FOREWORD

In an important demonstration of the Bracks Government’s commitment to improving air quality for all Victorians, Victoria has become the first Australian State to receive national approval for its air quality monitoring system. On 16 February, the Commonwealth, State and Territory Environment Ministers approved Victoria’s Air Quality Monitoring Plan for reporting air quality levels against national standards agreed on in 1998.

The Victorian Monitoring Plan contains substantial improvements to existing monitoring systems in Melbourne as part of the Government’s commitment to give Victorians a top quality regime for monitoring air quality. It includes a commitment to establish a new air monitoring station in an outer eastern suburb, which will fill a substantial gap in Melbourne’s air monitoring system.

The Plan also establishes procedures for extending air quality monitoring from Melbourne, Geelong and the LaTrobe Valley to major regional centres such as Bendigo and Ballarat. Over the next two to three years this will provide a better understanding of the air quality in these centres.

The Ambient Air Quality National Environment Protection Measure (Air NEPM), under which the plan is made, is a national law jointly made by the Commonwealth, State and Territory Governments. It sets agreed air quality standards and methods for monitoring six key air pollutants. Under the NEPM, each State and Territory must monitor and publicly report against these standards.

The Victorian Plan was approved by the Ministers on the basis of the recommendations of a technical peer review group, which included members from every Australian jurisdiction, as well as members from environment groups and industry. The fact that Victoria’s Monitoring Plan has passed through this technically rigorous process can provide Victorians with great confidence in our air monitoring system.

The Hon. Sherryl Garbutt
Minister for Environment and Conservation
SUMMARY

In June 1998, the National Environment Protection Measure (NEPM) for Ambient Air Quality set the desired environmental outcome for ambient air that allows for the adequate protection of human health and well-being. Victoria has developed a Monitoring Plan for the purposes of assessing compliance with this Measure.

The majority of monitoring (as shown below) will take place in the Port Phillip region and the Latrobe Valley region, the locations of the two major population centres and emission sources. Details of the monitoring stations are listed overleaf.

Campaign monitoring will also be carried out in the regional centres identified – Warrnambool, Mildura, Mooroolbark/Shepparton, Bendigo and Ballarat – to complement and validate the screening criteria used to assess the monitoring requirements for those regions. Additional campaigns will also be run in outer metropolitan areas of Melbourne.

The monitoring will be carried out via NATA certified methods, and annual reports will be provided on the status of Victoria’s air quality against the NEPM standards.
Summary of NEPM monitoring stations

<table>
<thead>
<tr>
<th>Station name</th>
<th>Location</th>
<th>O$_3$</th>
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<th>PM$_{10}$</th>
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<td>Ch</td>
<td>TEOM</td>
<td></td>
<td>FL</td>
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</tbody>
</table>

**Abbreviations**

* Trend station
† Partisol samplers may be considered for use at some stations if planned investigations show them to be an acceptable method.

Fl  Fluorescence  Ch  Chemiluminescence
IR  Non dispersive infra red  UV  Non dispersive ultra violet
TEOM Tapered element oscillating microbalance  AA  Atomic absorption
DOAS Differential optical absorption spectrometry (long path)
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1. INTRODUCTION

1.1 NEPM context

In June 1998 the National Environment Protection Measure (NEPM) for Ambient Air Quality set the desired environmental outcome for ambient air that allows for the adequate protection of human health and well-being. National standards were set for sulfur dioxide (SO$_2$), carbon monoxide (CO), nitrogen dioxide (NO$_2$), ozone (O$_3$), lead and PM$_{10}$. No standard is set for PM$_{2.5}$, but the Air NEPM Final Impact Statement requires monitoring of this pollutant for establishing data sets for future assessments and reviews. Each State and Territory jurisdiction is required to report annually on its compliance with the Measure, including in its report an analysis of the extent to which these standards are met. As a first step, each jurisdiction must develop a Monitoring Plan approved under the NEPM, setting out how the jurisdiction proposes to monitor air quality for the purposes of this Measure (Clause 10 of the Air NEPM).

After making the Measure, the Ministers resolved to establish a Peer Review Committee (PRC) to advise on jurisdictional monitoring plans. Under its terms of reference, the PRC has two complementary roles. First, the PRC is required to advise the NEPC Committee on the adequacy of monitoring plans submitted by jurisdictions. Second, it provides advice on technical issues related to the consistent implementation of the Measure’s monitoring protocol. The PRC has developed a series of guideline papers that provide a basis for the preparation of individual monitoring plans (by jurisdictions) and for the assessment of monitoring plans (by the PRC). The guideline papers are listed in the Glossary (Appendix A).

The NEPM provides for surrogates for monitoring, such as emission inventories and modelling, to be used for assessing air quality against the standards. Together with mobile monitoring, these methods may be used to confirm the locations of future performance monitoring stations and screen subregions. The Air NEPM contains certain requirements for NEPM monitoring that result in monitoring networks with differing characteristics from those employed for other purposes (eg. surveillance of point sources). Victoria’s NEPM monitoring will be a subset of its overall ambient air quality monitoring.

1.2 Victoria’s monitoring plan

This plan follows the prescribed PRC format to describe how Victoria plans to meet the monitoring and reporting requirements of the Air NEPM. It identifies and describes the major population centres and regions for monitoring or assessment. The topography, climate, meteorology, emissions and population distribution in each region are briefly summarised in Section 3, together with the proposed NEPM assessment schemes. Section 4 summarises station siting and instrumentation, and Section 5 the accreditation process for external auditing, including quality assurance measures.
2. SELECTION OF REGIONS

Regions have been selected to meet the Air NEPM’s monitoring and reporting requirements in accordance with the PRC Guideline on selection of regions.

The Air NEPM requires assessment of air quality at all urban centres with populations of 25,000 or more. The Australian Bureau of Statistics, in its publication *Census of Population and Housing, Selected Characteristics for Urban Centres and Localities, Victoria*, lists Victoria’s urban centres and localities ranked by population based on 1996 census. The top eight urban centres in this list have populations in excess of 25,000 and are listed below with their populations:

- Melbourne (2,865,329)
- Geelong (125,382)
- Ballarat (64,831)
- Bendigo (59,936)
- Shepparton/Mooroopna (31,945)
- Melton (30,304)
- Warrnambool (26,052)
- Wodonga part of Albury–Wodonga (25,825).

Historically, a large area covering Melbourne, Geelong, the Mornington Peninsula and the Western Port Bay has been defined as the Port Phillip Region. The region contains most of Victoria’s population and industry. Different locations within the region are affected by common meteorological mechanisms. It has been extensively monitored, studied and modelled in managing its air quality. A similar definition is maintained and, for Air NEPM purposes, the Port Phillip Region is nominated as the major monitoring region. Three of the eight centres listed above – Melbourne, Geelong and Melton – are contained in the Port Phillip Region. Outside the Port Phillip Region, there are five urban centres with populations over 25,000.

Cranbourne (24,752), Mildura (24,142) and Sunbury (22,126) are the only three centres with populations between 20,000 and the cut-off of 25,000. Cranbourne and Sunbury are included in the Port Phillip Region. EPA proposes to add Mildura to its list of five regional centres to be assessed.

The most significant industrial centre in Victoria outside the Port Phillip Region is the Latrobe Valley, from where the bulk of the State’s electricity is generated. Extensive monitoring and airshed studies have been carried out over the years. Traralgon (18,993), Moe (15,512) and Morwell (13,823) are the largest population centres in this region.

Portland, Anglesea and Geelong are the three other industrial centres of significance. Anglesea and Geelong are within the boundary of the Port Phillip Region; Portland, which is outside the region, has a population of around 10,000.
The PRC Guideline Paper defines three types of region:

Type 1 A large urban or town complex with a population in excess of 25,000. Type 1 requires direct monitoring and is contained within a single airshed.

Type 2 A region with no one population centre above 25,000 but with a total population above 25,000. Type 2 has significant point-source or area-based emissions as to require a level of direct monitoring.

Type 3 A region with a population in excess of 25,000 but with no significant point-source or area-based emissions, so that ancillary data can be used to infer that direct monitoring is not required.

Regions identified for air quality assessments for Air NEPM purposes are listed below, together with their populations. All are Type 1 regions in that they require monitoring of at least some parameters, except for the Latrobe Valley and Mildura which are Type 2. Mildura has a population of less than 25,000 but Redcliffs (2,553) is 13 km to the south and can be considered to be part of the same airshed, making a combined region with a population greater than 25,000. There are no other Type 2 regions in Victoria. Apart from the Port Phillip and Latrobe Valley Regions, the regions are defined approximately by the urban extent of the population centres.

- **Port Phillip Region.** The Port Phillip Region is nominated as the main region for monitoring and reporting for Air NEPM purposes. The population of the Port Phillip Region is 3,450,862. It extends in the north from Creswick (NW corner) to Buxton/Marysville (NE corner), and in the south from Kennett River (SW corner) to Inverloch (SE corner), and covers 24,000 km².

- **Latrobe Valley.** The total population of the defined region, which includes the urban centres of Traralgon, Moe and Morwell, is approximately 130,000. The NEPM region is shown in figure 18. The boundary is defined by the north-west corner (AMG 402E, 5800N), extending 129 km to the east and 54 km to the south at the eastern end. The western end of the southern boundary is defined by the boundaries of the shires of Baw Baw and La Trobe and follows the ridge of the Strzelecki Range, which forms a natural boundary between airsheds.

- **Ballarat** (64,831).
- **Bendigo** (59,936).
- **Shepparton/Mooroopna** (31,945).
- **Warrnambool** (26,052).
- **Wodonga** part of Albury Wodonga (25,825).
- **Mildura** including Redcliffs (26,695).
Air NEPM regions in Victoria are presented in figure 1. Population density (as grades of green) across the State is also presented on this figure.

Figure 1: Air NEPM regions and population density in Victoria
3. MONITORING REQUIREMENTS BY REGION

The nominated NEPM regions, with proposed means of assessing air quality against NEPM goals, are described below. Monitoring requirements have been determined bearing in mind Clause 14 of the NEPM, including the formula

\[
\text{No. of performance monitoring station (PMS)} = 1.5 \times \text{(population in millions)} + 0.5
\]

and the screening criteria developed by the PRC to define where fewer stations may be required (Guideline Paper # 4).

The following extract from the PRC guideline paper on Monitoring Strategy provides the rationale for siting of performance monitoring stations.

*In order to ensure compliance with the NEPM Standards, stations will generally be located so as to monitor the upper bound of the distribution of pollutant concentration likely to be experienced by portions of the population, while avoiding the direct impacts of localised pollutant sources. These stations are called generally representative upper bound for community exposure (GRUB) stations. In regions where there are to be more than one GRUB station, the stations will be distributed to measure the upper bound concentrations in different portions of the populated area, reflecting different emission or dispersion regimes.*

*An examination of the distribution of GRUB stations relative to the distribution of population and pollutant will determine the need and location of additional stations to achieve adequate representation of population-average concentrations. These additional stations will be sited to provide adequate estimates of the ambient air quality actually experienced by the overall population.*

By using GRUB stations to monitor the ambient air across a region, we can be reasonably sure that, if the NEPM standards are met at those sites, then most of the total population of the region will be exposed to air that meets the standards. In this way, the NEPC aim of equivalent environmental protection is assured.

3.1 Port Phillip Region

3.1.1 Regional description

**Topography**

Port Phillip Bay, a trapped water body, is the main feature in Port Phillip Region. Coastal areas, the main city of Melbourne and some plains are surrounded by the mountains (figure 2). The Dandenong Ranges are 30 km east of Melbourne and rise to about 700 m. This topography allows down slope (katabatic) winds to develop in the morning and up slope (anabatic) winds with bay breezes and sea breezes in the afternoon when the regional-scale pressure gradient is weak. The topographic features of the Port Phillip Region can result in recirculation of air due to offshore followed by onshore breezes; on rarer occasions an eddy may form (the Spillane Eddy).
Figure 2: Topography of the Port Phillip Region

Figure 3: Population distribution in the Port Phillip Region
Climatology

Port Phillip Region has a climate midway between maritime and continental. Port Phillip Bay has a moderating effect on temperatures in bayside areas, where summer temperatures are lower than in inland suburbs.

Periods of poor dispersion occur during winter and late autumn as a result of slow-moving anticyclones, typified by light winds and low mixing heights. This is a major mechanism for \( PM_{10} \) events.

Rainfall is fairly evenly distributed throughout the year, although spring is slightly wetter than other seasons. A considerable portion of the rain comes with westerly winds and cold fronts.

Air dispersion patterns are strongly influenced by Port Phillip Bay and the surrounding hills. Night-time katabatic flows can move pollutants towards Port Phillip Bay while at the same time restricting the extent that they disperse vertically. During summer and autumn, ozone generated photochemically from these pollutants may be carried to Melbourne suburbs by afternoon sea breezes. This is a major mechanism for ozone events.

