Perth Air Quality Management Plan

December 2000

Department of
Environmental Protection

Eco Action

Our environment, our future.

ISBN 0 7307 6623 3

Printed on recycled paper

Foreword

I am pleased to release this document as a positive step towards improving Perth's air quality.

The Perth Air Quality Management Plan (AQMP) outlines key strategies and actions to ensure that the people of Perth have clean air. This blueprint for air management over the next 30 years is important not only to the many national and international tourists that visit our city each year, but more importantly for us, our children and their children for generations to come.

The Plan provides a comprehensive guide and direction for air quality management in Perth on a pro-active basis. In the past, management plans have been reactive to changes in air quality. But the AQMP offers short term and long term actions through a range of initiatives that will provide immediate solutions and longer-term benefits. A number of actions are already underway.

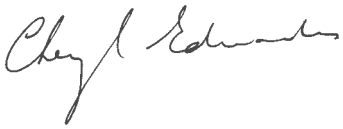
Some hard decisions will need to be made to ensure that Perth's air quality, most notably haze and photochemical smog, show signs of improvement. It will mean that for us to live in a cleaner air environment we will in some cases need to change our attitudes and our behaviour.

The AQMP will be implemented over a 30 year period with a particular emphasis on actions commenced or completed within the first five years. These immediate actions will lay the foundations for ensuring that Perth's air quality will remain at a level the community has declared, through consultation on developing this plan, it deems acceptable.

This Plan fulfils a State Government promise at the 1996 election to develop a plan to improve the quality of Perth's air.

It has been developed by the Air Quality Co-ordinating Committee in conjunction with the Department of Environmental Protection and reflects the direction provided by the Parliamentary Select Committee on Perth's Air Quality in its 1998 report and recommendations.

Ensuring better air quality will help provide a better environment, a healthier lifestyle and a cleaner, clearer skyline for ourselves, our visitors and our children.



CHERYL EDWARDES (Mrs) MLA
MINISTER FOR THE ENVIRONMENT

Perth Air Quality Management Plan

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Introduction and background to the Perth Air Quality Management Plan

Air quality in Perth

Purpose of the Perth Air Quality Management Plan

The Perth Air Quality Management Plan (AQMP) has been developed to ensure that clean air is achieved and maintained throughout the Perth metropolitan region over the next 30 years. The AQMP seeks to achieve this by reducing the emission of those air pollutants that are causing occasional episodes of unacceptable air quality now, and by preventing the development of future air quality problems. The aim of the AQMP is to steadily improve Perth's air quality so that we have cleaner air to a level that is acceptable to the community.

The overall objective of the AQMP is to achieve the vision originally outlined by the Parliamentary Select Committee on Perth's Air Quality in its 1998 report:

"Perth's air quality should be a reflection of the city itself. Clean air that is safe to breathe means that the city has an effective and efficient public transport system that is fully integrated with its urban design; where an imaginative blend of urban residential densities has created a community that uses the fullest range of transport methods and is therefore not car-dependent; and where industry provides employment and economic wealth without detracting from the city's attractive natural and social environments" (Legislative Assembly, 1998).

Where we are now?

Perth is on the threshold of having an air quality problem.

The levels of photochemical smog in Perth during summer regularly exceed guidelines established by international health experts and other scientific bodies. Likewise in colder months, a smoke haze frequently hangs over Perth. In most cases these episodes of unacceptable air quality are perpetuated by weather conditions that prevent air pollutants from dispersing rapidly. The management of the key pollutant sources is therefore essential.

A detailed analysis of the air quality experienced in the Perth metropolitan region is contained in the Department of Environmental Protection's (DEP) *State of Knowledge* (DEP, 2000c) report. In summary the report shows that:

- ozone (O_3) levels in summer are tending to remain high, approaching or exceeding the limits of the acceptable standard; and
- particle levels in winter are relatively high, and during spring and autumn are relatively low.

The report also highlights that there are many pollutant sources, ranging from emissions from motor vehicles to domestic sources such as wood heaters and lawn mowers.

While Perth's air quality may be unsatisfactory for relatively short periods of time each year, there is no room for complacency, with the combination of population growth in the region and increasing air emission sources expected to exacerbate the deterioration in Perth's air quality. Immediate action is needed to tackle photochemical smog and air-borne particles so their levels continue to comply with national environmental standards.

The major pollutants

The two main causes of air pollution in Perth are vehicle emissions and smoke. The findings of the *Perth Photochemical Smog Study* (Western Power Corporation & DEP, 1996a) and the *Perth Haze Study* (DEP, 1996) conclusively showed this and highlighted the importance of developing effective and long term management strategies.

In summer, the key air quality problem is the creation of photochemical smog - caused by sunlight reacting with nitrogen dioxide and reactive organic compounds (ROCs) (such as petrol vapours).

In winter, the key problem is haze caused mainly by domestic wood-burning heaters.

There are six main air pollutants found in all urban areas such as Perth. They are:

- carbon monoxide;
- nitrogen dioxide;
- photochemical oxidants (measured as ozone);
- sulfur dioxide;
- lead; and
- inhalable particles.

These major pollutants can adversely affect human health and the environment. Table 1 provides a summary of the major pollutants in Perth's air. It includes a comparison between air quality and the National Environment Protection Measure (NEPM) ambient air quality standards. Table 2 shows air quality compared to air quality guidelines adopted in other jurisdictions.

Table 1: NEPM ambient air quality standards and Perth's status *(DEP, 1999).*

Criteria pollutant	NEPM standard	Number of times monitored air quality was above the NEPM limit (from 1990 to 1998)
Carbon monoxide	9 ppm 8-hour average, not to be exceeded more than one day a year	2 - 1990 (Queens Buildings)
Nitrogen dioxide	0.12 ppm 1-hour average, not to be exceeded more than one day a year	1 - 1991 (1 Queens Buildings) 2 - 1992 (2 Queens Buildings) 1 - 1993 (1 Queens Buildings)
	0.03 ppm annual average, not to be exceeded	no exceedences recorded during period 1990 - 1998
Photochemical oxidants (measured as ozone)	0.10 ppm 1-hour average, not to be exceeded more than one day a year	2 - 1991 (2 Caversham) 2 - 1992 (2 Caversham) 2 - 1993 (1 Caversham, 1 Rolling Green) 1 - 1994 (1 Caversham) 4 - 1996 (2 Caversham, 2 Rolling Green) 3 - 1997 (1 Quinns Rock, 1 Rolling Green, 1 Swanbourne) 2 - 1998 (1 Caversham, 1 Rolling Green)
	0.08 ppm 4-hour average, not to be exceeded more than one day a year	2 - 1991 (2 Caversham) 1 - 1992 (1 Caversham) 1 - 1993 (1 Rolling Green) 3 - 1994 (2 Caversham, 1 Rolling Green) 1 - 1995 (1 Swanbourne) 8 - 1996 (1 Caversham, 1 Rockingham, 5 Rolling Green, 1 Swanbourne) 7 - 1997 (3 Caversham, 1 Quinns Rock, 2 Rolling Green, 1 Swanbourne) 4 - 1998 (2 Caversham, 2 Rolling Green)
Sulfur dioxide	0.20 ppm 1-hour average, not to be exceeded more than one day a year	1 - 1992 (1 Hope Valley) 3 - 1993 (1 Hope Valley, 1 Miguel Road, 1 Wattleup) 2 - 1994 (1 Hope Valley, 1 Rockingham)
	0.08 ppm 24-hour average, not to be exceeded more than one day a year	no exceedences recorded during period 1990 - 1998
	0.02 ppm annual average, not to be exceeded	no exceedences recorded during period 1990 - 1998
Lead	0.5 µg/m^3 annual average, not to be exceeded	no exceedences recorded during period 1990 - 1998
Inhalable particles (PM10)	50 µg/m^3 24-hour average, not to be exceeded more than 5 times a year	3 - 1990 (1 Caversham, 2 Queens Buildings) 2 - 1991 (1 Caversham, 1 Queens Buildings) 1 - 1992 (1 Queens Buildings) 3 - 1994 (1 Duncraig, 1 Queens Buildings, 1 Swanbourne) 2 - 1995 (2 Duncraig) 4 - 1996 (1 Caversham, 1 Duncraig, 1 Queens Buildings, 1 Swanbourne) 4 - 1997 (1 Caversham, 1 Duncraig, 1 Queens Buildings, 1 Swanbourne) 3 - 1998 (1 Duncraig, 1 Queens Buildings, 1 Swanbourne)

- Carbon monoxide (CO): Is an odourless, colourless, toxic gas produced by the incomplete burning of carbon-containing fuels. CO affects the body's ability to deliver oxygen to its tissues. Numerous studies indicate that even moderately raised levels of CO pollution can trigger or worsen cardiovascular problems. Increasing daily CO concentrations have also been associated with increased mortality, according to studies in Los Angeles. In Perth, up to 80% of all CO emissions are from motor vehicle exhausts. Other sources include industrial processes, and area-based sources such as bushfires, wood stoves and gas heating. Figure 1 shows the major sources of CO due to human activities.
- Nitrogen dioxide (NO_2): Is a brown, acidic gas produced - along with nitric oxide - by motor vehicles and industrial boilers and furnaces. Other sources of NO_2 are gas home heaters and stoves.

Table 2: Other ambient air quality guidelines and Perth's status *(Government of Victoria, 1999; Australian and New Zealand Environment Council (ANZEC), 1990; United Kingdom Department of Environment (UK DOE), 1996).*

Other pollutants	Guideline			Compliance achieved from 1992-98	Source
Visibility reducing particles	20 km 1-hour average, with allowable exceedence maximum 3 days a year.			At all the visibility monitoring sites around Perth, there are numerous breaches of this guideline value each year, especially during winter. The visual distance loss varies with location. Duncraig and Leeming experience more than 100 hours a year of visual distance loss, while other monitoring sites around Perth experience less than half of this.	(Government of Victoria, 1999)
Fluoride	Averaging period	General land use (HF µg/m^3)	Specialised land use (HF µg /m^3)	Exceedences occur regularly at Caversham and Middle Swan, but have not been recorded at Hazelmere in recent years.	(ANZEC, 1990)
	12 hours	3.7	1.8		
	1 day	2.9	1.5		
	7 days	1.7	0.8		
	30 days	0.84	0.4		
	90 days	0.5	0.25		
Benzene	5 ppbm annual average (UK guideline) 1 ppbm annual average (UK goal)			No record of guideline exceedences in Perth, but the goal has been exceeded. Data available for 1997-98 only.	(UK DOE, 1996)

NO_2 can render people more prone to respiratory infections and asthma attacks, and may increase the severity of attacks. Exposure to high levels of NO_2 causes severe lung injury. High levels of NO_2 can also cause reduced growth and visible injury in plants. NO_2 is a major component of urban haze and a precursor to ozone. Figure 2 shows the major sources of nitrogen oxides (NO_x) (as NO_2) due to human activities.

- Photochemical oxidants (measured as ozone): Photochemical oxidants - usually referred to as photochemical smog - are common air pollutants in Australia's large urban centres. Photochemical smog is produced when (NO_x) mix with ROCs (such as fuel vapours) in sunlight. The concentration of ozone is usually taken as an indicator of the amount of photochemical smog - since smog is about 85% ozone. Ozone is a colourless, highly reactive gas with a distinctive odour. Ozone close to the earth's surface is a pollutant - not to be confused with its presence in the stratosphere where it serves the useful function of screening the sun's harmful ultra-violet rays. Symptoms of exposure to ozone include irritation of the airways and minor lung function changes. Ozone concentrations have been associated with both increased hospital admissions and mortality. There is a significant difference between summer and winter emission rates of ROCs from human activities. Figure 3 shows the major sources of ROCs, a precursor of photochemical smog, due to human activities.
- Sulfur dioxide (SO_2): Is a colourless gas with a sharp odour. It is produced by the burning of fossil fuels such as diesel or coal. Coal-fired power stations are a major source of SO_2. SO_2 acts directly on the respiratory system, triggering rapid responses within minutes. The most common symptoms are coughing, wheezing and shortness of breath. Asthmatics are most sensitive to SO_2. Several scientific studies have reported an association between hospital admissions and SO_2 concentrations in the air. Figure 4 shows the major sources of SO_2 due to human activities.
- Lead: In urban areas, the overwhelming source of airborne lead has been the use of leaded petrol in vehicles. The level of airborne lead has declined very significantly in recent years with the growth in use of unleaded petrol. Lead may get into a person's body by inhalation or ingestion. The most vulnerable to adverse effects from lead are the foetus, babies and young children. Lead tends to accumulate in the human body, particularly in the bones. Studies have shown that increased lead levels in young children can impair intellectual development, and that this effect may persist for years. There is no known threshold level for these effects. Ambient air lead levels have been below the NEPM standard over the past few years, and appear to be static.
- Inhalable particles: These are small airborne particles capable of being inhaled deep into the respiratory system. Those with a diameter of less than 10 micrometres (µm) are known as PM10. A component of inhalable particles are fine particles,

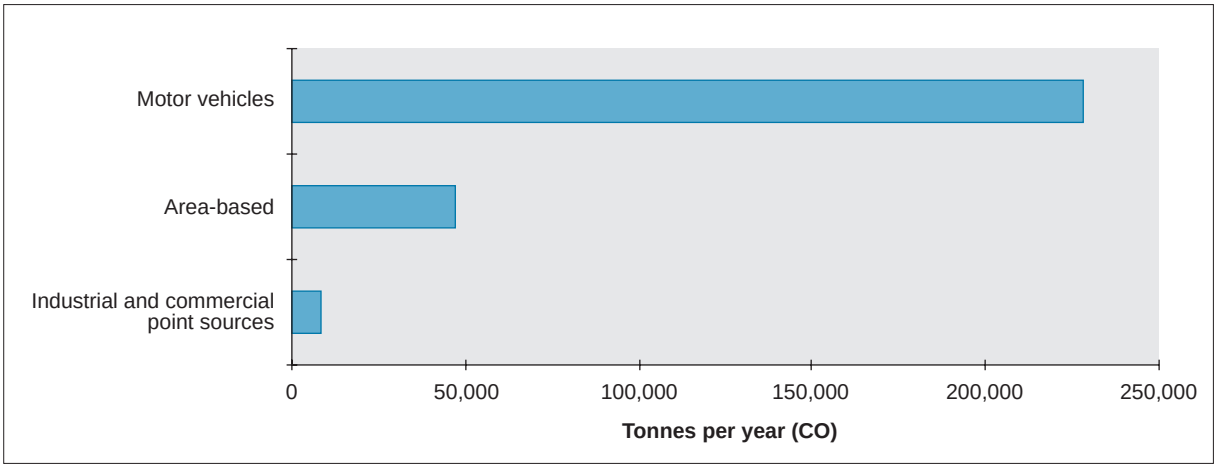


Figure 1: Major sources of CO due to human activities *(DEP, 2000b).*

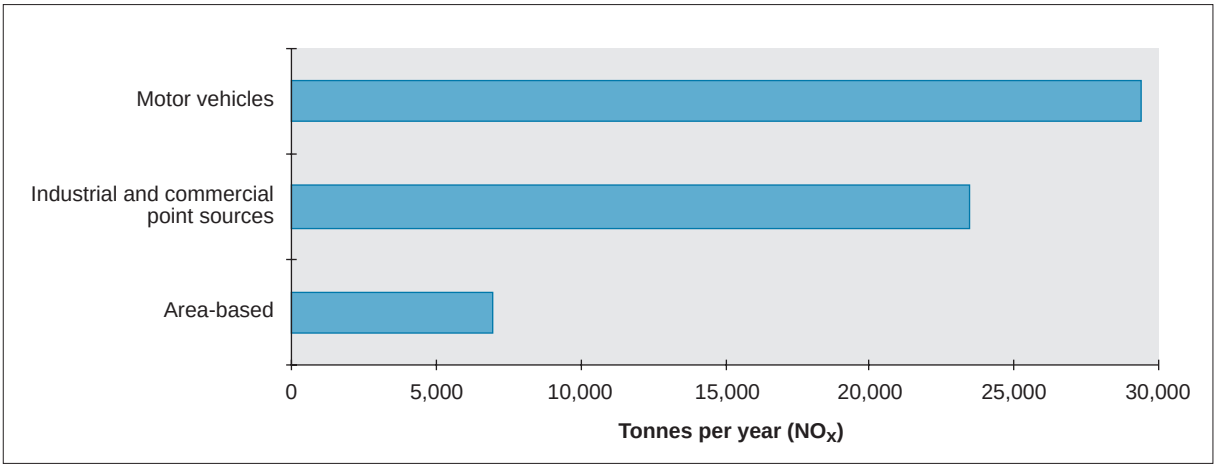


Figure 2: Major sources of NO_X due to human activities *(DEP, 2000b).*

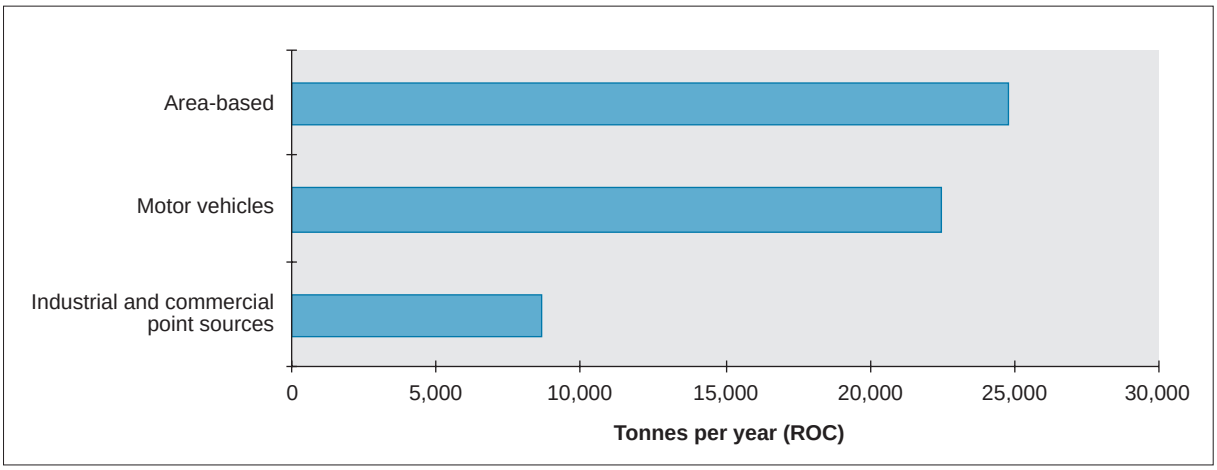


Figure 3: Major sources of ROCs due to human activities *(DEP, 2000b).*

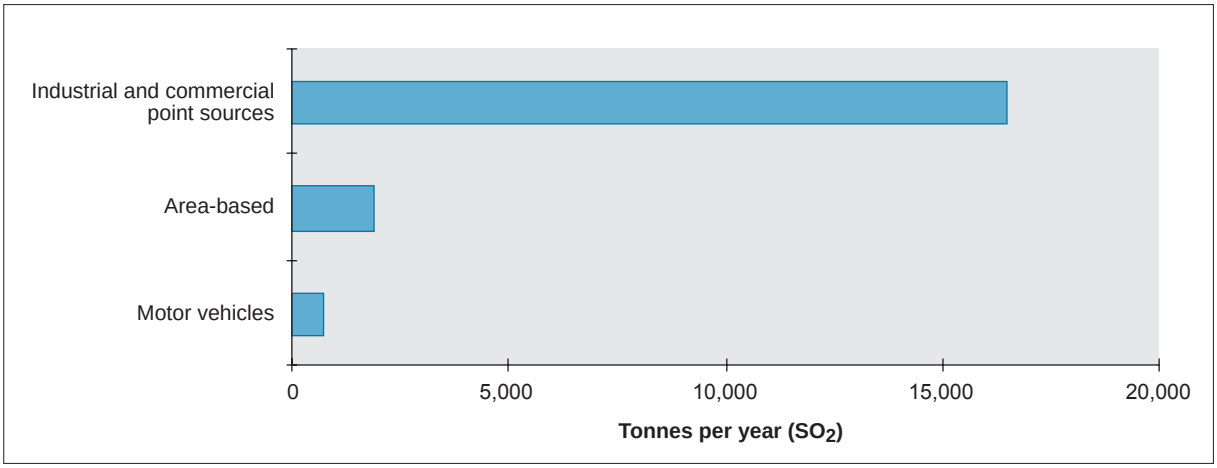


Figure 4: Major sources of SO_2 due to human activities *(DEP, 2000b).*

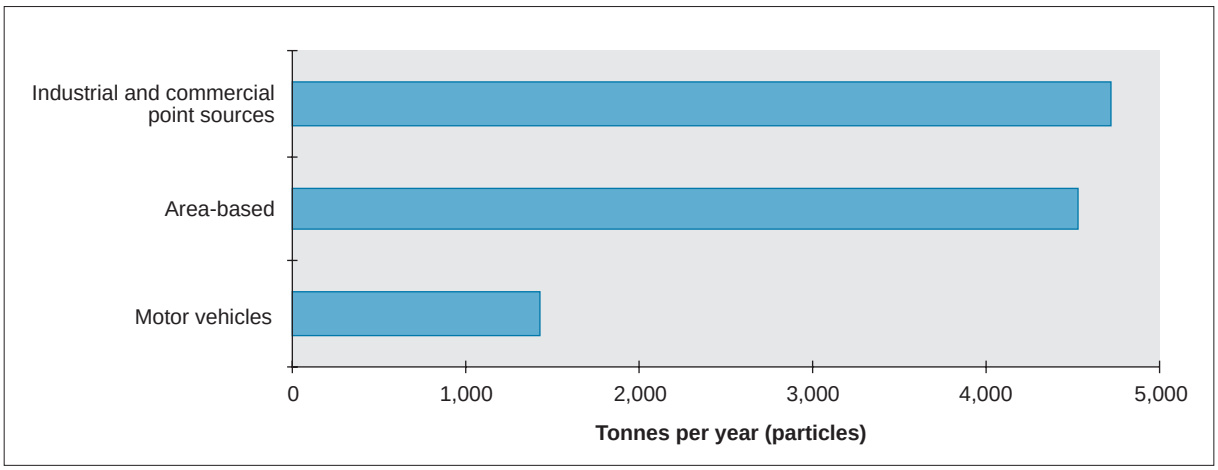


Figure 5: Major sources of particles due to human activities *(DEP, 2000b).*

which have a diameter of less than 2.5 micrometres (PM2.5). Inhalable particles are produced by the burning of fossil fuels (oil, coal and gas), biomass burning, industrial and photochemical processes and the wearing down of tyres and roads. Airborne particles are associated with increases in respiratory illnesses such as asthma, bronchitis and emphysema. PM10 particles have been strongly associated with serious health effects, and very recent evidence suggests that the smaller PM2.5 particles may be strongly implicated as the major cause of the health effects. Seasonal differences in particle levels are noticeable in Perth, both as source dominance and emission rate. Figure 5 shows the major sources of particles due to human activities.

Other pollutants of concern include:

- Air toxics, such as benzene (a carcinogen) and toluene, may be present in the air at low concentrations. Samples taken around Perth over the past few years revealed surprisingly high levels of benzene (a derived annual average concentration of 1.44 parts per billion) and toluene (2.56 ppb). What is of concern is that these levels are comparable with Sydney and Los Angeles, which have much larger populations, and far greater vehicle usage. In Western Australia, regulations have been introduced to reduce the benzene content of petrol.
- Visibility reducing particles: Wood heaters, vehicles, some industrial burning processes, incinerators and bushfires produce these small, airborne particles. The particles range in size from 0.1 to 2.0 µm. By scattering light, they reduce our ability to see objects at a distance. Clean air is defined as having a visual distance of 20 kilometres or more. No national standard has yet been established for visibility. For visual amenity or haze, Western Australia uses the Victorian standard as measured by the backscatter of light, that is, a visual distance of 20 km.
- Fluoride: Fluoride, in both gaseous and particle form, is discharged in the manufacture of bricks, clay tiles and ceramic products. Gaseous fluoride generally occurs in the form of hydrogen fluoride, silicon tetrafluoride and fluorsilicic acid. High levels of hydrogen fluoride are known to cause damage to sensitive plants, including grapevines

and stone fruits. Guidelines to protect commercially valuable plants sensitive to fluoride, and plant species generally, have been set by Australia and New Zealand Environment Council (ANZEC, 1990).

Health and environmental effects

Research has identified a range of health problems associated with air pollution, including:

- respiratory disease and illness such as asthma, bronchitis and pneumonia;
- decreased lung function; and
- damage to the nerves, brain, kidneys and liver.

Those most at risk are the young, the elderly and those with pre-existing illnesses.

Environmental effects resulting from air pollutants can include deposition into marine and estuarine environs, reduced visibility and direct impact on plant and animal life, such as phytotoxicity. The phytotoxic impacts of sulfur dioxide and fluoride have been outlined in this document.

Developing the Perth Air Quality Management Plan

Background

The routine monitoring of ambient air quality in the Perth metropolitan region commenced during the 1970s and continues today. A number of scientific studies have also been carried out in that time. These studies (including *The Kwinana Air Modelling Study* (Department of Conservation & Environment, 1982), *Perth Photochemical Smog Study* (Western Power Corporation & DEP, 1996a) and the *Perth Haze Study* (DEP, 1996)) have provided a solid foundation on which to base decision making for future actions. The need for strategies to improve air quality was specifically highlighted in the 1996 *Perth Photochemical Smog Study* and the 1996 *Perth Haze Study*.

Scientific studies

The *Perth Photochemical Smog Study* measured the magnitude and distribution of photochemical smog concentrations experienced in the Perth metropolitan region. Its key findings included the following:

- the control of photochemical smog is complex, and not amenable to simple and uniform solutions;
- while Perth is not yet experiencing acute photochemical smog problems, the potential exists for the photochemical smog problem to grow;
- continued monitoring of regional photochemical smog levels and meteorological conditions will be required to characterise individual smog events for modelling and management purposes;
- further assessment of chemistry models is needed; and
- further work is needed to improve the accuracy of biogenic emissions estimates.

The *Perth Haze Study* (DEP, 1996) investigated the nature and sources of fine particles in the Perth metropolitan region. These particles are responsible for reduced visibility. Amongst the findings of this study were the following recommendations:

- all efforts should be made to reduce airborne particle loadings;
- investigations should be undertaken to identify other locations, similar to Duncraig, where smoke may be a problem;
- public education on efficient burning conditions for domestic wood heating is necessary, and if this fails, tighter regulation on domestic smoke emissions may be required;
- controlled burning should not be undertaken when meteorological conditions are such that population centres will be fumigated either on the same day or subsequently after transport of the smoke;
- monitoring of fine particle matter should be given high priority; and
- moves toward making PM2.5 the relevant standard and adopting continuous monitoring should be continued and extended so that the whole population is adequately represented.

As a result of these studies, the Parliamentary Select Committee on Perth's Air Quality was established in May 1997. It was the first step in the State Government's four-year program to develop a basis to improve Perth's air quality, through the development of an AQMP.

Parliamentary Select Committee's report

The Select Committee's terms of reference were to investigate Perth's air quality and how it could be improved for current and future generations, with particular consideration of community attitudes and concerns.

The Select Committee investigated air quality management in other Australian cities and cities elsewhere in the world. The Select Committee also published five discussion papers outlining potential strategies for dealing with major issues identified for Perth. These were:

- smoke from domestic sources;
- smoke from biomass burning;
- vehicle emissions;
- industrial emissions; and
- land use and transport planning.

The Select Committee reported to Parliament on 21 May 1998, making 96 recommendations. It noted the report of the *Independent Inquiry into Urban Air Pollution* as a key document and referred to the outcomes of the *Perth Photochemical Smog Study* (Western Power Corporation & DEP, 1996a) and the *Perth Haze Study* (DEP, 1996).

A key recommendation of the Select Committee called for the establishment of a co-ordinating committee to facilitate implementation of air quality management strategies. It recommended that this committee represent all stakeholders, including relevant Government agencies as well as business, industry and the general community, because if improvements to Perth's air quality are to be achieved, then action from everyone is essential.

The Select Committee also went out of its way to stress the link between air pollution and health. It gave priority to the need to undertake research to determine the effects of air pollution on people. It also emphasised the importance of letting people know, in plain language, the results of monitoring to help clarify misconceptions about air quality.

Government Response to the Select Committee's report

In its formal response to the findings of the Select Committee, the State Government gave its support to 93 of the Committee's 96 recommendations, noting that it had already started implementing many of the proposed measures.

In particular, the Government established the recommended Air Quality Co-ordinating Committee (AQCC) to oversee development of the Perth AQMP, with the chair and membership (see Appendix 3) largely in line with the Select Committee's recommendations. The establishment of the AQCC was further acknowledgment that management of air quality requires co-ordination and co-operation amongst the key state government agencies, local government, industry, business and the community.

The Government Response identified the following key areas for action:

- preparing the AQMP;
- implementing established land use and transport planning processes;
- developing programs for managing vehicle emissions;
- developing community education programs to deal with domestic smoke;
- improving co-ordination of hazard reduction burning activities;
- supporting home designs that incorporate energy efficiency; and
- working with industry to improve environmental performance.

Documents published as part of the development of the Perth Air Quality Management Plan; the Perth Photochemical Smog Study, Perth Haze Study, Parliamentary Select Committee's Report and the Government's Response to the Select Committee's report.

The Air Quality Co-ordinating Committee

The AQCC first met on 13 October 1998, with the purpose of overseeing the development of the Perth AQMP. The AQCC established working groups (see Appendix 4) to ensure wide consultation in developing the Perth AQMP. The working groups met four times in formal sessions, but a considerable amount of their work was undertaken outside these sessions, particularly in drafting material and providing comment on drafts.

This Plan has been put together by the AQCC with input from more than 70 representatives from government, industry and the community, and with the help of the DEP.

