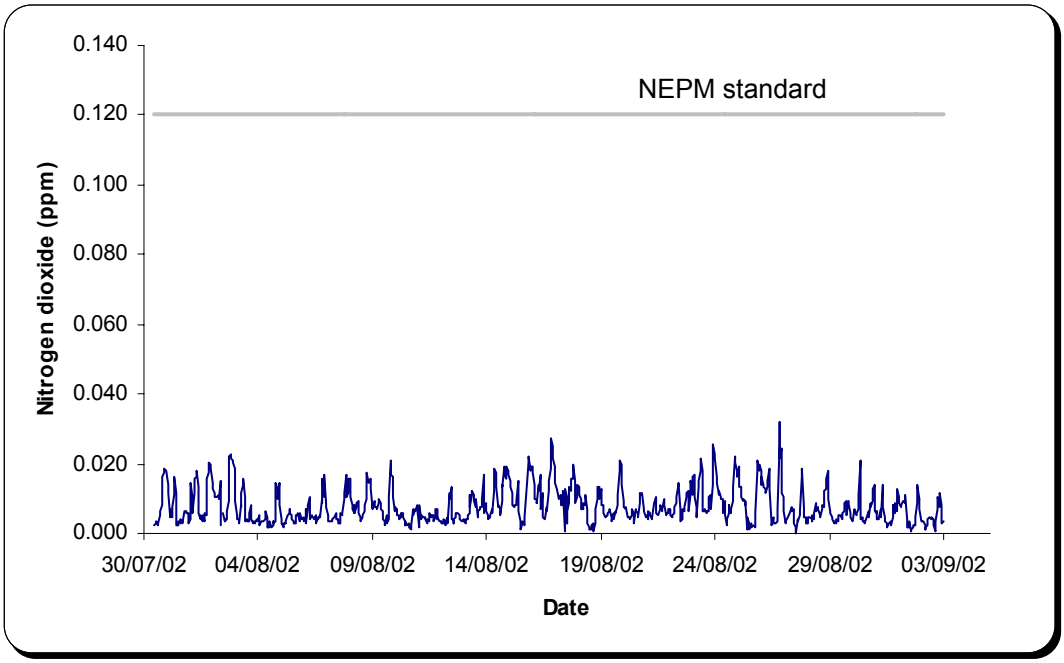


Figure 15 One-hour nitrogen dioxide concentrations at Mount Gambier west hotspot

Ozone (O_3)

Sources

Ozone (O_3) is usually not directly discharged to the air since it is formed from pollutants such as NO_x and reactive VOCs. O_3 levels depend on the rates of emission of these 'precursor' pollutants, which are normally associated with motor vehicle operation, fuel combustion and industrial processes.

O_3 can also be formed naturally—in the atmosphere by electrical discharge and in the stratosphere by solar radiation. The former process is not capable of producing significant urban concentrations of this pollutant but there is some belief that intrusion of O_3 from the stratosphere can contribute significantly elevated ground level concentrations of O_3 under certain meteorological conditions.

Because sunlight plays a major role in O_3 production, maximum O_3 levels generally occur in summer months between noon and early evening.

Health impact

O_3 is a strong oxidiser and can irritate the eyes, nose and throat. High concentrations can increase susceptibility to respiratory disease. O_3 also affects vegetation and ecosystems, decreasing yields of commercial crops and lowering the aesthetic value of national parks.

NEPM standard

The NEPM air quality standard for O_3 is 0.1 ppm as a one-hour mean. A four-hour standard has also been set at a level at which effects in healthy individuals have been demonstrated—0.08 ppm.

Monitoring results

Frew Park

One-hour and four-hour averages for O_3 are well below the NEPM air quality standard of 0.1 ppm (1 hour) and 0.08 ppm (4 hour). The range was 0–0.044 ppm for one-hour averages and 0–0.042 ppm for four-hour averages.

The Department of Human Services has advised that health impacts would not be anticipated.

Mount Gambier east

One-hour averages for O_3 were within the range 0.011–0.05 ppm, with an average for the sampling period of 0.03 ppm (Figure 16). The results are well below the NEPM standard.

The range was 0.01–0.044 ppm for four-hour averages with an average value of 0.03 ppm for the sampling period (Figure 17). The results are well below the NEPM standard.

The Department of Human Services has advised that health impacts would not be anticipated.

Mount Gambier west

The average measurement at Mount Gambier west was 0.023 ppm during the sampling period. The hourly averages for O_3 were within the range 0–0.044 ppm (Figure 18). The results are below the NEPM standard. The range was 0.002–0.04 ppm for four-hour averages with an average value of 0.023 ppm for the sampling period (Figure 19).

The Department of Human Services has advised that health impacts would not be anticipated.

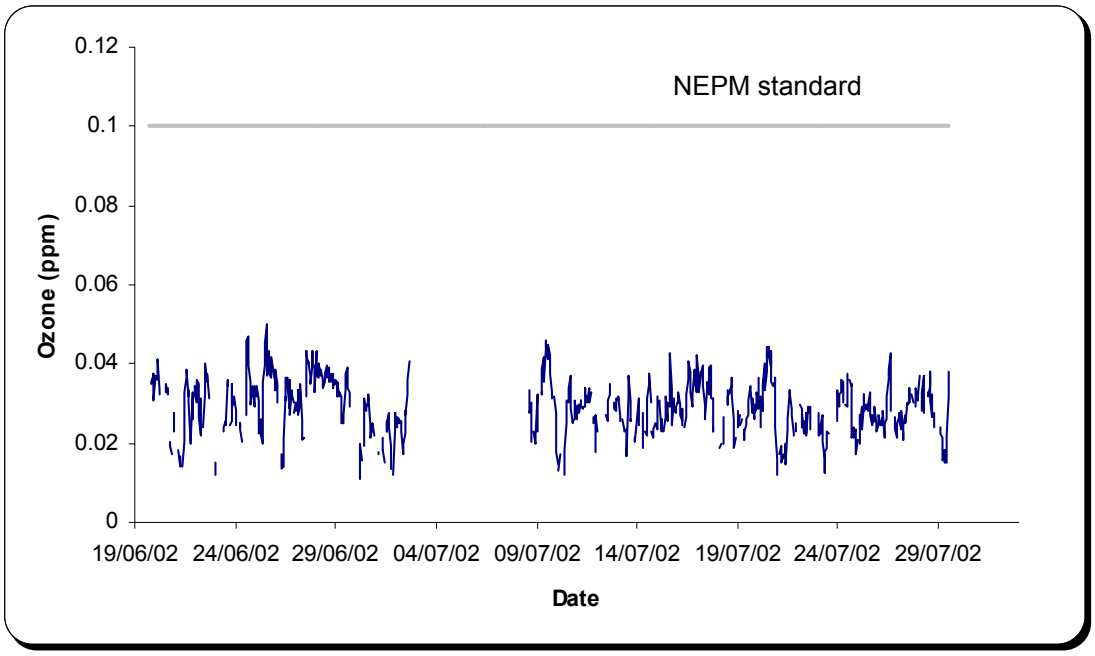


Figure 16 One-hour ozone concentrations at Mount Gambier east hotspot
(Note: gap in data due to instrument malfunction)