Population distribution

As described in Section 2, the Region contains a number of urban centres, including Melbourne. The population distribution is shown in figure 3.

Melbourne is the capital city of the State of Victoria, which has a population in excess of three million. In the State Environment Protection Policy (Air Quality Management), a large area including Melbourne, Geelong, the Mornington peninsula and the Western Port Bay was defined as the Port Phillip Control Region (PPCR). The PPCR contained most of State’s population and industry. Control strategies were designed for this emissions control region. For air quality management purposes the PPCR has been expanded to accommodate changed local government boundaries and has been renamed the Port Phillip Region.

Major regional emission sources

In 1998, EPA published a comprehensive inventory of pollutants emitted to air in the Port Phillip Airshed.\(^1\) The data, which have recently been updated, are summarised in figure 4, showing the contributions of different sources to the total load of NEPM pollutants emitted.

---

Figure 4: Estimated emissions of NEPM pollutants and precursors in the Port Phillip Airshed –1996

Motor vehicles are a major contributor to the total annual emissions of CO, VOC, NOx and lead, and also contribute significantly to particle emissions. Domestic, commercial and rural sources are the biggest contributors to particle emissions, with domestic wood heating contributing around 40 per cent of the total particle inventory.

The level of emissions is heavily influenced by land use and transport patterns across the airshed. Emissions mostly occur in the inner city and Melbourne’s eastern and south-eastern suburbs. Further details can be found in the published Port Phillip inventory.

Ozone is a secondary pollutant, not emitted by sources but formed in the atmosphere by complex chemical reactions between oxides of nitrogen and organic compounds. The chemistry of ozone formation is dependent on the precursor emissions and on a variety of meteorological parameters, including ultraviolet light. An understanding of this process and knowledge of the spatial distribution of the ozone concentration within an area are necessary for developing an ozone monitoring network.

Typical sources of particles are combustion of fossil fuels, industrial processes, fires, photochemical processes, windblown dust from dry soil, and local re-entrained dust emissions from roads. In the Port Phillip Region, motor
vehicles contribute up to a quarter of total particle emissions. In winter, open fires and wood heaters, and in
autumn prescribed burning are the more significant contributors. In the Port Phillip Region, particles are generally
emitted as primary pollutants and reach their maximum concentrations near the emission sources, such as wood
fires.

Regional air quality

Figure 5 shows the maximum recorded concentrations for NEPM pollutants as percentages of Air NEPM standards.
Data from all sites – including peak sites that may not be suitable for the purposes of the Air NEPM – are used in
this summary. Maximum concentrations recorded in the years 1994 to 1998 are also shown as white bands, the
lower maxima indicating significant improvements in air quality over this period.

Figure 5 illustrates that O₃ and PM₁₀ are the pollutants of concern in the region. Maximum recorded concentrations
for both these pollutants exceed the Air NEPM standards. For all other pollutants, concentrations are below the
standards. While CO concentrations approached the standard in 1994, peak concentrations are typically about 70
per cent of the standard. Maximum SO₂ concentrations presented in this figure were recorded at an industrial site
in Geelong; concentrations at the residential sites are very much lower.

![Figure 5: Maximum concentrations as percentages of air NEPM standards in the Port Phillip Region, 1979–98](image)

Maximum recorded 1-hour and 4-hour ozone concentrations in the Port Phillip Region are shown in figure 6.
Despite the downward trend during this period, current ozone concentrations for both averaging times are high
compared to the standards. The number of days when 1-hour and 4-hour standards are exceeded is shown in
figure 7. Again, the downward trend is very significant; however, peak levels still exceed the standards on a few
days a year.
The current nitrogen dioxide monitoring network in the Melbourne region (eight stations) has not reported any exceedences of the Air NEPM level since 1991. Current peak levels are about 80 per cent of the standard. The highest NO$_2$ concentrations are expected to be generated downwind of major emission sources at distances typically travelled by the air in one or two hours. NO$_2$ also plays a very important role in the photochemical production of oxidants such as ozone.
Although figure 5 shows the maximum PM$_{10}$ during 1994–1998 was lower than during 1979–1998, there has been no clear trend since monitoring began in the mid 1980s. The NEPM standard is exceeded on occasions.

Maximum monitored carbon monoxide has been close to the standard. A trend to lower values in the past five years is expected to be assisted in the next few years as the proportion of motor vehicles with recent pollution abatement technology increases.²

Sulfur dioxide levels are clearly below the NEPM standards, the highest being recorded at Point Henry, close to a major source.

Figure 5 shows that during 1994–1998 the highest lead concentration approached the Air NEPM standard. This concentration was recorded in 1994, at what could be described as a roadside station (Collingwood). For a better picture of the trend for this pollutant, annual lead concentrations for Collingwood and Alphington (densely populated residential areas) are shown in figure 8. The downward trend, particularly in recent years, is very pronounced. Lead is not seen as a pollutant of concern as further decreases are expected in the coming years due to the completion of the phase out of unleaded petrol by 2002.

Figure 8: Annual lead concentrations at Collingwood and Alphington, 1983–98

More details of air quality in the Port Phillip Region are presented in appendix B and in EPA reports on data monitoring\(^3\) and analysis.\(^4\)

3.1.2 Proposed NEPM assessment scheme

The formula given in Clause 14 of the Air NEPM for calculating the number of performance monitoring stations for a region indicates that six monitoring stations would be required for the Port Phillip Region. The actual number depends on the pollution levels experienced or expected with respect to each pollutant. If concentrations of a particular pollutant are, or are expected to be, well below the Air NEPM standards, fewer stations would be sufficient.

Based on the information presented in the previous section, particles and ozone are the two pollutants of most concern in the Port Phillip Region. Air NEPM standards for these pollutants are exceeded on occasions. For the remaining pollutants, smaller networks are considered adequate.

In nominating networks for each pollutant in accordance with the PRC guideline paper on monitoring strategy, consideration is given to:

- capturing an upper bound of the concentrations to which people are expected to be exposed, and
- providing an adequate coverage of pollutant distributions over populated areas.

Table 1 lists the performance and trend stations in the Port Phillip Region for each of the six Air NEPM pollutants. The methods of sampling and analysis are also shown in this table. Performance monitoring stations for each pollutant are described below in this section.

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Table 1: Performance monitoring stations for the Port Phillip Region

<table>
<thead>
<tr>
<th>Station name</th>
<th>Location</th>
<th>$O_3$</th>
<th>$NO_2$</th>
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</table>

**Abbreviations**

* Trend station
† Partisol samplers may be considered for use at some stations if planned investigations show them to be an acceptable method.

**Fl** Fluorescence
**Ch** Chemiluminescence
**IR** Non-dispersive infra red
**UV** Non dispersive ultra violet
**TEOM** Tapered element oscillating microbalance
**AA** Atomic absorption
**DOAS** Differential optical absorption spectrometry (long path)
Figure 9 shows the nominated Air NEPM stations against population density in the Port Phillip Region.

Figure 9: Air NEPM stations and population density in the Port Phillip Region

Quality assurance and quality control measures are detailed in Section 5. Currently, most of the sampling inlets are 6 metres above ground level, indicating non-compliance with AS 2922–1987 Ambient Air – Guide for the siting of sampling units, which specifies a height of 2–5 metres. All performance stations except the CBD site will be made to comply with this standard. At the CBD site, the sampling height is 19 metres as sampling is carried out on the roof of a building at the Royal Melbourne Institute of Technology (RMIT).

Ozone

In the Port Phillip Region there are a number of complex meteorological patterns that lead to high ozone events. These fall into the following broad categories.

1. Light N-NE wind (either synoptic or katabatic), followed by bay or sea breeze, resulting in high ozone, particularly in the western and north-western suburbs.

2. Very light winds caused by direct balancing of synoptic and sea-breeze effects, leading to stagnation and widespread ozone.

3. Combination of light synoptic and bay/sea-breeze winds resulting in the Spillane Eddy, causing widespread ozone.

These categories are not equal in terms of frequency of occurrence; category 1 accounts for about 80 per cent of ozone events.
Note that within category 1, depending on the synoptic wind strength and the land/sea temperature difference, the sea or bay breeze may be early or late, affecting the location of peak ozone. An early sea breeze will result in ozone in the suburbs just west of Melbourne, whereas a late sea breeze may result in ozone as far south as Geelong.

Similarly, whether a full sea breeze or only a weak bay breeze develops determines the extent of penetration of ozone into populated areas. The strength of the subsidence inversion will affect the concentration of an inland ozone plume.

Another factor is the location of sources. Generally, the highest NOx emissions come from the eastern suburbs of Melbourne, and the highest VOC emissions from the western suburbs. Therefore, the very highest ozone levels are associated with days of maximum recirculation (that is, categories 2 and 3 weather will result in optimum mixing of the VOC and NOx sources).

Figure 10 shows a typical ozone event (category 1) in Melbourne. Roads and existing monitoring stations are also shown in this figure. On this day, ozone reached 106 ppb at Mt Cottrell at 6:30 pm. The plot shows an air parcel trajectory ending at Mt Cottrell at 6:30 pm. Numbers on the plot show time of day, indicating clearly that peak-hour (7.00–10.00 am) traffic emissions have come from the E-NE suburbs.

Figure 10: Typical Melbourne summer smog day, 19 February 1997

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Note, however, that peak ozone levels under category 1 conditions could occur in many possible locations, so it is
difficult to define an upper bound monitoring location. The locations of highest ozone (peak readings) may also
be quite different from the locations that most commonly breach the Air NEPM standard (high event frequency).

From past observations it is known that the western coastline of Port Phillip Bay experiences the most frequent
breaches of the Air NEPM ozone standard. Outer West Metro (Point Cook) and Inner West Metro (Footscray) are
therefore nominated as GRUB stations, which will capture ozone associated with the most common type of
photochemical event (category 1).

Aircraft plume tracking data also demonstrate that on occasions high ozone concentrations can occur near
Melton, far to the NW of Melbourne; a new station (Northwest Metro) in this area is proposed in 2001–02, subject
to funding.

Other types of ozone events result in generally widespread ozone. As a result, the other performance monitoring
stations are nominated to provide good spatial coverage of the region’s population: South Metro (Brighton),
Southeast Metro (Dandenong), Inner East Metro (Alphington), Outer East Metro (at a site to be selected), Geelong
(Geelong South), and Outer Geelong (Point Henry).

The ozone network is shown in figure 11. Four stations are nominated as trend stations – Geelong, Inner West
Metro, Outer West Metro and South Metro.

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Figure 11: Ozone monitoring stations against 1996 population in the Port Phillip Region

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Ahmet and van Dijk, ibid.
In addition, campaign monitoring and other tools will be used to determine if there is a need for another ozone performance monitoring station in an area not covered by the proposed network. A relocatable monitor will be used to measure ozone in the areas of interest, initially for a period of one ozone season in each of the Outer Southeast, Outer South, and Outer North areas, commencing in 2001–02. Outer Southeast Metro will probably continue as a PMS provided funds are available.

Nitrogen dioxide

Emissions of NOx in Melbourne are dominated by motor vehicle emissions and the patterns of high NO overlap broadly those of traffic density and population. The nominated Air NEPM monitoring network therefore includes the following stations: Inner West Metro (Footscray), Inner East Metro (Alphington), CBD (RMIT), and South Metro (Brighton), which are representative of high NO overlap neighbourhoods. Geelong (Geelong South) is included as an upper-bound station for areas in the west of the region. Outer West Metro (Point Cook) has also been included as it has recorded high concentrations and because of its significance for ozone generation. Inner East Metro, Inner West Metro, CBD, and Geelong are also nominated as trend stations. These sites and population densities are shown in figure 12.

Figure 12: Air NEPM NO overlap stations and 1996 population density in the Port Phillip Region
Particles as PM$_{10}$

In the Port Phillip Region, breaches of the Air NEPM PM$_{10}$ standard do occur on occasions. There are essentially two meteorological patterns leading to high PM$_{10}$.

1. Extended periods of light winds associated with persistent high-pressure systems, resulting in the accumulation of particle emissions from domestic woodsmoke, vehicles and industry.

2. Extended periods of dry weather, followed by a rapid change of wind speed and direction (for example, passage of a cold front), causing large amounts of dust to be lifted into the air and carried to populated areas.

The principal sources of PM$_{10}$ emissions are motor vehicles (including road dust), industry and solid fuel combustion.  Emissions from solid fuel combustion for heating are highly seasonal; their incremental effect causes the highest PM$_{10}$ concentrations under category 1. Peak concentrations will be found close to sources, especially those that sustain emission over many hours (for example, smouldering fires). The PM$_{10}$ network will therefore broadly follow the population distribution in the region.