How the Air Quality Management Plan will tackle Perth's air quality problems

The Perth AQMP presents a strategy to manage Perth's air quality for the next 30 years - until the year 2029. The aim is to steadily improve Perth's air

quality so that we have cleaner air to a level that is acceptable to the community.

The AQMP is a comprehensive plan to improve Perth's air quality on three levels. These are the:

- local level (the immediate neighbourhood);
- regional level (the suburban or local government area); and
- entire Perth metropolitan region.

The AQMP is a combination of state and local government regulatory and planning measures, education (including monitoring and research) and voluntary actions.

The AQMP is tackling Perth's air quality in eight key areas, which are outlined in subsequent sections. These are:

- Health Effects Research;
- Monitoring, Modelling and Research;
- Land Use and Transport Planning;
- Vehicle Emissions Management;
- Domestic Activities Emissions;
- Burning Emissions Management;
- Industrial Emissions Management; and
- Community Information and Education.

Community consultation and finalisation of the Perth AQMP

Community feedback was taken into account in finalising the Perth AQMP following a five week community consultation phase.

Documents published as part of the consultation of the Perth Air Quality Management Plan; Consultation Draft and the State of Knowledge.

Part 2

Managing Perth's Air Quality - Objectives, Strategies and Actions

Air quality objectives, strategies and actions

This Plan is for the management of Perth's air quality over the next 30 years. The Plan's focus is not just on the immediate future but on the longer term. This section contains the detail of the Plan - the objectives, strategies and actions. Since Perth is considered to be on the threshold of an air quality problem, a number of actions have already started.

The Plan is a combination of state and local government regulatory and planning measures, education (including monitoring and research) and voluntary actions. The actions are broad ranging and a staged implementation approach has been adopted.

Further analysis of the strategies and actions was undertaken during the public consultation period. This included prioritising the actions for implementation and funding.

The key areas for action addressed in the Plan are:

- Health Effects Research (HER);
- Monitoring, Modelling and Research (MMR);
- Land Use and Transport Planning (LTP);
- Vehicle Emissions Management (VEM);
- Domestic Activities Emissions (DAE);
- Burning Emissions Management (BEM);
- Industry Emissions Management (IEM); and
- Community Information and Education (CIE).

Each key area is addressed in turn including the specification of objectives. The objectives are also reflected in the strategy statements and actions.

Health Effects Research (HER)

Part 1 of the AQMP provides an outline of the key pollutants of concern in Perth, and their potential health and environmental effects. A more detailed summary is contained in the DEP's *State of Knowledge* report (DEP, 2000c).

Numerous studies have investigated the relationship between ambient air quality and the effect on human health. These studies have found associations between air pollution and a number of human health effects, including respiratory diseases, asthma, bronchitis, pneumonia and cardiovascular diseases.

Those most at risk are the very young, the elderly and those with a pre-existing illness. One of the most common study designs used to investigate the health effects of air pollution is the time series study. These studies have been replicated in many cities around the world, including Sydney, Brisbane and Melbourne, with similar results. They have come under increasing scrutiny, due to concerns about the robustness of the statistical methods employed, the ability to take into account confounders, and the importance of the resultant risk estimates. Nevertheless, time series analysis combined with the other study designs and measured health outcomes provide general agreement that air quality is associated with a range of health effects, and refinement of the analysis methods and study design continues.

Perth's air quality is similar, in composition and concentration ranges, to other cities in Australia and other developed countries, indicating that the health of Western Australians may similarly be affected by air quality. Other factors unique to Perth such as meteorology and lifestyle may differ, and influence whether health effects can be observed.

These issues were highlighted in the *Report of the Select Committee on Perth's Air Quality* (Legislative Assembly, 1998). In particular, the need to review air pollution effects on the Perth community was emphasised. In response to the Select Committee's recommendations, the State Government has undertaken to:

- evaluate the research requirements in this area relevant to Perth;
- establish an initial investigative project to assist in the determination of the research requirements; and
- seek support for appropriate research and investigations from various funding sources.

To facilitate the progression of this work, the Health Research Working Group (HRWG) was established under the AQCC. Health and epidemiological research specialists within Western Australia were invited to make up the membership of this technical working group. The role of the working group is to provide informed and competent expert advice, principally on whether there is a measurable health impact on the Perth population resulting from current ambient air quality. To date the working group has completed a review of literature, an assessment of studies which have been conducted or are in progress and has completed the first of the initial investigative studies to determine the relationship between Perth's air quality and various health outcomes.

Objective for Health Effects Research

To improve understanding of the effects of air quality on people by:

- identifying research priorities to determine the potential impact of air quality parameters on health;
- undertaking research into air quality related health effects, and reporting findings; and
- reviewing and improving research methodology.

Strategies for Health Effects Research

The key strategies are to:

1. assess the relationship between Perth's air quality and human health effects;
2. identify other research priorities;
3. identify future research priorities and funding; and
4. investigate the community health impacts of smoke from prescribed burning and bushfire.

Actions for Health Effects Research

HER 1
Assess the relationship between Perth's air quality and human health effects.

One of the priorities identified by the HRWG was the need to identify whether the associations between air quality and mortality and morbidity, as observed in other Australian cities, could also be observed in Perth.

Exposure to pollutants in Perth may differ from Sydney and Brisbane for a number of reasons, such as lifestyle, meteorology, topography and the mix of pollutants. The key pollutants considered for investigation include particles, ozone, NO_2, CO and SO_2. Concentrations of SO_2 are considered very low in the Perth area and have not been considered further for a time series study of health effects. While NO_2 and CO levels are also below national standards, NO_2 has been included for study due to its potential to influence the human response to ozone. CO has been included due to the potential health effects observed in other studies at low concentrations, notably cardiovascular disease.

The preliminary research is presented as part of the AQMP and its implementation has been co-ordinated by the HRWG.

HER 1.1
Investigate the relationship between Perth's daily air quality and mortality.

As an initial step in the investigation of the health of Perth's population in relation to air quality, the relationship between daily mortality and daily air quality has been investigated. Available mortality and ambient air quality monitoring data have been analysed for correlations, using time series analysis based on the Air Pollution and Health European Approach (APHEA) protocol and a case cross-over logistic regression analysis. Results will be reported in a peer-reviewed scientific publication.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: Health Department Western Australia (HDWA)
Start date and duration: Start 1999 with report due end 2000.

HER 1.2
Investigate the relationship between Perth's daily air quality and hospitalisation.

In addition to HER 1.1, the relationship between hospital admissions for a range of diseases (including respiratory and heart diseases) and daily air quality has been investigated. Available morbidity (hospitalisation data) and ambient air quality monitoring data have been analysed for correlations, using time series analysis based on the APHEA protocol and a case cross-over logistic regression analysis. Results will be reported in a peer-reviewed scientific publication.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: HDWA
Start date and duration: Start 1999 with report due end 2000.

HER 1.3
Investigate the relationship between Perth's daily air quality and hospital emergency department attendance.

Scientific literature provides evidence that those with pre-existing illness, the very young and elderly are at increased risks of health impacts due to poor air quality. Presentation at an emergency department may provide another useful health outcome measure and may be a more sensitive indicator of effect than hospitalisation. As a follow-up study to the mortality/morbidity time series studies, an investigation of the relationship between emergency department attendance and air quality needs to be undertaken. Emergency data for 1992-1998 is available for use. Prior to commencing such a study however, the sample size needs to be evaluated to determine whether there is sufficient statistical power to observe any relationship, should one exist.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: HDWA, Curtin University
Start date and duration: Start 2001 and complete within one year.

HER 1.4
Undertake a project to trial the routine recording of General Practice (GP) health data in a standardised way.

Many people may suffer health impacts which do not result in hospital attendance but may require medical attention. Symptoms such as coughing, wheezing, decreased lung function and asthma have been shown to be associated with air pollution. At present the data from GPs is in a range of different forms. The ability to use routinely recorded GP data needs to be investigated and the feasibility of utilising the data needs to be determined. It is proposed to work with a specific Division of General Practice to study the prospective collection of data, allowing an in-depth picture of one region in Perth.

Lead Agency: HDWA
Supporting Agencies/Organisations: DEP, HRWG, GP Divisions of WA
Start date and duration: Start 2001 and complete within one year.

HER 1.5
Investigate the relationship between re-admission of patients and daily air quality.

As previously described those with pre-existing illness, the very young and the elderly are more prone to health problems due to poor air quality. The HDWA has a linked database which allows for an investigation of hospital re-admission and indicators of air pollution. The investigation will focus on people with and without prior hospitalisation for different groups of causes, and on hospitalisation for different groups of causes in people with and without prior admissions for the same cause. It is proposed to undertake this research for disease groups shown to be influenced by air quality for the years for which hospital re-admission data is available.

Lead Agency: HDWA
Supporting Agencies/Organisations: DEP, HRWG
Start date and duration: Start 2002 and complete within one year.

HER 2
Identify other research priorities.

The above actions meet the Government's current commitments to undertake an initial investigative project to determine health impacts on the community. The HRWG looked at further areas requiring research work. These included the potential health effects of local variations in daily air quality.

HER 2.1
Investigate the potential for local variations in Perth's daily air quality to have any impact on human health.

Local variations in air quality occur based on a number of factors, including location and prevalence of pollution sources and local topography that influences dispersion. International studies have considered variations in the presence of asthma amongst children in areas with differing levels of wood smoke.

Particle concentrations in Perth are variable and it is proposed to investigate whether local variations have an impact on health. The appropriateness of different study designs to conduct the research will need to be determined.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: Collaborative Project with Australian Research Council Strategic Partnerships with Industry – Research and Training (ARC SPIRT) Grant, HDWA
Start date and duration: Start 2001 and report within three years.

HER 2.2
Develop a program to investigate exposure of Perth's residents to air toxics (specifically Volatile Organic Compounds (VOCs)).

VOCs have been monitored in Perth. Benzene concentrations have been shown to be highly variable with some elevated concentrations. The monitoring program conducted to date has been preliminary and further study is required to characterise VOCs in ambient air. The nature of exposure needs to be defined using either mobile or personal sampling.

Environment Australia has funded a program to investigate personal exposure which will commence in 2001.

Lead Agency: DEP
Supporting Agencies/Organisations: HDWA, Universities, HRWG
Start date and duration: Start 2001 and complete within two years.

HER 2.3
Investigate the relationship between personal exposure, ambient air quality and defined health outcomes.

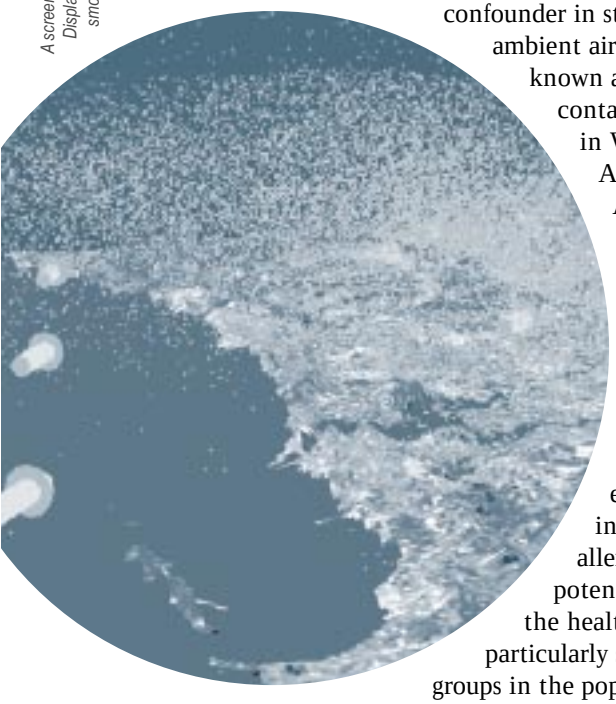
One of the deficiencies identified in the range of available national and international studies is the assessment of individual exposure to air pollution. In particular there are few studies which relate

personal exposure to a defined health outcome. For example, in-cabin vehicle air quality and indoor air quality may significantly influence exposure. To address this, better measures of personal exposure are required. Studies to investigate the relationship between defined health outcomes and levels of air toxics need to be undertaken. The HRWG will investigate options for improving exposure assessment and facilitate applications from academic organisations for funding.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: HDWA
Start date and duration: Start 2001 and report within three years.

HER 2.4
Develop a program to investigate the contribution of indoor air exposure to personal exposure.

In recent years there has been increasing concern about indoor air quality. The population now spends about 80% of its time indoors. It has been shown that for many airborne contaminants, the home presents much higher concentrations and hence is a more significant contributor to exposure. Indoor air quality is a confounder in studies of ambient air quality. Little is known about air contaminants indoors in Western Australia. Available information needs to be reviewed and a program developed to investigate the contribution of indoor air exposure, including allergies, and the potential effect on the health of people, particularly susceptible groups in the population.



A screen shot from Smog Show, the DEP's Photochemical Smog Display software, showing the movement of a photochemical smog plume over Perth.

Lead Agency: HDWA & DEP
Supporting Agencies/Organisations: HRWG
Start date and duration: Start 2003 and report within two years.

HER 3
Identify future research priorities and funding.

Based on the findings of studies undertaken as part of HER 1 and HER 2, it will be possible to determine the future research needs and their funding requirements. In addition, a number of avenues exist for pursuing collaborative studies and alternate sources of funding. Consideration will also be given to long term exposure studies.

HER 3.1
Periodically review research needs and funding sources.

In order to ensure that improvements to the level of understanding are maintained, a program of review will be adopted. This will include identifying priorities, recommending and supporting research programs and identifying appropriate funding sources.

The HRWG composition enables up-to-date information on funding organisations and grant processes to be available. For example, options include involvement in collaborative studies such as the ARC SPIRT Grant being conducted with Griffith University in Queensland, a collaborative program to evaluate the various study designs and their robustness. Further funding is to be pursued through involvement in Co-operative Research Centre (CRC) programs.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: HDWA
Start date and duration: Start 2000 and review every three years, ongoing.

HER 3.2
Periodically review the health impacts of air pollution or potential airborne contaminants.

The HRWG is comprised of experts who are able to provide advice to government on the impact of air pollutants on health. It is recommended that the HRWG maintain this composition, so that when there is a requirement for advice on concentrations of air pollutants, the HRWG can provide such advice.

Lead Agency: DEP & HRWG
Supporting Agencies/Organisations: HDWA
Start date and duration: Start 1999 and review every three years, ongoing.

HER 4
Investigate the community health impacts of smoke from prescribed burning and bushfire.

There is great degree of uncertainty as to the actual impact of smoke arising from prescribed burning and bushfire on public health. The burning emissions working group considered it imperative that research be undertaken to support further actions to minimise the community health effects of burning activities within and surrounding the Perth metropolitan region (see the BEM section for further detail). Prior to undertaking studies, a review of existing studies

will be conducted in order to avoid overlap of similar research and unnecessary commitment of resources.

HER 4.1
Assess the community health impacts of smoke from prescribed burning and bushfire.

Little is currently known concerning the health effects of smoke from burning emissions on residents in the Perth metropolitan region.

A research protocol will be developed and implemented to specifically assess the consideration of VOCs, polycyclic aromatic hydrocarbons (PAHs), particles and other component emissions, and the composition of the emissions.

Lead agency: DEP & HRWG
Supporting Agencies/Organisations: Department of Conservation and Land Management (CALM), Fire and Emergency Services Authority of Western Australia (FESA), HDWA
Start date and duration: Start 2002 and complete within 18 months.

HER 4.2
Undertake a comparative risk assessment of mortality and morbidity influenced by smoke from prescribed burning and bushfire.

The purpose of this investigation is to provide better information to fire managers and air quality managers involved in government policy and decision making. This comparative risk assessment would investigate the risk of mortality and morbidity resulting from the implementation of burning activities, and the estimated results in the event these activities were not undertaken. This can only be undertaken following the completion of action HER 4.1. Consideration also needs to be given to the relative risks to fire control officers directly involved in prescribed burning or bushfire management.

Lead agency: DEP & HRWG
Supporting Agencies/ Organisations: CALM, FESA, local government
Start date and duration: Start 2004 and complete within two years.

Monitoring, Modelling and Research (MMR)

To achieve an overall improvement in Perth's air quality, supporting information needs to be gathered to assist in determining and prioritising subsequent actions. This supporting information includes an update of the air emissions inventory, gathering of monitoring data, computer modelling and continued research, much of which is currently available or under way.

The availability of an updated and reliable air emissions inventory is essential to further decision making on priority issues. Such an inventory details emissions information contributed by individual industries, and estimated for motor vehicles, area-based sources (eg. paints, solvents, wood heaters and lawn mowing) and biogenic sources (eg. vegetation). Information from this inventory may then be used in air quality management activities, such as airshed modelling work. The first comprehensive air emissions inventory for Perth was developed in 1992, and an update was completed in 2000.

Monitoring ambient air quality provides information (data) essential for appropriate air quality management. This information is required for reporting, calibrating airshed models and research work.

The DEP currently maintains a network of ten ambient air quality monitoring stations measuring a range of parameters across the Perth metropolitan region. From time to time this network has been augmented to support investigations of specific areas or specific pollutants. For example, additional monitors were used during the *Perth Photochemical Smog Study* (Western Power Corporation and DEP, 1996a) and the *Perth Haze Study* (DEP, 1996).

In addition to this network, three monitoring sites are maintained by the Kwinana Industries Council (KIC) to measure sulfur dioxide and/or particles (monitored as PM10). Fluoride monitoring is conducted in the Caversham area, and data is provided by the Bureau of Meteorology (BoM) from many of their weather monitoring sites that measure local wind speed and direction, relative humidity and temperature. Ambient air quality monitoring sites across the Perth metropolitan region are shown in Figure 6.

Table 3 details the parameters measured at each fixed monitoring station in the Perth metropolitan region. Other parameters, including VOCs such as benzene and toluene, have been measured at various locations across Perth using portable equipment.

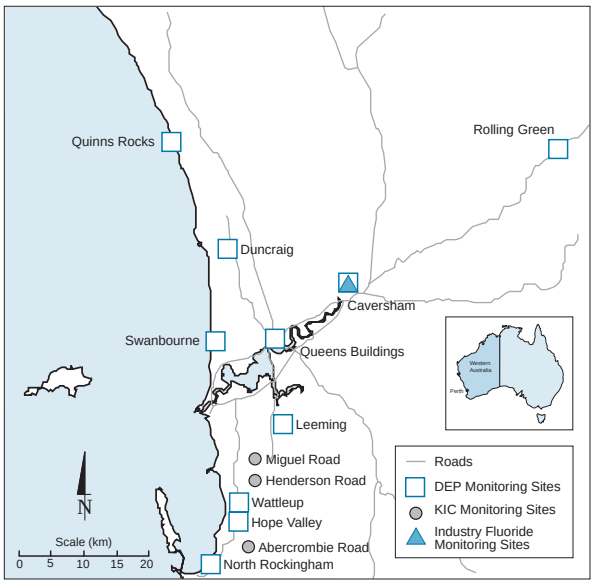


Figure 6: Ambient air quality monitoring sites in the Perth metropolitan region *(DEP, 1999).*

When analysing monitoring data, meteorological parameters such as wind direction and solar radiation must be included as they influence the movement and chemical transformations of constituents in the air. The formation of ozone, for example, is dependent on the amount of available sunlight. Ozone concentrations are relatively higher in the Perth airshed during the warmer months of the year. Table 4 highlights the meteorological parameters measured at the various air quality monitoring sites in the Perth metropolitan region.

Given that monitoring is undertaken for the purpose of air quality management, the objectives of the ambient air quality monitoring network include:

- determining the current and future need for air quality management at current levels or projected levels of air quality;
- evaluating the effectiveness of control measures;
- verifying compliance with statutory requirements such as regulatory standards (eg. NEPM);
- informing the community about the state of air quality;
- providing input data for air quality models;
- assessing and improving the accuracy of air quality models; and
- providing input data for models to assess population and ecosystem exposure.

Air quality monitoring objectives may change with time and circumstances, and it is necessary to review the reasons for conducting the monitoring and the data that is needed as well as assessing the adequacy and effectiveness of data in meeting the monitoring objectives. Periodic review of the data quality objectives is necessary to ensure that they are relevant.

Table 3: Air quality parameters measured at Perth air quality monitoring sites *(DEP, 1999).*

	Parameters Measured									
SITE	CO	Fluoride	NO_x	O_3	Lead	PM2.5	PM10	SO_2	Total Suspended Particles	Visibility
Abercrombie Road							●	●		
Caversham	●	●	●	●		●	●			●
Duncraig	●		●			●	●			●
Hazelmere		●								
Henderson Road								●		
Hope Valley			●					●		●
Leeming	●		●			●				●
Middle Swan		●								
Miguel Road							●	●		
Queens Buildings	●		●		●		●		●	●
Quinns Rocks			●	●						●
Rockingham			●	●				●		
Rolling Green			●	●						
Swanbourne	●		●	●			●			●
Wattleup								●		

Table 4: Meteorological parameters measured at Perth air quality monitoring sites *(DEP, 1999).*

	Parameters Measured							
SITE	WIND	AT	DT	RH	SR	NR	UV	RAIN
Abercrombie Road	●	●						
Caversham	●	●	●	●	●	●	●	●
Duncraig	●	●						
Henderson Road	●	●						
Hope Valley	●	●	●	●	●			
Leeming	●	●						
Miguel Road	●	●						
Queens Buildings		●						
Quinns Rocks	●	●						
Rockingham								
Rolling Green	●	●						
Swanbourne	●	●						
Wattleup	●	●		●				

Legend:

Parameter	Description	Parameter	Description
WIND	Wind speed, direction and sigma (ie variation in wind direction)	SR	Solar radiation
AT	Air temperature	NR	Net radiation
DT	Delta temperature (air temperature difference between 18 m and 6 m)	UV	Ultra violet radiation
RH	Relative humidity	RAIN	Rainfall

The DEP is currently finalising a review of the adequacy and effectiveness of the monitoring network, and will report the outcome to the Minister for the Environment.

This review includes an assessment of:

- trends in air quality;
- the identification of geographical “hot spots”; and
- the redundancies or gaps in the network which require relocation or augmentation of monitoring stations, and addition or removal of specific air quality parameters from the set monitored.

Computer modelling is an essential tool to interpolate or predict pollutant concentrations and to optimise strategies to maintain or improve Perth’s air quality. Computer models enable examination, comparison and simulation of ambient air quality resulting from various management options, as well as the consequences of no action. The accuracy of a computer model depends on many factors, including the accuracy of the source emissions data, the quality of knowledge of meteorological conditions in the area, and assumptions about physical and chemical processes in the atmosphere involving the transport and transformation of the pollutants.

The *Perth Photochemical Smog Study* (Western Power Corporation & DEP, 1996) and the *Perth Haze Study* (DEP, 1996) resulted in the development of a photochemical smog model and a haze model respectively. Future priorities include assessing the models for use as educational tools.

While there is a substantial amount of information available on air quality relevant to Perth, in some areas there are deficiencies. Further research is needed to establish a more complete picture of the characteristics of the Perth airshed. In particular, focus on the quantification of air toxics in the airshed, an accurate estimate of biogenic emissions and the investigation of the status of indoor air quality is required.

Objective for Monitoring, Modelling and Research

To improve knowledge and understanding of Perth's air quality, and to steadily improve air quality so we have clean air to a level that is acceptable to the community, by:

- undertaking regular reviews and updates of the Perth airshed emissions inventory, ambient air quality monitoring networks and computer modelling;
- providing the data required for rational and effective air quality management and research;
- disseminating information useful to industry, government and the community; and
- supporting community information and education programs on air quality.

Strategies for Monitoring, Modelling and Research

The key strategies are to:

1. maintain an up-to-date, comprehensive, effective and publicly accessible air emissions inventory;
2. maintain and improve the existing monitoring network in the Perth metropolitan region;
3. review and enhance air quality models, and communicate results; and
4. encourage research into the nature and sources of emissions contributing to the Perth airshed.

Actions for Monitoring, Modelling and Research

MMR 1
Maintain an up-to-date, comprehensive, effective and publicly accessible air emissions inventory.

The Government is committed to the provision of information to the public as far as is reasonably practicable. For example, the emissions inventory work undertaken as part of the *Perth Photochemical Smog Study* (Western Power Corporation & DEP, 1996a) and the *Perth Haze Study* (DEP, 1996) is publicly available. The DEP has recently updated the 1992 Perth emissions inventory and participated in the preparation of the National Pollutant Inventory (NPI), including a trial in the Kalgoorlie region. The NPI includes information about a range of emissions (including a number of air toxics), and is publicly available via the Internet, CD-ROM and published reports.

The Perth air emissions inventory considers emissions in four basic source groups:

- motor vehicles;
- major industrial sites;
- area-based (eg. service station vapour losses, surface coatings and thinners, aircraft, lawn mowing, domestic solvents and off-road engines); and
- biogenic (from native and cultivated vegetation and soil microbes).

It is important to note that this air quality management plan and the actions it contains are designed to address pollutant sources resulting from human activities, and therefore does not address management of biogenic sources of pollutants.

In preparing the updated Perth air emissions inventory, the emission of pollutants important in the development of photochemical smog (NO_x and ROCs) were estimated for all sources, along with carbon monoxide, sulfur oxides, particulate matter and lead. The year 1998/99 was the base year for the updated inventory (DEP, 2000b).

Periodic reviews and updates of the Perth air emissions inventory will provide the information on emission sources necessary for achieving improvements in Perth's air quality.

MMR 1.1
Update the Perth air emissions inventory.

The Perth air emissions inventory needs to be updated periodically utilising information from the NPI and other data sources. This will provide accessible information about a range of emissions to the Perth airshed, and the sources of these emissions. The inventory will be updated every three years, including area source, point source, mobile source and biogenic source emissions. The updated inventory will be made publicly available (see MMR 1).

Lead Agency: DEP
Supporting Agencies/Organisations: Industry, local government, relevant government agencies
Start date and duration: Completed in 2000, review and update in 2002, and review every three years.

MMR 1.2
Link data acquisitions of emissions inventories.

In order to provide an integrated emissions inventory for Perth, a management system will be developed to enable access to the combination of

data acquired for the NPI, available licensed premises monitoring data and the existing Perth air emissions inventory.

Lead Agency: DEP
Supporting Agencies/Organisations: Licensed industries
Start date and duration: Start 2002, complete within two years.

MMR 1.3
Quantify significant emissions sources outside the Perth metropolitan region contributing to Perth's air quality.

Smoke emissions from bushfires and hazard reduction burning, particularly in the South-West region, contribute significantly to pollution in the Perth airshed, and are not currently included in the Perth air emissions inventory. Weather patterns can result in the transport by winds of particles from bushfires and hazard reduction burning from the South-West to Perth, contributing to haze levels in the Perth airshed.

Contributions from these external sources of smoke will be identified and quantified. Information procured from the ambient air quality monitoring network in the Perth metropolitan region (see Figure 6) will facilitate this procedure. These revised estimates will be required in order to model fine particle impacts.

Lead Agency: DEP
Supporting Agencies/Organisations: CALM, FESA, BoM, local government
Start date and duration: Start 2001 and update every three years, ongoing.

MMR 1.4
Validate emissions estimates within the Perth airshed.

Additional measurements to be investigated include emissions from timbers burned in wood heaters, and biogenic, aviation and marine craft emissions. The aim will be to determine significant emissions from other sources via monitoring information, and to include them as appropriate in the Perth air emissions inventory.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, Western Australian Municipal Association (WAMA), BoM, relevant industry sectors, Conservation Council of Western Australia (CCWA), Pollution Action Network (PAN)
Start date and duration: Start 2001, complete within one year.

MMR 2
Maintain and improve the existing monitoring network in the Perth metropolitan region.

An ambient air quality monitoring network in the Perth metropolitan region is necessary to provide information on air quality and its long term trends. It is important that the network adequately represents variations across the Perth airshed, so that resultant information meets the needs of effective air quality management. Monitoring also provides a "hands-on" educational opportunity for schools and universities.

The pollutants monitored within the Perth air quality monitoring network are detailed in Table 3. Pollutants of particular concern regarding human health in the Perth metropolitan region are oxides of nitrogen, ozone, and airborne particles (PM2.5 and PM10). Further information is contained in the HER section.

Rooftop monitoring of volatile organic compounds (VOCs) in domestic wood heater smoke emissions from residences in Perth's suburbs.

Efficient and effective methods of monitoring air toxics require consideration. Air toxics affect ambient air quality at a local level, with contributing sources including vehicles on a heavily trafficked road, a single industrial premises or an industrial estate. Classes of chemicals defined as air toxics include VOCs such as benzene and toluene, and metals such as nickel and cadmium. These chemicals are toxic at low concentrations and are of concern for human health and the environment.

Ongoing monitoring of and research on air toxics is an essential component in devising a successful approach to reduce the levels of air toxics in the ambient air. The recent release of the DEP's air toxics report *Volatile Organic Compounds Monitoring in Perth: Baseline Air Toxics Project* (DEP, 2000a), will facilitate the development of an effective air toxics monitoring program.

MMR 2.1
Review current Perth ambient air quality monitoring data.

Existing monitoring data for Perth has been reviewed to determine whether the current locations of monitoring stations and parameters measured (shown in Figure 6 and Tables 3 and 4) are adequately representative. The review is currently being finalised.

On the basis of this review, it may be necessary to amend the existing monitoring network to ensure sufficient representation of the Perth airshed. This may include considering alternative or additional monitoring sites and the use of mobile monitoring stations for a more accurate reflection of localised conditions.

Lead Agency: DEP
Supporting Agencies/Organisations: WAMA, CCWA, industry, universities, PAN
Start date and duration: Completed 2000 and review every five years, ongoing.

MMR 2.2
Review and improve current monitoring equipment.

Alongside the review of the Perth monitoring network (see MMR 2.1), a review will be undertaken of the condition and type of the approved monitoring equipment currently in use. DEP is seeking National Association of Testing Authorities (NATA) accreditation for the network, which encompasses a review of equipment. Monitoring technology will be updated when necessary.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, KIC
Start date and duration: Underway and ongoing.