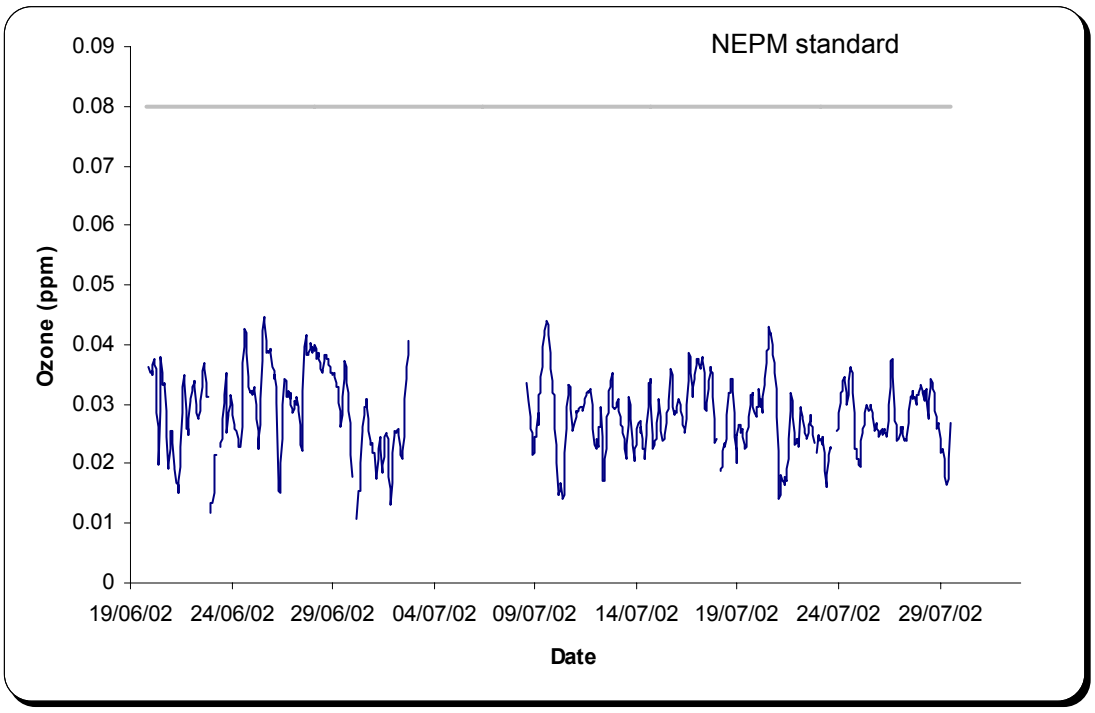


Figure 17 Rolling four-hour ozone concentrations at Mount Gambier east hotspot
(Note: gap in data due to instrument malfunction)

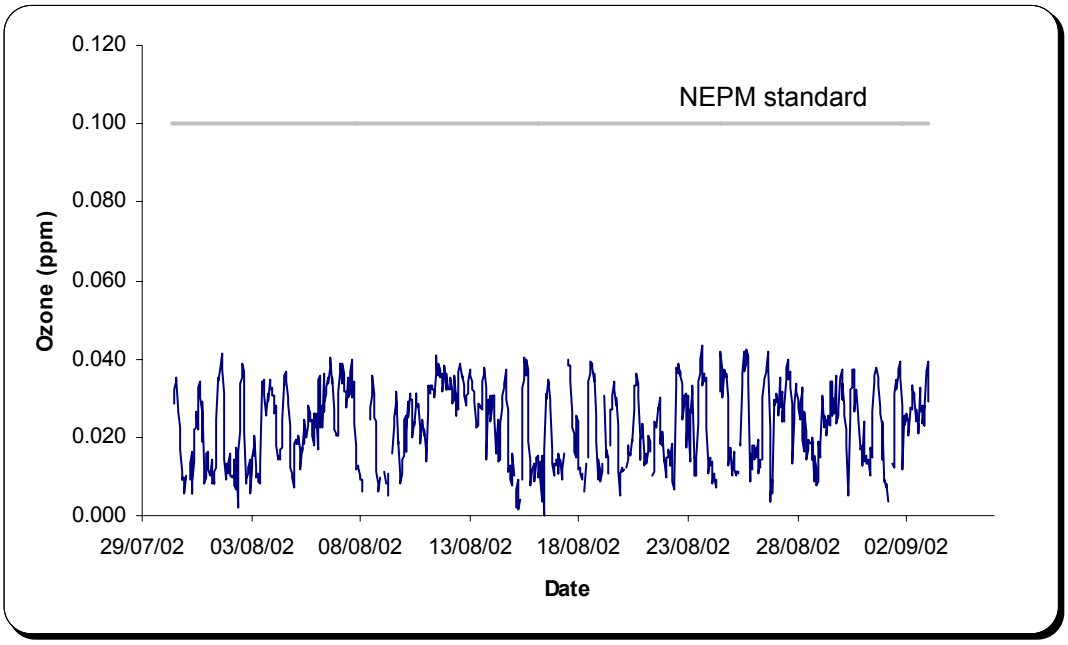


Figure 18 One-hour ozone concentrations at Mount Gambier west hotspot

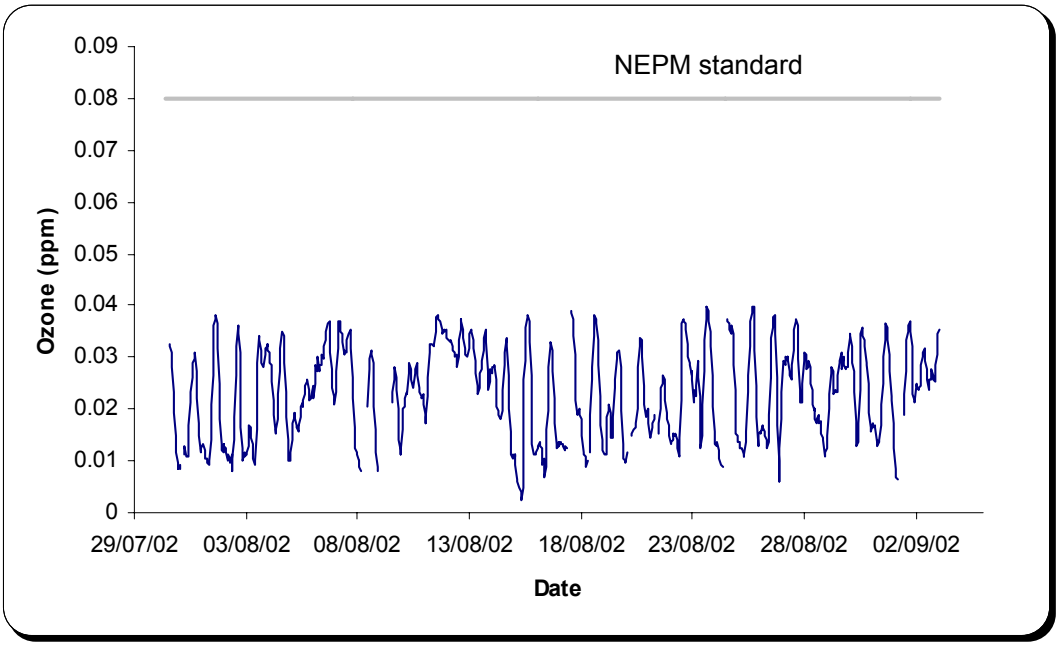


Figure 19 Rolling four-hour ozone concentrations at Mount Gambier west hotspot

Sulfur dioxide

Sources

SO_2 is a colourless gas with a choking odour that is formed when fuel containing sulfur (mainly coal and oil) is burned, and during other industrial processes. Sources of SO_2 include fossil fuel combustion (particularly from coal-burning power plants); and from industrial processes such as wood pulping, paper manufacture, petroleum, and metal refining and smelting (particularly from ores containing sulfide). Many of these activities do not occur in the Mount Gambier region, where the only source of SO_2 is the wood pulping industry.