For category 2, generally, the western regions of the city will experience the peak dust impact, because typically a cold front approaches from the west bringing a south-westerly wind; the majority of the dust will be deposited early on in the passage of the front across the city. Geelong and Inner West Metro are expected to pick up dust events as described in category 2.

The nominated Air NEPM particle (PM$_{10}$) network shown in figure 13 consists of Inner East Metro (Alphington), Inner West Metro (Footscray), South Metro (Brighton), CBD (RMIT), CBD Southeast (Richmond), Southeast Metro (Dandenong) and Geelong, and a station to be sited at Outer East Metro. PM$_{10}$ will be monitored at Outer Southeast Metro if an ozone station is established there. Inner East Metro, Inner West Metro, CBD and Geelong are also the nominated trend stations.

Figure 13: Air NEPM particle monitoring stations and 1996 population in the Port Phillip Region

Carbon monoxide

Peak levels measured over the past 5 years do not exceed 75 per cent of the standard (see appendix B). Thus, Screening Criterion B is satisfied, allowing less than the nominal six PMS for the region. Motor vehicles are the major source of carbon monoxide. In summer they account for about 90 per cent of emissions. CO concentrations are generally higher in the vicinity of heavy traffic.

CO will therefore be monitored at Inner East Metro (Alphington), CBD (RMIT) and CBD South East (Richmond). Geelong station is also included in the network to give upper bound readings for that subregion. Inner East Metro, CBD and Geelong are also nominated as trend stations.

At the CBD site the sampler is located on the roof of a building and the sampling height is 19 m AGL. Although this does not comply with the siting standard AS 2922–1987, the monitoring is considered to be generally representative of upper-bound concentrations in the high-rise area of the CBD. Recent measurements, in conjunction with RMIT, have shown the absence of vertical gradients up the side of the building.

The Air NEPM network for CO and population densities are shown in figure 14.

![Figure 14: Air NEPM CO stations and 1996 population density in the Port Phillip Region](image-url)
Sulfur dioxide

Industrial sources contribute 65 per cent of SO\textsubscript{2} emissions in the Port Phillip Region, and commercial ships 19 per cent.\(^8\) Peak levels over the last 3 years have not exceeded 66 per cent of the Air NEPM standards (see appendix B), except at Pt Henry, which is influenced by local sources and is not regarded as a suitable PMS for SO\textsubscript{2}.

Therefore, Screening Criterion B is satisfied and, in accordance with Clause 14 (3) of the Air NEPM, fewer than six stations may be nominated for NEPM purposes.

Upper-bound monitoring stations are proposed at Geelong, CBD and Southwest Metro (Paisley). In addition, monitoring at Inner East Metro (Alphington) will indicate SO\textsubscript{2} levels in general residential areas in Melbourne. It is intended that DOAS open path equipment will be used at Southwest Metro following the establishment of this method as an equivalent monitoring method for SO\textsubscript{2}. An experiment will be conducted for this purpose at the site. The non-standard sampling arrangement at the CBD site has been discussed above. Inner East Metro and Geelong will be trend stations. The SO\textsubscript{2} monitoring network is shown in figure 15, together with population densities.

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Lead
Levels of lead in Melbourne’s air have been consistently falling (see figure 8) and this downward trend is expected to continue as 97 per cent of emissions in the Port Phillip Region are from motor vehicles, emissions from leaded petrol are on the decline, and there are no proposed new sources of lead. Current levels at the peak station (Collingwood) in Melbourne are less than 50 per cent of the standard. As a result, a reduction from the nominal six stations is justified by Screening Criterion B (see monitoring results in appendix B). CBD Northeast (located at Collingwood; see figure 9) is the only site proposed; it is also a trend station for Air NEPM purposes.

3.2 Latrobe Valley Region

3.2.1 Region description

Topography
The Latrobe Valley begins some 100 km east of Melbourne and extends about 100 km further east before opening onto broad coastal plains. It is bounded by the Great Dividing Range to the north and the Strzelecki Range to the south. The western end of the southern boundary follows the ridge of the Strzelecki Range, which forms a natural boundary between airsheds. The valley floor is about 30 km wide at the western end, narrows near Yallourn and opens onto plains extending east to Sale and the coast. The NEPM region is shown in figure 16.

Figure 16: Topography of the Latrobe Valley

9 ibid.
Climate/Meteorology
The climate of the Latrobe Valley is controlled by the eastward progression of synoptic weather systems. The orientation of the valley tends to turn winds towards easterly and westerly directions. Sea breezes are important in summer and can penetrate from the east coast as far as the western boundary of the region. These wind regimes infrequently cause air masses to recirculate up and down the valley over a period of days, during which photochemical smog and other pollutants accumulate.

There is also a sea breeze that enters the central Latrobe Valley from the coast to the south-southwest via the Morwell River Valley. As a result, there is considerable variation of wind pattern with season and time of day, and importantly for pollution dispersion with height. A three-level wind structure is common in the morning, with shallow drainage flows near the surface, an intermediate easterly flow encompassing the plumes of most large emitters, separated by a temperature inversion from the overlying wind which results from interaction of the synoptic pressure pattern with the local topography. In late afternoon, sea breezes can cause complicated interleaving of flows at different heights in the central Latrobe Valley, where the major air pollution sources are located. Emission sources at ground and elevated levels usually contribute to ground level air quality via different mechanisms. Peak SO$_2$ measurements can usually be attributed to plume impacts from the major industrial sources in the region.

Stability at ground level shows a high level of near-neutral conditions, with unstable conditions less frequent than in States to the north. Extremely unstable conditions occur only on approximately 1 day in 4 in summer; in these conditions, mixing heights are significantly lower in the Latrobe Valley than in Melbourne.
Population distribution
The region has a population of approximately 130,000. Traralgon and Moe are the largest population centres in the Valley. Figure 17 shows the population density in the region, along with the major towns (circles) and emission sources (triangles).

Figure 17: Population, towns and emissions in the Latrobe Valley

Major regional emission sources
Outside the Port Phillip Region, the Latrobe Valley is the most significant industrial centre in Victoria. The Latrobe Valley Region contains the State’s major brown coal reserves and the bulk of the State’s electricity generating capacity. In 1981 the State Environment Protection Policy (The Air Environment) established the Latrobe Valley Control Region as a separate region to allow for the development of specific control programs to meet the particular needs of the region. The purpose was to preserve the capacity of the Latrobe Valley air environment to receive future emissions from electricity generation and other industrial activities.

Major industrial emission sources in the region are listed below. They are concentrated in the central Latrobe Valley, as shown by triangle symbols in figure 17.

- Loy Yang A power station (2000 MW)
- Hazelwood power station (1600 MW)
- Yallourn W power station (1450 MW)
- Loy Yang B power station (1000 MW)
- Jeeralang gas turbine station (466 MW)
- Morwell briquetting and power station (170 MW)
- Australian Paper mill
- Bonlac milk products factory
Regional air quality

A comprehensive study of air quality in the Valley (the Latrobe Valley Airshed Study) was carried out from the late 1970s to the mid 1980s. As part of this study, an emissions inventory and a dense air monitoring network were established; mathematical models were developed for predicting the impact of future emissions on the air quality in the Valley. Following a recent review, the network has been reduced to five stations and an acoustic sounder.

Two of these stations (EPA operated) are located at the largest population centres in the Valley: Traralgon (population: 18,993) and Moe (population: 15,512). The other industry-operated stations are at Rosedale, Darnum and Jeeralang.

According to the emissions inventory, almost all of the $\text{SO}_2$ and most of the $\text{NO}_x$ emissions come from power stations. However, because the emissions from power stations come from tall stacks, they contribute much less to ground-level concentrations than is suggested by their contribution to the total emissions. Complex terrain and meteorology are other factors affecting air quality at ground level. Monitoring data indicate that air quality is generally good, but on occasions short-term concentrations approach or exceed NEPM standards for $\text{O}_3$ and $\text{PM}_{10}$. The 1-hour $\text{SO}_2$ standard has been exceeded twice, on 1 day in each of 1998 and 1999.

Maximum concentrations from air quality monitoring during 1997–99 and earlier monitoring for CO and lead are summarised in Appendix D.
3.2.2 Proposed NEPM assessment scheme

The region has a population of approximately 130,000. According to the NEPM formula, this requires a base monitoring network of one station. The stations nominated as PMSs are shown in figure 18; monitoring details are given in table 2. The two stations are in the two largest towns, situated in light traffic residential areas within 1 km of the Princes Highway. Monitored concentrations are considered to be generally representative of air quality experienced by residents.

![Latrobe Valley performance monitoring stations](image)

**Figure 18: Latrobe Valley performance monitoring stations**

<table>
<thead>
<tr>
<th>Station name</th>
<th>Location</th>
<th>O$_3$</th>
<th>NO$_2$</th>
<th>PM$_{10}$</th>
<th>CO</th>
<th>SO$_2$</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latrobe Valley East Central</td>
<td>Traralgon</td>
<td>UV*</td>
<td>Ch*</td>
<td>TEOM*</td>
<td></td>
<td>Fl*</td>
<td></td>
</tr>
<tr>
<td>Latrobe Valley West Central</td>
<td>Moe</td>
<td>UV</td>
<td>Ch</td>
<td>TEOM</td>
<td></td>
<td>Fl</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Performance monitoring stations in the Latrobe Valley**

* Abbreviations
  
  * Trend station
  
  TEOM Tapered Element Oscillating Microbalance  
  UV Non dispersive ultra violet  
  Fl Fluorescence  
  Ch Chemiluminescence
Ozone

Ozone was extensively studied during the Latrobe Valley Airshed Study. It was found\(^{12}\) that the behaviour of \(O_3\) could be explained largely in terms of natural background atmospheric processes. However, higher concentrations (above 50 ppb) occurred in stagnant or light wind conditions to the rear of anticyclonic systems and were attributed to photochemical production. No marked dependence of high \(O_3\) concentrations on either 900 mb or surface wind direction could be found, but some individual events were identified which showed the influence of ozone originating from the Port Phillip airshed.

Since then, there has been little change in the population of the region, while electricity generation has approximately doubled. Limited modelling of the effects of power station emissions showed them to be complex, without producing uniform effects on regional ozone. Analysis of more recent ozone events confirms the conclusion from earlier research that the higher concentrations usually result from photochemical reactions of precursors as air masses recirculate up and down the valley, sometimes over several days. Concentrations are typically uniform over the valley; however, higher readings sometimes occur in the west of the region, which can be affected by photochemical reactants transported from the central Latrobe Valley or from Melbourne. Ozone concentrations usually remain below the NEPM standards but may approach them. In 19 years of monitoring, the 1-hour standard has been exceeded on 1 day at one station. On this day, there was recirculation within the valley and also a possible contribution from Melbourne.\(^{13}\)


Table 3 shows the highest values over several years of the annual maximum and second highest daily maximum 1-hour ozone concentrations recorded in the Latrobe Valley. Station locations are shown in appendix D.

### Table 3: One hour O$_3$ in the Latrobe Valley (1994–1999)

<table>
<thead>
<tr>
<th>Location</th>
<th>Maximum (ppm)</th>
<th>2nd highest (ppm)</th>
<th>Data availability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darnum North$^a$</td>
<td>0.11</td>
<td>0.08</td>
<td>91</td>
</tr>
<tr>
<td>Thoms Bridge</td>
<td>0.07</td>
<td>0.06</td>
<td>91</td>
</tr>
<tr>
<td>Minniedale Road</td>
<td>0.07</td>
<td>0.06</td>
<td>94</td>
</tr>
<tr>
<td>Moe$^b$</td>
<td>0.07</td>
<td>0.07</td>
<td>95</td>
</tr>
<tr>
<td>Traralgon</td>
<td>0.08</td>
<td>0.07</td>
<td>88</td>
</tr>
<tr>
<td>Mount Tassie$^a$</td>
<td>0.07</td>
<td>0.06</td>
<td>93</td>
</tr>
<tr>
<td>Rosedale South</td>
<td>0.06</td>
<td>0.06</td>
<td>91</td>
</tr>
<tr>
<td>Yinnar South</td>
<td>0.08</td>
<td>0.06</td>
<td>89</td>
</tr>
<tr>
<td>Jeeralang Hill$^b$</td>
<td>0.07</td>
<td>0.07</td>
<td>90</td>
</tr>
</tbody>
</table>

$^a$ 1994–98
$^b$ 1997–99

Consideration of previous monitored data, modelling and analysis studies leads to the following understanding of ozone behaviour in the Latrobe Valley. The recirculation mechanism accounts for most of the ozone events and causes uniform concentration extremes (as shown in table 4). The transport from Melbourne mechanism is associated with only a minority of ozone events, but they do seem to be the very highest. Hence, if an upper-bound station were to be located outside of the towns, it would be in the west of the valley. The Darnum North station is located in the west of the Latrobe Valley but only about 163 people live within a 2 km radius of it. This is typical of locations outside the towns, which are not considered to be generally representative of the population.