MMR 2.3
Encourage universities and other centres to be involved in air quality monitoring for educational purposes.

This may include setting up a monitoring program and providing educational information about air quality monitoring to the participating group. Regular reviews of the program would be included.

Lead Agency: DEP
Supporting Agencies/Organisations: Education Department of Western Australia (EDWA), universities, PAN
Start date and duration: Start 2001 and review annually, ongoing.

MMR 2.4
Evaluate the effectiveness of mobile monitoring stations.

The usefulness of mobile monitoring stations in determining localised "hot spots" that may be contributing to health effects (such as wood heater or vehicle emissions) will be investigated. An evaluation of their cost effectiveness, including maintenance costs and other costs that may be incurred, will be assessed. Opportunities for joint funding of mobile monitoring stations via DEP and Local Government or Main Roads Western Australia (MRWA), as well as other options, will be considered.

If the evaluation process provides positive results, mobile monitoring stations will be used in areas of localised concern within the Perth metropolitan region.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, MRWA
Start date and duration: Start 2001, review every five years, and assess effectiveness at AQMP 2005 review.

MMR 2.5
Establish an effective VOCs monitoring program in Perth.

Based on the findings of the DEP's report on VOCs (DEP, 2000a) and source testing and personal monitoring of VOCs, as well as a review of other data sources, a VOC monitoring program will be established throughout the Perth metropolitan region. This action is linked to HER 2.2.

Lead Agency: DEP
Supporting Agencies/Organisations: Industry, Chemistry Centre (Western Australia).
Start date and duration: Start July 2002, establish within one year and review every three years, ongoing.

MMR 2.6
Establish an indoor air quality monitoring program in Perth.

The DEP will review existing literature to determine a cost effective and representative method to monitor indoor air quality in Perth. This method will be used to obtain information for use in HER 2.4. Based on the outcome of MMR 2.4, mobile monitoring of indoor air quality may be adopted to monitor both home and workplace environments. Consultation with indoor air quality specialists at Murdoch and Curtin universities will be undertaken and a trial of the proposed program conducted prior to its implementation. Once established, the program's effectiveness will be reviewed every three years.

Lead Agency: HDWA & DEP
Supporting Agencies/Organisations: universities, local government
Start date and duration: Start 2002, complete trial within three years, review every three years, and assess effectiveness at AQMP 2005 review.

MMR 3
Review and enhance air quality models, and communicate results.

Computer modelling aims to provide accurate simulations of Perth's air quality to the general community, industry and government for a variety of purposes. Air quality modelling may be utilised for increased prediction capabilities, determination of airshed characteristics, impact assessment of major proposals and to raise community awareness. Models provide answers to many questions regarding environmental pollution, and are an important decision making tool for air quality management. Some examples of air quality modelling applications include scientific research, air pollution control strategies and environmental impact assessment.

It is desirable to provide industry, government and the general community with graphical presentations of Perth's air quality for education and information purposes. Greater understanding of the processes involved will lead to a variety of solutions towards the goal of improving Perth's air quality.

It will be necessary to model air quality scenarios which are likely to arise over the next 30 years to determine whether any actions are needed now to improve air quality in the Perth metropolitan region. Further modelling options require investigation into their applicability as tools for research, management and education.

MMR 3.1
Periodically review modelling development and maintenance requirements, and update models as necessary.

Air quality modelling is subject to frequent change as knowledge and technology improves. Furthermore, as Perth's population increases the possible air quality outcomes may change from the current state and predictions. The Perth photochemical smog model, developed by the DEP in 1996, and other scenario models are simulations of dynamic processes, and therefore it is imperative to keep up with ongoing changes.

The DEP will review air quality modelling development and maintenance requirements every two years. Improvements will be undertaken on the basis of these reviews, taking into account available resources and funding.

Lead Agency: DEP
Supporting Agencies/Organisations: BoM, industry
Start date and duration: Start 2001 and review every two years, ongoing.

MMR 3.2
Refine the Perth haze model.

As a priority, the Perth haze model developed by the DEP in 1996, should be further developed to provide a more accurate representation of the behaviour of inhalable particles (PM10 and PM2.5) in the Perth airshed. Work on the further development of the Perth haze model is currently in progress.

Roadside monitoring of volatile organic compounds (VOCs) discharged in the exhaust emissions of motor vehicles travelling along the Mitchell Freeway.

Lead Agency: DEP
Start date and duration: Start 2000, complete modelling development within one year and assess effectiveness at AQMP 2005 review.

MMR 3.3
Improve the graphical display of the Perth photochemical smog model.

The Perth photochemical smog model, developed by the DEP in 1996, is used to simulate the meteorological and chemical dynamics of photochemical smog episodes across the Perth metropolitan region. The graphical display of this simulation is currently limited in its visual effectiveness.

It is recommended that graphical display software be developed for education and information purposes. This software could be used to enhance the visualisation of output from the photochemical smog model.

Lead Agency: DEP
Supporting Agencies/ Organisations: EDWA, Western Australian Museum, all industry sectors
Start date and duration: Start 2001 and complete within one year.

MMR 3.4
Use output from the BoM mesoscale model as input to the photochemical smog model and other airshed models.

The BoM mesoscale model depicts simulations based on meteorological conditions in the Perth metropolitan region. Output from the BoM mesoscale airshed model may be useful for air

quality modelling developments, including photochemical smog and smoke plume modelling.

The initial steps undertaken will involve identifying the output requirements.

Lead Agency: DEP
Supporting Agencies/Organisations: BoM, CALM
Start date and duration: Start 2001, complete initial studies in six months, and assess effectiveness at AQMP 2005 review.

MMR 3.5
Use air quality models as an educational tool.

Air quality models assist in simulating the complex reactions that take place in the Perth airshed, resulting from meteorological conditions affecting the movement and chemical transformation of pollutants.

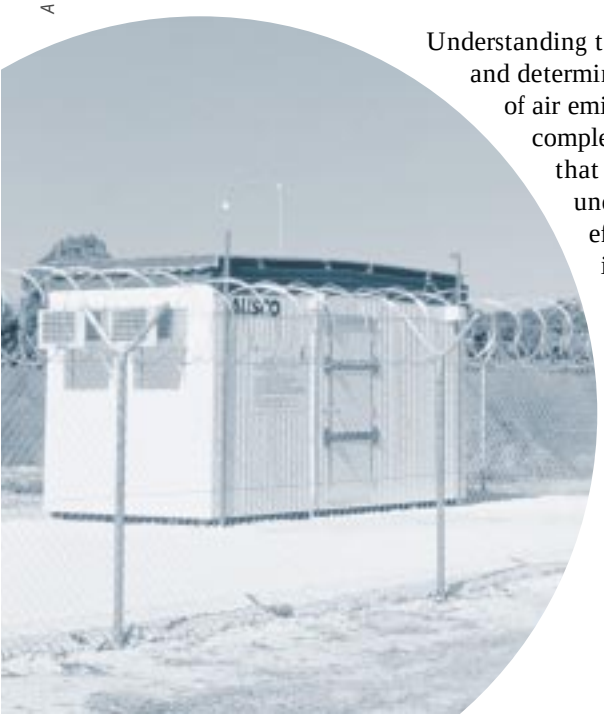
As an educational tool air quality models can be used to give a visual presentation of the complex processes affecting ambient air quality.

The available air quality models will be assessed for their suitability. Based on this assessment, the models will be used as an educational tool for applicable courses in secondary and tertiary institutions.

Lead Agency: DEP
Supporting Agencies/Organisations: BoM, relevant industry sectors, CALM, EDWA, universities
Start date and duration: Start 2001 and review annually, ongoing.

MMR 4
Encourage research into the nature and sources of emissions contributing to the Perth airshed.

The Perth airshed is influenced by emissions generated either naturally or by human activities. The management actions contained in this Plan are designed to address air pollutants resulting from human activities.



A typical DEP air quality monitoring station.

Understanding the composition and determining the sources of air emissions is a complex task, but one that is essential for understanding the effects and impacts of air emissions.

Extensive research has been undertaken in areas relating to air quality, both in Australia and worldwide. However, studies relating specifically to the Perth airshed and its characteristics are required so that further understanding on how to improve air quality in Perth may be gained. Published research material should be utilised as it will provide guidance for the methodology of a particular study. Priority areas requiring research include the improvement of biogenic emissions estimates, air toxics and fluoride emissions.

Another area where ongoing research is required is indoor air quality, covered in HER 2.4.

MMR 4.1
Commission research into the improvement of biogenic emissions estimates relevant to the Perth metropolitan region.

There is some concern regarding the emissions of VOCs from vegetation, during bushfires and prescribed burning in particular. Some plant species may emit chemicals that contribute significantly to total Perth airshed emissions. As yet, little work has been conducted in Australia in establishing the composition and sources of emissions from different vegetation types. International research results are not always relevant due to the differences in native vegetation. However, the techniques applied in previous studies may be useful.

Current methods used to estimate biogenic emissions from both native and cultivated vegetation can involve a degree of uncertainty that would be considered inappropriate for modelling purposes, but in general provide an indicative estimate suitable for proposing management options.

A research protocol will be developed to review the existing research material on estimating biogenic emissions in Australia, with a view to re-estimating the biogenic emissions (type and quantity) from vegetation, including those from bushfires and prescribed burning. The use of available image analysis, such as the data used in *Perth's Bushplan* (Ministry for Planning (MfP), 1998), will be investigated. The results of this study will be published.

Lead Agency: DEP
Supporting Agencies/Organisations: Universities
Start date and duration: Start 2001 and complete within three years.

MMR 4.2
Commission research into air toxics (constituents, sources and impacts).

As yet, little research relating to air toxics has been conducted in Perth. When air toxics are emitted from a source (eg. industry, vehicles, wood

fires, aircraft), there are a multitude of subsequent reactions in the ambient air as chemicals combine to form a range of compounds. Further study into the nature, origins and effects of air toxics is required, so that levels in the ambient air may be managed effectively.

DEP will initiate a desktop study in the first instance to identify the air toxics of concern in the Perth airshed. Information on VOCs has already been collected (DEP, 2000a). Monitoring data will be utilised, particularly data from monitoring stations located in industrial areas, as these are the areas of greatest concern regarding air toxics emissions. Relevant air toxics monitoring information may be available from industrial organisations. The results of this study will be published. Further research will be undertaken pending the results of the desktop study.

In addition, a number of projects are underway through Environment Australia's Living Cities – Air Toxics Program.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry sectors, MRWA, HDWA, universities
Start date and duration: Start 2002 and complete within two years, review every two years.

MMR 4.3
Commission research into fluoride and acid gas emissions (sources and impacts).

Research has been conducted on the impacts of fluoride emissions on crops, both in Australia and overseas. Fluoride levels are monitored at several sites within the Perth monitoring network, in the vicinity of existing brickworks. At times, the fluoride levels measured have exceeded levels set for the protection of sensitive or commercially important plant species.

Based on recent literature and monitoring information, the sources and impacts of fluoride emissions in Perth will be reviewed, with consideration given to the use of mobile monitoring to assess localised fluoride levels. The results of this study will be published.

A recent review of Swan Valley brickworks indicates an investigation of acid gas (hydrogen chloride and sulfur trioxide) sources, emissions and environmental and public health impacts is required.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry sectors, local government
Start date and duration: Start 2001 and complete within two years.

MMR 4.4
Periodically review the status of emerging air quality issues and actions available to address these issues.

Extensive research into the causes and consequences of air pollution is taking place both in Australia and worldwide. It is important that the results of this research and any important new information are closely monitored and made available, as bases for informed decision making and education strategies in the future.

The review will be annual with the most important issues highlighted in the DEP annual report. The review should be a useful tool for public policy makers, and interested stakeholders. The referenced material could be made available from a central clearing house with the widest possible access for government, industry and community stakeholders. Therefore the material will be available in both printed and electronic formats, available either on CD ROM or the Internet.

This action would also rely heavily on the outcomes of *HER 3.2 – Periodically review the health impacts of air pollution or potential airborne contaminants* and *MMR 1 – Maintain an up-to-date, comprehensive, effective and publicly accessible air emissions inventory*.

Lead Agency: DEP
Supporting Agencies/Organisations: Universities, relevant government agencies, industry and community groups
Start date and duration: Start 2001 and complete first review within six months, then maintain as an ongoing service on annual basis.

Land Use and Transport Planning (LTP)

The objectives, strategies and actions contained in this section reflect the Select Committee on Perth's Air Quality's vision for the Perth metropolitan region (see Part 1), and address the key areas of:

- transport planning;
- land use planning;
- integrating land use and transport planning; and
- energy efficiency.

Australian cities have higher energy resource flows than many of their counterparts in Europe and North America, that is, they use more resources and produce more wastes. Consumption levels have been increasing over the past few decades, both in total and on a per person basis. This issue was considered in the Federally funded inquiry into *Urban Air Pollution in Australia* (Australian Academy of Technological Sciences and Engineering, 1997). The study indicated that the Australian States needed to give greater consideration to:

- the shape of urban development;
- better integration of transport and land use;
- minimising the amount of travel required and the amount of inter-regional traffic; and
- encouraging higher levels of self-containment, that is, encouraging social, commercial and employment opportunities in the local environment.

Planning influences where people live, work and recreate, and predicates our mobility options between these activities. Planning decisions are therefore a major contributing factor to the quality of our air. Perth has high private vehicle ownership and increasing vehicle kilometres travelled (VKT). In some areas there is good public transport provision, cycling and/or pedestrian access.

The Western Australian Planning Commission (WAPC) and the Ministry for Planning develop Perth's transport, land use and development strategies. Input is also provided by Transport, MRWA and a wide range of government agencies including the 29 local governments in the Perth metropolitan region. The land development industry plays an important role in designing, advocating and providing an urban structure that meets the anticipated demand for new residential dwellings. There are also numerous agencies and instrumentalities which have a role and input into the land use and transport planning processes, such as the DEP, planning consultants, Westrail, Fremantle Port Authority and the WAMA.

There are a number of existing State Government policies, plans and guiding documents that embody the current and developing transport and land use planning approaches for Western Australia. The key documents are listed below:

- *Metroplan (1990- 2021)*, (Department of Planning and Urban Development (DPUD), 1990);
- *Metropolitan Transport Strategy (MTS) (1995-2029)*, (Transport, MRWA, MfP, Fremantle Port Authority, Westrail & Metrobus, 1995);
- *Better Public Transport Ten-Year Plan for Transperth (1998-2007)*, (Transport, 1998a);
- *Bike Ahead: Bicycle Strategy for the 21st Century (1996-2029)*, (Transport, 1996a);
- *Perth Walking: A Pedestrian Strategy for the Perth Metropolitan Region (Transport, 2000)*
- *TravelSmart 2010: A 10 Year Plan, (Transport, 1999)*
- *State Transport Policy: Western Australia (1996-2029)*, (Transport, 1996b);
- *State Planning Strategy (1999-2029)*, (WAPC, 1997b);
- *Liveable Neighbourhoods: Community Design Code (1999-2029)*, (WAPC, 1997a); and
- *Transform WA: Securing Western Australia's Future*, (MRWA, 1998).

Of these, both *Metroplan (1990-2021)* and the Perth *Metropolitan Transport Strategy (1995-2029)* will be undergoing review in the near future. *Metroplan* contains the current framework for urban growth in the Perth metropolitan region, for the period to 2021. *Metroplan* provides a general framework for growth and change, but it is not a detailed blueprint and is not a statutory plan. The WAPC has recently resolved to undertake a major review of Perth's strategic planning, known as *Future Perth*, following the release of *Metroplan* in 1990. Air quality considerations will be taken into account as part of this review. The detail for implementing *Metroplan* is contained in the following policies, strategies and programs:

- Strategic Policy Statements (eg. Urban Expansion Policy);
- Structure and Centre Plans;
- Metropolitan Development Program;
- Metropolitan Region Scheme; and
- *Metropolitan Transport Strategy (1995-2029)*, (Transport *et al.*, 1995).

The Perth MTS outlines the methods of implementation of the relevant sections of the *State*

Transport Policy: Western Australia, to 2029. The MTS aims at a more balanced and effective transport system in which the majority of people will have a variety of transport options to meet their needs (Transport *et al.*, 1995).

The major themes contained in the MTS include:

- better co-ordination of the components of the transport system;
- greater integration between the transport system and land use planning; and
- improved efficiency in the use of transport infrastructure and services.

Its aim is to reduce the overall total number of personal trips made in the Perth metropolitan region, as well as achieving changes in the preferred modal choice. The MTS targets are indicated in Figure 7.

By any international comparison, Perth is a very well planned city. Nevertheless, degraded air quality does occur.

Both national and international practice indicates that air quality objectives can be achieved by influencing urban form and structure, particularly if urban planning and transport objectives are aligned. Modelling by research organisations, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), demonstrates that careful urban planning can improve air quality. Some studies suggest that from an air quality perspective, development towards a compact city may be the most desirable path to follow. A compact city structure would encourage greater residential densities and urban infill, and require major destinations to be serviced by good public transport. This approach can also be applied to the development of regional focal points within the Perth metropolitan region, where residential, commercial and other business facilities co-locate and encourage the development of local employment opportunities. The planning and provision of public transport facilities and services in the early stages of development in a regional area is essential if air quality gains are to be achieved. Allowing urban development in locations separate from existing urban areas that are not connected with good public transport is problematic both in the immediate and long term.

Rapid change in urban growth has occurred over the last 10 to 15 years in the Perth metropolitan region, and is clearly evident by the extent of development throughout the region. This expansion is expected to continue in the future. Strategic urban policies and infrastructure investments could lead to a re-shaping of the Perth metropolitan region, in general, to a more positive and sustainable form. The emphasis would be on strategic regional centres, including Joondalup, Midland, Fremantle and Armadale.

Many of the actions in this AQMP will lead to outcomes consistent with the objectives of the National and draft State Greenhouse Strategies (Australian Greenhouse Office (AGO), 1998). These strategies reinforce the need to limit urban sprawl and to promote energy efficient patterns of development. Similarly, the *Cities for Climate Protection*™ program operating at the local government level is providing a framework to achieve emission reductions (Cities for Climate Protection™ Australia, 1998). The implementation of greenhouse strategies supports the goals of regional air quality management.

The principal aim of this section is to ensure that relevant State government policies, strategies, plans and actions take into account the potential influence of land use and transport planning on air quality.

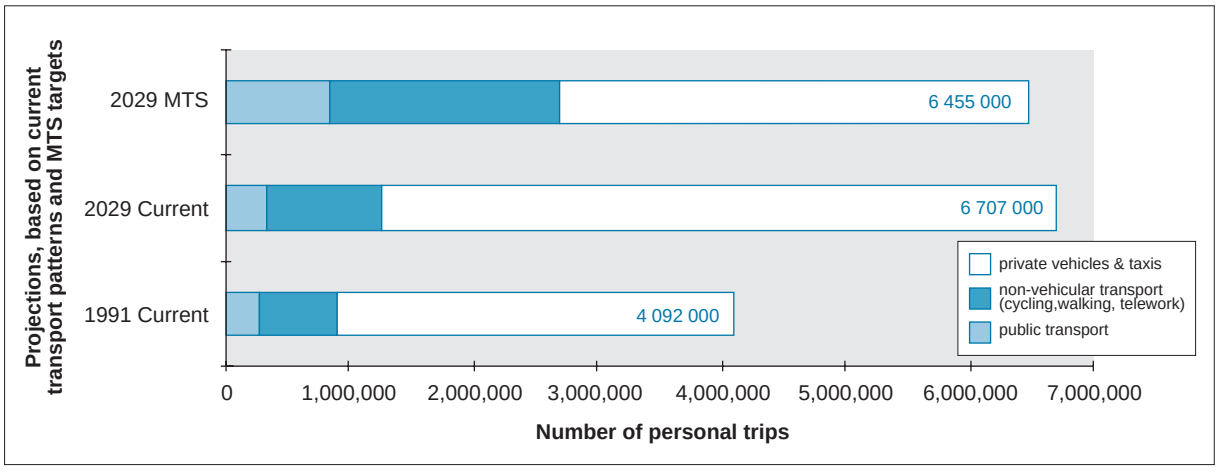


Figure 7: Metropolitan Transport Strategy Targets *(Transport et al., 1995).*

Objective for Land Use and Transport Planning

To steadily improve Perth's air quality so we have clean air to a level that is acceptable to the community, by:

- creating and implementing a more sustainable transport system;
- better integration of land use and public transport to reduce car dependence; and
- promoting the use of energy efficient design in domestic, government, commercial and industrial building development.

Strategies for Land Use and Transport Planning

The key strategies are to:

1. develop a more sustainable mix of transport modes and transport planning in the Perth metropolitan region;
2. review and improve land use planning;
3. integrate land use and transport planning; and
4. encourage the adoption of energy efficiency principles in planning, building design and construction.

In doing so, these initiatives should take a holistic view and consider environmental impact and greenhouse issues as well. Future relevant government policies, strategies and plans for the Perth metropolitan region should address air quality management issues, and be co-ordinated in working toward achieving the outcomes of this AQMP.

It is important to note that changes in urban form are very slow and will occur over years and decades. There is considerable stability in the existing city; 50 to 60% of year 2029 development is already in place. Evidently, well-structured and co-ordinated land use planning can make a positive difference in the long term.

Actions for Land Use and Transport Planning

LTP 1
Develop a more sustainable mix of transport modes and transport planning in the Perth metropolitan region.

The Perth transport system (in regard to people movement) is heavily used by single occupant private vehicles. The long term effects of the current transport system impose costs and negative externalities onto the community, such as degraded local and regional air quality and increased health impacts. Development towards a more sustainable transport system, such as the one proposed in the MTS (Transport *et al.*, 1995), would encourage mode shift away from single occupant vehicles towards multi-occupant vehicles and green transport modes (pedestrian, cycle and public transport). This shift to alternative forms of transport would reduce the impacts of motor vehicles on air quality.

Improvements within the public transport system will encourage more people to consider trains, buses or ferries as a commuting option. Transport's *Better Public Transport: Ten-Year Plan for Transperth* (Transport, 1998a) details the intentions for public transport over the period 1998-2008. The complementary TravelSmart® program is aimed at informing the community of the alternative transport modes available and encouraging their use. The extension of this program to cover the wider Perth metropolitan region is desirable.

Other approaches to encourage people to drive less include car pooling, teleworking, home business and parking restrictions. Different strategies will work more effectively for different sectors of the community. Trials have been conducted of car pooling and teleworking programs, primarily within government agencies. Results from these trials indicate that car pooling is less effective than teleworking, in that it requires considerable effort to organise. Emphasis on strategic regional centre development, along with restrictions on parking in major employment, shopping and recreational centres will provide people with the incentive to consider alternative means of transport to the private vehicle. Restrictions could include reducing the number of available parking spaces and increasing parking fees, with the aim to reduce traffic congestion and emissions in major regional centres.

Planning for transport has a major impact on future land use planning outcomes. The impact on air quality should be taken into consideration when planning a road network, development or redevelopment. It is at the planning stage that the greatest influence on the transport infrastructure is possible. By planning for the most desirable outcome in terms of air quality (as well as other factors) later impacts may be avoided.

The following actions address these issues.

LTP 1.1
Assess the environmental impact of the Perth *Metropolitan Transport Strategy.*

It is proposed that the various strategies that seek to achieve the air quality and other related targets contained within the MTS be assessed. The review

should assess the adequacy of the targets for air quality and quantify its impact on or benefit for regional air quality. The next periodic review of the MTS by Transport is planned to be undertaken by end 2000. An assessment of the air quality impacts of the MTS was undertaken in 1999. It is proposed to re-assess the MTS as it is revised at regular intervals.

Lead Agency: DEP & Environmental Protection Authority (EPA)
Supporting Agencies/Organisations: Transport, MfP, MRWA
Start date and duration: Re-assess in 2005 and every 5 years, ongoing.

LTP 1.2
Prepare local Integrated Transport Plans within the framework of the *Metropolitan Transport Strategy.*

The definition of an "integrated transport plan", provided by Transport, is "to maximise accessibility from the transport system through a variety of transport modes whilst improving liveability and reducing costs for users and the community". Integrated multi-modal plans at a local level will assist in achieving MTS targets and reduce reliance on private vehicle travel.

Outcomes of these plans could lead to targeted infrastructure improvements for public transport, cycling and walking, better information for users and service level improvements for the general public. They may also result in reduced investment in relative terms on roads for general traffic. Local integrated transport plans should occur in conjunction with the WAPC Metropolitan Development Program. Work on this program has commenced.

Lead Agency: Transport in collaboration with MfP
Supporting Agencies/Organisations: Local government, land developers, MRWA, WAPC,
Start date and duration: Start 2000 and review annually, ongoing.

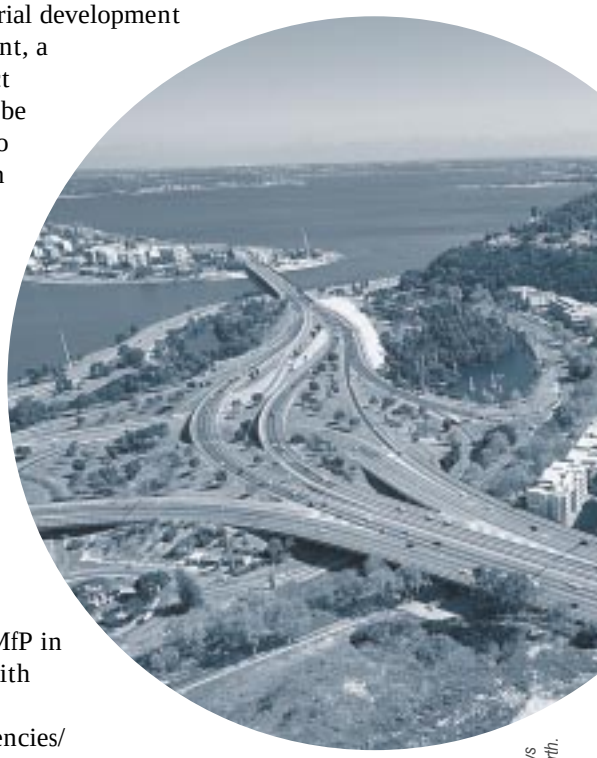
LTP 1.3
Assess local and regional air quality impacts when considering road network planning.

This would be based on the predicted traffic levels on a road network if it were built, and should include projections of air quality impact in the short, medium and long term.

Lead Agency: MRWA
Supporting Agencies/Organisations: DEP, local government, Transport, MfP
Start date and duration: Start 2001, ongoing.

LTP 1.4
Include transport impact assessment as performance criteria for new major development and redevelopment proposals.

When submitting proposals for major urban or industrial development or redevelopment, a transport impact assessment will be required prior to approval, which includes how public transport, bicycle and pedestrian access could be integrated into such a scheme. This work has commenced and will continue.



Aerial view of the freeway and Narrows Bridge, looking towards South Perth.

Lead Agency: MfP in collaboration with Transport
Supporting Agencies/ Organisations: EPA, DEP, MRWA, local government
Start date and duration: Start 2000, ongoing.

LTP 1.5
Monitor the implementation of the *Better Public Transport: Ten-Year Plan for Transperth*.

The State Government has announced a number of commitments to improve and extend the public transport system within the Perth region. This ongoing development of the Perth public transport system will facilitate mode shift from the single occupant motor car to public transport, and reduce transport sourced emissions with consequent air quality improvement.

The *Better Public Transport: Ten-Year Plan for Transperth* (Transport, 1998a) facilitates ongoing work which will include the identification and development of dedicated facilities for bus and rail systems. Transport will monitor the implementation of its plan every three years.

Lead Agency: Transport
Supporting Agencies/Organisations: MRWA, Westrail, MfP, DEP, local government, CCWA
Start date and duration: Start 2000, review every three years, and assess effectiveness at AQMP 2010 review.

LTP 1.6
Encourage the further implementation of teleworking in government agencies.

Teleworking (working from home), also termed telecommuting, is seen as one mechanism to reduce the need for vehicle travel. Its successful implementation would aid in improving Perth's air quality by reducing the number of vehicles commuting throughout the Perth metropolitan region.

Cycling 100 participants - an air quality friendly and healthy alternative to private vehicle use.

Teleworking is currently available to employees of various government agencies. A formal telework scheme has been developed and is currently being trialed by Transport. Appropriate policies and processes should be adopted according to the outcome of this trial.

Lead Agency: Transport
Supporting Agencies/Organisations: DEP, WAMA, Department of Local Government (DLG), MfP
Start date and duration: Under way, review annually, and assess effectiveness at AQMP 2005 review.

LTP 1.7
Facilitate the development of home-based employment and business through appropriate planning provisions.

In addition to extending teleworking in government agencies (LTP 1.6), working from home should be encouraged within local government and the business sector. Separate policies and processes would be developed for these employment sectors.

An increasing number of people are choosing to establish their own home-based businesses. This should be actively encouraged by local governments through their Town Planning Schemes and policies.

Lead Agency: WAMA in collaboration with MfP
Supporting Agencies/Organisations: DLG, local government, Transport, business sector
Start date and duration: Start 2000, review annually, and assess effectiveness at AQMP 2005 review.

LTP 1.8
Continue with travel behaviour programs, such as TravelSmart®.

TravelSmart® is a Transport program encouraging the use of alternate transport modes (public transport, cycling, walking) through motivation, information and empowerment (see CIE 2.1). A pilot project in South Perth achieved a significant reduction in car use on an average day and a decline in the number of car trips per day. The overall result was a 14% decline in VKT and included a 25% increase in public transport boardings (March-June 1999 compared to March-June 2000).

These programs support strategic regional centres and major workplaces across the Perth metropolitan region, and are a means of minimising travel requirements and long-term parking.

Other TravelSmart® programs being developed include workplace and school programs. TravelSmart Workplace is a program based within the DEP, and is a part of the overall TravelSmart® program. It is targeted at people employed in the Perth Central Business District (CBD), raising awareness and understanding of air pollution issues and transport choices.