Health impact

SO_2 is a pungent, poisonous irritant that can interfere with normal breathing functions even at low levels. It aggravates respiratory diseases such as asthma, emphysema and bronchitis. High SO_2 levels can obstruct breathing passages and cause increased death rates among people with existing heart and lung diseases.

NEPM standard

The NEPM air quality standard for SO_2 is 0.20 ppm as a one-hour mean. The maximum allowable daily average is 0.08 ppm and, over one year, 0.02 ppm.

Monitoring results

Frew Park

No exceedances of the one-hour or 24-hour average SO_2 standard occurred at the Frew Park site during September 2001–August 2002. SO_2 concentrations at Frew Park were very low, with one-hour averages within the range 0–0.012 ppm and well below the NEPM air quality standard of 0.20 ppm.

The Department of Human Services has advised that health impacts would not be anticipated.

Mount Gambier east and Mount Gambier west

Both east and west hotspot measurements show that average hourly concentrations of SO_2 are well below the national standard, with the highest recorded maximum value being less than half of the standard. One-hour averages for SO_2 were within the range 0–0.01 ppm at both hotspot sites and well below the NEPM air quality standard of 0.20 ppm (Figures 20 and 21).

An assessment of the relationship between Frew Park and Mount Gambier east during 20 June–27 July 2002 found a poor correlation for SO_2 concentrations between the two sites ($r^2 = 0.13$, 24-hour). Figure 22 illustrates the 24-hour average concentrations at each site during the sampling period. A poor correlation ($r^2 = -0.31$, 24-hour) between the 24-hour average SO_2 concentrations was also found between Mount Gambier west and Frew Park (Figure 23) for the sampling period 30 June–31 August 2002. Results could indicate that sources of SO_2 are different at each of these sites. All data at Frew Park is close to the limit of detection.

It is interesting to note the variation in concentration of SO_2 at Frew Park compared to Mount Gambier east and west. This variation at Frew Park may suggest a nearby source.

The Department of Human Services has advised that health impacts would not be anticipated at this level of SO_2.

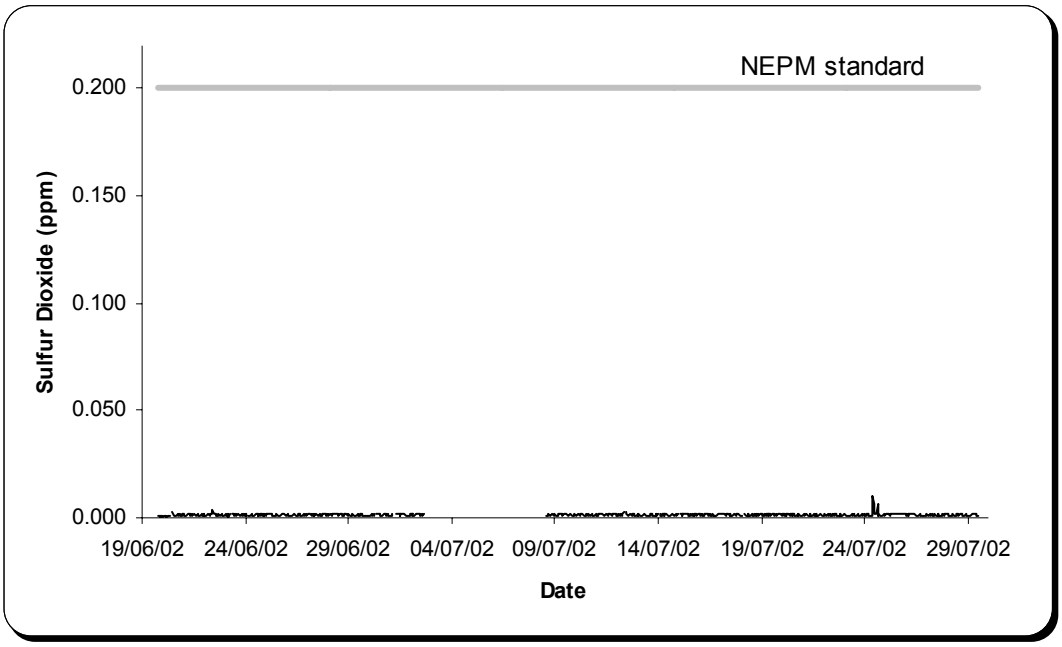


Figure 20 One-hour sulfur dioxide concentrations at Mount Gambier east hotspot
(Note: gap in data due to instrument malfunction)