With decreasing O$_3$ concentrations generated in Melbourne (figure 6), interregional transport may become a less important contributor to peak concentrations than it has been in the past.

The stations at Traralgon and Moe will become performance monitoring stations (Latrobe Valley East Central and Latrobe Valley West Central) and will monitor ozone. The former will be a trend station. These stations are representative of concentrations experienced within the towns Traralgon and Moe.
Nitrogen dioxide

NO₂ concentrations are clearly higher in towns than at rural locations. Some high concentrations occur as a result of power station plume impacts on the Strzelecki Range, but these are in sparsely populated areas not generally representative of areas on the valley floor.

The Traralgon and Moe stations will become performance monitoring stations (Latrobe Valley East Central and Latrobe Valley West Central) for NO₂. Latrobe Valley East Central will be a trend station. These stations are representative of concentrations experienced within the towns of Traralgon and Moe, which are generally low but higher than elsewhere in the Latrobe Valley (see table 2 of appendix D).

NO₂ will also be monitored at the Latrobe Valley West station to supplement O₃ monitoring there. As this is not an upper-bound location for NO₂, the results will not be reported as such.

Particles as PM₁₀

Emissions from industrial sources and bushfires are well dispersed. Other sources causing peak concentrations, such as fires and construction work, are localised but well-distributed spatially. The incremental effect of town sources causes upper-bound concentrations to occur in the towns. Town stations have not monitored PM₁₀ in recent years but earlier monitoring confirmed that they recorded the highest PM₁₀ concentrations in the Latrobe Valley.¹⁴ Nephelometer readings also show higher particulate concentrations at these stations than in rural areas of the Latrobe Valley. PM₁₀ concentrations are not expected to exceed the NEPM standard.

PM₁₀ will be monitored by TEOM at the Latrobe Valley East Central and Latrobe Valley West Central stations, commencing by July 2001. Latrobe Valley East will be a trend station. These stations are representative of concentrations experienced within the towns of Traralgon and Moe.

Carbon monoxide

No monitoring is proposed. Monitoring of CO in the Latrobe Valley was discontinued in 1989 because of low values, which were below 45 per cent of the NEPM standard (see table 6 of appendix D). Since then, the population of the towns has not increased markedly and it is expected (as is the case in Melbourne over the same period) that ambient concentrations have not increased. Hence, Screening Procedure A is satisfied and no monitoring of CO is necessary in the Latrobe Valley region.

Sulfur dioxide

The highest SO₂ concentrations occur infrequently due to power station plumes impacting on elevated terrain during stable atmospheric conditions. These events occur in sparsely populated areas and are not generally representative of areas on the valley floor. The next most significant mechanism for high SO₂ concentrations is impingement of elevated plumes on the valley floor by looping or fumigation under convective conditions. This occasionally causes plume impacts at Traralgon and Moe, where measurements are similar to concentrations experienced elsewhere in the central Latrobe Valley, with a small increment due to town sources.

SO₂ will be monitored at the Latrobe Valley East Central and Latrobe Valley West Central stations, located at Traralgon and Moe. Latrobe Valley East Central will also be a trend station.

Licensed emitters are required to monitor for SO₂ at the Rosedale South and Jeeralang Hill stations and to model some high-pollution events. In addition, regional modelling for air quality surveillance will be conducted on a regular basis.

**Lead**

No monitoring of lead is proposed. Previous monitoring at Traralgon and Morwell East was discontinued in 1985 because of low concentrations and emissions have since decreased markedly due to the reduced use of leaded petrol. At that time, lead levels were below 40 per cent of the NEPM standard, thereby satisfying Screening Procedure A.

### 3.3 Other rural centres

#### 3.3.1 Ballarat Region

**Topography**

Ballarat is situated at roughly 400 m elevation, with a minor ridge and plateau to the east of the town rising to approximately 550 m elevation (figure 19). The roughly north-south oriented ridge runs along the length of the town. A significant lake (Lake Wendouree) exists near the centre of the town.

![Ballarat topography and rivers](image)
Climate/Meteorology

Ballarat’s temperate climate is characterised by warm summers, cool to cold winters and moderate rainfall (710 mm/year). The town is 100 km from Bass Strait, and so experiences significant temperature swings. Ballarat’s 400 m elevation also affects its temperature patterns; 4°C is a typical winter overnight minimum temperature. Accumulation of pollutants on calm, stable nights can be expected.

Average winds in Ballarat are quite high, with 9.00 am wind speeds varying from 5.5 m/s in January to 3.8 m/s in July, while average 3.00 pm wind speeds are generally around 5.5–6.0 m/s throughout the year. Patterns of low wind speed are typically associated with winds from the east or north-east, corresponding to cold air drainage from the more elevated areas. Approximately 2 per cent of wind measurements are 0.5 m/s or less; 17 per cent of hourly weather readings correspond to stability class F (highly stable weather).

Population distribution

Ballarat has a total population of 64,831. Population density (shown in figure 20) is generally low, the highest being 3,500 persons per km².

Figure 20: Ballarat population density and industries

**Major regional emission sources**

The are four industrial point sources of note in the Ballarat area:

- Bendix – washing machine and dryer repairs
- Selkirk’s Bricks – brick and paver manufacture
- Joe White Maltings Delacombe
- Joe White Maltings Ballarat.

By comparison with large point sources in the larger regions (for example, power generation), these emission sources are considered to be small, and thus are unlikely to directly result in NEPM breaches.

Fuel combustion processes generate nitrogen oxides. Approximately 90 per cent of these primary emissions will be in the form of nitric oxide (NO) and 10 per cent as nitrogen dioxide (NO₂). Significant amounts of the nitric oxide emissions can also be converted to nitrogen dioxide but these reactions take time to occur. In smaller regional centres, it is rare for significant amounts of NO₂ to be generated by this process before winds move and disperse the NO₂ outside the town limits. For this reason, NO₂ levels in these areas are generally due to the primary emissions from traffic, heating and industrial sources.

Other major emission sources are believed to be woodsmoke from domestic heating, prescribed burning and motor vehicle emissions.

**Regional air quality**

No ambient air quality measurements exist for Ballarat.
3.3.2 Bendigo Region

Topography
Bendigo is situated at roughly 240 m elevation. To the south are a number of small ridges and valleys (shown in figure 21), with elevations varying from 240–340 m; to the north are two smaller ridges and a relatively flat plain with elevation 180 m.

![Bendigo Topography and Rivers](image)

**Figure 21: Bendigo topography and rivers**

Climate/Meteorology
Bendigo’s climate is cool to warm temperate; it has low to moderate rainfall (550 mm/year) and warm to hot summers.

Average winds in Bendigo are fairly typical of much of the State, with 9.00 am wind speeds varying from 4.7 m/s in January to 3.2 m/s in July, and average 3.00 pm wind speeds varying from 4.8 m/s in January to 4.2 m/s in July.

Periods of low wind speed are associated with winds from the south and southwest, consistent with cold air drainage from the more elevated areas south and southwest of the town.

A significant proportion (9 per cent) of wind measurements were 0.5 m/s or less. In addition, 25 per cent of hourly weather readings correspond to stability class F (highly stable weather).
Population distribution
Bendigo has a total population of 59,936. Population density is generally quite low (as shown in figure 22), the highest density being 2,500 persons per km².

Figure 22: Bendigo population density and industries

Major regional emission sources
There are four industrial point sources in Bendigo of note:
- Bendigo Bricks – brick manufacture (kiln)
- Anne Caudel Hospital – co-generation plant
- Hazeldene Farm – waste oil burners
- Phillips Bricks and Pottery – clay brick manufacture.

Other major emission sources are woodsmoke and motor vehicle emissions, which may be estimated in general terms with respect to population and the likely use of wood heaters in the region.

Regional air quality
PM$_{10}$ monitoring has been conducted in Bendigo during 2000, using a high volume sampler operating once in 6 days. Initial results generally indicate levels below 35 µg/m$^3$, except for one day, 4 February, where the PM$_{10}$ reached 53.3 µg/m$^3$, largely from wind-blown dust associated with a major wind change on that day.

No other air quality data are available for Bendigo.
3.3.3 Shepparton/Mooroopna Region

Topography

The Shepparton/Mooroopna region (henceforth referred to as Shepparton) is situated at roughly 105 m elevation, surrounded largely by flat terrain (shown in figure 23). The Goulbourn and Broken Rivers run through this region, which includes some lowland swamps.

![Shepparton Topography and Rivers](image)

Figure 23: Shepparton Topography and Rivers

Climate/Meteorology

Shepparton’s climate is cool to warm temperate. It has a low to moderate rainfall (503 mm/year) and warm to hot summers. The region is 240 km from Bass Strait and so experiences significant temperature swings.

Only 3-hour wind measurements are available for Shepparton. Based on 1998 data, average 12 noon–3.00 pm wind speeds are 5.5 m/s in January and 4.2 m/s in July.

Approximately 2 per cent of wind readings were 0.5 m/s or below.

Population distribution

The Shepparton region has a total population of 31,945. Population density (shown in figure 24) is usually low, the highest density being 3,630 persons/sq. km.
Figure 24: Shepparton population density and industries

**Major regional emission sources**

There are two industrial point sources of note in the region:

- Ardmona Foods – cannery
- SPC – cannery.

Other potential sources include stubble burning, burning leaves in backyards, motor vehicle emissions and windblown dust. Domestic woodsmoke emissions are likely to be significant.

**Regional air quality**

No ambient air quality measurements exist for Shepparton.
3.3.4 Warrnambool Region

**Topography**

Warrnambool is situated on the western Victorian coastline at roughly 20 m elevation. There are two rivers (Merri and Hopkins) on either side of the town, and it has a small lake (Pertobe) and a small bay (Lady Bay). Surrounding terrain (shown in figure 25) is relatively gentle in slope (approx. 100 m in 20 km).

![Figure 25: Warrnambool topography and rivers](image)

**Climate/Meteorology**

Warrnambool's climate is cool temperate; it has moderate rainfall (744 mm/year), mild summers and cool winters. As a coastal town the thermal climate is strongly stabilised by open ocean temperatures.

Only 3-hour wind measurements are available for Warrnambool. Based on 1998 data, average 12 noon–3.00 pm wind speeds are 6.1 m/s in January and 3.9 m/s in July.

Because light winds occur so infrequently in Warrnambool, meteorological conditions that would encourage the build-up of pollution levels are expected only infrequently.
Population distribution

The Warrnambool region has a total population of 26,052. Population density (shown in figure 26) is generally quite low, the highest density being about 3,000 persons per km².

![Map of Warrnambool population density and industries](image)

**Figure 26: Warrnambool population density and industries**

**Major regional emission sources**

There is one industrial point source of note in the region:
- Nestle – food manufacture

Other major emission sources are motor vehicle emissions, woodsmoke from heating and smoke from burning rubbish in the backyard.

**Regional Air Quality**

No ambient air quality measurements exist for Warrnambool.
3.3.5 Wodonga Region

Topography
Wodonga, just south of the Murray river in north-east Victoria, is situated at roughly 170 m elevation. Elevated ridges up to 450 m exist to the north and southwest of the town as shown in figure 27.

Figure 27: Wodonga topography and rivers

Climate/Meteorology
Wodonga's climate is warm temperate. It has moderate rainfall (714 mm/year) and warm to hot summers. The region is remote from the sea (225 km from Bass Strait) and so experiences significant temperature swings.

Wind data show that the Albury–Wodonga area is, in general, a region of light winds. At night there is a very clear and well-developed, though complicated, drainage wind system, which reduces the area’s liability to air pollution.\textsuperscript{16} Albury data show a very large proportion (18 per cent)

\textsuperscript{16} Moriarty, W. 1979, Survey of Low Level Winds and Air Dispersion Characteristics of the Albury–Wodonga Area, Bulletin 50, Bureau of Meteorology, AGPS.
of wind readings at or below 0.5 m/s, with 28 per cent of hourly weather readings corresponding to stability class F (highly stable weather).

Population distribution

The Wodonga region has a total population of 25,825. Population density (shown in figure 28) is generally quite low, the highest density being 2,660 persons per km$^2$. Across the Murray River (about 5 km away) is Albury, a major regional centre with a population of 41,491.

![Figure 28: Wodonga population density and industries](image)

**Figure 28: Wodonga population density and industries**

**Major regional emission sources**

There are a number of industrial point sources of note in Wodonga:
- Wodonga Rendering
- Wodonga Quarries, CSR/Readymix, Delaneys – quarries
- Uncle Ben’s – pet food manufacture
- Bradken ANI – metal foundry.