TravelSmart® school programs are intended to raise awareness among children in primary schools of alternative transport choices to the car at an early age. Research indicates that social conditioning of children in the "car culture" is already evident in children as young as seven, and is well established by the time they are 13. A trial at Kardinya Primary School resulted in a 22% reduction in car trips to the school. The outcome of this trial is a resource kit for years five to seven and a program to extend the initiative to many other schools.

Transport has provided subsidies to eight local government authorities to employ local TravelSmart® officers. These officers will have the task of helping local authorities and their communities develop their own TravelSmart® initiatives, including TravelSmart® to school.

Lead Agency: Transport
Supporting Agencies/Organisations: DEP, MRWA, local government, commercial and business sectors
Start date and duration: Under way, review annually, and assess effectiveness at AQMP 2005 review.

LTP 1.9
Review and improve access within the Perth metropolitan region for pedestrians and cyclists.

Transport has developed and released a cycling strategy *Bike Ahead: Bicycle Strategy for the 21st Century* (Transport, 1996a) and a pedestrian

strategy *Perth Walking: A Pedestrian Strategy for the Metropolitan Region* (Transport, 2000). These strategies advocate the need for pedestrian and cycle access and facilities, such as bicycle parking and shower facilities for cyclists. The pedestrian strategy supports the Australian charter of rights for pedestrians.

A key aspect of the cycling strategy is the implementation of Stages II and III of the Perth Bicycle Network. This requires funding support from Transport, MRWA and metropolitan local authorities.

Local government authorities play a key role in the provision of facilities for pedestrians and cyclists. This is achieved through their town planning schemes and works programmes. Local government authorities as a matter of course should adopt minimum access standards for major trip attractors such as shopping centres, employment locations and recreation centres.

There is a need for an ongoing review to monitor the implementation of facilities, standards and programmes to achieve higher levels of cycling and walking.

Lead Agency: Transport
Supporting Agencies/Organisations: MfP, MRWA, WAMA, local government, relevant community organisations
Start date and duration: Start 2001 and review every three years, ongoing.

LTP 1.10
Manage regional parking in key destinations (CBD and strategic regional centres).

Parking is a key component of the transport system. In central Perth the State Government, in collaboration with the City of Perth, has introduced a new policy and is enabling legislation that will manage parking within the broad context of strategic accessibility to the central city. Reductions in parking facilities over the long term are required to encourage greater use of alternative forms of transport (eg. public transport and cycling).

Parking at strategic regional centres and major district centres needs to be managed with a strategic approach to accessibility that recognises and reconciles the legitimate access needs of car users with the need to shift towards a more sustainable transport system. Local authorities should be encouraged to reduce the quantum of parking at major traffic generators and to develop parking pricing strategies in conjunction with improvements to the public transport system. These actions should be integrated with Strategic Regional Centre Strategies.

At the same time, parking at some major transport interchanges should be encouraged, eg. Park 'n Ride. This will improve accessibility to available public transport and thus provide an incentive for more commuters to use such a service.

It is necessary to consider the benefits/costs of alternative land uses to parking facilities. Mechanisms to achieve this outcome include approvals and amendments to town planning schemes and local and State Government policies.

Lead Agency: Transport in consultation with local government
Supporting Agencies/Organisations: MfP, WAMA, business sector
Start date and duration: Underway and review annually, ongoing.

LTP 1.11
Assess the cost-effectiveness of public money spent on transport modes and services in terms of air quality benefits.

This investigation of the current transport funding system (including Commonwealth, State and local government funding) would seek to set relative priorities towards particular modes and make recommendations for reform which reflect a more balanced transport system.

In its response to the Select Committee, the State Government agreed with the Select Committee for the need to undertake an economic analysis of the public monies provided to the various forms of public and private transport modes, facilities and services available in the Perth metropolitan region.

This study, to be carried out under the guidance of the AQCC with an appropriate level of public consultation, requires initial definition of project scope and identification of existing data. An analysis protocol will be developed which can be used to determine the environmental effectiveness of proposed future transport modes and services in Perth and make recommendations for reform when results indicate this is necessary.

Lead Agency: DEP in consultation with Transport
Supporting Agencies/Organisations: MRWA, MfP, Treasury
Start date and duration: Start 2001, and complete within two years.

LTP 2
Review and improve land use planning.

From 1991 to 1996, the population of Western Australia grew by 8.9%. The majority of growth has taken place in the outer metropolitan area and this trend is likely to continue. The projected population growth of the Perth metropolitan region to the year 2029 is significant. The population is expected to

increase at a rate of 1.39% per year to 1.98 million people in 2029 (Australian Bureau of Statistics (ABS), 1996). This corresponds to an increase in demand for land, resources, services and mobility.

Similar trends are apparent in the population's mobility around the region. The total distance travelled in passenger vehicles has increased by 11% (from 1991 to 1995), with the average distance travelled also increasing by 2% (ABS, 1997). With around four million trips being made on a typical weekday, only 6% of these are made by bus, train or ferry (Transport, 1998a).

At the local level, the *Liveable Neighbourhoods Community Design Code* (WAPC, 1997a) is a strategic policy statement endorsed by the WAPC for a three year trial period. It seeks to guide development towards greater sustainability by encouraging energy efficient urban village design that promotes access to public transport and facilitates cycling and walking, rather than car dependency.

The WAPC is commencing a review of key strategic planning considerations relating to the planning of Perth. This review will take account of the environmental constraints on Perth, including the extent to which land use planning may reduce or ameliorate air quality problems. The review, titled *Future Perth* will result in policies and strategies which provide direction across government. In particular it will guide the WAPC in the exercise of its statutory responsibilities, regarding the design of land uses, to maximise energy efficiency and minimise detrimental impacts on Perth's airshed. The study will investigate Perth in its regional context as well as at the metropolitan level.

Fast, modern, minimally polluting electric trains servicing Perth evening peak hour commuters.

LTP 2.1
Incorporate air quality issues in the development of *Future Perth*.

The *Future Perth* project aims to provide a new strategic plan for Perth. It will offer a series of strategies relating to environmental and resource protection, the community, the economy and infrastructure to guide the development of Perth for the next 10 to 20 years.

One of the principal aims of the project is to promote sustainable growth in the Perth metropolitan region from a social, economic and environmental perspective. *Metroplan* (DPUD, 1990), now termed *Future Perth*, contains the framework for urban growth in the Perth metropolitan region, for the period to 2021. (It is a guiding document, not a statutory requirement.) The implementation of *Future Perth* will seek to concentrate major employment and residential centres around public transport routes. Commercial centres and community facilities will be encouraged close to the public transport network. The underlying objective of *Future Perth* is to integrate public transport at an early stage in the development of new subdivisions.

Existing land use and transport processes will be reviewed in the implementation of the *Future Perth* project.

Lead Agency: MfP
Supporting Agencies/Organisations: WAMA, MRWA, Transport
Start date and duration: Under way, review period to be determined, and assess effectiveness at AQMP 2005 review.

LTP 2.2
Research and evaluate the application of urban consolidation strategies in the Perth metropolitan region.

The CSIRO conducted a Melbourne case study in 1997 to investigate the effects of six alternative urban forms on air quality (Manins *et al.*, 1998). Results from this study indicated that a "Compact City", focussing on increased population and density of an inner group of suburbs, appeared to be the most desirable approach to urban form. The "Compact City" scenario showed marked improvements in photochemical smog levels, carbon dioxide emissions and fuel consumption. However, concentrations of particles were considerably higher in the "Compact City" compared to other urban forms. Study results were not conclusive in showing that a particular urban form would deliver all desired air quality benefits. It is therefore important to consider all options that may have the potential to deliver air quality benefits, such as the development of regional focal points within the Perth metropolitan region that are supported by strategic public transport facilities and services.

Air quality strategies will be addressed as part of *Future Perth* to assist in the determination of the most appropriate urban form.

Lead Agency: MfP
Supporting Agencies/Organisations: DEP, Transport, WAMA, local government
Start date and duration: Start 2001 and complete within two years.

LTP 2.3
Develop a government policy position on increased levels of urban infill, density and renewal.

This action is contingent on the outcome of LTP 2.2. The purpose is to achieve a more compact metropolitan region and to reduce urban sprawl. This would include a statement of support for allowing more compatible mixed use activities to co-locate in urban areas. This could be achieved as a major initiative of *Future Perth*.

The *Liveable Neighbourhoods Community Design Code* (WAPC, 1997a) is available as a trial policy to guide development at the subdivision level. A similar policy is needed to support strategic regional centres, and will be undertaken as part of *Future Perth*.

Lead Agency: MfP
Supporting Agencies/Organisations: WAMA, DEP, Transport
Start date and duration: Start 2003 and complete within one year.

LTP 3
Integrate land use and transport planning.

An effective transport system is largely dependent on sympathetic land use planning and development. It requires land use and transport planners and developers to work closely together in achieving a desirable outcome.

Effective integration of land use and transport planning is essential for attainment of the overall objective of improving Perth's air quality, and should be an outcome of Strategic Regional Plans.

LTP 3.1
Identify the optimal public transport corridors and transport interchanges in Perth and undertake planning and reservation as a priority.

There is a need to identify strategic public transport spines that comprise rights of way or priorities for public transport services. The suburban railway network already exhibits these characteristics. Key strategic bus routes have been identified that link Strategic and Other Regional Centres.

The effectiveness of these public transport spines can be greatly enhanced by supportive land use developments around the nodes (eg. railway stations) on these spines. There is a need for cooperation between State and local government authorities to encourage such land use developments. The *Future Perth* process will assist in the identification of important nodes.

Lead Agency: Transport in collaboration with MfP
Supporting Agencies/Organisations: MRWA, DEP, local government, land developers
Start date and duration: Start 2002 and review annually, ongoing.

LTP 3.2
Implement Policy DC 1.6 *Planning to Enhance Public Transport Usage*.

In addition to the statutory requirements of the Statements of Planning Policy, the WAPC has endorsed a number of operational policies that are used to guide decision making on subdivision or development applications. *DC 1.6 Planning to Enhance Public Transport Usage* (WAPC, 1999) is of particular benefit. Review of the policy DC 1.6 is complete and its implementation is now required to further promote the integration of transport and land use planning.

Lead Agency: WAPC & MfP
Supporting Agencies/Organisations: Land developers, local government, Transport
Start date and duration: Start 2001 and complete initial review within 12 months, ongoing.

LTP 4
Encourage the adoption of energy efficiency principles in planning, building design and construction.

The inquiry into *Urban Air Pollution in Australia* (Australian Academy for Technological Sciences and Engineering, 1997) advocated the adoption of a whole-of-life approach to building and dwelling design. This includes construction and operation of buildings with a view to optimising both the embodied energy incorporated in the building and its life-time operating energy requirements. This issue is also addressed in the DAE section.

LTP 4.1
Support the development and implementation of an appropriate education campaign on energy efficiency and environmentally sensitive design.

The advantages of environmentally sensitive design including passive solar energy and energy efficient design along with the many other options are identified in *Liveable Neighbourhoods: Community Design Code* (WAPC, 1997a). Support would be given to assist representative bodies in the building industry and local government authorities in the development of campaign concepts and materials which would be appropriate for those bodies to implement to educate their

members, officers responsible for planning approvals and their wider client community as to these advantages.

Lead Agency: Office of Energy (OoE)
Supporting Agencies/Organisations: DLG, WAMA, MfP, Housing Industry Association (HIA), Master Builders Association (MBA), DEP, CCWA, PAN
Start date and duration: Start 2001, implement over 18 months.

LTP 4.2
Support the preparation of energy efficiency requirements in the Building Code for the design of new commercial and residential buildings, major renovations and redevelopments.

The implementation of these guidelines and polices would be through State policies, town planning schemes, subdivision and building approvals processes. This approach is aimed at the universal adoption of energy efficient design throughout the building sector and related agencies.

Lead Agency: DLG
Supporting Agencies/Organisations: WAMA, MfP, OoE, DEP, HIA, Transport
Start date and duration: Start 2001 and complete over five years.

LTP 4.3
Support an increase in the use of energy rating schemes for buildings.

The House Energy Rating Scheme for housing was introduced in Western Australia in 1996 as part of the Nationwide House Energy Rating Scheme (NatHERS). This scheme could be used to foster the promotion of the cost effectiveness of energy efficient principles in building design. Buildings would be rated on aspects concerning the use of energy in an efficient manner. Home energy rating schemes have been successfully established in the Australian Capital Territory and Victoria, based on a star rating system (similar to whitegoods).

Lead Agency: OoE
Supporting Agencies/Organisations: WAMA, local government, DEP, HIA, DLG
Start date and duration: Start 2001 and implement over two years.

Vehicle Emissions Management (VEM)

Of the wide range of sources contributing to the pollutant load into the Perth airshed, the emissions resulting from motor vehicles have been identified as being the single largest contributor (see Table 5 and Figure 8). With VKT expected to increase, there is a need to ensure that strategies are in place to manage transport emissions, both in the immediate and longer term.

Table 5: Contribution of air pollutants from vehicle emissions to the Perth airshed *(DEP, 2000b).*

Pollutant	Contribution (tonnes per year)	Contribution (%)
CO	228 290	81
NO_x	29 330	49
ROC	22 490	40
PM10	1 440	13
SO_2	710	4

Note: Contribution (%) calculated excluding biogenic emission estimates.

The significance of motor vehicle emissions in influencing the quality of the air we breathe is not restricted to the local or regional level. It has been recognised for some time that transport emissions are primary contributors to health risks and environmental damage at a global level, requiring a cooperative effort within and across jurisdictions to establish effective reduction strategies (Organisation for Economic Co-operation and Development (OECD), 1995). The push to minimise greenhouse gas emissions from the global vehicle fleet arising from the Kyoto Protocols provides an illustrative example.

In his statement *Safeguarding the Future: Australia's Response to Climate Change*, in 1997, Prime Minister John Howard announced a range of initiatives to assist in reducing greenhouse gas emissions from the transport sector. The $6.3 million package included a commitment to implement an Environmental Strategy for the automotive industry, which involves the introduction of mandatory fuel efficiency labelling, harmonisation of emissions standards with international standards, a 15% fuel efficiency improvement target by 2010, and the early phasing out of leaded petrol (Howard, 1997). These strategies, together with the Federal Government's commitment to develop a Compressed Natural Gas Infrastructure Program, are in alignment with many of the actions required to improve Perth's air quality at the regional level.

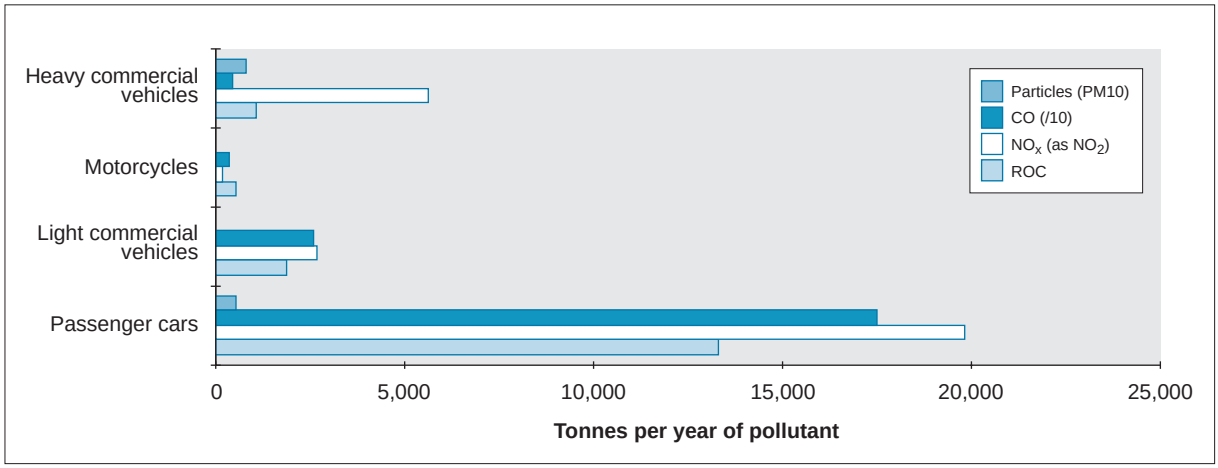


Figure 8: Emissions contribution of major air pollutants from vehicles (by type), estimated for 1998/99 *(DEP, 2000b).*

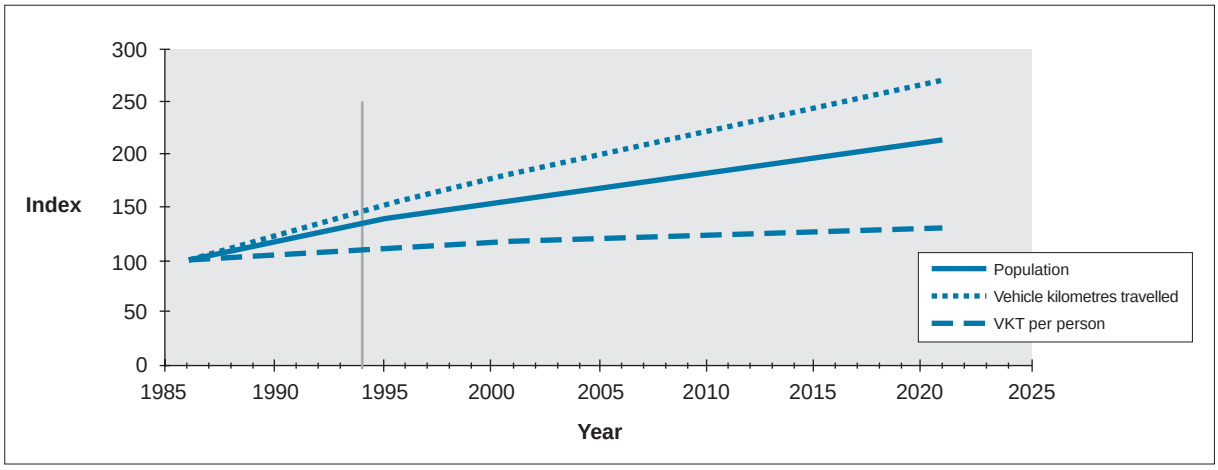


Figure 9: Travel extrapolation based on population growth patterns *(James, 1997).*

Achieving a reduction in the impact of motor vehicles on air quality can only be truly effective in the longer term by changes in the planning and infrastructure development of various transport modes. Current travel data indicates that VKT is increasing at a greater rate than the projected population growth. This increase in VKT is due to greater distances being travelled as low-density urban development continues to expand in the outer metropolitan region (see Figure 9). As such, a number of initiatives have been developed which seek to focus on reducing our reliance on private vehicle usage, including the Perth *Metropolitan Transport Strategy* (Transport *et al.*, 1995), the *Better Public Transport: Ten-Year Plan for Transperth* (Transport, 1998a), the *Liveable Neighbourhoods: Community Design Code* (WAPC, 1997) and *Transform WA: Securing Western Australia's Future* (MRWA, 1998). These broader strategies, which also consider the issues of Travel Demand Management (TDM), telecommuting and car-pooling, are addressed as part of the LTP section of this plan.

A management strategy for vehicle emissions needs to reflect the different contributions of pollutants from various road transport types. For instance, evidence suggests that particles are largely contributed by diesel-powered engines, whilst the less visible pollutants such as NO_x, CO and ROCs fall primarily under the responsibility of the larger petrol-fuelled passenger vehicle fleet. In addition, a number of air toxics, some of which are known or suspected to be carcinogenic, have been shown to be emitted primarily from motor vehicle exhausts. This may be of particular concern due to the capacity of these compounds to be adsorbed onto particles. A vehicle's emission will be influenced by the nature of its design and operation. This includes the quality of the fuel used to power the vehicle. Table 6 indicates the status of fuel quality standards in Australia and Western Australia, as well as overseas, and the dates from which the standards are applicable.

In general, to achieve durable improvements in air quality by decreasing vehicle emissions, there are a number of generic policy approaches which may be adopted. *Technological advances* in vehicle design and engine specifications, through the Australian Design Rules (ADRs), can ensure that new vehicles are intrinsically cleaner and emit less harmful pollutants. Existing vehicles may be periodically checked to determine compliance to emission standards over the

Table 6: Fuel quality standards (current and future) *(European Commission, 1999, Walsh, 1999 and Coffey Geosciences, 2000).*

		Petrol (ULP)					Diesel
Country	**Timing**	**Sulfur (ppm.w)**	**Lead (g/L)**	**Benzene (% vol)**	**RVP (kPa)**	**Aromatics (% vol)**	**Sulfur (ppm.w)**
Australia	current (Aust. Standards) 2002 2006	500	as permitted by legislation (<0.013 g/L in WA) Standards yet to be confirmed Standards yet to be confirmed	5	80	no specification	5000
Europe	current (Euro III) 2005 (Euro IV)	150 50	0.005 -	1 1	60 55	42 35	350 50
Hong Kong	current (since 1997) 2001	500 150	0.005 0.005	5 1	74-88 60	 42	500
South Korea	current 2002	200 130	0.013 0.013	2 1.5	82 70	35 30	200
USA	current (since 1995) 2004 2005 2006	- 300 180 80	-	1	47		500 15
Western Australia	current (2000) 2001	- 150	0.013 0.005	2 1	72 67	48 42	500 500

life of the vehicle, by *in-service maintenance*. *Cleaner fuels*, and the penetration of alternative transportation fuels into the automotive market, will decrease emissions and allow the transition to cleaner, more sustainable energy sources in the longer term. Finally, reductions in transport demand may be achieved through *behavioural changes* of commuters to consider alternative transport options, which has a strong element of public education and awareness.

Objective for Vehicle Emissions Management

To steadily improve Perth's air quality so we have clean air to a level that is acceptable to the community, by:

- reducing overall vehicle usage and encouraging the use of less polluting vehicles and fuel sources; and
- reducing emissions per vehicle kilometre travelled from both the current and future vehicle fleet in Perth.

Strategies for Vehicle Emissions Management

The key strategies are to:

1. implement on-road enforcement of controls on excessive vehicle emissions;
2. encourage the removal of older vehicles from the Perth fleet;
3. reduce vehicle emissions through appropriate in-service emission testing;
4. promote the use and management of clean fuels in Perth; and
5. improve vehicle technology to produce 'cleaner' new vehicles.

Actions for Vehicle Emissions Management

VEM 1
Implement on-road enforcement of controls on excessive vehicle emissions.

While new technology continues to reduce the emissions from new vehicles, older vehicles are of increasing concern for their contribution to atmospheric pollutants. The *National In-Service Vehicle Emissions Study* showed that, while the oldest vehicles were individually the highest emitters, they constitute only a small proportion of the total vehicle population (Federal Office of Road Safety (FORS), 1996). As a result, it is generally the 'middle aged' cars which have been shown to be the greatest source of exhaust pollutants. On this basis, it is essential to ensure that corrective action is established to control excessive pollution from the existing Perth vehicle fleet.

The Australian fleet is characteristically old compared to the USA or Europe, with Western Australia being slightly older than the national average of 10.7 years (ABS, 1999). This, combined

with the estimation that a focus of attention on the worst 20% of vehicles is likely to deliver 80% of the attainable reductions in emissions, supports on-road enforcement of controls on gross polluters as an effective means of reducing transport emissions in a relatively short period of time.

VEM 1.1
Introduce the 'ten-second' regulations for visibly smoky vehicles.

The *National Transport Reform (Vehicle Standards) Regulations 1998* established guidelines for individual States to adopt the enforcement of a ten-second (visual determination) emission limit for vehicle exhausts ("Ten-Second Rule"). Endorsement by State Cabinet will allow the Western Australian Government to introduce the regulations. The State Government has decided on a staged approach, progressing from an initial emphasis on community awareness to gradual full enforcement on gross polluters by authorised Police and Transport officers.

Lead Agency: Transport
Supporting Agencies/Organisations: DEP, Western Australian Police Service (WAPS), Royal Automobile Club of Western Australia (RACWA)
Start date and duration: Start 2001 and review within one year.

VEM 1.2
Review the DEP Smoky Vehicle reporting program.

This voluntary reporting program has operated since July 1995. In that time over 23,000 vehicles have been reported, with almost 300 multiple reports having been identified. With the introduction of the "Ten-Second Rule", the future of the program is being re-assessed.

The existing Smoky Vehicle program will be evaluated for the number of vehicles reported, the profile of vehicle models and age, and its effectiveness in encouraging vehicle owners to take action. The enhancement and continuation of the program primarily as a means of increasing community awareness in association with the new "Ten-Second Rule" will be considered.

Lead Agency: DEP
Supporting Agencies/Organisations: Transport, RACWA
Start date and duration: Start 2001, to be completed within four months.

VEM 2
Encourage the removal of older vehicles from the Perth fleet.

Accelerated vehicle retirement programs have been introduced elsewhere, designed to provide incentives for owners to trade their older high polluting vehicles with cleaner forms of transport. The voluntary *Scrap It* program in British Columbia, for instance, offers monetary incentives towards a new vehicle, a 1988 or newer used vehicle, a new natural gas vehicle, bicycle or taxi and transit passes.

The Federal Government has recently agreed to consider the recommendations of a report proposing a vehicle buy-back scheme in Australia. However, this is only at an early stage of evaluation. To consider the feasibility of introducing a scrappage program specific to Western Australia, a working group involving representatives from the DEP and Transport will be established. This working group would be responsible for the co-ordination of investigations and public discussions to determine the viability and acceptability of proposed mechanisms to encourage greater turnover of the Perth vehicle fleet. This will also determine the need to address the turnover rates of trucks and other commercial vehicles within the region.

VEM 2.1
Evaluate the potential for introducing a voluntary accelerated vehicle retirement (scrappage) program in Perth.

The relative costs and benefits (economic, environmental and social) of implementation will be assessed. Consideration will be given to the appropriateness of proposed options to ensure that owners are given incentives to choose 'cleaner' forms of transport. Equity issues will also be taken into account.

The options to be evaluated include:

- 'business as usual' (maintain existing Government policies without further modifications);
- introduction of a voluntary scrappage program, taking into account the merits of other programs established elsewhere; and
- other feasible alternatives to encourage greater turnover of the Perth private and commercial fleet.

Lead Agency: DEP in collaboration with Transport
Supporting Agencies/Organisations: RACWA
Start date and duration: Start 2001, to be completed within six months.

VEM 2.2
Implement the committed outcomes of the evaluation process to encourage the removal of older vehicles from the Perth fleet.

This action is contingent on the outcome of the review process, described by VEM 2.1. If the evaluation indicates it to be a viable action, a voluntary scrappage program, with support from relevant industry members, would be implemented.

If other alternatives are shown to be more beneficial, then preference will be given to their implementation instead.

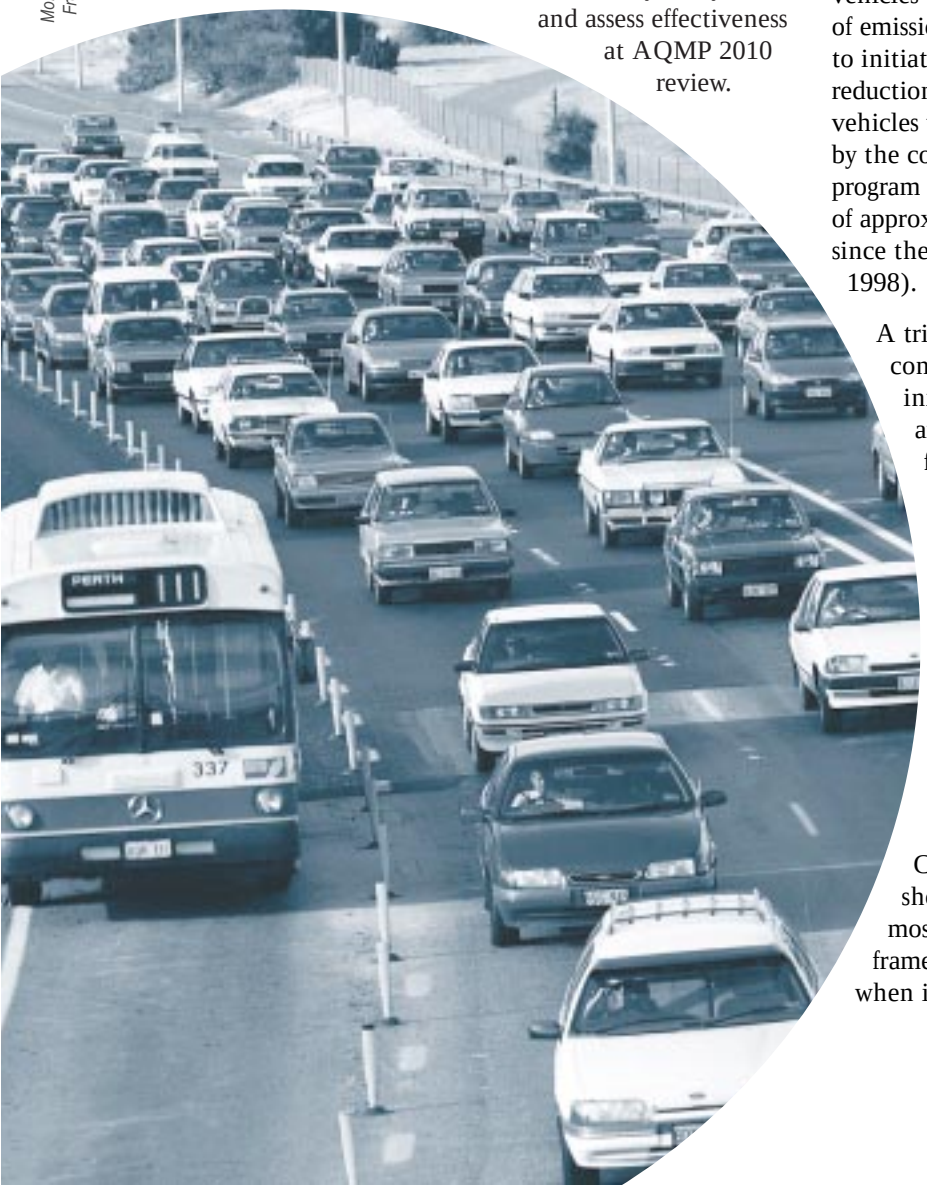
Lead Agency: DEP in collaboration with Transport
Supporting Agencies/Organisations: RACWA, relevant industry representatives
Start date and duration: Contingent on VEM 2.1, implementation of evaluation outcome within 18 months, and assess effectiveness at AQMP 2010 review.