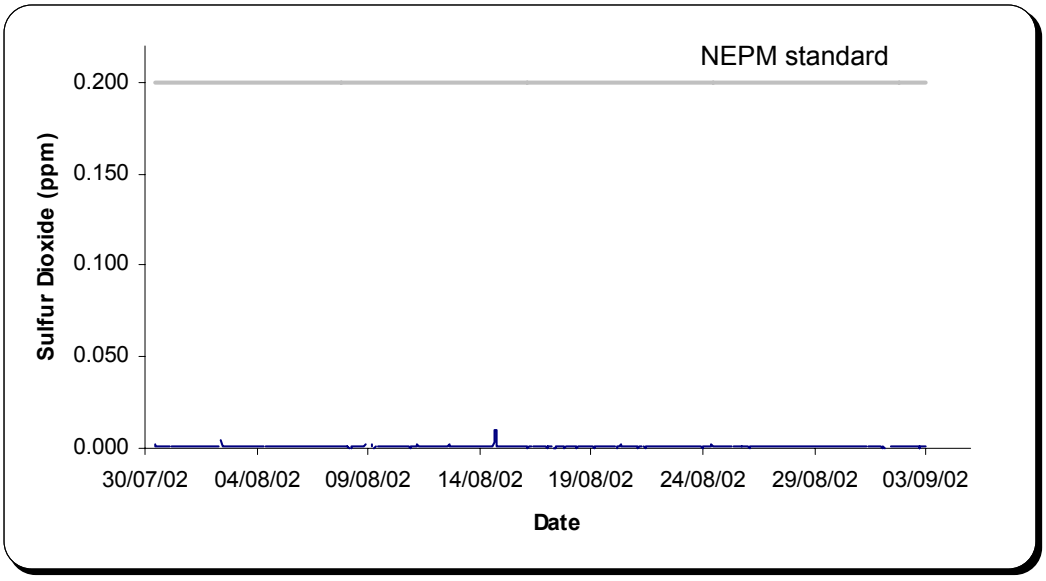


Figure 21 One-hour sulfur dioxide concentrations at Mount Gambier west hotspot

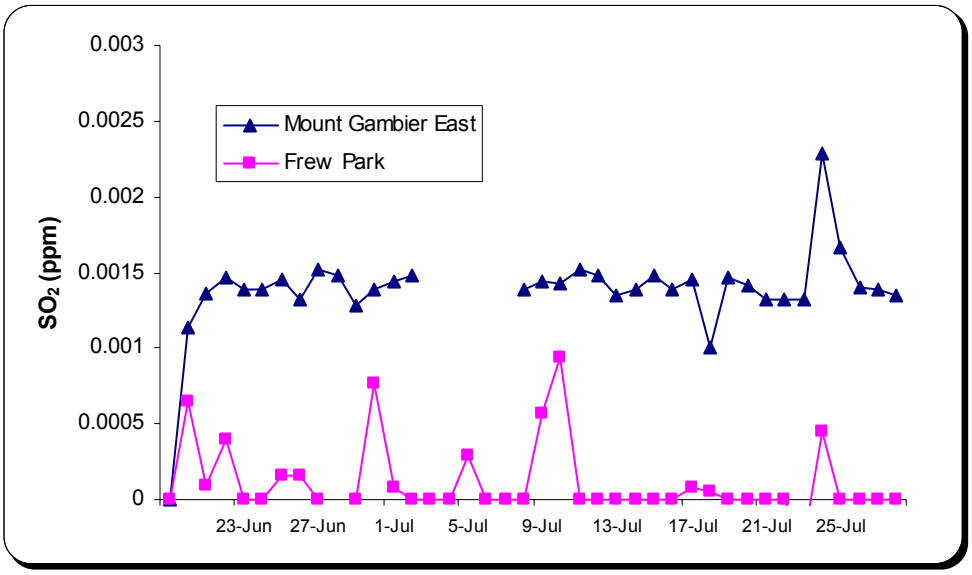


Figure 22 Daily sulfur dioxide concentrations at Frew Park and Mount Gambier east hotspot between 20 June and 27 August 2002

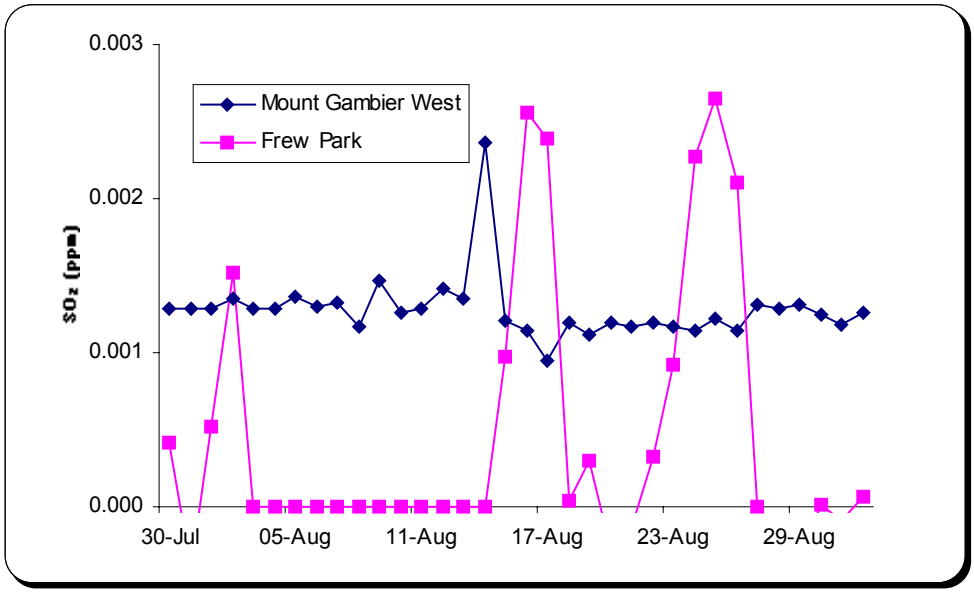


Figure 23 Daily sulfur dioxide concentrations at Frew Park and Mount Gambier west hotspot between 30 July and 31 August 2002

Particulate matter (PM_{10})

Sources

PM_{10} (inhalable particulate matter with a diameter of 10 μm or less) contains primary particles arising from combustion sources; secondary particles, mainly sulphate and nitrate, formed by chemical reactions in the atmosphere; and coarse particles, suspended soils, dusts and biological particles. In rural areas and drier environments, natural sources such as wind-blown soil, forest fires, ocean spray may dominate.

The relative contribution of each source and type varies from day to day, depending on meteorological conditions and quantities of emissions from mobile and static sources.

Health impact

Exposure to PM_{10} can chronically and acutely affect human health, particularly the pulmonary function. Major effects of PM_{10} include aggravation of existing respiratory and cardiovascular diseases, alterations in immune responses in the lung, damage to lung tissue, carcinogenesis and premature mortality. The most sensitive populations are those with chronic obstructive pulmonary or cardiovascular disease, asthmatics, the elderly and children.

NEPM standard

The NEPM air quality standard is 50 $\mu g/m^3$ as a 24-hour average.

Monitoring results

Frew Park

Technical paper number 10 (NEPC Peer Review Committee 2001) outlines the following four options for reporting of PM_{10} data (see *www.bom.gov.au/bmrc/csr/prc* for details):

- Collocate tapered element oscillating microbalances (TEOMs) with high volume samplers, develop and apply site specific adjustments to TEOM PM_{10} data.
- Adjust the TEOM PM_{10} data with a national temperature adjustment (CSIRO method).
- As an interim measure, apply to the TEOM PM_{10} data a factor such as 1.3 or 1.4 to make TEOM measurements comparable with high-volume sampler measurements, particularly in the critical range of concentrations around the NEPM standard.
- Report and use TEOM data without any adjustments but clearly distinguish as 'TEOM data' and provide an estimate of uncertainty and accuracy of the measurement.

As shown in Table 5, the results of the four approaches are clearly different and do warrant further investigation for accuracy and precision. In spite of the differences, the results indicate that, on occasions, PM_{10} levels in the Frew Park exceeded the NEPM standard.

A total of three PM_{10} exceedances were noted using the CSIRO method (Appendix 1) of temperature adjustment (Table 4). One-day averages for PM_{10} particles were within the range 4.5–81 $\mu g/m^3$, with a one-day average over the monitoring period of 17.25 $\mu g/m^3$. The highest value of 81 $\mu g/m^3$ on 7 June 2002 was due to extensive earthworks around the monitoring site.

Table 5 Summary of PM_{10} standard exceedances at Frew Park (1 September 2001–19 August 2002)

	Total number of days exceeded PM_{10} standard (50 µg/m^3)	Maximum 24 hour average PM_{10} concentration (µg/m^3)
Site specific adjustments to TEOM PM_{10} data	12	134
National temperature adjustment (CSIRO method)	3	81
Interim measure	3	97.4
No adjustment	1	70

The PM_{10} concentration is compared on a summer month (January 2002) and winter month (June 2002) in Figure 24. The average hourly PM_{10} concentration was 16.23 µg/m^3 in January and 25 µg/m^3 in June. The early morning and early afternoon differences in concentration are small (Figure 24). In January, concentrations decrease more rapidly after the morning peak, possibly reflecting enhanced dispersion conditions in summer relative to winter. The biggest increase in concentration of PM_{10} is observed from 1600 hours, possibly due to a combination of differences in dispersion potential and particulate emissions from domestic heating.