Fires and stubble burning by the Department of Natural Resources and Environment are known to impact on the town on about 2 days per year. Other major emission sources are motor vehicle emissions and woodsmoke from heating, neither of which have been quantified as part of this study but may be estimated in general terms with respect to population and the likely use of wood heaters in the region.
Emission sources from Albury have not been assessed in this study; however, it is likely that on occasion the emissions from both towns accumulate in the river valley.

**Regional air quality**

No ambient air quality measurements exist for Wodonga. However, NSW EPA has just installed (in July 2000) a new monitoring station in Albury that will monitor PM$_{10}$. Given the small distance between the two towns, it is expected that data obtained in Albury will form a reasonable upper-bound approximation to the air quality in Wodonga.

### 3.3.6 Mildura Region

**Topography**

Mildura is situated by the Murray River at roughly 40 m elevation and is surrounded by largely flat terrain (figure 29). The region includes the centres of Redcliffs and Merbein.

![Figure 29: Mildura topography and rivers](image-url)
Climate/Meteorology
Mildura’s climate is dry, with low rainfall (293 mm/year), warm to hot summers and cool to mild winters. The town is 450 km from Bass Strait, so experiences significant temperature swings. Typical daily average wind speeds in Mildura are 4.1 m/s in January and 3.2 m/s in July. Strong winds are most frequent in the afternoon during late winter and spring, with wind gusts up to 40 m/s on record. Twenty-two per cent of hourly weather readings correspond to stability class F (highly stable weather).

Population distribution
Mildura has a total population of 24,142. Population density (shown in figure 30) is generally low, the highest density being 2,990 persons per km².

Figure 30: Mildura population density

Major regional emission sources
Major emission sources are woodsmoke, windblown dust and motor vehicle emissions. No significant industrial sources have been identified.
Regional air quality
No ambient air quality measurements exist for Mildura.

3.3.7 Proposed NEPM Assessment Schemes

Application of the NEPM formula for network size leads to a nominal one station for each of the rural centres. In each case except Wodonga, PM$_{10}$ campaign monitoring is proposed for one year to ascertain the need to monitor. Other pollutants can be screened out and no monitoring is proposed. At Wodonga, use will be made of the monitoring station at Albury operated by the NSW EPA.

Ozone
High concentrations of ozone are unlikely in any of the regions because the populated regions are smaller than about 6 km radius, so emissions will be advected away and diluted before significant photochemical smog production occurs. In addition, for the inland sites there are none of the obvious recirculation mechanisms that are required for high concentrations of ozone to form (as emissions need to be aged over several hours).

Ozone data are available from the short campaign monitoring done in Hobart (1994–95) and Launceston (1992–93), where no 1-hour ozone readings were above 40 per cent of the standard. Note, however, that these data must be treated with some caution because of the fact that only one site was used per region and only one or two seasons were measured; also, summer temperatures and solar radiation levels are lower than in Victoria.

It is not proposed to monitor ozone. This screening decision will be reviewed following completion of a consultancy by CSIRO using the TAPM model, which is expected to provide a basis for using the PRC procedures to screen out rural centres.

Nitrogen dioxide
Nitrogen oxides are emitted from all combustion processes, with only 10 per cent emitted in the form on NO$_2$. Nitric oxide is progressively converted to the more toxic NO$_2$ through photochemical processes. The reactions take time to occur, and peak concentrations are usually generated some kilometres downwind of urban sources. Therefore, it is unlikely that significant amounts on NO$_2$ produced via the secondary reactions will be present in the regional towns. Emissions will be low because of the low population density and the absence of any major point or area sources.

No monitoring of NO$_2$ is proposed. TAPM modelling by CSIRO is expected to justify this screening in accordance with the PRC procedures.

Particles as PM$_{10}$
Light overnight winds associated with clear skies can result in strong surface-based inversions. The frequency of such conditions will vary in the different regions. Since there is generally a high local usage of wood heaters, there is the potential for woodsmoke to be trapped close to ground within this layer. Although population density is not high, the other major factors (topography and climate) are likely to result in occasional episodes of high woodsmoke concentrations. Also, on rare occasions, controlled burning activities and wildfires may have an
impact on the town. For these reasons campaign monitoring will be undertaken to determine whether a PMS for PM$_{10}$ is required.

Monitoring by high-volume sampler is being carried out in Bendigo in 2000 and will begin in Ballarat by July 2001. Monitoring in the other regions will follow sequentially and run for 1–2 years each. The sites have not yet been chosen but will be located close to the most populated area of the town in order to best estimate the upper bound of population exposure, particularly for woodsmoke pollutants. The results will then be used to screen the region to determine whether further monitoring is required to demonstrate compliance with the NEPM. Results from the Albury station will be used to assess whether monitoring is needed at Wodonga, which is approximately 5 km away.

Carbon monoxide
It is not expected that CO concentrations will be significant in the regional centres, where they are likely to be dominated by motor vehicle emissions. The potential for CO from wood fires is unclear. Historical data from the Latrobe Valley (appendix D) is slightly too high to satisfy the screening criteria but no monitoring is proposed. Instead, Victoria will await the outcome of NEPM monitoring in other regions such as Mount Gambier (2001) and Toowoomba (2003), from which it is expected the regions will be screened out using Procedure F.

Sulfur dioxide
No significant sources of sulfur dioxide have been identified in the regional centres. Therefore SO$_2$ is unlikely to be of concern. For screening purposes, a comparison is made with the Geelong monitoring station, which represents a subregion with greater population and adjacent sources of SO$_2$. The Geelong station has not recorded concentrations above 40 per cent of the standards and so Screening Procedure F is satisfied and no monitoring is proposed.

Lead
No significant sources of lead have been identified in the regional centres. Motor vehicle sources of lead are expected to be low and to follow a declining trend which is seen in the Port Phillip Region, where peak concentrations do not exceed 40 per cent of the standard. Therefore, Screening Procedure F is satisfied and no monitoring of lead is proposed.

4. SITING AND INSTRUMENTATION

4.1 Instrument standards

Table 4 lists methods used for monitoring the NEPM pollutants. Table 5 lists methods used for associated monitoring of other pollutants. All instrument measurements are in accordance with the relevant Australian
standard unless noted below. Meteorological measurements are generally in accordance with the PRC Guideline Paper under development.

The Air NEPM requires that particles are monitored by high-volume samplers with size selective inlets (gravimetric method) or by other methods meeting certain criteria to supply equivalent information. There are difficulties in providing continuous (daily) monitoring with this method as recommended by the Air NEPM and sampling is normally carried out on every sixth day. This method does not provide the continuous monitoring required to correlate observed particle concentrations with weather conditions. In order to obtain this information, EPA has recently established TEOM (Tapered Element Oscillating Microbalance) networks for continuous particle measurements. The acceptability of TEOM measurements and the development of an appropriate Australian Standard are important issues being resolved by the PRC in consultation with the jurisdictions and other relevant organisations. Here it is assumed that TEOM monitoring will be acceptable and this is proposed for all stations. As an alternative, Partisol monitoring will be considered if planned investigations prove it to be an acceptable method. If Partisol measurements were proposed, their equivalence would first be demonstrated to the satisfaction of the PRC.

The Air NEPM requires that \( \text{SO}_2 \) is monitored by an approved method. While \( \text{SO}_2 \) will be measured using an Australian Standard method at most sites, it is planned to use an Opsis DOAS unit at the Inner West Metro site, so that the same unit may monitor other compounds of concern to the community. This instrument has been certified as an equivalent method for \( \text{SO}_2 \) by USEPA. In order to confirm equivalence, the DOAS and an Australian Standard instrument will be co-located for a period of 6 months, and a study conducted to determine the correlation between the two measurement techniques. If the DOAS is shown to produce results that would misrepresent compliance with the NEPM, then the Australian Standard instrument would be retained. This work will be completed by December 2001.

Lead is determined in the \( \text{PM}_{10} \) particle fraction using AS 3580.9.6. This is contrary to the NEPM, which requires lead concentrations to be derived from samples of total suspended particulate matter (TSP). To convert \( \text{PM}_{10} \) lead to TSP lead, a pre-determined, site-specific relation

\[
Pb(\text{TSP}) = 0.011 + 1.14 \text{Pb}(\text{PM}_{10})
\]

is applied. This relationship was developed from side-by-side monitoring at the Collingwood site in 1993–94 and is considered to remain valid. The derivation of the relationship and its robustness are described in Appendix E.
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
<th>Title</th>
<th>Method Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen dioxide</td>
<td>NO₂</td>
<td>AS3580.5.1–1993</td>
<td>Ambient Air – Determination of Oxides of Nitrogen – Chemiluminescence Method Gas phase chemiluminescence.</td>
</tr>
<tr>
<td>Particles</td>
<td>PM₁₀</td>
<td>AS3580.9.6–1990 used for campaign monitoring at rural centres</td>
<td>Ambient Air – Determination of Suspended Particulate Matter PM-10 – High Volume sampler with Size Selective Inlet Gravimetric Method Determination of PM₁₀ and PM₁₀., by the Tapered Element Oscillating Microbalance Continuous Method Size Selective Inlet. One day in 6 monitoring. Tapered element oscillating microbalance (TEOM).</td>
</tr>
<tr>
<td></td>
<td>PM₁₀</td>
<td>EPAV Method no. B30 (Dec 1999)* used at PMS in Port Phillip and Latrobe Valley Regions To be developed†</td>
<td>Partisol gravimetric</td>
</tr>
<tr>
<td></td>
<td>PM₁₀</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SO₂</td>
<td>US Federal Register, vol 60, no 84, pp 21518–21520 (2 May 1995)</td>
<td></td>
</tr>
</tbody>
</table>

* EPA has developed and formally adopted this in-house standard pending development of a national or international standard.

† Partisol samplers may be considered for use at some stations if planned investigations show them to be an acceptable method.
Table 5: Methods for monitoring other pollutants

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
<th>Title</th>
<th>Method Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particles</td>
<td>PM$_{2.5}$</td>
<td>EPAV Method no. B30 (Dec 1999) *</td>
<td>Tapered element oscillating microbalance continuous method (TEOM)</td>
</tr>
<tr>
<td>Particles (Airborne Particle Index)</td>
<td>API</td>
<td>AS2724.4–1987</td>
<td>Light scattering/nephelometry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ambient Air – Particulate Matter – Determination of Light Scattering Integrating Nephelometer Method</td>
<td></td>
</tr>
</tbody>
</table>

* EPA has developed and formally adopted this in-house standard pending development of a national or international standard.

4.2 Station siting compliance

Current status

All NEPM stations comply with the Australian Standard AS 2922–1987 Ambient Air Guide for the Siting of Sampling Units, unless noted in table 6. Further details of station siting in the Port Phillip Region are given in Appendix C.
Table 6: Summary of PMS siting compliance with AS 2922–1987

<table>
<thead>
<tr>
<th>Location</th>
<th>Height above Ground</th>
<th>Min. Distance to Support Structure</th>
<th>Clear sky Angle of 120°</th>
<th>Unrestricted Airflow of 270°/360°</th>
<th>20m from Trees</th>
<th>No Boiler or Incinerators nearby</th>
<th>Minimum Distance from Road or Traffic</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner East Metro (Alphington)</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>Sampling height 6m AGL. HiVol too close to road</td>
</tr>
<tr>
<td>Inner West Metro (Footscray)</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>Proximity of vegetation.</td>
</tr>
<tr>
<td>Southwest Metro (Paisley)</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 6m AGL.</td>
</tr>
<tr>
<td>Outer West Metro (Pt Cook)</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 6m AGL.</td>
</tr>
<tr>
<td>South Metro (Brighton)</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 6m AGL.</td>
</tr>
<tr>
<td>Southeast Metro (Dandenong)</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 6m AGL.</td>
</tr>
<tr>
<td>CBD (RMIT)</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 19 metres AGL</td>
</tr>
<tr>
<td>CBD Southeast (Richmond)</td>
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<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Tree too close, impinging clear sky angle</td>
</tr>
<tr>
<td>CBD Northeast (Collingwood)</td>
<td>☑</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>HiVol too close to road.</td>
</tr>
<tr>
<td>Geelong (Geelong South)</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 6m AGL.</td>
</tr>
<tr>
<td>Outer Geelong (Pt Henry)</td>
<td>☑</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Sampling height 6m AGL.</td>
</tr>
<tr>
<td>Latrobe Valley East Central (Traralgon)</td>
<td>☑</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>Trees too close, impinging clear sky angle</td>
</tr>
<tr>
<td>Latrobe Valley West Central (Moe)</td>
<td>☑</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
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</tr>
</tbody>
</table>

Non-compliances

There are five non-compliances where action will be taken.