VEM 2.3

Assess and develop policies to reduce emissions from the light commercial vehicle (LCV) sector.

The LCV sector is responsible for 68% of freight movements in the Perth metropolitan region, although comprising only 10% of total freight (Transport, 1999). The need to address this issue will be determined on completion of VEM 2.1; the evaluation of options to remove older vehicles from the Perth fleet.

Lead Agency: Transport
Supporting Agencies/Organisations: commercial sector, DEP
Start date and duration: Start 2003, review status of LCV sector every five years, and assess effectiveness at AQMP 2010 review.



Morning peak hour traffic on the Kwinana Freeway.

VEM 3

Reduce vehicle emissions through appropriate in-service emission testing.

The control of exhaust and evaporative emissions from vehicles once they are on the road may be achieved through periodic inspection and maintenance (I/M) programs. International experience has shown that good on-road emission performance is significantly aided by effective vehicle maintenance and adjustment. I/M programs focus on identifying those vehicles which exceed acceptable emission limits due to improper maintenance or tampering and require remedial repair (OECD, 1995). A number of tests have been developed which allow the rapid quantification of exhaust emissions of CO, hydrocarbon (HC) and NO_x, and evaporative losses of HC from fuel tank caps from light-duty vehicles. Many I/M programs have progressed to include measuring the opacity of the exhaust gases from heavy-duty (diesel) engines, which is reflective of the amount of particles emitted by the vehicle.

Numerous examples around the world have highlighted the effectiveness of vehicle I/M programs in reducing emissions of key pollutants. The *AirCare® Program* in British Columbia, for instance, has estimated that repairs completed on inspected vehicles have cumulatively achieved a 30% reduction of emissions relative to the baseline conditions prior to initiation of the program in 1992. An additional reduction of 22% from the replacement of older vehicles with newer, lower-emitting vehicles, assisted by the complementary accelerated retirement program *Scrap It*, has indicated an overall reduction of approximately 50% in transport-related emissions since the start of the program (Stewart & Gourley, 1998).

A trial vehicle I/M program is currently being conducted by the New South Wales EPA. This initial centralised program currently operates around the establishment of two testing facilities, which determine exhaust emissions of light duty vehicles using the IM240 transient dynamometer short test method. If it is shown that a full I/M program would be beneficial, the New South Wales EPA intends to increase the number of testing facilities, with a view to ensure that a testing station is available within nine kilometres of Sydney residents. The preliminary results of the trial program may assist in the evaluation of a similar program in Western Australia.

Comprehensive scenario modelling work has shown that in-service inspection programs are most effective in the short to medium time frame, and the greatest overall benefits are gained when integrated with longer term strategies such as

tightening vehicle manufacturers' specifications and encouraging the use of alternative fuel sources. Experience in various countries indicates that the reduction of on-road emissions is maximised by ensuring that a proposed enforcement program is well thought out and evaluated prior to implementation. It is for this reason that the Western Australian Government will adopt a staged approach, so that a field trial and comprehensive evaluation will determine the need for introducing a regular vehicle inspection program in Perth.

VEM 3.1
Evaluate the various emission testing options for their cost effectiveness and environmental benefits, for introduction into Perth.

A review of the existing schemes will be undertaken to evaluate their suitability to Perth. Specific consideration will be given to establishment and operating costs, along with consideration of the relative benefits of centralised and decentralised testing schemes, criteria for testing, and the effectiveness of the trial random road-side testing system (see VEM 3.2). A comprehensive cost-benefit analysis of all potential options will be carried out to identify the most appropriate means of reducing in-service emissions from the Perth motor vehicle fleet.

The evaluation will consider a range of proposed scenarios to determine the largest gains in improving air quality in the Perth airshed, including:

- 'business as usual' (maintain existing Government policies without further modifications);
- introduction of a regular I/M program, considering a range of testing frequencies (annual, or biennial), and means by which to ensure social equity is achieved; and
- alternatives to vehicle in-service testing.

Lead Agency: DEP
Supporting Agencies/Organisations: RACWA, Transport
Start date and duration: Start review in July 2001, to be completed within nine months.

VEM 3.2
Trial a random road-side emissions testing system as a screening method for comparison of on-road vehicle emissions against appropriate standards.

A trial road-side testing regime will be undertaken in conjunction with existing regulatory approaches. The purpose of the trial program will be to determine its effectiveness as a method for identifying vehicles that require further attention. The trial would involve two components, to focus on heavy duty and light duty emissions respectively. Initial random testing of particle levels from diesel engines is to be established with the 'Truckalyser' weight-check system currently employed by the WAPS, and light-duty vehicle emissions testing equipment may accompany Random Breath Test mobile units in the Perth metropolitan region. As part of the trial heavy vehicle testing system, the feasibility of introducing an emission accreditation system for diesel fleet owners will be evaluated. The purpose of this scheme will be to enable accredited private fleets to circumvent random road-side checks.

Lead Agency: DEP
Supporting Agencies/Organisations: Transport, WAPS, RACWA
Start date and duration: Trial to start 2003, to continue for 12 months.

VEM 3.3
Implement the committed outcomes of the evaluation process and trial to reduce in-service emissions from the Perth motor vehicle fleet.

It was agreed by all working group stakeholders that there will be a commitment to implement the outcomes determined by the comprehensive evaluation, described in VEM 3.1 and VEM 3.2.

If the evaluation and random roadside trial support the conclusion that periodic vehicle inspection and maintenance brings a substantial benefit in terms of maintaining and enhancing Perth's air quality, a compulsory program will be established for the metropolitan region. If there are alternative means which are identified as being more cost-effective and more beneficial in minimising in-service vehicle emissions, it is agreed that these will be developed further.

Lead Agency: DEP
Supporting Agencies/Organisations: Transport, WAPS, RACWA
Start date and duration: Contingent on VEM 3.1 and VEM 3.2, assess effectiveness at AQMP 2005 review.

VEM 3.4
Establish a training program for the automotive industry to ensure sufficient expertise in emissions testing, maintenance and repairs.

Automotive industry members need to be provided with adequate training in order to keep up with new developments in exhaust emission testing equipment and repair facilities.

A series of educational workshops will be implemented, aimed at increasing the expertise to improve the emission performance of Perth's motor vehicle fleet. Consideration will be given to

developing an accreditation system for vehicle repairers and mechanics to repair those vehicles identified as excessive polluters.

Lead Agency: DEP
Supporting Agencies/Organisations: Chamber of Automotive Industries (Western Australia), Motor Trades Association (MTA), RACWA
Start date and duration: Start 2001, implement within 12 months, and assess effectiveness at AQMP 2005 review.

VEM 3.5
Periodically review emissions testing equipment and technology.

Ongoing technological advances in emissions testing equipment necessitates the periodic evaluation of the strategies which are most appropriate for Perth. As new methods and equipment are established, they need to be considered so as to ensure the reductions in vehicle emissions are achieved in the most cost-effective and reliable manner.

Lead Agency: DEP
Supporting Agencies/Organisations: RACWA, Transport, MTA, Chamber of Automotive Industries (Western Australia)
Start date and duration: Start 2001, review available technology every three years, and assess effectiveness at AQMP 2005 review.

VEM 4
Promote the use and management of clean fuels in Perth.

In addressing the impact of motor vehicle emissions on Perth's air quality, consideration needs to be given to the quality of automotive fuel in the region. The progressive phasing out of lead in Australian fuel has shown to be integral in reducing atmospheric lead levels in Perth, but there are a number of other components of fuel which may be reformulated so as to gain similarly positive results for reducing vehicle emissions.

Evaporative losses of hydrocarbons from vehicles have been shown to contribute significantly to total vehicular emissions of ROCs contributing to photochemical smog formation, especially on days of high temperatures experienced during the summer months. By reducing fuel vapour pressure (commonly measured as Reid Vapour Pressure (RVP)), the volatility of the fuel is lowered. This in turn has the effect of decreasing the amount of unburnt hydrocarbons released into the atmosphere. International experience has demonstrated RVP reduction to be an effective means of minimising ROC emissions, not just from vehicles but also from the handling and storage of automotive fuel by industry and fuel retailers. The oil industry and the New South Wales EPA, for instance, have established a voluntary agreement to maintain a 9 kilopascals (kPa) reduction in RVP during the summer months, to minimise evaporative (HC) emissions.

Similar benefits are seen in the reformulation of other parameters as well. Levels of benzene, one of the key air toxics of concern, are an important consideration in determining the relative impact of motor vehicle emissions on public health. The sulfur content of diesel fuel is widely recognised as a key factor determining the amount of particulate matter being emitted by diesel engines, and this is currently being addressed.

BP Refinery (Kwinana), in response to the *Report of the Select Committee on Perth's Air Quality* (Legislative Assembly, 1998), released its *Cleaner Fuels Western Australia Strategy* in 1998, which outlined proposed modifications to fuel specifications in Western Australia (BP Kwinana, 1998). Some of the benefits include an estimated 35-40% reduction in vehicle evaporative ROC emissions by lowering RVP from 75 kPa to 67 kPa. Similarly, a 41% decrease in benzene emissions in the Perth metropolitan region may be gained by limiting petrol benzene content from 5% to 2%, in conjunction with summer RVP reduction (BP, Kwinana 1998).

After substantial consultation with the oil industry and other stakeholder groups, the Premier launched the Western Australian government's 'Cleaner Fuel Initiative' on August 1999, which saw the establishment (as of January 1, 2000) of regulations to deliver Australia's cleanest fuel to Western Australians.

The current (2000) and future (2001) specifications for fuel quality in Western Australia, are detailed in Table 6.

VEM 4.1
Develop a fuel formulation policy for locally produced and imported petrol and diesel automotive fuel.

An agreed fuel policy will be developed which will set the standards and goals for fuel quality parameters in both locally produced and imported automotive fuel. The policy will provide a strategic focus on the development of fuel standards so that Western Australia's fuel quality remains consistent with international trends of harmonisation. The direction for cleaner fuels will be defined in light of the new and emerging vehicle technologies being developed to control vehicle emissions even further. These considerations will include advanced catalyst formulations which are increasingly sensitive to contaminants such as lead, sulfur and phosphorus in the fuel.

Lead Agency: DEP
Supporting Agencies/Organisations: Transport, oil industry representatives, community organisations
Start date and duration: Start 2001 and complete within six months and review 2005.

VEM 4.2
Regulate fuel quality standards.

Controlling the quality of automotive fuel used by vehicles in Western Australia needs to consider not only the existing manufacturers supplying local and imported fuel, but also new enterprises which are likely to enter the market in the future. Regulations established under the *Environmental Protection Act 1986* specify the minimum fuel quality standards which are to be complied with by all distributors, and provide immediate benefits in reducing vehicle-related emissions contributing to photochemical smog formation.

The Premier's announcement of the Western Australian Government's 'Cleaner Fuel Initiative' prescribed a move to 'EURO II' and 'EURO III' standards for fuel quality, which are an improvement on existing Australian standards. The *Environmental Protection (Diesel and Petrol) Regulations 1999* were subsequently gazetted on 17 December 1999 to give effect to the Premier's commitment. The regulations achieved the staged introduction of low sulfur diesel (500ppm) to reduce particulate emissions from the diesel fleet. Levels of key parameters in petrol, such as benzene, RVP, aromatics and sulfur, have been lowered, in addition to phasing out lead in petrol. The regulations will need to be reviewed in the future to ensure best practice is achieved consistent with international trends to provide better quality automotive fuels.

Lead Agency: DEP and EPA
Supporting Agencies/Organisations: Industry representatives
Start date and duration: Regulations have been gazetted, and will be kept under review.

VEM 4.3
Encourage national moves towards regulating for cleaner fuel formulation.

In addition to strategies developed at the State level to consider automotive fuel quality, the Perth AQMP needs to address and encourage national moves at the Commonwealth level also. The Federal Government has recently completed its National Fuel Quality Review process with a view to develop national fuel quality standards for petrol and diesel to target parameters of key environmental and operational importance. The Western Australian Government has been actively involved with the national process and will continue to encourage further improvements in fuel quality for its air quality benefits.

Current Western Australian regulations maintain the position of supporting higher quality fuels than that being proposed at the Commonwealth level.

Lead Agency: DEP
Supporting Agencies/Organisations: Motor Vehicle Environment Committee (MVEC), Transport, MTA, OoE
Start date and duration: Started 2000, ongoing.

VEM 4.4
Promote the introduction of Stage II vapour recovery through national forums.

Stage II controls require the installation of equipment at petrol stations to capture fuel vapours which are released when filling vehicles. Improvements in the handling of fuel are likely to result in decreased evaporative emissions of ROCs. National bodies (eg. MVEC) will be encouraged to determine the feasibility of implementing Stage II fuel vapour recovery in Australia.

Lead Agency: DEP
Supporting Agencies/Organisations: MVEC, industry representatives
Start date and duration: Start 2001, ongoing.

VEM 5
Improve vehicle technology to produce 'cleaner' new vehicles.

The testing of the exhaust emissions from a family car as part of RAC's Air Care campaign.

The ADRs, determined under the Federal *Motor Vehicle Standards Act 1989*, control the design parameters and emission limits of new vehicle models. The current standards are approximately 10 years behind the control measures established in the USA and member states of the European Union (EU), highlighting the clear need to participate in national moves towards harmonisation of Australian vehicle design rules with international standards.

The Federal independent inquiry into *Urban Air Pollution in Australia* (Australian Academy for

Technological Sciences and Engineering, 1997) recognised that the United Nations Economic Commission for Europe (UN ECE) regulations are the only truly international standards for motor vehicle emissions (Australian Academy of Technological Sciences and Engineering, 1997). Because of this, there is a clear trend that future Australian certification standards will follow those of the UN ECE, rather than the USA standards, which have previously formed the foundation of existing ADRs. This was formalised in December 1999 when the Commonwealth gazetted five new ADRs, which will set more stringent emission limits for new vehicles commencing from 2002/3. Euro II, III and IV limits (set by the UN ECE) have been defined for new heavy duty engines to be introduced progressively over the next seven years, and Euro II and III emission limits for light duty engines have also been established.

Strategies also need to be developed which facilitate the adoption of cleaner alternative fuels as technological advances allow them to be viable options in the future (compressed natural gas (CNG), liquefied petroleum gas (LPG), electric vehicles, hydrogen fuel cells, hybrids). Particulate emissions from LPG and CNG have been shown to be substantially lower than achievable with traditional diesel fuels, although significant improvements for diesel vehicles are seen with the use of low sulfur diesel and oxidation catalyst technology. The emissions of air toxics from the use of LPG and CNG is also much lower compared to equivalent petrol and diesel vehicles (especially benzene, acetaldehyde, formaldehyde and 1,3 butadiene) (Australian Academy of Technological Sciences and Engineering, 1997). Figures 10 and 11 summarise the differences.

The Western Australian Government currently has in place an LPG vehicle fleet trial. The two year program commenced in July 1998, and is co-ordinated jointly by the DEP, Transport, OoE and the Department of Contract and Management Services (CAMS). An evaluation of the trial data in 2000 will provide some comparison of the relative efficiency of LPG fuelled fleet vehicles compared to conventional petrol vehicles, although further work is required to evaluate relative emission performance of the LPG fleet. Consideration should also be given

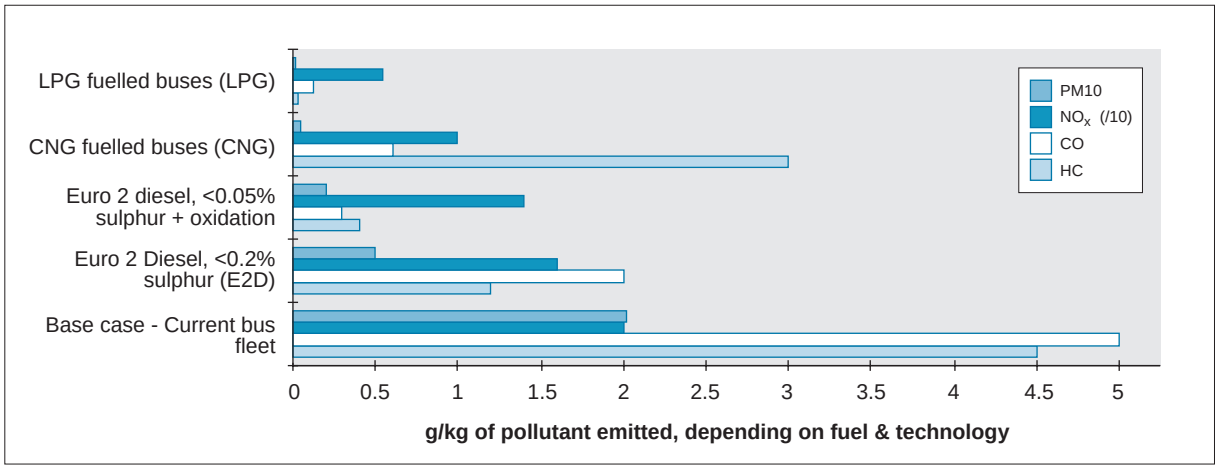


Figure 10: Variation in pollution emissions based on bus fuel type and quality *(Transport, 1998b).*

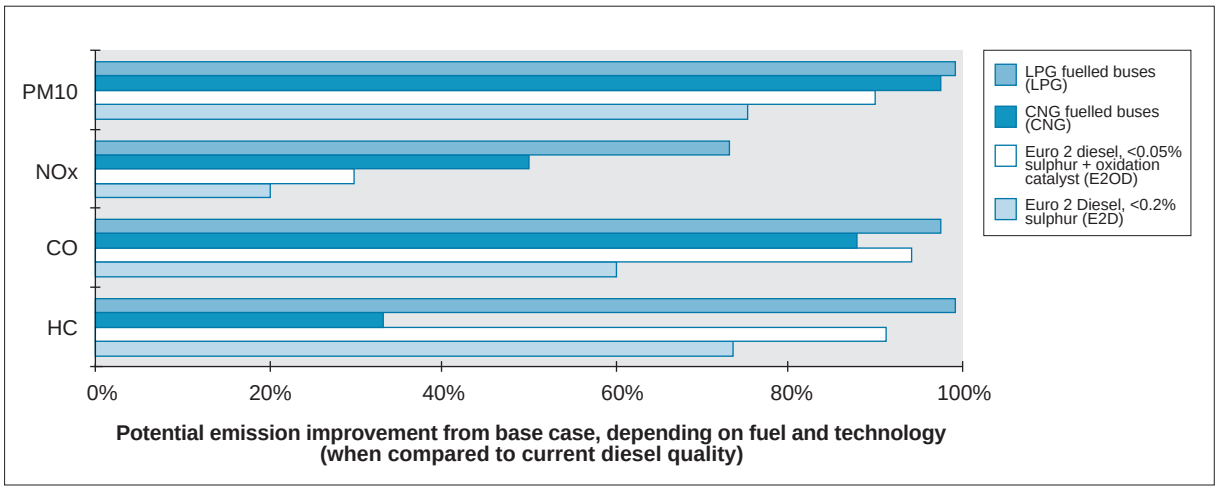


Figure 11: Potential emission improvements based on bus fuel type and quality *(Transport, 1998b).*

to recent developments in the marketing of dedicated LPG vehicles which demonstrate significant emission reduction benefits while overcoming some of the previous limitations of dual-fuelled passenger vehicles.

The Western Australian State Government has recently established an incentive scheme to encourage the use of LPG by contributing $500 per vehicle towards the cost of a new dedicated LPG powered vehicle, or the conversion of petrol powered vehicles. State Cabinet has also recently endorsed the conversion of part of the Government car fleet to LPG.

In addition to improved emissions performance, CNG is also relatively simple to produce and is currently excise-free. Presently, CNG is used for depot-based vehicles operating within a limited radius of major population centres. CNG vehicles may be used more widely in the future with the development of refuelling infrastructure and improvements in on-board fuel storage and vehicle range.

Alternative vehicle technology is making rapid progress around the world. The mandating by California that 10% of new vehicle sales be zero-emitting by 2003 has been a major initiative. All major vehicle manufacturers, supported by major oil companies, are trialing alternative fuels and power sources.

A number of hybrid powered vehicles have been developed and are being tested. Battery powered vehicles are also being tested but are limited by the battery technology in terms of the vehicle performance that can be produced.

Fuel cells are emerging as perhaps the most likely next major transport power source. Most major vehicle manufacturers have significant research and development programmes. Fuel cell powered buses have been successfully evaluated under operational conditions in several cities in North America. Major oil companies such as BP and Shell see their future, at least in part, as suppliers of hydrogen to power fuel cell vehicles.

VEM 5.1
Support the consistency and early adoption of Australian Design Rule emission standards with international best practice emission standards.

In May 1999 the MVEC completed a major review of national vehicle emission standards and recommended the phased introduction of new, tighter standards harmonised with international standards. This resulted in the introduction of ADRs 30/01, 79/00, 79/01, 80/00 and 80/01 to encourage alignment with the *Euro* or equivalent USA standards. Support for the adoption of more stringent vehicle emission standards in Australia will be pursued through national forums, although a separate implementation time frame may be pursued.

Lead agency: DEP
Supporting agencies/organisations: MVEC, Transport
Start date and duration: Started 1999 ongoing, and assess effectiveness at AQMP 2010 review.

VEM 5.2
Support national moves to encourage the co-ordination of vehicle emission standards with automotive fuel standards.

Smoke emitted from a vehicles exhaust.

The greatest environmental benefits of developing more stringent automotive fuel standards can only be truly realised if there is a sufficient market of vehicle engines which are appropriately designed to benefit from the different fuel quality. There is a clear need to harmonise changes made by automotive engine manufacturers, to improve emission performance with those changes which are to come about through the adoption of the UN ECE emission standards.

Lead Agency: DEP
Supporting Agencies/Organisations: Transport, MVEC, National Road Transport Commission (NRTC)
Start date and duration: Start 2000, and assess effectiveness at AQMP 2005 review.

VEM 5.3
Report on the effectiveness of the government fleet LPG trial.

The preliminary results of the government LPG fleet trial, in conjunction with those obtained elsewhere, will be used to determine the feasibility of enhancing the trial to incorporate a greater proportion of the government light-duty vehicle fleet. An evaluation of the results from other studies on LPG will be undertaken concurrently. This is to overcome the limited amount of information available locally due to the replacement of government vehicles at a relatively low mileage.

Lead Agency: CAMS
Supporting Agencies/Organisations: DEP, OoE, Transport
Start date and duration: Report 2001.

VEM 5.4
Investigate and promote the benefits and feasibility of using CNG and LPG as fuel sources for the road passenger transport and freight sectors where appropriate.

The potential relative health, environmental and economic benefits of LPG and CNG over current dominant fuels will be investigated. This study may also look into the expansion of CNG outlets in Perth, and methods for encouraging the use of LPG and CNG as clean alternative fuels. Funding will be sought from the Commonwealth Government to contribute to the establishment of a CNG refuelling infrastructure in Perth.

The Commonwealth Government has funded through the Alternative Fuels Conversion Program, a trial of five new technology CNG buses. The trial is being undertaken by Transport and if successful it will be expanded and an additional 20 CNG buses introduced into the government bus fleet.

Lead Agency: DEP
Supporting Agencies/Organisations: Transport, HDWA, OoE, AlintaGas, relevant industry representatives
Start date and duration: Start 2001, to be completed within two years.

VEM 5.5
Investigate the use of electric, alternative fuel vehicles and ultra-light vehicles.

Small electric vehicles have been shown to be very economical compared to most small cars, and demonstrate zero emission levels. As automotive technology advances, it is appropriate to develop effective strategies to encourage the greater uptake of electric, hybrid and fuel cell vehicles as they continue to penetrate the Australian market. Hydrogen fuel cell buses may become significant in public transport. Available research and development materials will be reviewed periodically, particularly in the area of new fuel technologies.

Lead Agency: Transport
Supporting Agencies/Organisations: RACWA, DEP, MRWA, local government, OoE
Start date and duration: Start 2002, complete initial report within 6 months, and assess effectiveness at AQMP 2010 review.

Domestic Activities Emissions (DAE)

The daily activities of all individuals have a significant impact on Perth's air quality, a point which is frequently overlooked. Traditionally, attention has focussed on single visible point sources as primarily contributing to atmospheric pollution. However, it is now clear that the cumulative effects of our actions at work and at home contribute significantly to smog or haze events in the Perth metropolitan region. The importance of vehicle emissions and the use of more environmentally sustainable transport modes in maintaining Perth's air quality has been discussed previously (see the discussions referring to VEM and LTP), but a range of other domestic activities are also significant issues which need to be addressed.

The *Perth Haze Study* (DEP, 1996), for instance, showed domestic smoke to be a primary contributor towards winter haze events in the region (see Figure 16, pg 52), with other sources dominating during other times of the year. Of the area-based emissions that contribute to the particle load in Perth, domestic fuel combustion is the largest source, contributing more than 50% of the total amount emitted annually (see Figure 12) (DEP, 2000b). The data compiled for the Perth-area emissions inventory revealed a total of 123,700 wood heaters in the Perth metropolitan region. There is also a need to address the impact arising from 'backyard burning' practices, and to encourage alternative means of domestic green waste disposal.

The concern over domestic emissions is not solely restricted to fine particles - a range of other sources also generate a significant amount of NO_x, CO, ROCs and semi-volatile air toxics (Australian Academy of Technological Sciences and Engineering, 1997). For instance, solvent use and the application of surface coatings are responsible for some 19% and 23% of the area-based emissions of ROCs respectively (see Figure 13). Even equipment such as lawn mowers, especially those with two-stroke engines, have been shown to emit a disproportionately large amount of ROCs and CO.

Objective for Domestic Activities Emissions

To steadily improve Perth's air quality so we have clean air to a level that is acceptable to the community, by:

- reducing the contribution of localised domestic smoke sources to haze formation in the Perth metropolitan region;

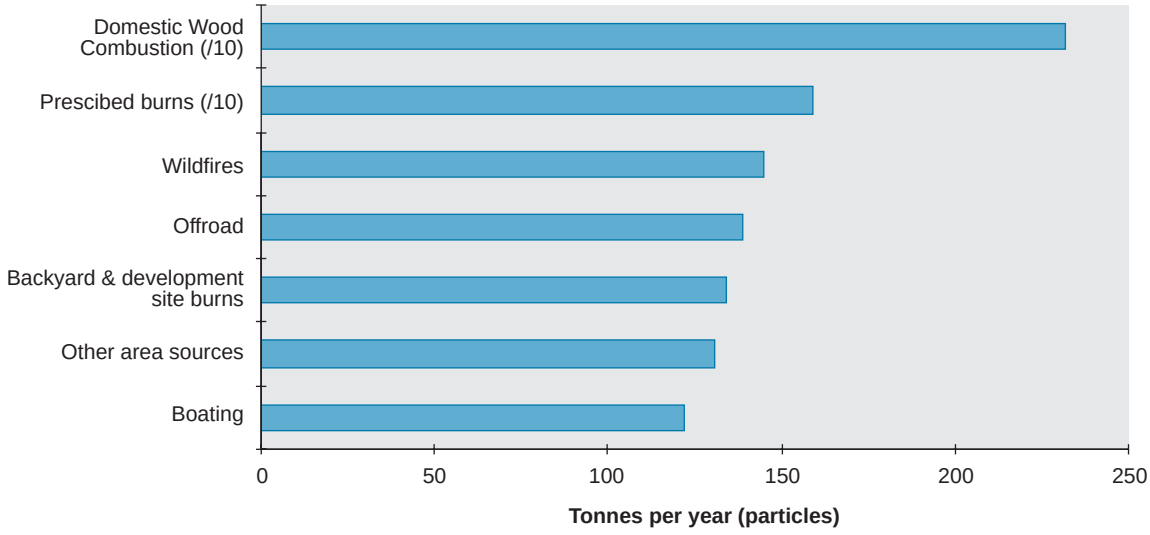


Figure 12: Aggregated area-based sources of particles in the Perth airshed, 1998/99 *(DEP, 2000b).*

- promoting the use of energy efficiency principles in building design and construction; and
- increasing community awareness of the air quality impacts of domestic products and promoting the use of alternatives.

Strategies for Domestic Activities Emissions

The key strategies are:

1. reduce emissions from solid fuel heaters through improved design, installation and use;
2. ban 'backyard burning' practices in urban residential areas of the Perth metropolitan region;
3. increase energy efficiency of domestic dwellings through better insulation and home design and by adoption of energy efficiency principles in building design and construction; and
4. encourage the community to consider air quality issues when purchasing domestic products.

Actions for Domestic Activities Emissions

DAE 1
Reduce emissions from solid fuel heaters through improved design, installation and use.

The contributions of domestic wood heating appliances to haze concentrations in Perth have been shown to be substantial. During episodes of winter haze events, smoke accumulation from domestic sources is the primary contributor, due to increased reliance on wood heaters during the colder months.

The *Environmental Protection (Firewood Supply) Regulations 1998* mandates compliance with AS4013-1992 (Standards Australia, 1992) for the sale of new and used wood heaters, and requires the moisture content of sold wood to be no greater than 20%. This design requirement, however, is only one aspect of managing emissions from solid fuel appliances. There is also a clear need to increase industry awareness of the correct installation procedure, so as to reduce nuisance smoke received by neighbours. Also, a greater appreciation by householders of the correct operating procedure for heaters has been shown elsewhere to be very beneficial in reducing domestic wood smoke emissions and improving heating efficiency.

DAE 1.1
Conduct a full lifecycle analysis of all available domestic heating alternatives.