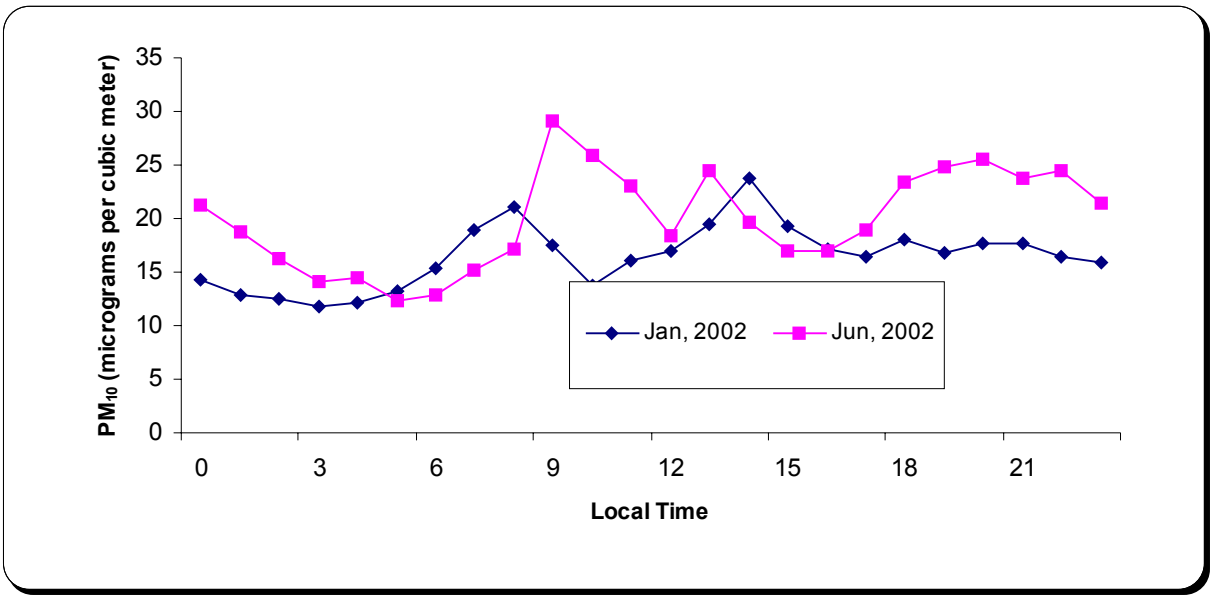


Figure 24 Diurnal variation in the concentration of PM_{10} at Frew Park during January 2002 and June 2002

Mount Gambier east

One-day averages for PM_{10} particles were within the range 7.4–34 µg/m^3 and below the NEPM air quality standard of 50 µg/m^3 (Figure 25).

The Department of Human Services has advised that health impacts would not be anticipated.

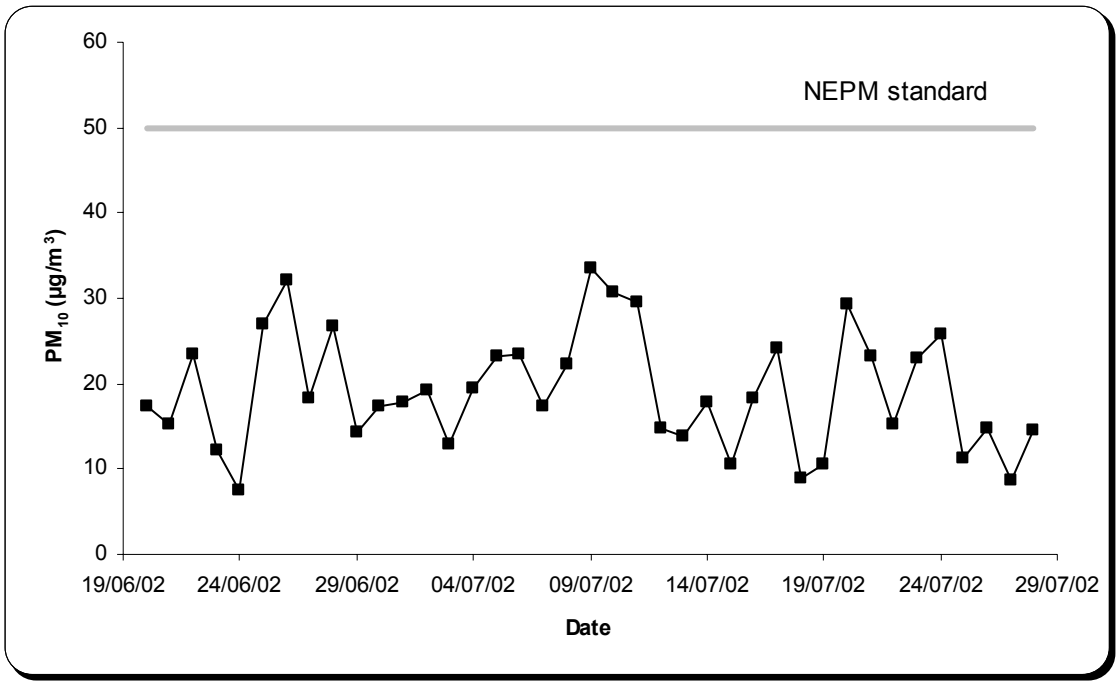


Figure 25 One-day particulate matter (PM_{10}) concentration at the hotspot east

Mount Gambier west

A total of two PM_{10} exceedances were noted during the sampling campaign at the hotspot west site (Figure 26). One-day averages for PM_{10} particles were 8.5–65 µg/m^3, with a one-day average over the monitoring period of 22.6 µg/m^3. The highest PM_{10} concentration measured at the monitoring site was 65 µg/m^3 on 16 August 2002.