1. All stations with non-compliant sampling heights of 6 metres are to be rectified by June 2001 (except CBD).
2. Inner East Metro station will remain non-compliant with respect to proximity of the tree because of community pressure to retain this feature. Agreement has been reached to maintain a ‘clear air cone’ of 120° for the sample inlet by judicious pruning. Physical site restrictions preclude the rectification of the non-compliance for the high volume sampler.
3. Inner West Metro is scheduled to be resited before January 2001.
4. CBD is a rooftop-based air monitoring station. A research project (in conjunction with RMIT) to ascertain the homogeneity of the atmosphere in this configuration has shown an absence of vertical gradients.
5. *CBD Southeast* is scheduled to have the offending tree removed within 6 months.
6. *CBD Northeast* is designated a roadside site.
7. *Latrobe Valley West Central* is affected by trees which cannot be trimmed. Consideration is being given to moving the station.
4.3 Station locations and parameters

Current air monitoring stations are summarised in table 7. Stations in bold will be PMS.

**Table 7: Summary of stations in EPA network**

<table>
<thead>
<tr>
<th>Site Type</th>
<th>Start Date</th>
<th>Carbon</th>
<th>Monoxide</th>
<th>Ozone</th>
<th>Nitrogen</th>
<th>Dioxide</th>
<th>Airborne</th>
<th>Particulate Index</th>
<th>Non-methane Hydrocarbons</th>
<th>PM10</th>
<th>PM2.5</th>
<th>Lead</th>
<th>Wind Speed &amp; Direction</th>
<th>Temperature</th>
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</thead>
<tbody>
<tr>
<td>Inner East Metro (Alphington)</td>
<td>Res 1979</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>H</td>
<td>T</td>
<td>T</td>
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<td></td>
</tr>
<tr>
<td>Box Hill</td>
<td>Res 1992</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>T</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>South Metro (Brighton)</td>
<td>Res 1983</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>T</td>
<td>T</td>
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<td></td>
</tr>
<tr>
<td>Southeast Metro (Dandenong)</td>
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<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>T</td>
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</tr>
<tr>
<td>Inner West Metro (Footscray)</td>
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<td>✓</td>
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<tr>
<td>Paisley</td>
<td>Res/Ind 1983</td>
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<tr>
<td>Mount Cottrell</td>
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</tr>
<tr>
<td>Outer West Metro (Point Cook)</td>
<td>Rur/Res 1981</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td></td>
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<tr>
<td>CBD (RMIT)</td>
<td>CBD 1999</td>
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<td>✓</td>
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<td>✓</td>
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</tr>
<tr>
<td>Outer Geelong (Point Henry (1))</td>
<td>Ind 1991</td>
<td>✓</td>
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<tr>
<td>Geelong (Geelong South)</td>
<td>Res/LI 1997</td>
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<tr>
<td>Grovedale</td>
<td>Rur 1992</td>
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<td></td>
</tr>
<tr>
<td>CBD Northeast (Collingwood)</td>
<td>Res/LI 1981</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>H</td>
<td>H</td>
<td></td>
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</tr>
<tr>
<td>CBD Southeast (Richmond)</td>
<td>Res 1981</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>H</td>
<td>T</td>
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<td></td>
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</tr>
<tr>
<td>Latrobe Valley East Central (Traralgon (2))</td>
<td>Res 1981</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Latrobe Valley West (Darnum North (1))</td>
<td>Rur 1979</td>
<td>✓</td>
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<tr>
<td>Rosedale South (1)</td>
<td>Rur 1987</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jeeralang Hill (1)</td>
<td>Rur 1996</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

✓ = Instrumented  
H = High volume sampler  
T = TEOM  
(1) = Self-Monitoring (Industry)  
(2) = Operation contracted out  
LI = Light Industrial  
Res = Residential  
Rur = Rural  
Ind = Industrial  
CBD = Central Business District
4.4 Service and maintenance

A service and maintenance regime operates to ensure that the stations produce quality data. The following levels are in use at EPA-operated stations, as detailed in the quality manual. Similar procedures are required at stations operated by industry or contractors. Problems that are encountered at any stage are corrected.

**Daily**
Printouts of overnight calibration errors and data at hours 0400/0500 and 1400/1500 are received each morning and examined by experienced staff. This is used as an aid to discover or predict station or instrument malfunction.

**Reactive service**
A reactive call-out service is provided to Port Phillip Region and Latrobe Valley sites to minimise data loss.

**Weekly/Fortnightly**
Staff attend each station to perform a prescribed routine check of station operations. This is a preventative measure aimed at minimising data loss by forestalling any serious problems that may not be picked up in the daily check.

**Monthly service**
Each month the station undergoes a major service. This includes components of the weekly check. At this stage, filters are changed as specified, consumables replenished and sample lines cleaned or replaced. All pressure and vacuum settings are checked. Other preventive maintenance measures are also performed to a prescribed schedule. Logbook sheets are returned along with charts for use with data validation.

**Six-monthly service**
This service includes some components of the monthly check. All major instruments, equipment and systems are checked and relevant components serviced.

**Annual servicing**
Annual servicing is restricted to the exchange/overhaul of certain pieces of equipment performed by outside contractors.

4.5 Calibration

Calibrations are performed to ensure the traceability of measurement to Australian National Standards. Calibrations are scheduled and performed according to NATA or Australian Standards requirements, good laboratory practice, manufacturers’ specifications or as needed after analyser relocation, servicing, repairs or major breakdown.

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17 Environmental Chemistry Unit, *Ambient Air Monitoring Network Manual*, EPA.
18 Staff in this case includes members of the volunteer ‘Community Access to Air Monitoring’ program operated by EPA. They receive technical training to a standard that enables them to perform these tasks.
4.6 Inter-laboratory comparisons

EPA has in the past participated in inter-laboratory comparisons of calibration reference standards with other States and maintained regular comparisons between Port Phillip and the Latrobe Valley regions. A system of inter-laboratory comparisons is being discussed by the PRC. EPA performs its own calibrations which are traceable to international standards and satisfy NATA requirements, and therefore would not depend on interstate calibration programs. However, EPA recognises the value of inter-laboratory comparisons and would participate in such a program provided that it did not entail a substantial cost to Victoria.

4.7 Data storage and validation

At each monitoring station all data are recorded on charts as well as being transmitted via telephone (leased) line to a central computer. Data are gathered, reformatted and finally stored on a central UNIX database system.

The electronically collected data are considered to be the primary data record. Station and instrument log books, and calibration and chart records are used to substantiate it.

The following records and their characteristics are generated in measuring air quality:

- Data that are electronically obtained are stored and archived. Backups are automatically made each weekday and stored offsite.
- Chart recordings, station logbooks, individual instrument log books, validation calculation and worksheets and calibration data. After the data are validated they are archived. Storage periods are governed by statutory requirements.
- Overnight calibration report sheets. These are working sheets and are stored for 3 years. They are used only for daily work planning requirements.

Data are validated to ensure that non-compliant data are not included in the primary data record. Sources of error include calibration and traceability related errors, data logger malfunction, transmission and communications errors, operator errors, calculation errors and errors in reporting.

Validation is handled by a custom-developed EXCEL-based application. All spreadsheets associated with validation work are archived and stored offsite.

Data storage is handled by a relational database. The current relational database allows for some compliance assessment and reporting. Extensive redevelopment of this database and reporting system is currently underway. The redevelopment work is strongly focused on the NEPM criteria pollutants and averaging times. The intention is to compute information such as exceedences of the NEPM standards, making use of data handling guidelines being developed by the PRC. The redeveloped database will contain up-to-date derived statistics (such as annual averages, percentiles, etc.) on each of the Air NEPM criteria pollutants. Recent 5 minute average data will be readily available on the database; older data will be kept in archive storage.
EPA is participating actively in the PRC’s current project to develop standardised data handling procedures. The advantages of standardisation are recognised and guidelines to be developed will complied with as far as is practical. EPA retains its prerogative to store data in systems developed for internal use.

Validation and data handling are generally in agreement with the procedures being discussed in the preparation of the Guideline Paper on data handling (in preparation).

5. ACCREDITATION

EPA is committed to maintaining a high level of quality assurance and quality control measures to assure itself that the quality of its air quality monitoring data meets appropriate standards.

To achieve this, the following activities are undertaken.

1. Maintenance of a quality system through a recognised technical quality assurance regime (NATA).
2. Continuous training and development of staff and the involvement of all staff in a corrective and preventative action program.
3. Regular internal auditing of system components, procedures and management reviews of the system.
4. Compliance with appropriate Australian Standards or other established protocols and procedures.
5. A rigorous service and maintenance procedure.
6. Compliance with an established calibration regime that meets NATA and good laboratory practice requirements.
8. Validation and verification of all data prior to their release for scientific and public use.

5.1 Accreditation/Quality system

EPA is committed to maintaining its NATA accreditation in the field of ambient air quality monitoring. This includes a documented quality system that meets NATA and other general quality measures.¹⁹

¹⁹ Environmental Chemistry Unit, ibid.
EPA is accredited by NATA (Accreditation Number 1576) for the following classes of test for its self-owned, self-operated stations.

### 7.81 Constituents of the environment
#### .21 Air
Analysis by AAS (flame) and classical techniques by the methods of:
- AS 2800
- EPA (Victoria) methods: 2090 and 2098
for the following determinations:
- Cadmium, calcium, carbon monoxide, chromium, copper, deposited matter, iron, lead, manganese, total suspended particles, zinc

Continuous monitoring for EPA ambient air stations
Analysis by gas analyser and classical techniques by the methods of:
- AS 2724.3, 2724.4, 2923, 3580.4.1, 3580.5.1, 3580.6.1, 3580.7.1, 3580.9.6, 3580.10.1, 3580.11.1, EPA (Victoria) method: B30
for the following determinations:
- Air monitoring stations: carbon monoxide; non-methane hydrocarbons; oxides of nitrogen; ozone; particles, PM10, PM2.5; sulfur dioxide; visibility-reducing particles.
- Meteorological stations: temperature; wind direction; wind speed

### 5.2 Staff
All staff receive training to ensure that they are capable of undertaking their required tasks. This is achieved through on-the-job instruction by experienced staff, the in-house EPA Training Program and specialist training courses conducted by external organisations. All staff are encouraged to participate in corrective actions and system improvements by a number of mechanisms used to identify and rectify deficiencies and to prevent their recurrence.

‘Staff’ includes members of the volunteer Community Access to Air Monitoring program operated by EPA. They receive technical training to a standard that enables them to perform the tasks appropriate for their role in station operation.

### 5.3 Auditing
Audits are conducted regularly according to good laboratory practice and NATA requirements. The most recent external audit by NATA was conducted on 17 February 2000 and the next audit is scheduled for early 2001.
5.4 EPA stations operated under contract

EPA has two stations in the Latrobe Valley operated under contract (Moe, Traralgon). Part of that contract states that the contractor obtains or maintains NATA accreditation. The contractor, Pacific Power International, is in the process of obtaining NATA accreditation for all air monitoring stations it owns or operates under contract. Accreditation is expected to be achieved by March 2001.

5.5 Industry owned and operated stations

Licensing conditions on industry self-monitoring stations require their operations to be NATA accredited. One such station, at Geelong (Point Henry, owned by Alcoa) is nominated as a PMS. This station is NATA accredited for SO\textsubscript{2} and meteorological parameters. EPA has installed an O\textsubscript{3} analyser in the station with the cooperation of Alcoa. EPA is responsible for the operation, maintenance and calibration of this instrument.

6. REPORTING AND COMMUNICATIONS

In accordance with Air NEPM requirements Victoria will report to NEPC every calendar year on the performance of each station against the standards and goals and provide an overview of whether the standards are being met. Technical information will be presented in this report in the required format and according to data-handling conventions adopted for consistency between the jurisdictions (see PRC Guideline Papers 5 and 8, to be finalised). It is envisaged that the information will also be presented to the public in a way that will be relevant and ‘real’ to members of the community.

National Environment Protection Measures exist to provide the community with confidence that environmental quality issues are addressed in a consistent manner regardless of State and regional boundaries. It is therefore important that the community receives meaningful and clear information on the NEPM monitoring results, what the results mean in relation to human health, and how and why pollutants vary across Victoria and, when data are available, across Australia. When presenting this information it is EPA’s role to make clear how the current standards have been derived (human health parameters), what an exceedence of the standards means, and what are the main causes of any exceedence of the standard for a pollutant.

How this information is presented to the community is very important. It needs to be up-to-date, location specific and, where possible, provided in the context of other parts of Victoria and Australia. EPA has effectively utilised its website in the past to provide up-to-date air quality information at each monitoring station. The main tool for this has been the development of an air quality index that provides a quick reference scale for members of the community to ascertain whether their local air quality is very good, good, fair, poor or very poor. The data are updated hourly; daily and weekly averages are also available.