The total energy efficiency and lifetime emissions of all heating sources currently available for domestic use (wood, gas, kerosene, electricity) will be investigated. Data will be collated to facilitate a comparative representation of market products to enhance consumer knowledge. Consideration will be given to undertaking the development of the lifecycle analysis, in co-operation with the Life Cycle Institute Co-operative Research Centre, Australia.

Lead Agency: DEP
Supporting Agencies/Organisations: OoE, AlintaGas, Western Power, universities, local government, Australian Home Heating Association (AHHA)

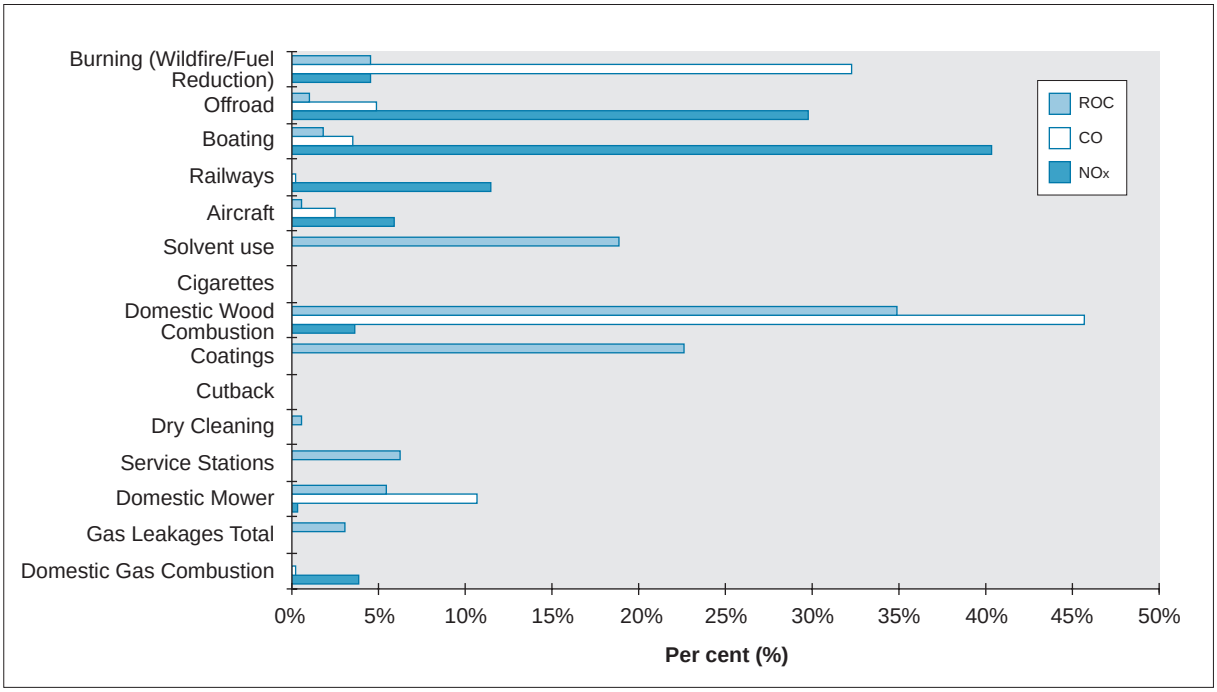


Figure 13: Domestic (area) source contributions to ROC, CO and NO_x in the Perth airshed, 1998/99 *(DEP, 2000b).*

Start date and duration: Start 2001 and complete within 18 months.

DAE 1.2

Develop incentives to encourage home owners to use alternative forms of heating.

The outcomes of action DAE 1.1 (lifecycle analysis) will be used to implement effective methods to change consumer behaviour regarding the purchase of heating appliances. Such incentives should initially focus on encouraging the greater uptake of preferred wood heating appliances which conform to the Australian Standard AS4013-1992.

Lead Agency: DEP
Supporting Agencies/Organisations: AHHA, local government, relevant industry representatives, CCWA, PAN
Start date and duration: Start 2001 and assess effectiveness at AQMP 2005 review.

DAE 1.3

Establish a mediating process for the resolution of domestic smoke nuisance complaints as a component of the annual "Halt the Haze" campaign.

The AHHA has had success in mediating disputes concerning domestic nuisance smoke in Victoria and New South Wales, and is supportive of establishing a similar mechanism in Western Australia. Based on the Victorian and New South Wales programs, an effective mediation process will be developed which facilitates authorised local government officers and AHHA representatives to work together to address domestic smoke nuisance complaints. Members from the AHHA will assist by providing expert advice and proposed recommendations so that the householder may minimise the impact on surrounding residences.

Following approaches by the DEP and local government authorities, the Citizens Advice Bureau has offered to deal with resolution of domestic smoke nuisance issues through their established mediation service.

Lead Agency: DLG in collaboration with DEP
Supporting Agencies/Organisations: AHHA, local government
Start date and duration: Commenced, review success every two years, and assess effectiveness at AQMP 2005 review.

DAE 1.4

Advocate and adopt the upgraded Australian Standards for solid fuel heater emissions when introduced.

The Australian Standards Committee has recently drafted more strict emission limits for solid fuel heaters under AS 4013, proposing a reduction of particle emissions from 5.5 g/kg to 4.0 g/kg. The new Australian Standard comes into effect in July 2001. Western Australia's regulations will be amended to incorporate the revised Australian Standards.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government
Start date and duration: Start 2001 and complete within six months.

DAE 1.5

Finalise and adopt an industry code of practice for the proper installation of wood heaters.

The current Building Code of Australia, whilst specifying the minimum requirements for flue height and position, does not require the installation of a domestic heater to take into account the relative height and nature of surrounding residences. A comprehensive industry code of practice for the installation, operation and maintenance of domestic wood heaters will be developed and made available to retailers and installers, consumer bodies and local government authorities. The code of practice will facilitate self-certification within the industry. The New South Wales Code of Practice (currently being finalised) will be considered as a potential model.

If the Building Code of Australia is amended to take into account these issues, this action may not be required.

Lead Agency: WAMA in collaboration with DLG and AHHA
Supporting Agencies/Organisations: Local government, industry representatives
Start date and duration: Start 2001 and complete within one year.

DAE 1.6

Implement an accredited course or equivalent for wood heater installers as a means of increasing industry awareness.

Relevant training courses are considered a useful tool to increase industry awareness of the most appropriate installation procedures for solid fuel heaters. A training course has been designed and is able to be implemented to facilitate self-certification within the heater installation industry. This will be closely co-ordinated with the development of the code of practice (see DAE 1.5).

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry representatives, AHHA, training institutes and colleges
Start date and duration: Start 2001 and assess effectiveness at AQMP 2005 review.

DAE 1.7

Recommend amendments to current legislation to ensure adequate powers are given to local government officers to deal with domestic smoke nuisance.

Appropriate devolution of legislative powers to local government officers is required to resolve community nuisance complaints resulting from domestic smoke. This may be achieved either through amendments to the *Health Act 1911*, or alternatively through the passage of a new Public Health Bill.

Lead Agency: HDWA
Supporting Agencies/Organisations: Local government, WAMA, DLG
Start date and duration: Start 2001 and complete within 12 months.

DAE 1.8

Enhance the awareness of wood suppliers in the Perth metropolitan region with regard to the need for compliance with the *Environmental Protection (Firewood Supply) Regulations 1998*.

With the introduction of the *Environmental Protection (Firewood Supply) Regulations 1998*, there is a need to ensure that wood suppliers are aware of the new requirements for the moisture content of sold wood to be no greater than 20%. The provision of educational material to those people supplying firewood will also have an indirect benefit in allowing relevant and up-to-date information to be passed on to consumers.

Testing of domestic fire wood for moisture content.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, AHHA, OoE
Start date and duration: Commenced, ongoing.

DAE 2

Ban 'backyard burning' practices in urban residential areas of the Perth metropolitan region.

Local authorities within the Perth metropolitan region use a range of management strategies to control 'backyard burning' practices within their area. All local government authorities have traditionally had some form of local law, established under the *Health Act 1911*, which covered domestic burning practices. More recent initiatives have included the development of a model Health By-Law by the City of Perth in 1993, and other authorities have subsequently adopted this generic model, either by full reprint or incorporation by reference. Yet others have, as an alternative, informal council policies specifically addressing 'backyard burning'. The domestic activities working group was of the opinion that a consistent approach to managing the issue of 'backyard burning' is required and, with the

increased efficiency and frequency of greenwaste collection services, the need for householders to burn refuse is becoming increasingly difficult to justify.

DAE 2.1
Introduce a total ban on burning in all urban residential properties in the Perth metropolitan region by 2001, except for hazard reduction burning, through development of appropriate legislation.

There is currently a lack of consistency in approach adopted by local government to the management of "backyard burning", ranging from complete bans enforced by Local Laws to an absence of policy.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, WAMA, HDWA, FESA
Start date and duration: Start June 2001 and complete within one year.

DAE 2.2
Promote effective greenwaste collection and reprocessing services and support a co-ordinated approach by all local government authorities in Perth.

The DEP will work with local government to develop a co-ordinated approach to greenwaste collection and reprocessing in the Perth metropolitan region.

This will be assisted by objectives of the Western Australian Waste Management and Greenwaste Strategies, in encouraging and enhancing greenwaste collection services to significantly reduce landfill waste.

Lead Agency: DEP in collaboration with local government
Supporting Agencies/Organisations: WAMA
Start date and duration: Start 2001, ongoing.

Staff from the Office of Energy promoting the Home Energy Line.

DAE 3
Increase energy efficiency of domestic dwellings through better insulation, home design and by adoption of energy efficiency principles in building design and construction.

Improving the thermal performance of homes generates noticeable benefits through a reduction in energy use and air pollution, and has the added benefit of an increased level of comfort (Australian Academy of Technological Sciences and Engineering, 1997). Local government, in particular, has a potentially significant role in encouraging solar design and energy efficiency, during the consideration of applications for renovating or constructing domestic dwellings.

The House Energy Rating Scheme, run by the OoE, was introduced in Western Australia in 1996 as part of the nation-wide House Energy Rating Scheme. The domestic activities working group identified the need to provide home owners and builders with a staged approach to ensuring that new homes are more energy efficient, and thereby decrease reliance on domestic heating sources. As such, it is considered appropriate to encourage and enhance the existing voluntary scheme to raise general community and industry awareness, before determining regulatory mechanisms to specify compliance with minimum energy efficiency standards. Improved energy efficiency of new dwellings may also be used as a successful marketing tool. Further information relevant to this issue is contained in the LTP section.

DAE 3.1
Support the enhancement of the existing voluntary program to promote energy efficiency in building design and the construction of new dwellings, major renovations and redevelopments.

Benefits can be seen in terms of a reduction in costs associated with home heating and environmental benefits by minimising the amount of atmospheric emissions released from domestic heating sources in the winter months. The existing national House Energy Rating Scheme will be further developed to assist in the promotion and awareness of energy efficiency considerations in building design. The user-friendly rating system established by the OoE could be further promoted to allow home owners to determine the efficiency of their homes as part of this awareness program.

Lead Agency: OoE
Supporting Agencies/Organisations: Local government, DLG, DEP, HIA, MBA
Start date and duration: Start 2001, and assess effectiveness at AQMP 2005 review.

DAE 3.2
Support the establishment of minimum standards for energy efficiency for all new houses, major renovations and redevelopments by the adoption of the standards to be introduced into the Building Code of Australia.

It may be appropriate to specify requirements for energy efficiency for all new dwellings. This will be done through appropriate amendments to the Building Code of Australia (see DAE 3.3).

Lead Agency: DLG in collaboration with DEP

Supporting Agencies/Organisations: Local government, OoE
Start date and duration: Start 2001, and complete over four years.

DAE 3.3
Advocate the introduction of energy efficiency standards into the Building Code of Australia.

Amendment of the Building Code of Australia will be encouraged to ensure that minimum requirements for energy efficiency are specified for all new buildings that are constructed. However, it is important that ventilation rates should not be unduly restricted in obtaining energy efficiency improvements.

Lead Agency: DLG in collaboration with DEP
Supporting Agencies/Organisations: HIA, OoE, MBA
Start date and duration: Start 2001 and complete over four years.

DAE 4
Encourage the community to consider air quality issues when purchasing domestic products.

There is a need to promote consumer awareness of the air quality benefits of individual actions. For instance, the purchase of low emission lawn mowers (many two-stroke engines have relatively high emissions of CO and ROCs compared to four-stroke), aerosols, solvents, and paints (water-based acrylics versus oil-based) all have a significant beneficial effect on reducing domestic emissions, and improving the quality of Perth's air.

DAE 4.1
Provide an information package for consumers regarding the pollution potential of domestic products.

Product-specific brochures will be developed and made available through retail outlets. Specific issues will include the benefits of purchasing four-stroke lawn mowers instead of two-stroke, or avoiding solvent emissions through the use of water-based paints.

There is also scope to incorporate information regarding the importance of correctly maintaining domestic and recreational equipment such as lawn mowers and marine engines.

Lead Agency: DEP
Supporting Agencies/Organisations: Australian Consumers Association, relevant industry representatives
Start date and duration: Start 2001 and review every two years, ongoing. Assess effectiveness at AQMP 2005 review.

DAE 4.2
Investigate the feasibility of developing a rating scheme for domestic appliances and recreational equipment according to relative impacts on air quality.

An air emissions rating scheme, similar to the energy efficiency system seen attached to white goods, would be an effective mechanism to provide consumers with a user-friendly indicator of the air quality effects arising from the use of various domestic products. Products to be rated according to their relative emissions may include gardening equipment (eg. lawn mowers or edging equipment), household products (eg. solvents or aerosol sprays), or recreational equipment (eg. outboard motors, jet-skis).

An initial trial will be carried out involving the industry sector. Based on an evaluation of the trial, consideration will be given to developing a broader rating scheme involving a range of stakeholders. Consideration needs to be given to the integration of the proposed rating scheme with national initiatives which may be established.

Lead Agency: DEP
Supporting Agencies/Organisations: OoE, Australian Consumers Association, relevant industry representatives
Start date and duration: Start 2002, review every two years, and assess effectiveness at AQMP 2005 review.

Burning Emissions Management (BEM)

Emissions from burning activities and bushfires within and beyond the Perth metropolitan region influence regional air quality. Particles generated from open fires can contribute to periods of reduced visibility and, in more extreme circumstances, contribute to levels that exceed the national health-based standards established by the Ambient Air Quality NEPM. Further information regarding the health effects of exposure to particles is contained in the HER section. Table 7 outlines the standards and guidelines for particles, as used in Western Australia.

Findings from the *Perth Haze Study* (DEP,1996) indicated that the predominant winter source of smoke particles is domestic combustion, whereas the dominant spring and summer source of smoke particles is open burning activities and bushfires (see Figure 16). It should also be noted that there are significantly more particles in the ambient air during winter than summer. Figure 14 provides a comparison between summer and winter levels of smoke from all source categories, highlighting the seasonal differences.

Both planned burning activities and bushfires contribute to undesirable impacts on Perth's air quality. However, managing fuel loads is recognised by fire managers as being the most effective and efficient way of reducing the likelihood of bushfire outbreak.

The planned use of fire is carried out extensively throughout WA. It is used by State government agencies and organisations (CALM and FESA), voluntary bushfire brigades, private land owners and developers for a number of reasons. Their objectives include:

- reduction of fuel loads to ensure community and property safety from bushfire;
- the regeneration and silviculture management of forests;
- pasture revegetation, stubble burning and control of weeds on farms;
- the protection of native and plantation forest resources;
- the sustained ecological management and regeneration of forests and other vegetation types in parks, reserves and other bush areas; and
- the removal of slash and other debris.

This section of the AQMP considers only planned burning activities, and includes those activities occurring within and adjacent to the Perth metropolitan region. It is applicable to activities carried out by both public and private land managers.

In the development of the plan's objectives, strategies and actions, acknowledgment has been given to the use of fire to meet the designated land use activity objectives within the State. Consistent with the

Table 7: Particulate standards and guidelines.

Particle measure	Value	NEPM Goal
Visibility guideline	2.35 x 10-4 Bsp (1-hour average) equivalent to 20 km local visual distance	n.a.*
National health-based standard PM10	50 µg/m^3 (24-hour average)	Maximum of 5 exceedences per year (10-year goal)

* n.a. not applicable - Visibility is a guideline only, and is not part of the NEPM for Ambient Air Quality.

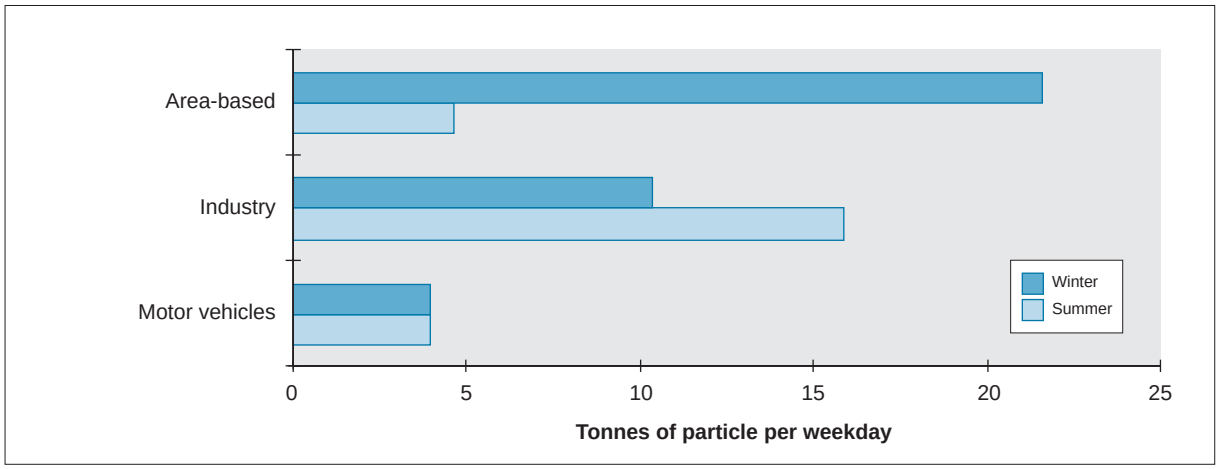


Figure 14: Seasonal contribution to particles emitted in Perth, 1998/99 *(DEP, 2000b).*

comments and recommendations of the *Select Committee on Perth's Air Quality* (Legislative Assembly, 1998), the Plan identifies those actions that will support air quality objectives. These will be achieved by ensuring air quality considerations are addressed in the planning and implementation of all burning activities, and not by the exclusion of burning activities.

In general, it is agreed that a single well planned and conducted burning activity carried out either within or external to the Perth metropolitan region is unlikely to cause unacceptable air quality in the region. Indeed, available data does not support any evidence of planned burning directly causing PM10 exceedences in Perth. However, in conjunction with other burning activity and collectively with other particle sources in the Perth metropolitan region, and depending on meteorological conditions, periods of reduced air quality can and have occurred in the Perth metropolitan region.

Figure 15 shows long term trend data of PM10 levels at selected monitoring sites in Perth, outlining the seasonal fluctuation of predominant smoke sources identified as contributing to particulate haze. The data indicate that levels of particles (PM10) are generally low during the spring and autumn prescribed burning periods, and high during summer and winter months. Since 1994, there has been no exceedence of the PM10 standard by smoke from prescribed burning.

The DEP commenced fine particle PM2.5 monitoring in the Perth metropolitan region during 1996. During the *Perth Haze Study* (DEP,1996), a comparison of the PM10 and PM2.5 data indicated that approximately 80 to 90% of the PM10 (10-minute and 1-hour average) recorded is contributed by PM2.5. This proportion increases up to 95% (10-minute and 1-hour average) during a haze event.

Collectively, the burning activities addressed in the AQMP are:

- agricultural and horticultural burns, designed to reduce grass fuels (including stubble) and green waste, used for reasons of expediency and cost and for control of diseases and parasites, these are conducted either by the land owner or by a volunteer fire brigade on behalf of the owner;
- land development burns, used historically to reduce green waste resulting from the clearing of vegetation from the site, carried out for reasons of expediency and cost; and
- planned burns carried out by or under the control of CALM, FESA, volunteer fire brigades and by individuals. They involve the controlled application of fire under specified environmental conditions (or prescriptions) to a predetermined area and at the time, intensity and rate of spread necessary to attain specific land-use or resource management objectives. Planned burn prescriptions define the burn objective and take into consideration the weather and fuel moisture conditions, atmospheric stability and smoke dispersal conditions, and the lighting patterns required to achieve the objectives.

Planned burns include:

- fuel hazard reduction in strategically located areas aimed at protecting human life, community assets and environmental values including fire sensitive species. Fuels in these areas are reduced regularly so that wildfires can be readily suppressed on most summer days;
- ecological management burns that use fire in a specific way that maintains and enhances the ecological processes on which native animals and plants depend; and
- silviculture burns that create nutrient rich ashbeds and/or stimulate regrowth for native forest regeneration.

Planned burning programs applied by CALM and bushfire brigades have been demonstrated to reduce the size, intensity and damage incurred by summer bushfires (Underwood et al, 1985). It has been claimed that, by reducing the extent and intensity of bushfires, well planned burns reduce potential impacts of bushfire smoke on air quality. However, there is an ongoing debate regarding the benefits of planned burning to community safety, any possible health risks to residents from the inhalation of fine particle matter, and on the environment generally from the frequency of burning. This Plan seeks to determine the relative risks of planned burning and bushfires by way of a comparative risk assessment to be undertaken in the near future (see HER 4.2).

As part of Western Australia's "Jurisdictional Air Quality Implementation Plan" for the Ambient Air Quality NEPM, comparative risk assessment of bushfires was taken into consideration (National Environment Protection Council (NEPC), 1998b). It was recommended that "a comparative study of life and injury risk from bushfires versus life and health risk from smoke particles is needed. If the former outweighs the latter, a management program for planned burning which explicitly accommodates possible exceedences of the NEPM particle standard is appropriate." Acting on this recommendation, a number of research items have been included as part of the HER section of this AQMP, specifically addressing the relative community health impacts from planned burning and bushfires.

Data obtained as part of the *Perth Haze Study* (DEP,1996) indicated that burning activities (on

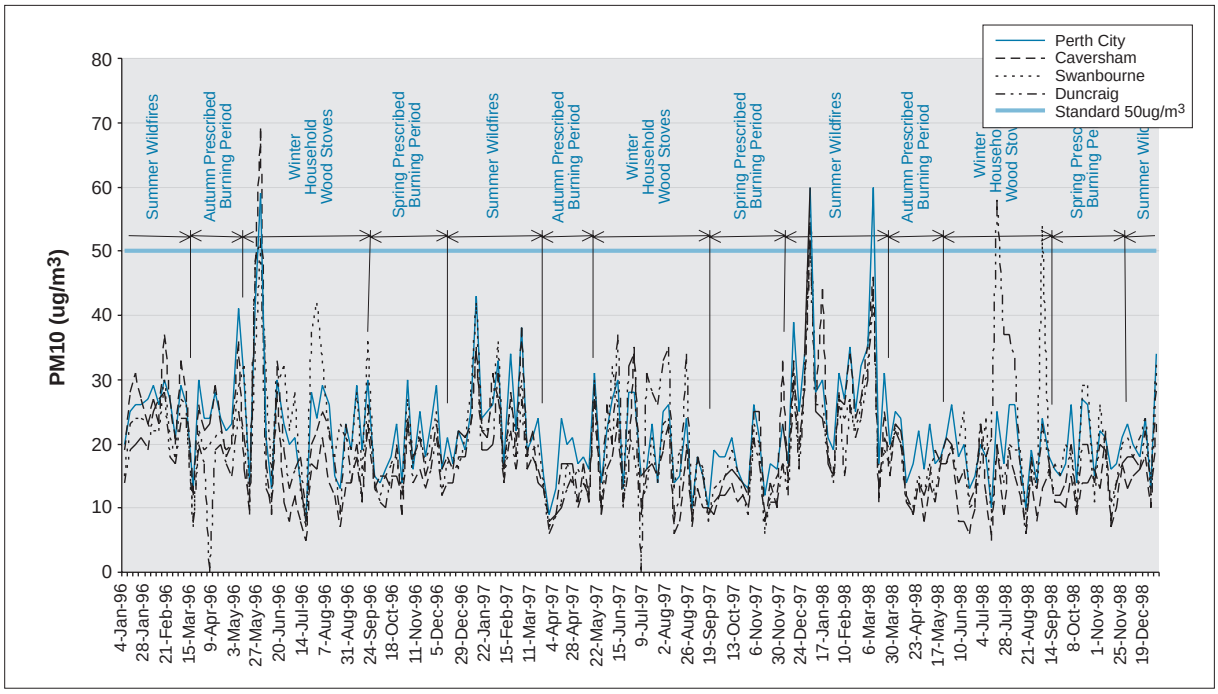


Figure 15: Particulate (PM10) levels at four Perth metropolitan sites between January 1996 and December 1998, using DEP hi-vol monitoring data *(CALMt, 1999).*

average) contribute to 33% of particles from known sources in the airshed (Gras, 1996). This average is seasonally influenced as a result of the meteorological conditions at the time and also the predominant type of smoke producing activity. The relative contributions of fine particles (PM2.5) resulting from domestic sources versus open burning are uncertain. During the winter months, however, domestic fuel combustion has been shown to be a key concern for Perth's air quality, and is addressed as part of the DAE section.

Figure 16 shows the relative contribution of burning activities (smoke) to particle levels in the Perth metropolitan region. It is important to note that, in Figure 16, sources of smoke include wood heater emissions, 'backyard burning', prescribed burning and bushfires.

The Perth AQMP acknowledges that opinions regarding the use of fire as a management tool vary considerably. Some members of the community object to the frequency and extensiveness of planned burning practices, and advocate the consideration of alternative options for forest management (as highlighted, for example, by the *Conservation Council's Fire Control Policy* (CCWA, 1996)). In focussing on the air quality issues related to burning activities within and surrounding the Perth metropolitan region, there is a consensus that attention needs to be drawn to increasing community awareness of current and alternative management practices. This needs to be supported by further research to adequately quantify the magnitude of the influence of various burning activities on Perth's air quality.

Management of burning activities adopted in other Australian States and Territories

There is a range of avenues by which relevant agencies in other Australian States and Territories have chosen to control burning activities (see Appendix 7 for an overview).

All States and Territories have in place a voluntary agreement between key agencies in co-ordinating burn programs to periodically discuss the

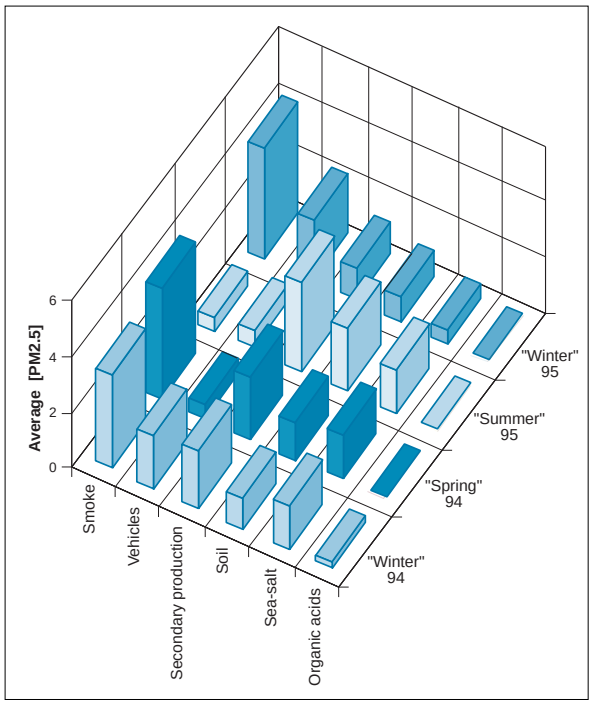


Figure 16: Source contributions to average PM2.5 concentration in the Perth metropolitan region between winter 1994 and winter 1995, recorded as part of the Perth Haze Study *(DEP, 1996).*

management of burning activities. In South-East Queensland, for instance, the Interdepartmental Committee on bushfires was established in 1994, in order to achieve a whole-of-government approach to the management of hazard reduction and fire suppression activities (Queensland Department of Environment, 1998). The committee is comprised of representatives from a range of government agencies (including the Fire and Rescue Authority, Department of Environment and BoM), which facilitate the improved co-ordination and operation of fire management practices in Queensland. Similar arrangements have been established in other States and Territories.

In New South Wales, regulatory authorities have adopted legislative controls to manage the regional impacts of smoke accumulation on urban areas. The provisions of the *New South Wales Protection of the Environment Administration Act 1991* give the New South Wales EPA the power to direct any public authority to cease planned burning activities based on air quality considerations.

Management of burning activities in Western Australia

The legislative control of burning activities in Western Australia may be considered through four primary statutes:

- *BushFires Act 1954* - intended for the prevention, control and extinguishment of bushfires, with a primary focus on immediate safety and protection from the fire itself.
- *Conservation and Land Management Act 1984* - relevant sections detail the preparation of management plans, necessary (protection) operations and requirements for neighbours to notify CALM of burning activities.
- *Health Act 1911* and local laws - the provisions of the Health Act 1911 allow local government to establish local laws which address specific issues relevant to public health.
- *Environmental Protection Act 1986* and proposed regulations - note that burning on development sites will be banned by regulations in 2000.

In addition to the legislative control imposed by State law, a voluntary agreed process has been established in Western Australia. CALM, in association with the DEP, BoM and FESA, has applied a relatively successful smoke management system for CALM's planned burns since 1993.

Meteorological considerations

There are a number of issues which relate specifically to undertaking research programs that improve smoke plume modelling and smoke accumulation prediction capabilities. These issues are addressed in the actions listed in this section.

Objective for Burning Emissions Management

To steadily improve air quality so we have clean air to a level that is acceptable to the community, by:

- reducing the adverse impacts on local and regional air quality resulting from burning activities within and adjacent to the Perth metropolitan region.