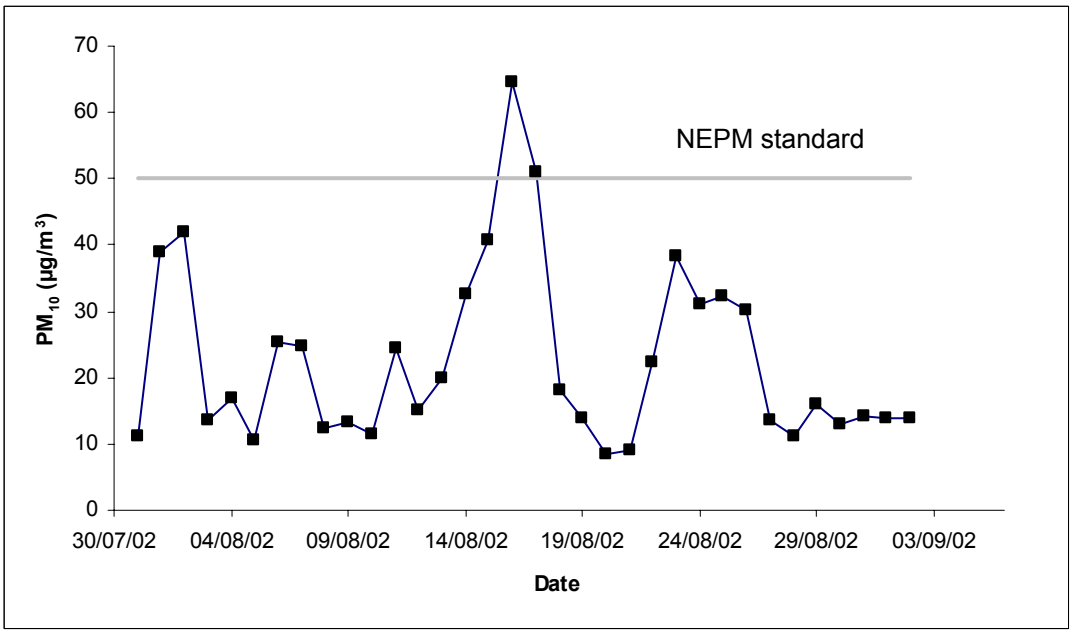


Figure 26 One-day particulate matter (PM_{10}) concentration at the hotspot west

CONCLUDING REMARKS

Concentrations of all gaseous air quality parameters monitored in the Frew Park and two hotspot monitoring sites were below the air quality NEPM standard.

Although benzene levels did not exceed the UK health guideline, ongoing monitoring and assessment of benzene and possibly other volatile organic compounds such as formaldehyde is recommended.

Monitoring data has identified that, on occasions, PM_{10} levels in the Frew Park and Mount Gambier west hotspot exceeded the NEPM standard. The principal sources of PM_{10} pollutants are industry, residential wood burning and road traffic. Emissions from particular industrial processes (i.e. wood fired boilers) could also be responsible for the high PM_{10} levels monitored. Winter measurements of PM_{10} in Mount Gambier (i.e. the Frew Park monitoring site) are considerably higher than the summer measurements and this may be explained by residential wood burning. Monitoring data provides sufficient evidence to suggest that further assessment of PM_{10} in the Mount Gambier area, including the contribution from regional sources (i.e. source apportionment), is required.

In addition, the wood processing industry produces a number of distinctive substances that may be hazardous to human heath. The US EPA sector notebook for the 'lumber and wood' industry has identified hazardous substances such as acetone, ammonia, creosote, methanol, methyl ethyl ketone, phenol, toluene and xylene (*www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks)*. No detailed emission estimates are available in the Mount Gambier area for these substances. A desktop study should be conducted to identify these air toxics in the area. Depending on the outcome, future hotspot monitoring programs conducted in the vicinity of wood industry should include some of these substances.

ACKNOWLEDGEMENTS

The EPA thanks the Mount Gambier RSL and District Bowling Club, 2 Jubilee Highway East, Mount Gambier for allowing air quality monitoring to be conducted at Frew Park.

The EPA would also like to thank the Department of Human Services for comments on this report.

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APPENDIX 1 MONITORING METHODS

The following sampling methods and analytical techniques were used for ambient air quality monitoring in Mount Gambier.

Particulate matter—PM_{10} (TEOM)

The tapered element oscillating microbalance (TEOM) is an approved equivalent method (AS 3580.98) for the measurement of PM_{10}. The TEOM draws in ambient air through a Teflon-coated borosilicate glass filter at a constant flow rate of 3 litres of ambient air per minute (L/min). The final mass concentrations are expressed as micrograms of particulate matter per cubic metre of ambient air sampled ($\mu g/m^3$).

The Ambient air quality measure guideline paper no. 10 (NEPC Peer Review Committee 2001) describes how all continuous PM_{10} data obtained from TEOM can be adjusted for ambient temperature.

The adjustment is applied if the daily average temperature falls below 15°C. The first adjustment accounts for temperatures of 5–15°C. The second adjustment accounts for temperatures less than or equal to 5°C. If the temperature is greater than or equal to 15°C then no adjustment is made.

For further details see *www.rupprechtandpatashnick.com* and *www.ephc.com*.

Carbon monoxide (non-dispersive infrared analyser)

The analyser determines the amount of CO in a sample of ambient air by measuring the amount of infrared radiation the sample absorbs. A reference cell is filled with a non-infrared absorbing gas (nitrogen) and a sample cell is continuously flushed with ambient air containing an unknown amount of CO. Infrared radiation is passed through both cells. The results are expressed in parts of CO per million parts of sampled ambient air. The monitor operates continuously.

The analyser complies with Australian Standard AS 3580.7.1. For details of siting, operation and calibration of the carbon monoxide analyser, refer to Australian Standards AS 2922 and AS 3580.7.1 at *www.thermo.com/subsid/tmo1.html*.

Ozone (ultraviolet absorption photometry)

O_3 is measured by ultraviolet absorption photometry using Beer-Lambert law. UV light is emitted by a low pressure Hg vapour lamp. Air is drawn through a sample cell where ultraviolet light (254 nm wavelength) passes through it. Light absorbed by the O_3 is converted into an electrical signal proportional to the O_3 concentration. A thermo electron 49C O_3 analyser, which conforms to Australian Standard AS 3580.6.1, was used in Frew Park. For details of siting, operation and calibration of the ozone analyser, see Australian Standards AS 2922 and AS 3580.6.1. Also see *www.thermoei.com*.

Sulfur dioxide (pulsed fluorescence analyser)

EPA measures SO_2 using the technique of fluorescence. Air is drawn through a sample cell where it is subjected to high intensity UV light. This causes SO_2 molecules in the air to fluoresce and release light. The fluorescence is detected with a photomultiplier tube and converted to an electrical signal proportional to the SO_2 concentration. Results are expressed in parts of SO_2 per million parts of sampled ambient air (ppm). A thermo

electron 43 SO_2 analyser, which conforms to Australian Standard AS 3580.4.1, was used at the Frew Park site. The monitor operates continuously.

For details of siting, operation and calibration of the sulfur dioxide analyser, see Australian Standards AS 2922, AS 3580.4.1, AS 3580.2.1 and AS 3580.2.2. Also see *www.thermoei.com*.

Nitrogen dioxide (chemiluminescence)

Concentrations of NO_2, NO and total NO_X are measured using the principle of chemiluminescence, involving a gas phase reaction with O_3. For NO_2, the sample passes through a catalytic converter where the NO_2 is reduced to NO. NO_2 is calculated based on measurement of nitrogen oxides using O_3 chemiluminescence.

NO_2 at the site is monitored by single channel measurement. NO_2 is calculated based on the difference between measurements of total NO_x and NO measurements. A Monitor Labs 9841B NO_x analyser, which conforms to Australian Standard AS 3580.5.1, was in use at Frew Park in 2001.

For details of siting, operation and calibration of the NO_x analyser, see Australian Standards AS 2922, AS 3580.5.1, AS 3580.2.1 and AS 3580.2.2, and *www.monitorlabs.com*.