EPA proposes that the information from the NEPM stations would be reported in the same way with some enhancements. Specifically, information on the NEPM standards would be made available, as would the likely causes of an exceedence in each parameter. The potential health effects of such an exceedence and how
individuals can prevent exacerbation of health conditions would also be made available. In addition, there would be enhanced links to proactive messages about how individuals can keep their local air quality clear.

Recognising that not all members of the community have access to the internet, EPA also utilises the media to communicate air quality data. This information is disseminated twice a day; ‘smog alerts’ are issued on days of expected high pollution levels.

Public reporting is only half of the equation. It is also important to inform the community about the impacts of their actions in order to provide them with a choice. To this end, EPA conducts two high-profile information campaigns each year. The AirCare campaign, conducted in autumn, focuses on encouraging individuals to reduce their use of motor vehicles and to keep their cars tuned. The winter Clean Air campaign informs the community about the effects of wood heaters on air quality and how heaters can be used more efficiently. These education campaigns are supplemented by a participatory program that involves members of the community in managing five NEPM stations across Victoria.

Community Access to Air Monitoring (CAAM) is a unique program that enables EPA to establish effective networks into the community and provides an invaluable source of feedback on matters such as the best means of presenting air quality information and the level of understanding about air quality in the broader community. It is expected that CAAM will be expanded to all performance monitoring stations in the future.

In public annual reports assessments in each region will be presented on a pollutant-by-pollutant basis. Summaries of the overall performance of each region will be presented. This will enable members of the community to compare their local air quality with other regions in Victoria and, when available, with other States and regions in Australia.

To contextualise the information, data from previous years will be compared with the current year; it is expected that this information will be presented in easy-to-read graphs and charts. The data obtained from the stations will be supplemented by modelling results and mobile monitoring data to provide a more complete picture of air quality around and between the performance stations.

Ultimately, this document will be the foundation of an action plan for monitoring in the next calendar year and will feed into EPA’s broader air quality programs. These issues and actions will normally be on a shorter timescale than those requiring revisions to the Air NEPM Monitoring Plan.
APPENDIX A: GLOSSARY

AGL Above ground level
AGPS Australia Government Publishing Service
Air NEPM National Environment Protection Measure for Ambient Air Quality (26 June 1998)
airshed An area in which air quality is subject to common influences from emissions, meteorology and topography
API Airborne particle index
CO Carbon monoxide
DOAS Differential Optical Absorption Spectrometry
EPA EPA Victoria
GRUB Generally representative upper bound (referring to a performance monitoring station, as described in the PRC Guideline Paper).
Guideline papers Papers produced by the PRC to facilitate uniformity between the jurisdictions.

At the time of writing this monitoring plan, several of these were still in draft form:

- ‘Screening procedures’, National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 4, November 2000
- ‘Meteorological measurements’, National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 6, November 2000
- ‘Annual reports’, National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 8, November 2000

Katabatic Refers to movements of cold air. Katabatic flows drain down a valley, analogous to stormwater flows.

NATA National Association of Testing Authorities
### Pollutant Standards

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Maximum concentration</th>
<th>Goal within 10 years Maximum allowable exceedences</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>8 hours</td>
<td>9.0 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td>NO₂</td>
<td>1 hour</td>
<td>0.12 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>1 year</td>
<td>0.03 ppm</td>
<td>none</td>
</tr>
<tr>
<td>O₃</td>
<td>1 hour</td>
<td>0.10 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>4 hours</td>
<td>0.08 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td>SO₂</td>
<td>1 hour</td>
<td>0.20 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>0.08 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>1 year</td>
<td>0.02 ppm</td>
<td>none</td>
</tr>
<tr>
<td>Lead</td>
<td>1 year</td>
<td>0.50 µg m⁻³</td>
<td>none</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>1 day</td>
<td>50 µg m⁻³</td>
<td>5 days a year</td>
</tr>
</tbody>
</table>

**Additional Definitions:**

- **CO**: Carbon monoxide
- **NO₂**: Nitrogen dioxide
- **NOx**: Oxides of nitrogen
- **NMHC**: Non-methane hydrocarbons
- **O₃**: Ozone
- **PM₁₀**: Particles which have an aerodynamic diameter less than 10 µm
- **PM₂.₅**: Particles which have an aerodynamic diameter less than 2.5 µm
- **PMS**: Performance monitoring station, as defined in the Air NEPM.
- **PPCR**: Port Phillip Control Region
- **ppb**: Parts per billion by volume
- **ppm**: Parts per million by volume
- **PRC**: Peer Review Committee
- **RMIT**: Royal Melbourne Institute of Technology
Screening Criteria developed by the PRC which may be used to:

- reduce the number of performance monitoring sites for a given pollutant below that proposed by the NEPM formula of Clause 14(1); or
- justify not monitoring a pollutant in regions with a population over 25,000.

Those used in this monitoring plan, for CO, SO$_2$ and lead, are shown below.

<table>
<thead>
<tr>
<th>Screening Procedure</th>
<th>Acceptance Limit (% of NEPM standard)</th>
</tr>
</thead>
</table>
| A. Campaign monitoring at a Generally Representative Upper Bound (GRUB) monitoring location (with no significant deterioration expected over 5-10 years). | 55% for 1 year of data  
60% for 2 or more years of data |
| B. Use of historical data within a region which will contain one or more GRUB monitoring stations to demonstrate that the full number of stations (according to 14(1)) is not required, either to detect exceedences or gain a more representative depiction of pollutant distribution. | 65% for 2–4 years of data  
75% for 5 or more years of data |
| F. In a region with no performance monitoring, comparison with a NEPM compliant region with greater population, emissions and pollution potential$^{(2)}$. | 40% |

SEPP State environment protection policy  
SO$_2$ Sulfur dioxide  
TEOM Tapered element oscillating microbalance  
TSP Total suspended particulate matter  
VOC Volatile organic compounds  
µg m$^{-3}$ Microgram (1 millionth of 1 gram) per cubic metre.

$^{(2)}$ Pollution potential must take into account meteorology and topography.
APPENDIX B: AIR QUALITY IN THE PORT PHILLIP REGION

NEPM monitoring stations are indicated in bold.

Table 1: Monitored Ozone Levels in the Port Phillip Region

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 1h $O_3$ (ppm)</th>
<th>Max 4h $O_3$ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphington</td>
<td>0.099</td>
<td>0.088</td>
</tr>
<tr>
<td>Dandenong</td>
<td>0.107</td>
<td>0.096</td>
</tr>
<tr>
<td>RMIT</td>
<td>0.087</td>
<td>0.069</td>
</tr>
<tr>
<td>Footscray</td>
<td>0.105</td>
<td>0.113</td>
</tr>
<tr>
<td>Mt Cottrell</td>
<td>0.106</td>
<td>0.122</td>
</tr>
<tr>
<td>Pt Cook</td>
<td>0.126</td>
<td>0.107</td>
</tr>
<tr>
<td>Paisley</td>
<td>0.120</td>
<td>0.095</td>
</tr>
<tr>
<td>Brighton</td>
<td>0.112</td>
<td>0.085</td>
</tr>
<tr>
<td>Box Hill</td>
<td>0.107</td>
<td>0.084</td>
</tr>
<tr>
<td>Pt Henry</td>
<td>0.081</td>
<td>0.087</td>
</tr>
<tr>
<td>Geelong S</td>
<td>0.079</td>
<td>0.077</td>
</tr>
</tbody>
</table>

Table 2: Monitored NO$_2$ levels in the Port Phillip Region

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 1h NO$_2$ (ppm)</th>
<th>Annual NO$_2$ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphington</td>
<td>0.075</td>
<td>0.073</td>
</tr>
<tr>
<td>Paisley</td>
<td>0.066</td>
<td>0.085</td>
</tr>
<tr>
<td>RMIT</td>
<td>0.100</td>
<td>0.089</td>
</tr>
<tr>
<td>Brighton</td>
<td>0.077</td>
<td>0.054</td>
</tr>
<tr>
<td>Footscray</td>
<td>0.088</td>
<td>0.070</td>
</tr>
<tr>
<td>Dandenong</td>
<td>0.067</td>
<td>0.064</td>
</tr>
<tr>
<td>Box Hill</td>
<td>0.073</td>
<td>0.060</td>
</tr>
<tr>
<td>Pt Cook</td>
<td>0.074</td>
<td>0.067</td>
</tr>
<tr>
<td>Geelong S</td>
<td>0.067</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Table 3: Monitored PM$_{10}$ levels in the Port Phillip Region

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 24h PM$_{10}$ (HiVol) ($\mu$g m$^{-3}$)</th>
<th>Max 24h PM$_{10}$ (TEOM) ($\mu$g m$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphington</td>
<td>47</td>
<td>46</td>
</tr>
<tr>
<td>Collingwood</td>
<td>55</td>
<td>58</td>
</tr>
<tr>
<td>Richmond</td>
<td>54</td>
<td>48</td>
</tr>
<tr>
<td>Paisley</td>
<td>42</td>
<td>48</td>
</tr>
<tr>
<td>RMIT</td>
<td>49</td>
<td>54</td>
</tr>
<tr>
<td>Brighton</td>
<td>Footscray</td>
<td>Dandenong</td>
</tr>
</tbody>
</table>
Table 4: Monitored CO Levels in the Port Phillip Region

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphington</td>
<td>6.0</td>
<td>6.5</td>
<td>6.5</td>
<td>6.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Box Hill</td>
<td>6.3</td>
<td>6.1</td>
<td>6.5</td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Footscray</td>
<td>3.9</td>
<td>3.9</td>
<td>3.3</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>RMIT</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
<td>5.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Geelong S</td>
<td>4.2</td>
<td>4.3</td>
<td></td>
<td>3.3</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Table 5: Monitored SO₂ levels in the Port Phillip Region

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 1h SO₂ (ppm)</th>
<th>Max 24h SO₂ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphington</td>
<td>0.012</td>
<td>0.015</td>
</tr>
<tr>
<td>RMIT</td>
<td>0.029</td>
<td>0.038</td>
</tr>
<tr>
<td>Footscray</td>
<td>0.020</td>
<td>0.027</td>
</tr>
<tr>
<td>Paisley</td>
<td>0.069</td>
<td>0.125</td>
</tr>
<tr>
<td>Box Hill</td>
<td>0.007</td>
<td>0.017</td>
</tr>
<tr>
<td>Pt Henry</td>
<td>0.127</td>
<td>0.148</td>
</tr>
<tr>
<td>Geelong S</td>
<td>0.038</td>
<td>0.038</td>
</tr>
</tbody>
</table>

Table 6: Monitored lead levels in the Port Phillip Region

<table>
<thead>
<tr>
<th>Location</th>
<th>Annual Pb (µg m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1997</td>
</tr>
<tr>
<td>Alphington</td>
<td>0.09</td>
</tr>
<tr>
<td>Collingwood</td>
<td>0.20</td>
</tr>
<tr>
<td>Richmond</td>
<td>0.09</td>
</tr>
<tr>
<td>Paisley</td>
<td>0.07</td>
</tr>
<tr>
<td>RMIT</td>
<td>0.08</td>
</tr>
<tr>
<td>Geelong S</td>
<td>0.08</td>
</tr>
</tbody>
</table>
APPENDIX C: DETAILS OF NOMINATED PERFORMANCE MONITORING STATIONS

**Central Business District (CBD):** This station is located in the central business district at RMIT. Measurements are representative of the central business district, where the sampling site is on the roof of a building. The station does not fully conform to the Australian standard for station siting or to the definition of a GRUB station; however, it is important to maintain trend measurements in the CBD.

**CBD North East:** This station is located approximately 10 m from a major arterial road that runs through a residential/light industrial area in Collingwood. It is regarded as a peak site for lead.

**Geelong:** This station is of neighbourhood scale, in a residential area and about 100 m from medium-traffic roads. Monitoring at this site would indicate general particle levels in the general area. The station records occasional elevated SO\(_2\) levels and monitoring at this site would indicate SO\(_2\) levels in the general residential areas of Geelong. Monitoring at this site would indicate general NO\(_x\) levels experienced in the surrounding residential area. Due to the scavenging effect of NO\(_x\) sources, lower ozone concentrations are usually recorded at this site.

**Inner East Metro:** This station is located in Alphington, a high population and traffic area; it is considered neighbourhood in scale. The site is representative of Melbourne’s inner suburban residential areas. Recorded CO concentrations reflect the road traffic as well as residential wood burning open fires. This is the station with the longest data record for CO (since the late 1970s) and the longest-running station for ozone (since 1978). It is not expected to capture peak ozone concentrations.

**Inner West Metro:** This station is located at Footscray in a residential/industrial area. It is considered to be upper bound for ozone in the inner west.

**Latrobe Valley East Central:** This station is located in a park in a residential area of Traralgon, the largest town in the region.

**Latrobe Valley West Central:** This station is located in a residential area of Moe, the second largest town in the region.