Strategies for Burning Emissions Management

The key strategies are to:

1. improve community awareness about air quality considerations, planned burning activities and smoke management - the role, benefits and best methods of using fire;
2. enhance smoke management expertise amongst burn managers and fire control officers;
3. review and amend statutory requirements for fire control measures to take account of air quality management in the Perth metropolitan region;
4. promote consistency in approving, managing and undertaking planned burning activities; and
5. evaluate the effectiveness of smoke management programs for planned burning activities.

Actions for Burning Emissions Management

BEM 1

Improve community awareness about air quality considerations, planned burning activities and smoke management - the role, benefits and best methods of using fire.

In acknowledging the need to incorporate air quality considerations into the decision making process for planned burns, there is an obvious need to raise general community awareness. The level of understanding and acceptance of the justifications for carrying out planned burning activities varies within the community. To ensure that burning activities are well planned and conducted appropriately and effectively by all individuals, and having regard to all concerns, requires improving the level of general awareness especially in the areas of the:

- role and benefits of fire in appropriate situations;
- appropriate and best methods of using fire; and
- appropriate alternatives to the use of fire.

BEM 1.1
Implement an active community education campaign on burning and smoke management.

The purpose of the campaign will be to raise the general level of community awareness so that when individuals undertake burning activities, the fire is appropriate, well planned and conducted effectively with minimal impact on local air quality. The need to protect both land use and environmental objectives will be emphasised, alternatives to burning will be outlined, and the incorporation of air quality considerations into the decision making processes will be explained.

Lead Agency: DEP
Supporting Agencies/Organisations: CALM, local government, FESA, CCWA, PAN
Start date and duration: Start 2001 and assess implementation annually, ongoing.

BEM 1.2
Develop and distribute an information leaflet to be attached to all burning permits.

Burning permits are currently issued in accordance with the provisions of the *Bush Fires Act 1954* to those intending to use fire as a management tool. This includes individual land owners as well as CALM. Explanatory notes are contained on the reverse side of all issued permits, but does not include information or advice directly related to air quality considerations. A leaflet could include advice detailing:

- the possible air quality impacts arising from burning activities (both local and regional) including health and amenity issues;
- reference to air quality guidelines and standards; and
- suggestions for alternative approaches and practices, as contained in the draft Environmental Code of Practice (see BEM 2.3).

Lead Agency: FESA in collaboration with DEP
Supporting Agencies/Organisations: CALM, BoM, local government
Start date and duration: Prepare and commence distribution 2001, assess implementation annually, ongoing.

BEM 1.3
Develop information on planned burning and smoke management activities to be included in local government information services.

Increased community awareness of the potential air quality impacts of burning activities may be facilitated by existing information services offered by local government authorities. As with the information prepared in BEM 1.2 above, similar advice would be prepared and put into a format suitable for inclusion in local government directories, internet services and advice to new residents.

Lead Agency: FESA
Supporting Agencies/Organisations: DEP, CALM, BoM, local government
Start date and duration: Prepare and commence distribution 2001, assess implementation annually, ongoing.

BEM 2
Enhance smoke management expertise amongst burn managers and fire control officers.

The burning emissions working group acknowledged that there currently exists a wide range of expertise in smoke management across State and local government agencies. There is an obvious benefit of sharing and enhancing the knowledge gained so as to enhance the overall competence of all officers involved in fire control and management.

The objective of increasing the level of expertise to minimise adverse effects on Perth's air quality requires the consideration of a variety of avenues. Ongoing competency-based training is constantly being refined, and scope exists to include components aimed at increasing officer awareness of the environmental implications of fire control. Benefits are also seen to arise from greater inter-agency collaboration and information sharing.

BEM 2.1
Include air quality information in FESA and CALM training program and guidelines.

The joint FESA and CALM program provides an overview of planned burning and includes advice on how fire managers and fire control officers can take into consideration all relevant factors when planning and undertaking a burning activity. These factors include vegetation components and the appropriate fire regime for that vegetation type, through to identifying and defining the strategic benefits of a particular burn.

The FESA training manual is considered to be the most effective medium for the presentation and integration of air quality considerations for those involved with the approval, administering, planning and conducting of burning activities. The draft training manual contains input from a number of stakeholders, including the regional fire control officers, BoM and DEP. The FESA training manual is currently in the final draft stage.

Lead Agency: FESA
Supporting Agencies/Organisations: CALM, DEP, BoM, local government.
Start date and duration: Action completed.

BEM 2.2
Include air quality information in FESA and CALM run training workshops.

CALM and FESA currently run workshops for fire managers and fire control officers as part of the normal training program. Air quality components of the training manual (see BEM 2.1) would be emphasised through the training program. As fire officers enhance their understanding and awareness, it would become possible to increase the level of detail contained in the workshops to include more specific attention to such issues as meteorological constraints and interpretation of meteorological advice.

Lead Agency: FESA
Supporting Agencies/Organisations: CALM, DEP, BoM, local government
Start date and duration: Commenced, assess implementation annually, ongoing.

BEM 2.3
Develop environmental codes of practice for use of fire in horticultural and agricultural practices within the Perth metropolitan region.

A draft Environmental Code of Practice for managing smoke from planned burning is being developed by the DEP in conjunction with CALM and FESA. It provides guidance to property managers. The preparation of similar guidance relevant to agricultural and horticultural activities is seen as beneficial.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, FESA, CALM
Start date and duration: Start 2002 and complete within nine months.

BEM 3
Review and amend statutory requirements for fire control measures to take account of air quality management in the Perth metropolitan region.

There are two existing legislative avenues for establishing fire control measures in the community:

- local laws established by local government through the provisions of the *Health Act 1911*, where the emphasis is on public health and amenity issues; and
- the provisions of the *Bush Fires Act 1954*, where the primary focus of the existing statutory requirements is that of immediate safety and protection from the fire itself, and there is no scope for environmental considerations.

The AQCC considers there to be deficiencies in both statutes, in particular that permits (under the *Bush Fires Act 1954*) are required only during a defined period covering four months of the year, during the spring and autumn burning periods. Outside the restricted burning period, no permit is required during the open season.

BEM 3.1
Require regulation of burning throughout the year in areas within and surrounding the Perth metropolitan region.

Local government authorities are able to make local laws under provisions of the *Health Act 1911* to ensure burning activities are carried out appropriately. The development of a model local law would assist local government and provide consistency. The City of Mandurah has already applied such a local law.

Lead Agency: DLG and WAMA
Supporting Agencies/Organisations: FESA, HDWA
Start date and duration: Start 2000, ongoing.

BEM 3.2
Regulate the use of fire on development sites within the Perth metropolitan region.

The burning of cleared vegetation has been a significant localised issue in the Perth metropolitan region for a number of years and has been identified as a significant issue which needs to be addressed. The DEP, in conjunction with local government, has adopted a staged process of changing the practices of land developers following the announcement of the State Government's intention to ban the activity at the end of 1997. Formal applications for burning on development sites were not permitted from 31st December 1997 onwards.

Ministerial consent was given for the drafting of regulations to prevent burning activities from being undertaken by developers, contractors and sub-contractors on development sites in urbanised parts of the Perth metropolitan region. These regulations are being drafted under the provisions of the *Environmental Protection Act 1986*, and are expected to be in place by the end of 2000.

The intention is to regulate to have a total ban on burning cleared vegetation or debris, in the urban areas of the Perth metropolitan region, as has been established in other states of Australia. The owner/occupier of the land will be responsible for the full cost of fire control on the site in the event of a fire being started, with significant penalties established. Developers are to provide a fire control plan and adequate resources.

Lead Agency: DEP
Supporting Agencies/Organisations: Local government, FESA, WAMA, building industry representatives

Start date and duration: Drafting in progress with implementation expected in 2000.

BEM 3.3
Promote the development of environmental management plans to incorporate fire hazard reduction strategies for regionally and locally significant remnant bushland in the Perth metropolitan region.

Areas of remnant bushland within the Perth metropolitan region are important for a number of reasons. It is also important that each area is appropriately managed and does not present an uncontrollable bushfire threat. The preparation of a management plan that takes into account appropriate means of hazard reduction and fire suppression response is essential. Consideration could be given to requiring all sites to have fire management plans where it is intended to use fire as a management tool.

Lead Agency: DEP in consultation with land owners
Supporting Agencies/Organisations: Local government, CALM, FESA, Bushland Conservation Groups
Start date and duration: Commenced and assess effectiveness at AQMP 2005 review.

BEM 4
Promote consistency in approving, managing and undertaking planned burning activities.

The burning emissions working group identified a number of improvements that could be made to the decision making process leading to the use of fire as a management tool. A key issue was the need to ensure consistency in approach, requirements and administration in fire management across the Perth metropolitan region. Differences in approach currently exist between local government authorities. This will facilitate improving community awareness as expectations across areas would remain the same.

Smoke resulting from a controlled burn.

BEM 4.1
Support the development of hazard reduction policies for adoption by local government to encourage consistency in smoke management.

FESA has developed a draft Hazard Reduction Policy providing a means by which a level of consistency in fire management may be established within the Perth metropolitan region. The policy could be modified with the objective of promoting consistent and integrated smoke management processes between local government authorities, particularly in areas of:

(i) issuing permits and conditions for burning approval; and

(ii) management of burning activities.

Lead Agency: FESA in collaboration with DEP
Supporting Agencies/Organisations: Local government, CALM
Start date and duration: Start 2001 and complete within 12 months.

BEM 4.2
Support the development of agreed consistent approaches and procedures for smoke management in all burning activities.

All agencies involved in hazard reduction recognise the need to plan and prepare for all burning activities, both as an individual event and within the broader strategic perspective. FESA's draft Hazard Reduction Policy could provide an initial focus for consistency amongst fire managers within and surrounding the metropolitan region.

Lead Agency: FESA in collaboration with DEP
Supporting Agencies/ Organisations: Local government, CALM
Start date and duration: Commenced, review 2002, and assess effectiveness at AQMP 2005 review.

BEM 4.3
Support the development of a uniform approach to the assessment of smoke management conditions used to issue burning permits.

The use of common approaches in the issuing of permits, receipt of air quality advice, and the dissemination of air quality advice to the holders of burning permits and local brigades is seen as beneficial. In some instances burning prescriptions are being prepared that take into account fuel loadings and land management objectives as part of the considerations when planning the burning activity. A simplified version of CALM's burn decision model was considered to be a potential appropriate model on which to base local decision making.

Lead Agency: FESA in collaboration with DEP
Supporting Agencies/Organisations: Local government, CALM
Start date and duration: Develop 2001 for trial implementation in a number of local government areas in the 2001/2002 and subsequent burning periods.

BEM 4.4
Establish a working group to raise awareness amongst agencies regarding smoke management issues.

A working group comprising representatives from the FESA, local government, volunteer brigades and the DEP shall be established to facilitate a co-operative approach towards smoke management in the Perth metropolitan region.

The first stage will be to develop an understanding amongst fire control officers of the negative impacts of smoke from burning off on amenity in the Perth metropolitan region. Once that understanding is reached, ways of informing the community of burning off operations will be considered, so that adverse reaction is minimised.

Lead Agency: DEP
Supporting Agencies/Organisations: CALM, FESA, local government
Start date and duration: Start 2001, ongoing.

BEM 4.5
Include broader local government representation in the Smoke Management Liaison Group.

The existing Smoke Management Liaison Group meets twice yearly to discuss issues regarding the management of smoke from burning activities undertaken in the Perth metropolitan region. The Smoke Management Liaison Group currently comprises DEP, BoM, CALM and FESA. It is through this group that relevant policies, processes and programs are discussed and recommendations made. The involvement of local government in this group will extend representation to the local level. Local government's role in burning activities is in the consideration and issuing of burning permits to landholders, and the operation and management of burning programs.

One issue of concern is achieving effective communication among landholders, local government, the FESA, and the Bush Fires Service. Currently, there is no adequate means of notification among these groups when a burn is planned. This creates the potential for numerous burns to occur on the same day, leading to amenity and safety concerns. To avoid such an unfavourable situation, the most effective and appropriate means of communication between stakeholders needs to be determined. Communication techniques adopted in Victoria and South-East Queensland, for example, may provide useful information on procedures used and their effectiveness.

Lead Agency: DEP in collaboration with FESA
Supporting Agencies/Organisations: BoM, CALM, WAMA
Start date and duration: Commenced, ongoing.

BEM 4.6
Undertake studies on weather and smoke modelling to improve burn decision processes.

CALM will promote co-operative research with the BoM and the Bureau of Meteorology Research Centre on a range of studies that will improve prediction and accuracy of weather forecasting for smoke management.

The studies will include:

- climatological research of Perth's radiation inversions;
- smoke transport to improve the prediction of burning opportunities from specific sites;
- smoke trajectory and dispersal predictions based on MesoLaps and the HySplit4 weather forecasting models; and
- analysis of weather data quality to improve the location of future weather observation sites in south-western Australia.

Lead Agency: CALM in collaboration with BoM
Supporting Agencies/Organisations: DEP, FESA
Start date and duration: Commenced, review annually, and assess effectiveness at AQMP 2005 review.

BEM 5
Evaluate the effectiveness of smoke management programs for planned burning activities.

The consideration of smoke management objectives in the burn programs adopted by fire managers can be improved and enhanced only if such programs are periodically reviewed. The means by which various authorities take into account smoke accumulation as part of their work program need to be considered. This will allow decision-makers to refine existing measures so as to minimise cumulative impacts of smoke contributing to particulate haze episodes within the Perth region.

BEM 5.1
Review the effectiveness of the existing DEP, CALM, FESA & BoM inter-agency agreement.

The Smoke Management Liaison Group (see BEM 4.5) has developed a procedure which incorporates the consideration of smoke management in the overall planning of CALM's burning activities. The smoke management guidelines are designed to ensure that burns are not lit when meteorological conditions do not support adequate smoke dispersion. The guidelines address other concerns, including seeking to avoid the deposition of ash into water supply dams, minimising the amount of fire around granite outcrops and peat swamps, and only burning on one side of a main public road. An outline of the procedure is contained in the

Appendices (Appendix 8). This working group arrangement has been in place since 1993 and is reviewed annually.

Lead Agency: BoM
Supporting Agencies/Organisations: DEP, CALM, FESA
Start date and duration: Start 2001 and review annually, ongoing.

BEM 5.2
Continue to promote and review risk assessment of bushfire impacts, taking into account air quality and other environmental impacts.

Some local authorities involved in fire management currently use the Australian/New Zealand risk assessment model AS 4360-1999 (Standards Australia, 1999) as a standard model for evaluating comparative risk assessment. Consistent with the Australian Standard, CALM uses its Wildfire Threat Analysis process.

As part of Western Australia's Jurisdictional Air Quality Implementation Plan for the NEPM for ambient air quality, comparative risk assessment of bushfires was taken into consideration (NEPC, 1998b). The research items addressed as part of the HER section need to be considered in conjunction with existing risk assessment procedures adopted by fire and land use managers, and the incorporation of air quality (and intangibles) in future guidelines.

Lead Agency: DEP
Supporting Agencies/Organisations: CALM, FESA
Start date and duration: Start 2001, ongoing.

Industry Emissions Management (IEM)

On a world-wide basis, industrial emission sources continue to be a significant contributor to urban air pollution, despite substantial improvements in cleaner process technologies and equipment. The degree to which large point source emissions impact on a particular airshed is dependent on economic activity and the industrial characteristics within the region (Australian Academy of Technological Sciences and Engineering, 1997). With the location of Perth's industrial activity primarily in the Kwinana Industrial Area (KIA), the Perth AQMP needs to ensure regional air quality is maintained as industry continues to grow and expand over the coming decades. Table 8 and Figure 17 indicate industry's relative contribution of key pollutants to the Perth metropolitan region.

Table 8: Contribution of air pollutants from industry to the Perth airshed *(DEP, 2000b).*

Pollutant	Contribution (tonnes per year)	Contribution (%)
SO_2	16 486	87
Particles	4 725	44
NO_x	23 381	39
ROC	8 665	15
CO	8 065	3

Note: Contribution (%) calculated excluding biogenic emission estimates.

The outcomes of the *Perth Airshed Emissions Inventory Update* (DEP, 2000b) highlighted a pattern common to many urban airsheds, in that a relatively small number of sources account for the bulk of industrial emissions. Indeed, the ten largest NO_x emitters were responsible for 92% of the total industrial NO_x emissions (see Figure 18), and similarly, 97% of industrial ROC emissions (see Figure 19) were

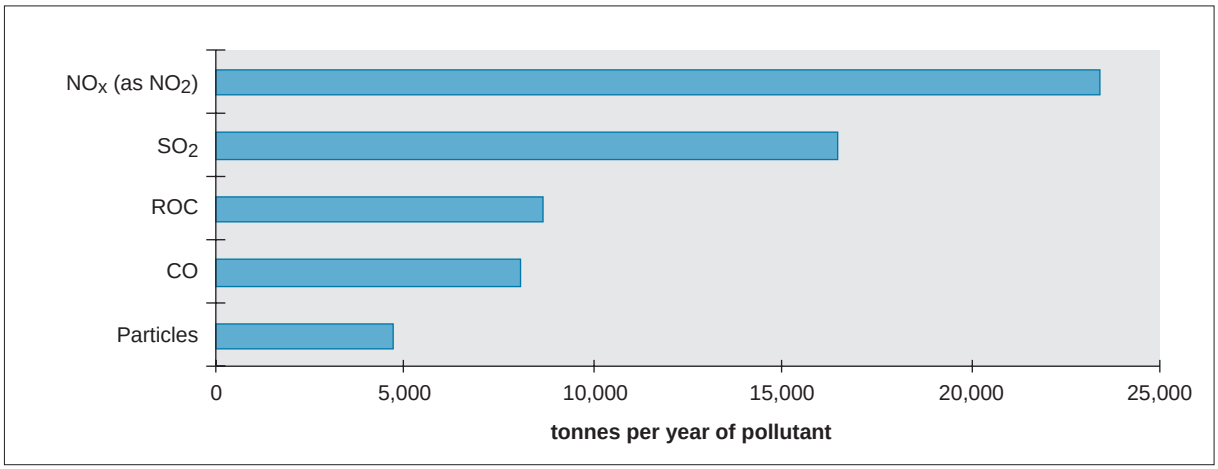


Figure 17: Contribution of air pollutants from industry emissions to the Perth airshed *(DEP, 2000b).*

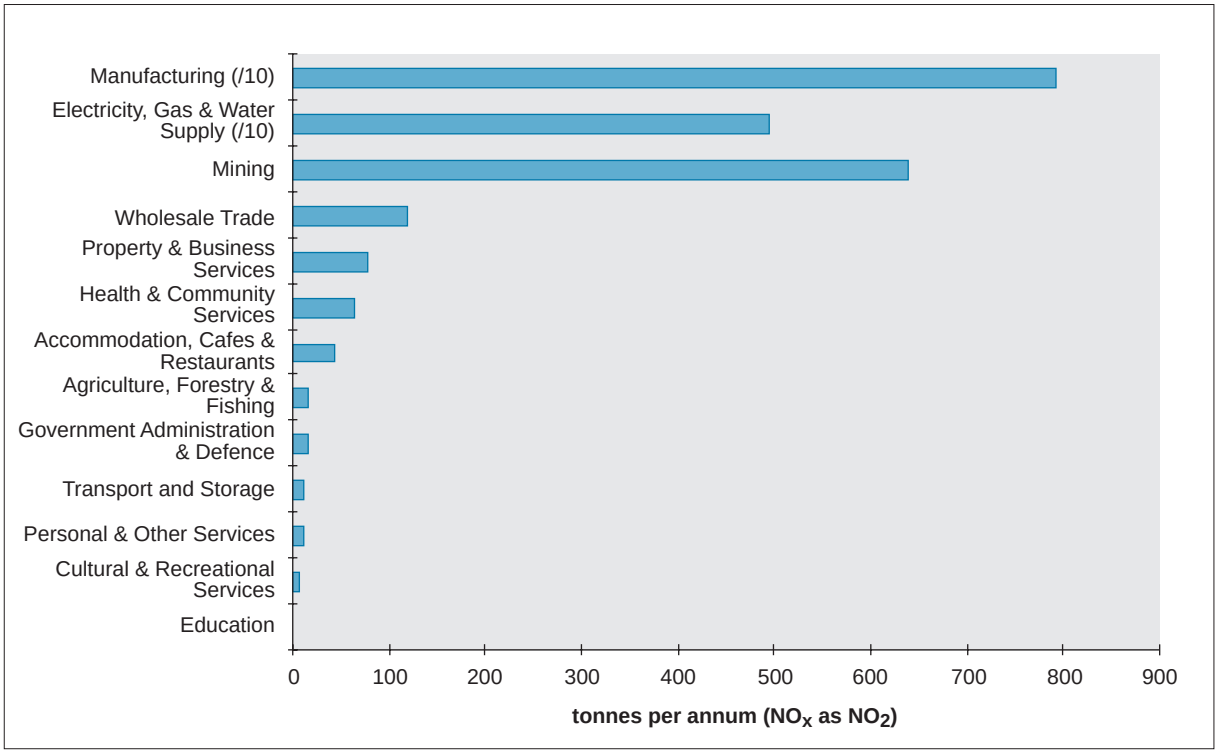


Figure 18:Contribution of various categories to NO_X emissions to the Perth airshed, 1998/99 *(DEP, 2000b).*

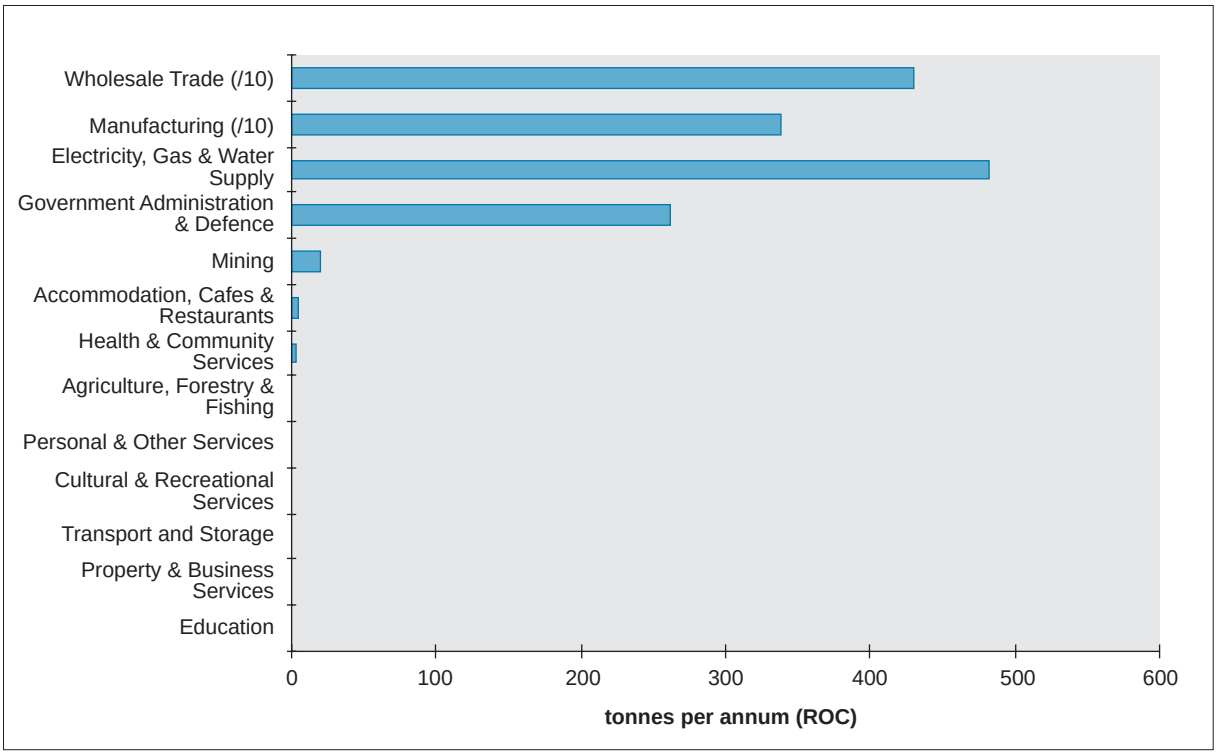


Figure 19: Contribution of various categories to ROC emissions to the Perth airshed, 1998/99 *(DEP, 2000b).*

traceable to ten key point sources. These primary contributors included manufacturing, wholesale trade, electricity, gas and water supply and mining. Figures 18 and 19 show the relative contribution of industry sectors to NO_x and ROC loads in the Perth metropolitan region respectively.

It must be recognised that significant improvements have subsequently been achieved by the largest emitters since the 1992 Perth emissions inventory was conducted. With the advent of an updated emissions profile, the AQCC considered it appropriate to direct a staged approach to managing industrial point sources in Perth. That is, most gains are likely to be achieved by initially focussing on a small number of key emitters. Then, as these larger industries continue to minimise air emissions as far as

practicable through the process of continuous improvement, there should be a logical change in focus towards smaller, yet significant, industries in the metropolitan region.

Objective for Industry Emissions Management

To steadily improve Perth's air quality so we have clean air to a level that is acceptable to the community, by:

- reducing the emissions of atmospheric pollutants from new and existing industrial emission sources in the Perth metropolitan region; and
- encouraging and assisting industrial enterprises to adopt cleaner technologies which reduce pollutant loads into the Perth airshed.

Strategies for Industry Emissions Management

The key strategies are:

1. reduce atmospheric emissions from industrial processes by advocating the concept of 'best practice';
2. establish the impact of major NO_x emitters of point-source combustion products, consider options for their cost effective control and implement control strategies;
3. ensure appropriate airshed planning for future industrial development and power generation in the Perth metropolitan region;
4. identify and assist the major emitters of ROCs to reduce industrial contributions; and
5. promote and provide incentives for the broader adoption of 'cleaner technologies' in all industrial activities.

Actions for Industry Emissions Management

IEM 1
Reduce atmospheric emissions from industrial processes by advocating the concept of 'best practice'.

Best practice environmental management (BPEM), as determined by the DEP's regulatory approach, is met when an industrial premises takes all reasonable and practicable measures to minimise waste discharge. BPEM encompasses a performance range where the top performer is 'best in class'. Integral to the identification of best practice is the process of benchmarking, required to compare environmental performance and practice with other industries which have similar operations and conditions. Industry can pursue a best practice environmental licence which provides premises with the flexibility to meet environmental performance objectives through a process of audited self management, while government oversees the effectiveness and independence of the process.

The existing environmental codes of practice were developed by the DEP to provide guidelines for prospective licensees and facility operators for baseline environmental standards which are expected to be met for various industry types. They do not necessarily encourage premises to extend beyond these minimum requirements. Furthermore, many of the codes of practice are more suited to applicants who do not necessarily have to be licensed but still require registration. Greater clarity and certainty as to what is expected to meet best practice standards will encourage continuous improvement in air emission control. This will also aid licence officers of the DEP when processing licence applications, as clear guidelines will ensure a more efficient assessment process.

Environmental benefits can be gained if industrial premises pursue cleaner technologies and control options which are widely recognised as meeting best practice, particularly where industrial premises or sectors have been identified as being significant contributors to air emissions.

IEM 1.1
Develop a series of emissions management guidelines in consultation with relevant industry sectors, to be used jointly by the DEP and industry.

Emissions management guidelines will be developed to provide up-to-date information regarding all available best practice emission control options for key pollutants of concern. The best practice guidelines will be available to DEP personnel, to be used as a reference for assessing applications, and industry representatives, who will be informed of the DEP's expectation of best practice. Best practice will not be limited to material described in the guidelines, as technology is constantly improving. The emissions management guidelines will be regularly updated to take into account new technologies considered to be best practice.

By establishing a series of commonly accepted emissions management guidelines, industry representatives can ensure licence applications for prescribed premises are assessed with a degree of transparency and consistency according to best practice principles.

Lead Agency: DEP
Supporting Agencies/Organisations: relevant industry representatives
Start date and duration: Start 2001, and assess effectiveness at AQMP 2005 review.

IEM 2
Establish the impact of major NO_x emitters of point-source combustion products and consider options for their cost effective control and implement control strategies.

The *Report of the Select Committee on Perth's Air Quality* (Legislative Assembly, 1998) acknowledged that the majority of the industrial emissions in the Perth airshed were attributable to only a few key point-sources. Of these, electrical power generation by the Kwinana Power Station was shown to be one of the major emitters of combustion products, primarily SO_2 and NO_x (DEP, 2000b). Whilst SO_2 is essentially addressed as part of the *Environmental Protection (Kwinana Atmospheric Wastes) Policy 1992*, effective management strategies need to ensure that NO_x emissions from key industries are managed so that ambient concentrations are maintained within acceptable levels on a long-term basis.

The determination of the most appropriate management options needs to be based on updated emissions inventory data (see MMR section), so that all significant emitters may be accounted for. Economic feasibility also needs to be considered when establishing the most appropriate control options to achieve NO_x reduction and control.

IEM 2.1
Establish the impact of the Kwinana Power Station and other key NO_x emitters on air quality in the Perth airshed.

An analysis of the impact of the Kwinana Power Station and other key NO_x emitters on air quality will be based on the available data. This will determine the significance of other local industries (such as metallic and non-metallic mineral processing and chemical production) and whether these industries will need to decrease NO_x emissions in the longer term.

Lead Agency: DEP
Supporting Agencies/Organisations: Western Power, relevant industry representatives
Start date and duration: Start 2001 and complete within two years.

IEM 2.2
Establish the most cost effective emission reduction options for the Kwinana Power Station and other key NO_x emitters, pending conclusions of the updated inventory and investigation of the impact of NO_x emitters on air quality in the Perth airshed.