OPSIS-DOAS multiple pollutants

Benzene, formaldehyde, O_3, NO, NO_2, and SO_2 were measured at a mean level of 10 m above ground in hotspot sites by means of a commercial differential optical absorption spectrometer (OPSIS-DOAS), model ER130. The DOAS uses absorption of light at wavelengths specific to a particular gaseous species and compares this to a reference spectrum.

These pollutants were measured with a 10-minute temporal resolution. The 10-minute values are then averaged to form the hourly values used in the present study.

Briefly, light from the emitter (a 150 W high-pressure xenon lamp) is collected by the receiver (a telescope) and is led, through an optical fibre, to a differential optical spectrometer. Inside the spectrometer, a grating refracts the light into its wavelength components in the UV-VIS region. The refracted light is then projected onto a rotating (at 300 rpm) slotted disk in front of a photomultiplier. The light is subsequently detected from the photomultiplier. It is then converted to a digital signal before it is finally stored to a computer.

Approximately 100 scans are accumulated and their average value is calculated in order to decrease the signal noise. The measured atmospheric spectrum is divided with a pre-recorded light source reference spectrum (measured every month) to eliminate the wavelength dependence of the optical parts of the instrument; the quotient is then divided with a 5^{th} order polynomial which suits the broad band wavelength variations of the spectrum. The result is a spectrum (called differential spectrum) which is free from the extinction effects of atmospheric particles. See *www.opsis.se*.

Meteorological data

Wind was measured at a height of 10 m at the monitoring sites using the vector instrument's pulse output cup anemometer for speed and a potentiometer wind vane for direction. Thermistors (by Unidata manufacturers) were used to measure temperature at the sampling sites. Measurements of horizontal wind conform to Australian Standard AS 2923-1987.

Data loggers

The data loggers used by the EPA for air pollutants are made by Ecotech (model 9400 DAS). They are capable of storing data from a number of instruments. The data loggers typically scan every 3 seconds (can vary depending on the number of instruments and channels) and log 3-minute and 10-minute averages from all the instruments at the site.

The data loggers used by EPA for meteorological parameters are made by Unidata (model 6004).

Housing

Most of the equipment purchased for air quality monitoring sites operate to Australian Standards. Consequently, good quality housing is required to minimise the effect of sensitivities of the instruments. Typically, temperature is the most important consideration in this regard. Air conditioning units are required to keep the internal temperature within the recommended 25(± 5)°C.

APPENDIX 2 METADATA FOR MOUNT GAMBIER CONTINUOUS, AMBIENT AND HOTSPOT SAMPLING

Site information (metadata)	
Site name:	Frew Park, Mount Gambier Ambient Monitoring Station
	EPA site number (0180—continuos pollutants)
Site details	
Street address	Jubilee Highway East and Hedley Street, Mount Gambier
Date established	29 September 2000 (July 2001)
Date terminated	2 September 2002
Siting guidelines (AS 2922-1987) exceptions	None
Description of surrounding land use	Residential
Description of nearby emission sources	Motor vehicles, housing (wood smoke)
Map coordinates	
Datum	GDA 94
Projection	AMG Zone 54
Easting	480880
Northing	5813370

Data corrections

Zero corrections in ppm:

SO_2 Oct: +0.005; Nov (1–15/11): +0.009; Dec (23–31/12): +0.008

NO Oct: (29/9–7/10) +0.015; Nov (1–18/11): +0.010; Dec (1–17/12): 0.014, (17–31/12): 0.016

NO_X Oct:+0.008; Nov (29–30/11): +0.007; Dec (1–17/12): 0.015, (17–31/12): +0.018

Span corrections as factors made per calibration (3 days) (*whole month standard correction)

SO_2 Oct: 1.06; Nov (1–15/11): 1.127*; Dec: 1.0023

NO Oct: nil; Nov: nil; Dec (1–17/12): 1.0049, (17–31/12): 1.0193

NO_X Oct: nil; Nov (24–30/11): 1.12*; Dec (1–17/12): 1.007, (17–31/12): 1.0173

Pollutants measured							
Oxides of nitrogen (NO_X, NO_2, NO)		Particulate matter (PM_{10})		Ozone (O_3)		Sulfur dioxide (SO_2)	
Instrument types							
Make	Monitor Labs	Make	R&P	Make	Thermo Electron	Make	Thermo Electron
Model	ML 9840B	Model	TEOM PM_{10}	Model	49	Model	43
Serial number		Serial number		Serial number		Serial number	
Minimum detection level	<0.001 ppm	Minimum detection level	n.a.	Minimum detection level	0.001 ppm	Minimum detection level	0.002 ppm
Units	ppm	Units	$\mu g/m^3$	Units	ppm	Units	ppm
Sampling rate	<25 seconds	Sampling rate		Sampling rate	10 seconds	Sampling rate	10 seconds
Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes
Data return	86%	Data return	99%	Data return	96%	Data return	96%
Clock adjustment	Period ending	Clock adjustment	Period ending	Clock adjustment	Period ending	Clock adjustment	Period ending

Site information (metadata)					
Site name:	Mount Gambier east hotspot site No. 1	Zero corrections in ppm—carbon monoxide:			
Site details		23–24/6: +0.1; 24–25/6: +0.2; 25–26/6:+0.4; 27/6: +0.2; 27/6–1/7: +0.3; 1–2/7: +0.4; 8–9/7: +0.7			
Street address	Mount Gambier Showgrounds, Pick Avenue and Jubilee Highway East	Zero corrections in ug/m^3—OPSIS			
Date established	19 June 2002	SO_2 –2; O_3 +47; NO n.a.; NO_2 +69; Benzene –12; Formaldehyde –174			
Date terminated	29 July 2002	Values reported meet diagnostic criteria (light levels, noise, measurement deviation); other data rejected			
Siting guidelines (AS 2922-1987) exceptions	None	* Naphthalene and toluene measured but unreliable—large interference with unknown substances in airshed			
Description of surrounding land use	Industrial and residential	** OPSIS parameter data returns			
Description of nearby emission sources	Wood processing, housing (wood smoke), motor vehicles	SO_2 83%; O_3 71%; NO 77%; NO_2 85%; Benzene 61%; Formaldehyde 98%			
Map coordinates		TEOM (PM_{10})			
Datum	GDA 94	All values reported meet diagnostic criteria (flow, temperature, noise and filter loading)			
Projection	AMG Zone 54	Data corrected for temperature as per the NEPC Peer Review Committee Technical Paper 10			
Easting	5812442				
Northing	482425				

Pollutants measured*					
SO_2, O_3, NO, NO_2, benzene, formaldehyde		Particulate matter (PM_{10})		Carbon monoxide (CO)	
Instrument types					
Make	OPSIS	Make	R&P	Make	Thermo Electron
Model	ER130 & AR500	Model	TEOM PM_{10}	Model	Model 48 NDIR analyser
Serial number	E672	Serial number	140AB221849807	Serial number	48-16574-162
Minimum detection level	10 ppb–122 m path length *(1–10 ppb dependent on path length 340 m & 134 m respectively)*	Minimum detection level	n.a.	Minimum detection level	0.05 ppm or 2%
Units	µg/m^3 (converted to ppm where applicable)	Units	µg/m^3	Units	ppm
Measurement cycle	10 minutes 45 seconds	Sampling rate	10 minutes	Sampling rate	6 seconds
Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes
Data return	Various** %	Data return	100%	Data return	84%
Clock adjustment	Period ending	Clock adjustment	Period ending	Clock adjustment	Period ending