**Northwest Metro:** A location is to be determined for a GRUB ozone station in a high growth area near Melton. Provided funding is available, ozone monitoring will commence for the 2001–02 ozone season and a full monitoring station will be introduced in 2003.

**Outer East Metro:** Monitoring will commence in 2000–01 at a site to be chosen.

**Outer West Metro:** This station is located on an airforce base with limited residential housing at Point Cook. It is also a housing development area with potential for future population exposure. The station, opened in 1982, is in a rural area. The site is located on the western coastline of Port Phillip Bay. The Outer West Metro station measures ozone resulting from ozone precursors that have previously been transported offshore by night-time and early morning drainage winds. A common trajectory on ozone conducive days shows the drift of primary...
emissions from the densely populated eastern suburbs offshore followed by stagnation over the Bay and return, as ozone, with the sea breeze over the western suburbs. This site often measures the highest concentrations consistent with an ozone-rich air mass crossing the coastline at its most concentrated with the onset of the sea breeze. The Outer West Metro station provides representative measurements of the coastal area in the west.

_Southeast Metro_: This station is located at Dandenong, in a light industrial residential area, close to a road bearing light traffic, about 400 m from an arterial road.

_South Metro_: This station is located at Brighton, in a residential, light traffic, high population area. Continuous TEOM measurements of PM$_{10}$ started in December 1996. It is considered representative of that part of coastal area in the east.

_Southwest Metro_: This station, located at Paisley, will be discontinued except for SO$_2$ and non-NEPM pollutants monitored by DOAS. It is located in a residential/industrial area and is considered an important station for SO$_2$ as it will record the impact of industry, including the Altona petrochemical complex.

_Campaign stations for ozone (commencing 2001–2002)_

_Outer North Metro_: Monitoring for ozone will be conducted at a site to be selected.

_Outer South Metro_: Monitoring for ozone will be conducted at a site to be selected.

_Outer Southeast Metro_: Monitoring for ozone will be conducted at a site to be selected. It is likely that a PMS for ozone and PM$_{10}$ will be established, provided funds are available.
Exposed populations

The exposed population at each PMS is qualitatively described by the location categories in the following table.

<table>
<thead>
<tr>
<th>Station name</th>
<th>Location</th>
<th>Location category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner East Metro</td>
<td>Alphington</td>
<td>Residential/light industrial</td>
</tr>
<tr>
<td>Inner West Metro</td>
<td>Footscray</td>
<td>Industrial/residential</td>
</tr>
<tr>
<td>Southwest Metro</td>
<td>Paisley</td>
<td>Residential/industrial</td>
</tr>
<tr>
<td>Outer West Metro</td>
<td>Pt Cook</td>
<td>Rural</td>
</tr>
<tr>
<td>North West Metro</td>
<td>Site to be finalised</td>
<td>Residential</td>
</tr>
<tr>
<td>South Metro</td>
<td>Brighton</td>
<td>Residential</td>
</tr>
<tr>
<td>South East Metro</td>
<td>Dandenong</td>
<td>Residential</td>
</tr>
<tr>
<td>CBD</td>
<td>RMIT</td>
<td>CBD</td>
</tr>
<tr>
<td>CBD South East</td>
<td>Richmond</td>
<td>Residential</td>
</tr>
<tr>
<td>CBD North East</td>
<td>Collingwood</td>
<td>Residential/light industrial</td>
</tr>
<tr>
<td>Outer East Metro</td>
<td>Site to be finalised</td>
<td>Residential</td>
</tr>
<tr>
<td>Geelong</td>
<td>Geelong South</td>
<td>Residential/industrial</td>
</tr>
<tr>
<td>Outer Geelong</td>
<td>Pt Henry</td>
<td>Industrial/rural</td>
</tr>
<tr>
<td>Latrobe Valley East Central</td>
<td>Traralgon</td>
<td>Residential</td>
</tr>
<tr>
<td>Latrobe Valley West Central</td>
<td>Moe</td>
<td>Residential</td>
</tr>
</tbody>
</table>
APPENDIX D: AIR QUALITY IN THE LATROBE VALLEY

The following tables summarise monitoring data from the Latrobe Valley. Locations of nominated performance monitoring stations for each pollutant are shown in bold. Figure 1 shows the location of performance monitoring stations and other stations from which historical data are quoted.

![Figure 1: Latrobe Valley monitoring stations](image)

Table 1: Monitored 1-hour ozone levels in the Latrobe Valley

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 1-hour $O_3$ (ppm)</th>
<th>Max 4-hour $O_3$ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darnum North</td>
<td>0.05</td>
<td>0.11</td>
</tr>
<tr>
<td>Thoms Bridge</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Minnie Road</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Moe</strong></td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Traralgon</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Mount Tassie</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Rosedale South</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Yinnar South</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Jeeralang Hill</td>
<td>0.05</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Table 2: Monitored 1-hour NO\(_2\) Levels in the Latrobe Valley

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 1-hour NO(_2) (ppm)</th>
<th>Annual NO(_2) (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darnum North</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Thoms Bridge</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Minniedale Road</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Moe</strong></td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Traralgon</strong></td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Mount Tassie</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Rosedale South</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Yinnar South</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Jeeralang Hill</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Table 3: Monitored PM\(_{10}\) levels in the Latrobe Valley

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 24-hour PM(_{10}) (µg m(^{-3}))(^{a})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darnum North</td>
<td>41</td>
</tr>
<tr>
<td>Thoms Bridge</td>
<td>53</td>
</tr>
<tr>
<td>Minniedale Road</td>
<td>49</td>
</tr>
<tr>
<td><strong>Moe</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Traralgon</strong></td>
<td></td>
</tr>
<tr>
<td>Mount Tassie</td>
<td>36</td>
</tr>
<tr>
<td>Rosedale South</td>
<td>56</td>
</tr>
<tr>
<td>Yinnar South</td>
<td>48</td>
</tr>
<tr>
<td>Jeeralang Hill</td>
<td>22</td>
</tr>
</tbody>
</table>

\(^{a}\) 1 day in 6 monitoring.

Table 4: Monitored CO levels in the Latrobe Valley

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 8-hour CO (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moe</strong></td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Traralgon</strong></td>
<td>2.2</td>
</tr>
<tr>
<td>Morwell East</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Table 5: Monitored SO$_2$ levels in the Latrobe Valley

<table>
<thead>
<tr>
<th>Location</th>
<th>Max 1-hour SO$_2$ (ppm)</th>
<th>Max 24-hour SO$_2$ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darnum North</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Thoms Bridge</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Minniedale Road</td>
<td>0.05</td>
<td>0.09</td>
</tr>
<tr>
<td>Moe</td>
<td>0.04</td>
<td>0.05</td>
</tr>
<tr>
<td>Traralgon</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>Mount Tassie</td>
<td>0.10</td>
<td>0.13</td>
</tr>
<tr>
<td>Rosedale South</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>Yinnar South</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Jeeralang Hill</td>
<td>0.10</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Table 6: Monitored lead levels in the Latrobe Valley

<table>
<thead>
<tr>
<th>Location</th>
<th>Annual average Pb (µg m$^{-3}$) 1984</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morwell East</td>
<td>0.19</td>
</tr>
<tr>
<td>Traralgon</td>
<td>0.18</td>
</tr>
</tbody>
</table>
APPENDIX E: LED ESTIMATION FROM PM_{10}

Lead monitoring in Victoria was originally based on the analysis of lead contained in the total suspended particle fraction of ambient aerosol. During the late 1980s particle size selective sampling of particles less than 10µm (PM_{10}) was introduced to obtain data on the particle fraction believed to be implicated in effects on human health. For a period both TSP and PM_{10} sampling was conducted at three sites in the Melbourne particle monitoring network, TSP being measured almost exclusively for reporting lead. It was realised that this practice was wasteful of resources as it was established that approximately 90 per cent of the TSP lead was contained in the PM_{10} fraction. Trends in lead data also showed that with the introduction of unleaded petrol in 1986 lead levels were declining.

For the NEPM monitoring plan for Victoria it is proposed that lead monitoring be performed at only one site. The site selected for NEPM reporting is the lead monitoring site located in Collingwood. This site is considered an upper bound performance monitoring site for NEPM reporting. For NEPM reporting, lead results must be expressed on the TSP fraction of the collected particulate matter. Alternatively results can be expressed on an equivalent TSP lead concentration derived from experimental data from size-selective sampling for the proposed site. This empirically derived lead value is the approach proposed by EPA.

In 1995 a statistical analysis was conducted on the relationship between TSP lead and PM_{10} lead. The aims were to answer the following questions:

1. Does the relationship between TSP Lead and PM_{10} Lead vary between sites, between years and/or between seasons? This question was answered by testing for homogeneity in the slope coefficient in the relationship between log_{10}(TSP Lead) and log_{10}(PM_{10} Lead) across the range of combinations of sites, years and seasons.

2. Does the prediction error for TSP Lead using PM_{10} Lead vary between sites, between years and/or between seasons? This question was answered by testing for homogeneity of the (transformed) prediction interval widths over the available combinations of sites, years and seasons.

**Statistical analyses**

**Data set 1**: Macarthur Street · CBD (2/1/88 - 28/4/92)

The 1992 data were trimmed from the data set so that a balanced YEAR by SEASON model could later be fitted and so tests for interaction between YEAR and SEASON could be done.

A linear regression equation expressing log_{10}(TSP Lead) as a function of log_{10}(PM_{10} Lead) was derived, ie.

\[
\log_{10}(\text{TSP Lead}) = (0.026 \pm 0.018) + (0.944 \pm 0.028)\log_{10}(\text{PM}_{10}\ \text{Lead}),
\]

where the coefficient errors given are 95 per cent confidence intervals for each coefficient assuming that the other coefficient remains constant.
The proportion of variance in $\log_{10}(TSP \ Lead)$ which was explained by the inclusion of $\log_{10}(PM_{10} \ Lead)$ was 95.6 per cent (ie. $r = 0.978$).

An analysis including a test of similarity of slopes suggested non-homogeneity (at $\alpha=0.05$), with Summer 1988 having above-average slope (1.07426) and Autumn 1988 having below-average slope (0.72559).

A two-way Analysis of Variance (YEAR by SEASON) on the transformed prediction interval widths suggested no variation between years and/or seasons in the prediction error.

Geometric prediction errors were all about 1.42 (ie. 42 per cent), meaning that the lower 95 per cent confidence limit for an individual prediction can be estimated as (fitted value)/1.42 and the upper limit can be estimated as (fitted value)×1.42.

Data set 2: Alphington and Collingwood (5/1/93 - 31/3/94)

A linear regression equation expressing $\log_{10}(TSP \ Lead)$ as a function of $\log_{10}(PM_{10} \ Lead)$ was fitted, ie.

$$\log_{10}(TSP \ Lead) = (0.056 \pm 0.029) + (0.998 \pm 0.044)\log_{10}(PM_{10} \ Lead),$$

where the coefficient errors given are 95 per cent confidence intervals for each coefficient assuming that the other coefficient remains constant.

The proportion of variance in $\log_{10}(TSP \ Lead)$ which was explained by the inclusion of $\log_{10}(PM_{10} \ Lead)$ was 94.6 per cent (ie. $r = 0.973$).

An analysis including a test of similarity of slopes suggested overall homogeneity (at $\alpha=0.05$) of slopes over combinations of sites and seasons.
A two-way Analysis of Variance (SITE by SEASON) on the transformed prediction interval widths suggested some seasonal variation in the prediction error, however the magnitude of the variation in the actual prediction errors does not appear to be of practical significance.

Geometric prediction errors were all about 1.42 (ie. 42 per cent), suggesting a prediction error for the 3-monthly mean of about 11 per cent.

**Conclusions**

On the basis of the preceding analyses it seems acceptable to use PM$_{10}$ Lead concentrations to estimate TSP Lead concentrations so long as a prediction error of 42 per cent is acceptable for an individual value (which suggests 11 per cent for a 3-monthly mean). For NEPM reporting, only annual mean values are considered therefore the prediction error will be better than 10 per cent.

EPA propose to maintain one site for reporting lead for NEPM purposes. This will be the Collingwood lead monitoring site which is considered an upper bound performance monitoring site for lead.

Statistical analysis of data from this site produced the following regression expression which can be used to predict the TSP Lead from measurements of the PM$_{10}$ Lead:

Collingwood (n=66) \[ Pb(TSP) = 0.011 + 1.14 \ Pb(PM_{10}) \]

By comparison the relationship for the other sites show close agreement and suggest that a single expression could be used for sites in Melbourne where motor vehicle emissions are the main contributors to particulate lead.

Alphington (n=73) \[ Pb(TSP) = 0.010 + 1.03 \ Pb(PM_{10}) \]

CBD (n=233) \[ Pb(TSP) = 0.014 + 1.09 \ Pb(PM_{10}) \]