Site information (metadata)		
Site name:	Mount Gambier west hotspot site No. 2	Zero corrections in ppm—carbon monoxide:
Site Details		Nil
Street address	Mount Gambier SA Water Depot 290 Commercial Street West	Zero corrections in ug/m^3—OPSIS
Date established	30/07/02	SO_2 –2; O_3 +47; NO +6; NO_2 +70; Benzene –5; Formaldehyde –187
Date terminated	03/09/02	Values reported meet diagnostic criteria (light levels, noise, measurement deviation); other data rejected
Siting guidelines (AS 2922-1987) exceptions	None	* Naphthalene and toluene measured but unreliable—large interference with unknown substances in the airshed
Description of surrounding land use	Industrial/residential	** OPSIS parameter data returns
Description of nearby emission sources	Wood processing, housing (wood smoke)	SO_2 97%; O_3 95%; NO 87%; NO_2 100%; Benzene 97%; Formaldehyde 87%
Map coordinates		TEOM (PM_{10})
Datum	GDA 94	All values reported meet diagnostic criteria (flow, temperature, noise and filter loading)
Projection	AMG Zone 54	Data corrected for temperature as per the NEPC Peer Review Committee Technical Paper 10
Easting	478828	
Northing	5814098	

Pollutants measured*		
SO_2, O_3, NO, NO_2, benzene, formaldehyde	Particulate matter (PM_{10})	Carbon monoxide (CO)

Instrument Types					
Make	OPSIS	Make	R&P	Make	Thermo Electron
Model	ER130 & AR500	Model	TEOM PM_{10}	Model	Model 48 NDIR analyser
Serial number	E672	Serial number	140AB221849807	Serial number	48-16574-162
Minimum detection level	10 ppb–122 m path length *(1–10 ppb dependent on path length 340 m & 134 m respectively)*)	Minimum detection level	n.a.	Minimum detection level	0.05 ppm or 2%
Units	µg/m^3 (converted to ppm where applicable)	Units	µg/m^3	Units	ppm
Measurement cycle	10 minutes 45 seconds	Sampling rate	10 minutes	Sampling rate	6 seconds
Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes
Data return	Various** %	Data return	100%	Data return	100%
Clock adjustment	Period ending	Clock adjustment	Period ending	Clock adjustment	Period ending

APPENDIX 3 AIR QUALITY MONITORING DATA SUMMARIES

Table A3.1 Frew Park monitoring station

Pollutant	Averaging period	Frequency distribution (centiles)								Data available (%)*
		MIN	10	30	50	70	90	99	MAX	
SO_2	1 hr	0	0	0	0.001	0.002	0.003	0.007	0.012	86
	24 hr	0	0.001	0.002	0.003	0.004	0.006	0.009	0.012	100
PM_{10}	24 hr	4.5	9.6	12.7	15.44	18.83	27.4	37.2	81	88
O_3	1 hr	0	0.005	0.012	0.016	0.021	0.026	0.032	0.044	95
	4 hr	0	0.006	0.012	0.016	0.020	0.025	0.031	0.042	99
NO_2	1 hr	0	0.001	0.002	0.003	0.005	0.012	0.023	0.038	98
	24 hr	0	0.002	0.003	0.004	0.006	0.009	0.014	0.016	100

* valid measurements only

Table A3.2 Frew Park monitoring station

Parameter	Monthly means												Annual mean	Standard deviation
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
SO_2	0.002	0.002	n.a.	0.001	0.001	0.001	n.a.	0.001	0.001	0.001	0.002	0.002	0.0014	0.0005
PM_{10}	16.23	20.03	17.5	17.10	n.a.	24.8	17.15	21	16.01	15.3	13	12	17.25	3.62
O_3	0.013	0.015	0.014	0.015	0.013	0.02	0.02	0.02	0.02	0.021	0.02	0.013	0.02	0.003
NO_2	0.002	0.003	0.003	0.007	0.009	0.007	0.005	0.007	0.005	0.004	0.004	0.003	0.005	0.002

n.a. = not enough data points to calculate monthly average

Table A3.3 Mount Gambier east monitoring station

Pollutant	Averaging period	Frequency distribution (centiles)								Data available (%)*
		MIN	10	30	50	70	90	99	MAX	
SO_2	1 hr	0	0.001	0.001	0.001	0.002	0.002	0.002	0.01	83
	24 hr	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	82.5
PM_{10}	24 hr	7.4	11	15	18	23.22	29.40	33.03	34	100
O_3	1 hr	0.011	0.02	0.025	0.029	0.033	0.038	0.044	0.05	71
	4 hr	0.011	0.02	0.025	0.029	0.032	0.037	0.042	0.045	83.3
NO_2	1 hr	0.001	0.002	0.004	0.006	0.008	0.014	0.022	0.039	85
	24 hr	0.002	0.004	0.005	0.006	0.008	0.009	0.0142	0.016	85
Benzene	1 hr	0	2.4	4.6	6.3	8.2	12	17.3	24.5	61.3
	24 hr	4.14	5.10	6.12	6.8	7.2	8.04	9.3	9.4	79.4
CO	1 hr	0	0.1	0.13	0.2	0.3	0.63	2	3	95
Formaldehyde	30-min	0	24	27.4	30.01	32.4	37	45.3	53.4	81.3
	24 hr	23.02	27.4	28.5	30.02	31.12	30.1	35.1	35.4	87.2

* valid measurements only

Table A3.4 Mount Gambier west monitoring station

Pollutant	Averaging period	Frequency distribution (centiles)								Data available (%)*
		MIN	10	30	50	70	90	99	MAX	
SO_2	1 hr	0	0.001	0.001	0.001	0.001	0.001	0.002	0.01	97
	24 hr	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	100
PM_{10}	24 hr	8.5	11.5	13.5	16.3	26	40.1	60.1	65	100
O_3	1 hr	0	0.01	0.015	0.024	0.03	0.036	0.04	0.044	95
	4 hr	0.002	0.011	0.017	0.024	0.03	0.035	0.038	0.04	94
NO_2	1 hr	0	0.003	0.004	0.006	0.009	0.02	0.022	0.032	99
	24 hr	0.004	0.005	0.006	0.007	0.009	0.011	0.013	0.014	100
Benzene	1 hr	0	5.512	8.4	10.1	12.7	18.6	36.3	45.6	97
	24 hr	7.63	8.5	9.8	11	11.5	16.23	22	24	100
CO	1 hr	0.1	0.15	0.2	0.3	0.44	1.7	4.2	6.2	99.5
Formal-dehyde	30-min	2.24	17.5	22.3	26	30.3	38	52.11	62.3	86
	24 hr	20.2	22	24.2	27	29.05	32.1	34.23	34.32	97

* valid measurements only

APPENDIX 4 WIND ROSES FOR MOUNT GAMBIER

The wind rose diagrams on the following pages were prepared by the Climate and Consultancy Section in the South Australian Office of the Bureau of Meteorology (see page 5 of this report—Climate of the Mount Gambier area).