The *Perth Photochemical Smog Study* (Western Power Corporation and DEP, 1996a) established that the Kwinana Power Station contributes through its NO_x emissions to photochemical smog. The outcomes of the updated emissions inventory will be assessed to determine whether further emissions reductions are required from the Kwinana Power Station. Emission management objectives for other significant industrial emitters of combustion products will be determined. Emission reduction options need to be reviewed taking into account the revised emissions inventory for the Perth airshed and results of the analysis undertaken for IEM 2.1.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry representatives
Start date and duration: Contingent on IEM 2.1 and complete within one year.

IEM 2.3
Implement appropriate action plans to address significant industrial sources of NO_x in Perth.

Once the key contributors have been identified (see IEM 2.1) and cost-effective control strategies determined (see IEM 2.2), the DEP will liaise with industry to develop targeted action plans for NO_x reduction.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry representatives
Start date and duration: Start 2003 and assess effectiveness at AQMP 2010 review.

IEM 3
Ensure appropriate airshed planning for future industrial development and power generation in the Perth metropolitan region.

During deliberations, the AQCC noted the air quality constraints facing future industrial development in the Kwinana heavy industrial area. Within the context of air quality and the time frame of the AQMP (ie. 30 years), the AQCC believe that additional industrial sites need to be planned for now, and established within the next 10 years, as a joint priority for Government and industry. Planning within the Perth metropolitan region would need to take into account current and possible future air quality constraints.

More specifically, the possible siting of future power generating facilities within the Perth metropolitan region will require careful consideration and management of air emissions, in particular NO_x, ROCs, SO_2 and particles. Long term planning should commence now to ensure that development is not unduly constrained as a result of existing pollutant sources within the Perth metropolitan region.

Co-generation is a means of simultaneously generating heat and electric power from the same energy source. The primary energy used to drive the co-generation plant is most commonly natural gas, but other renewable energy sources such as biogas, sewage gas and landfill gas have been used elsewhere. Co-generation represents a significant greenhouse gas initiative and an opportunity for industries to reduce operating costs by marked improvements in energy efficiency. However, the relative effects of co-generation on the production of NO_x emissions are uncertain. The impact of co-generation production on NO_x emissions contributing to photochemical smog formation should be carefully evaluated before significant numbers of co-generation plants are established in the Perth metropolitan region.

IEM 3.1
Apply emission guidelines for future power generation in the Perth airshed.

The NEPM standards and goals define what is considered acceptable air quality in the Perth metropolitan region. To assist industry and government in its long term planning for future power generation capacity, the EPA has developed a guidance statement which deals with emissions of NO_x from gas turbines which adopt emission guidelines for NO_x. Since any new power station would be required to meet the air quality standards of the time, these guidelines will be revised periodically and will form one of the bases on which any relevant environmental impact assessment would be conducted.

Lead Agency: DEP
Supporting Agencies/Organisations: MfP, PAN
Start date and duration: Complete. Revise every five years, ongoing.

IEM 3.2
Develop and implement a position paper and policy on co-generation and its implications for the Perth airshed.

The DEP will estimate the impact of increased emissions from combustion sources at likely locations outside Kwinana using computer modelling. This position paper may be referred to the EPA for consideration with a view to adopting it as guidance in Environmental Impact Assessment.

Lead Agency: DEP
Supporting Agencies/Organisations: OoE, power generating industry, EPA, PAN
Start date and duration: Start 2002 and complete position paper within six months. Implementation ongoing.

IEM 4
Identify and assist the major emitters of ROCs to reduce industrial contributions.

Aside from the significant contribution of ROCs from tank and fugitive emissions at the BP Refinery (Kwinana), a number of other industry emissions have previously been identified, including the food and beverage industries, paper production and printing, aviation and paint manufacturing. While it may have appeared to be appropriate to focus on BP Refinery's ROC emissions in the short-term, consideration needs to be given to other significant emitters as part of longer term strategies.

IEM 4.1
Encourage continuous improvement in ROC control measures for ROC emitters in Kwinana.

While the *Perth Photochemical Smog Study* (Western Power Corporation and DEP, 1996a) identified BP Refinery as being the largest single stationary source of ROCs in the Perth metropolitan region, substantial improvements in tank and fugitive emission control have reduced BP Refinery's ROC contributions since 1992. The *1999 Perth Airshed Emissions Inventory Update* (DEP, 2000b) identified that the BP Refinery has reduced its total ROC emissions in the Perth airshed by 44%. The government has committed itself to work with BP to ensure continuous emissions reduction.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry representatives
Start date and duration: Start 2001 and assess effectiveness at AQMP 2005 review.

IEM 4.2
Identify the other major emitters of ROCs in the Perth airshed.

The updated air emissions inventory will include an assessment of all major industrial emitters of ROCs in the Perth airshed (see MMR 1.1). The industrial emitters of ROCs will then be combined with area based, motor vehicle and biogenic sources of ROCs to enhance airshed modelling capabilities.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry representatives
Start date and duration: Start 2001 and complete by end 2002.

IEM 4.3
Work with industry to identify and analyse the cost-effectiveness of options for ROC management.

Several options are available for industry, area-based sources and motor vehicles to achieve the air quality goals set out under the NEPM for ambient air quality. The economic analysis will aim to identify the most cost effective options to meet the air quality goals with a view to ensuring a degree of equity.

Lead Agency: DEP in conjunction with relevant industry representatives
Supporting Agencies/Organisations: Relevant industry representatives
Start date and duration: 2002 but contingent on IEM 4.2.

IEM 4.4
Work with industry to develop and implement cost-effective emission management plans for industrial ROC emissions.

ROC control action plans will be developed for industrial sources and will be based on sound economic analysis. Computer modelling of data from the Perth air emissions inventory (see MMR 1.1) and the economic analysis carried out for a number of options will be used to identify the most equitable option for ROC control.

Lead Agency: DEP in conjunction with relevant industry representatives
Start date and duration: Contingent on IEM 4.3.

IEM 5
Promote and provide incentives for the broader adoption of 'cleaner technologies' in all industrial activities.

In the next 10 years, industry will face pressure to upgrade combustion and emission control equipment, as well as pursuing the use of renewable/alternative energy sources such as solar and wind. This is as a result of greenhouse gas initiatives, as well as steps taken to meet the NEPM standards for ambient air quality. Through the implementation of the National Greenhouse Strategy , electricity retailers and other large electricity buyers will be required to source a proportion of their electricity from renewable or specified waste-product energy sources. This includes direct investment in solar water heaters.

There have been a number of initiatives that have recently been proposed to encourage the adoption of cleaner production in industrial processes. For example, the draft *Western Australian Cleaner Production Strategy* (DEP, 1998) proposes incentives for small to medium enterprises to improve environmental performance through a combination of co-regulatory mechanisms (such as the 'Green Certificate' program), audit assistance, environmental subsidies and enhanced awareness of cleaner production. Future developments in the *Cleaner Production Strategy* need to be closely followed as part of the Perth AQMP, to ensure that atmospheric discharges from smaller enterprises are given due consideration.

Aerial view of the Kwinana Industrial Area.

Incentives currently exist within the Australian taxation system. However, the complexity of the system suggests that some incentives for 'cleaner technologies' may not be fully utilised by small to medium sized industries. The Federal Government has an important supporting role in this case by ensuring that industries are made fully aware of all potential tax incentives.

IEM 5.1
Amend the Environmental Protection Act 1986 to include the principles of waste minimisation.

An appropriate legislative framework providing direction would facilitate the promotion of waste minimisation in industry. The DEP will work with relevant industry representatives to consider possible amendments to the *Environmental Protection Act 1986* enunciating a general principle of waste minimisation.

Lead Agency: DEP (with suggested amendments to be submitted to Parliament)
Supporting Agencies/Organisations: Relevant industry representatives
Start date and duration: Commenced 1999.

IEM 5.2
Encourage the industrial use of solar and wind power in the Perth metropolitan region.

Through their existing programs and processes, State government agencies will take the opportunity to advocate to industry the use and development of alternative power generation, particularly solar and wind.

Lead Agency: OoE
Supporting Agencies/Organisations: DEP, power generating industry, EPA, CCWA, PAN
Start date and duration: Start 2000, ongoing.

IEM 5.3
Develop a discussion paper on the range of financial and economic mechanisms available for industrial emission control.

Industrial emission control is usually achieved by regulatory instruments, but these cover only one mechanism to manage industrial emissions. There

are a number of financial incentives that can be used to achieve the same results as regulation. Promoting public discussion to consider the feasibility of various incentives, including a tradeable emissions permit system, is one option that could be pursued, as could a review of the DEP's load-based licensing fees.

Lead Agency: DEP
Supporting Agencies/Organisations: Relevant industry associations, Treasury
Start date and duration: Start 2001 and develop discussion paper within 2 years.

IEM 5.4
Promote the awareness of industry achievements in atmospheric emission reductions through 'green industry' awards.

A range of industry and business awards currently exist in Western Australia which reward excellence in environmental performance, for instance the Golden Gecko Awards and the Recycling and Waste Reduction Awards. At this stage, however, there is no specific recognition for improvements made in the area of air quality. There is a need to evaluate the potential to incorporate an air quality category as part of existing industry awards. Consideration will be given to who should be responsible for developing these awards to ensure a high standard of credibility.

Lead Agency: DEP (to act as an initial organising agency, to support an independent sponsor)
Supporting Agencies/Organisations: Relevant industry associations, Chamber of Commerce and Industry Western Australia (CCIWA)
Start date and duration: Start evaluation in 2005 and complete within two years.

Community Information and Education (CIE)

Complementary to the technical and policy solutions, behavioural changes at an individual level are essential if Perth's good air quality is to be maintained for present and future generations. Improving and protecting Perth's air quality will require all Western Australians to understand and appreciate air quality issues, develop positive attitudes and beliefs, and ultimately modify behaviour. There are many opportunities for large scale changes in community attitude and behaviour through effective awareness-raising and education programs. Communication linked with active participation is a key strategy for achieving improved air quality in Perth.

The focus in the *Government's Response to the Report of the Select Committee on Perth's Air Quality* (Government of Western Australia, 1998b) is on the need for an integrated community awareness program. The need for effective communication of the importance of vehicle maintenance, alternative transport options and indoor air quality to the community is highlighted. The CIE working group also raised the issues of community education concerning wood heaters, energy efficiency and prescribed burning. These issues are addressed in the actions in this section.

There are currently many community education programs and awareness campaigns with an air quality component. They contain differing messages depending on the respective organisation's or agency's purpose. Existing programs include:

- Smogbusters - CCWA/Commonwealth program supporting community action to reduce vehicle use and emissions;
- Smoky Vehicle Program - DEP vehicle emissions program;
- TravelSmart® - Transport program leading to use of alternative transport choices, including DEP workplace program;
- Cycle 100 - DEP in conjunction with Bikewest workplace program encouraging CBD commuters to cycle to work;
- Cycle Instead® - Bikewest program to encourage cycling among the public and school children;
- Halt the Haze - DEP general community program providing information on wood heater use (haze, chimney checker and wood); and
- AirWatch® - DEP school air monitoring program.
- Air Care® - RACWA vehicle maintenance awareness campaign.

A range of information is also accessible to the general community in the form of pamphlets, booklets and the internet. They are readily available at libraries, community organisations and government departments. Co-ordination and integration of air quality programs and information is desirable in attaining the goal of improved air quality in Perth.

Included in the *Government's Response to the Report of the Select Committee on Perth's Air Quality* (Government of Western Australia, 1998b) is the commitment that "the AQCC will be the focus for the expansion and consolidation of current community awareness activities into an integrated program in partnership with various industry and community interests". To meet the Government's commitment, a forum is needed that encourages key stakeholders to work closely together towards the achievement of common community education goals. The forum recommended is through the development of a Community Education Strategy; a comprehensive planning process that provides clear direction and purpose for a behaviour change program.

Objectives for Community Information and Education

To steadily improve Perth's air quality so we have clean air to a level that is acceptable to the community, by:

- developing an integrated and comprehensive community education strategy that influences positive community behaviour;
- developing and continually improving the awareness, education and quality of information regarding air quality issues to influence positive community behaviour; and
- informing and involving the community in the implementation of the AQMP.

Strategies for Community Information and Education

The key strategies are to:

1. improve the co-ordination and integration of air quality community education programs and awareness campaigns;
2. improve community understanding of the benefits of alternative transport modes and correct vehicle maintenance;
3. improve community understanding of the sources and impacts of emissions related to domestic activities;
4. improve community understanding of indoor air quality issues; and
5. ascertain target audiences within the community, industry, and government.

Actions for Community Information and Education

CIE 1
Improve the co-ordination and integration of air quality community education programs and awareness campaigns.

Currently, there is an array of community education programs and awareness campaigns focussing on air quality issues, some of these competing or overlapping with others. There are also large gaps in the comprehensive coverage of air quality issues, due to the current lack of co-ordination and integration of these programs and campaigns.

CIE 1.1
Review existing air quality community education programs.

The purpose of the review is to:

- determine the suitability of the existing programs for inclusion in the Community Education Strategy, including those targeting specific issues and audiences such as the winter wood heater campaign ("Less Smoke, Cleaner Air");
- identify the programs which are redundant, inappropriate or ineffective, making recommendations on their fate;
- incorporate the suitable existing air quality programs within the framework of the Community Education Strategy; and
- identify areas not covered, such as an ongoing program to encourage motorists to keep vehicles tuned.

The effectiveness of all relevant community initiatives, including RACWA's Air Care® campaign, Transport's TravelSmart® program, and the Cycle 100 trial, will be evaluated to determine the feasibility of developing a more integrated approach in achieving the common objective of reducing transport-related air emissions by changing travel behaviour. All programs will be regularly reviewed to consider the range of target audiences, with a view to enhancing their scope and coverage of the Perth community. It is imperative to the goal of improving Perth's air quality to ensure that campaigns and information reach the desired target audiences. Furthermore,

some important target audiences may have been overlooked, and these need to be identified.

The DEP will work with the community, industry, corporate sector and government to determine missed target audiences regarding air quality messages. Examples of missed target audiences include heavy goods vehicle and LCV owners and drivers, fleet buyers, purchasers of new motor vehicles, and lower socio-economic groups.

Lead Agency: DEP
Supporting Agencies/Organisations: CCWA, relevant industry sectors, relevant government agencies, local government, PAN
Start date and duration: Start 2001 and complete review within one year.

CIE 1.2
Develop and implement a Community Education Strategy.

This Strategy will be developed in partnership between the DEP, other government agencies, community and industry, and endorsed by the AQCC. A Working Group will be established with representation from all key stakeholders.

Students participating in the DEP's award winning AirWatch program.

The purpose of the Strategy is to facilitate the co-ordination and integration of all education and awareness programs that contain an air quality component.

The Community Education Strategy would contain a range of activities including community education and involvement, community consultation, public relations, media relations and advertising. It will incorporate performance indicators and periodic reviews of progress. As these activities are interrelated, linkages will be acknowledged in the Strategy.

Lead Agency: DEP (working group)
Supporting Agencies/Organisations: CCWA, relevant industry sectors, relevant government agencies, local government, PAN
Start date and duration: Start 2001 and review annually, ongoing.

CIE 2
Improve community understanding of the benefits of alternative transport modes and correct vehicle maintenance.

As motor vehicles are the primary source of emissions contributing to photochemical smog and haze in the Perth airshed, it is imperative that the community gains sufficient awareness and understanding of their role in improving Perth's air quality. The two areas in which members of the community can have the greatest positive influence on air quality is in their choice of the mode of transport used and the regular maintenance of their vehicle.

Providing the community with adequate information on the advantages of commuting via "green" transport modes, such as public transport (buses, trains and ferries), cycling and walking, will encourage greater use of these modes. The advantages to the community and the environment include:

- reduction in costs (private vehicles are expensive to purchase and maintain compared to the cost of alternative transport modes);
- health benefits (a reduction in private vehicle use will result in a reduction in vehicle emissions and a subsequent reduction in health-related effects); and
- environmental benefits (a reduction in private vehicle use will result in a healthier environment).

Also, increased community usage of alternative forms of transport will support changes and improvements in the areas of public transport (buses, trains and ferries), and planning decisions such as access (cycleways, or footpaths), parking (decrease the number of available parking spaces in strategic regional centres) and bus priority facilities. Communicating these potential benefits to the community in a comprehensive and effective manner will be an essential element in achieving the desired outcome of reduced vehicle emissions in the Perth metropolitan region. Transport's TravelSmart® program, described in CIE 2.1, is an example of an effective approach towards encouraging commuters to consider using alternative transport modes.

The second component regarding the community's role in reducing vehicle emissions involves regular vehicle maintenance. The benefits of servicing a motor vehicle outweigh the non-benefits. *The National In-Service Vehicle Emissions Study*, conducted by the FORS between 1994 and 1996, showed that correct vehicle tuning and maintenance reduced the amount of pollutants emitted by up to 26% (FORS, 1996). Acting on this, the RACWA launched its Air Care® campaign, aimed at increasing public awareness of the environmental and health effects

resulting from a poorly maintained vehicle. The RACWA now intends to run the campaign every year.

CIE 2.1
Identify and encourage the use of travel alternatives within the community.

TravelSmart® is a Transport program encouraging the use of alternative transport modes (public transport, cycling, walking) by highlighting their benefits. TravelSmart® includes programs such as individualised marketing schemes and workplace programs. A successful South Perth trial of the individualised marketing scheme resulted in a 14% reduction in private car use. This presented justification for the individualised marketing technique to be applied to the whole of the City of South Perth (ie. 35 000 people). It is desirable to extend this program to reach the broader community.

Other programs that encourage the use of travel alternatives include:

- Cycle 100 - a program that through direct incentives, encourages commuters to the Perth CBD to cycle to work; and
- Cycle Instead® - a community awareness campaign which encourage people to use bicycles instead of motor vehicles.

The most appropriate methods to facilitate the continued operation of TravelSmart® will be identified. The program messages will continue to highlight the safety, health, environmental and economic benefits of choosing sustainable transport, ie. public transport, cycling and walking (see LTP 1.8).

Lead Agency: Transport and DEP
Supporting Agencies/Organisations: MRWA, MfP, local government, CCWA, PAN
Start date and duration: Start 1999, review annually, and assess effectiveness at AQMP 2010 review.

CIE 2.2
Initiate an education campaign focussing on vehicle maintenance.

RACWA successfully launched its trial six week vehicle maintenance awareness campaign, Air Care®, in January 1999. This was RACWA's first environmental campaign, focussing on correct vehicle tuning and promoting the use of alternative transport. The RACWA has indicated that it will continue the Air Care® community awareness program until 2002.

A joint long term initiative by the DEP with assistance from Transport and RACWA aims to educate the community on the importance of regular and correct vehicle maintenance, both in terms of financial benefits and contribution to improved air quality. The longer term financial benefits from regular vehicle maintenance as an incentive for community action will be emphasised in the program's message.

Lead Agency: DEP & RACWA
Supporting Agencies/Organisations: Transport
Start date and duration: Start 2003, review annually, and assess effectiveness at AQMP 2010 review.

CIE 2.3
Establish links between existing information centres and websites for public dissemination of information regarding various air quality issues, transport modes, programs and actions.

There is a need to ensure that the Perth community has access to relevant information on existing and proposed transport-related programs as well as general air quality issues. Readily accessible information will aid commuters in making an informed decision regarding modal choice. Access of this information will be facilitated though a series of links to existing websites containing information on air quality issues and transport related programs.

Lead Agency: Transport in collaboration with DEP, CCWA, OoE
Supporting Agencies/Organisations: MRWA, MTA, PAN
Start date and duration: Establish 2001 and review annually.

CIE 2.4
Advise the community of the risk to drivers and passengers from exhaust emissions.

Studies have indicated that motor vehicles offer little or no protection against the pollutants generated by the traffic. Drivers and passengers face pollution levels inside a car two or three times higher than those experienced by pedestrians.

The proposed strategy will assess the quantity of gas emissions entering a vehicle, followed by a campaign aimed at educating drivers about the dangers of pollutants.

This action is contingent on the assessment of all air quality community education programs in CIE 1.1 and 1.2.

Lead Agency: DEP in collaboration with Transport
Supporting Agencies/Organisations: RACWA, HDWA
Start date and duration: 2003 and assess effectiveness at AQMP 2005 review.

CIE 3
Improve community understanding of the sources and impacts of emissions related to domestic activities.

A significant proportion of our time is spent around the home partaking in activities such as lawn mowing, trimming edges, painting, and using cleaning agents and pesticides. During the warmer months barbeques are a popular social activity, and in winter many people find wood heaters appealing for their warmth and cosy atmosphere.

All of these activities contribute emissions to the ambient air and, combined with emissions from other sources, ultimately contribute to photochemical smog and/or haze formation. The total emissions resulting from domestic activities can be successfully managed through increasing community awareness and knowledge of the sources and their impacts, and providing the community with alternative options to reduce emissions. Some of these issues are addressed through actions in the DAE section.

CIE 3.1
Educate the community on correct wood heater operation and maintenance.

The DEP is involved in a media campaign to increase community awareness of the correct operation of wood heaters, and the need to check domestic chimneys in preparation for the winter months. Launched in June 1999, the 'Less Smoke, Cleaner Air' campaign involves a series of television and newspaper advertisements, a radio advertisement and information packages available at wood retailers.

The 'Less Smoke, Cleaner Air' program has been evaluated by the DEP and found to be ineffective in that it did not achieve the required behaviour changes by wood heater users.

The DEP will use the information gathered through the evaluation to develop a program based on individualised socialised marketing techniques.

This action is contingent on the assessment of all air quality community education programs in CIE 1.1 and 1.2.

Lead Agency: DEP
Supporting Agencies/Organisations: AHHA, local government, CCWA, PAN
Start date and duration: Campaign ran in June 1999, review 2001.

CIE 3.2
Continue to inform and advise the community of the benefits of alternative heating options.

The environmental, economic and health benefits of gas or electric heating as opposed to wood heating are significant. Ongoing provision of information and advice to consumers, including the hospitality sector (hotels, restaurants, etc) and the general community, will provide the incentive to consider alternative heating options.

The continuation of information and advice by the OoE will ensure that the public and relevant business sectors are aware of the benefits and non-benefits of the available heating choices. Annual surveys will be conducted as a performance indicator to gauge the awareness of the community regarding heating appliances.

Lead Agency: OoE
Supporting Agencies/Organisations: AlintaGas, Western Power, DEP, heating industry representatives, CCWA, PAN
Start date and duration: Under way, and assess effectiveness at AQMP 2010 review.

CIE 4
Improve community understanding of indoor air quality issues.

The potential impact on health of indoor air quality was recognised as an important issue by the *Select Committee on Perth's Air Quality* (Legislative Assembly, 1998). Indoor air quality is influenced by outdoor air entering indoors, and by materials, products and fuels found and used indoors. As it is estimated that we spend up to 90% of our time indoors, the possible impact of indoor air quality on human health is a topic of considerable concern (Australian Academy of Technological Sciences and Engineering, 1997). The Select Committee recommended increasing community knowledge of substances causing poor indoor air quality, their health effects and what can be done to improve indoor air quality.

CIE 4.1
Develop an indoor air quality awareness program.

The potential impact of indoor air quality on health is an important issue, to be incorporated into the Community Education Strategy. Included in the *Government's Response to the Report of the Select Committee on Perth's Air Quality* (Government of Western Australia, 1998b) is the commitment to "maintain a watching brief on indoor air quality".

Preliminary studies by tertiary education institutions such as Murdoch and Curtin Universities will be reinforced by monitoring (see MMR 2.6) and further research (see MMR 4.3). Based on the outcomes of this work, methods for successfully informing the community of the steps that can be taken to improve indoor air quality, will be assessed.

Lead Agency: DEP and HDWA
Supporting Agencies/Organisations: Universities, DLG
Start date and duration: Start 2001, review every three years, and assess effectiveness at AQMP 2010 review.

CIE 5
Ascertain target audiences within the community, industry and government.

In conveying general and specific air quality messages and information, it is essential to ensure that relevant audiences within the community, industry and government are targeted. This should be incorporated into the Community Education Strategy, so that target audiences are considered during the development of education and awareness-raising campaigns and programs. Missed target audiences should be identified, with measures to educate and inform them to be determined and implemented.

One area in particular that deserves considerable attention is the education system (primary and secondary schools, and tertiary education institutions). Currently there is an overload of information available to schools in the form of educational packages, coming from industrial organisations, government agencies and departments and community organisations. Only some of this information can be used within the structure of the curriculum, therefore some material may not be covered in adequate detail. An integrated environmental package for education institutions, covering all relevant environmental topics (air, water, forests, land, etc), appears to be a favourable approach in addressing this problem.

CIE 5.1
Review current curriculum materials and advise on how air quality issues can better be included.

Education institutions are a key target audience, as they are educating the next generation that will influence the future outcome of air quality and other environmental issues. School children will also convey material learned at school to their parents and the general community, thus spreading knowledge and understanding.

Recent changes to the school curriculum have resulted in an outcome based approach. Currently there are a variety of competing school programs with an air quality message, eg. the DEP's AirWatch® program, Transport's TravelSmart® Schools program and the BoM's Meteorological Package.

All current school packages will be reviewed with the aim of presenting an integrated "Environmental Package" to schools that fits in with the curriculum.

Lead Agency: EDWA & DEP
Supporting Agencies/Organisations: Curriculum Council, CCWA, relevant industrial organisations, relevant government agencies, PAN
Start date and duration: Start 2001 and complete within one year.

Part 3

Implementing the Air Quality Management Plan

Development of an Implementation Plan

Introduction

Implementing the actions of the AQMP will take place over the next 30 years. In some instances, actions are already under way, and this has been indicated in Part 2 of the plan.

There are 15 government agencies and other groups which have responsibility for ensuring that various actions contained in the AQMP are implemented. Only the State government agencies will be responsible for pursuing funding for the implementation of the actions. It should be noted though, that many actions within the Plan rely upon community, industry and business involvement.

Table 9 summarises all the actions contained in the Plan, and indicates:

- the expected outcome and potential impact on air quality from the implementation of the action;
- the timing for implementing the action; and
- the agency responsible for the action.

Performance indicators against which the success of the Plan is to be measured will also be developed, as well as defining the frequency and form for reporting implementation progress.

At this stage it is intended that the AQMP will be reviewed:

1. after five years, to report on progress made on implementing actions, continued action applicability and prioritisation of subsequent or future actions (including emerging issues), and pursuit of funding; and
2. annually, with an annual report of progress being submitted to the Minister for the Environment. Further details are contained in the AQCC Terms of Reference (see Appendix 3).

The overall objective of the AQMP is to steadily improve Perth's air quality so we have clean air to a level that is acceptable to the majority of the community. A staged approach, taking into consideration the relative impacts of the actions, is necessary to ensure that the most effective strategy is adopted.

The AQCC considered that the most effective programs should be identified, rather than merely stating which programs will be undertaken. A process of prioritisation and scheduling of all actions, with input from the community, government and industry sectors, was therefore necessary.

The AQCC requested that actions be considered in light of their environmental benefits and practicality, and developed a process to achieve a list of priority actions.

Prioritisation Process

The aim of the prioritisation process was to identify those actions which were considered to be key projects and which would deliver the greatest improvements in Perth's air quality.

Prioritisation of actions in each of the eight key areas was initially undertaken by working groups for each of the key areas. Working groups scored each action against a range of criteria listed below. Scores were used to rank all actions in each of the key areas. This process provided an estimate of the relative effectiveness or prevention potential for each action.

The criteria recommended for ranking the strategies were:

Indirect emission reduction potential

Does it lead to increased information being available to allow future pollutant reduction?

Is it necessary to complete another action?

Emission reduction potential

What is the unit reduction in pollution per year, per capita?

What total emission reduction is possible?

Timing of effectiveness

What time frame is needed for the strategy to have an effect?

How long will it take to fully implement the action?

Equity

Are there individuals or groups within the community who will be disadvantaged by the action?

Is the original source of pollution being targeted?

Will the polluter pay?

Technical feasibility

Is the technology currently available?

Are there administrative or public perception barriers to the introduction of the action?

Is there a high likelihood of new technology being developed in the future to solve the problem?

Enforceability

Are regulatory mechanisms in place to support the action?

Is there a need to enhance the mechanism?

Is there a need to create a new mechanism?

Is the mechanism enforceable?

Cost effectiveness

What is the cost of the action to the individual?

What is the cost of the action to the community?

What is the cost of the action to industry?

What is the cost of the action to Government?

Public acceptance

What is the community's opinion of the action?

Public health benefits

What is the public health benefit of the action in terms of reduced hospital admissions, morbidity and mortality?

Following the community consultation period the working groups were asked to reconsider the ranking based on comments received in submissions, and a review of the prioritisation for each of the key areas. The results of the final prioritisation process are given below, listed for each key area.

Health Effects Research (HER)

1. HER 1.3: Investigate the relationship between Perth's daily air quality and hospital emergency department attendance.
2. HER 1.4: Undertake a project to trial the routine recording of GP health data in a standardised way.
3. HER 1.5: Investigate the relationship between re-admissions of patients and daily air quality.
4. HER 2.1: Investigate the potential for local variations in Perth's daily air quality to have any impact on human health.
5. HER 2.2: Develop a program to investigate exposure of Perth's residents to air toxics and potential health effects.

Modelling Monitoring and Research (MMR)

1. MMR 1.1: Update the Perth air emissions inventory.
2. MMR 2.1: Review current Perth ambient air quality monitoring data.
3. MMR 4.2: Commission research into air toxics (constituents, sources and impacts).
4. MMR 3.2: Refine the Perth Haze model.
5. MMR 1.4: Investigate requirements for validating emissions estimates within the Perth airshed.

Land Use and Transport Planning (LTP)

1. LTP 1.8: Continue with travel behaviour programs, such as TravelSmart®
2. LTP 1.9: Review and improve access within the Perth metropolitan region for pedestrians and cyclists.
3. LTP 2.1: Incorporate air quality issues in development of *Future Perth*.
4. LTP 1.2: Prepare local Integrated Transport Plans within the framework of the *Metropolitan Transport Strategy*.
5. LTP 1.4: Include transport impact assessment as performance criteria for new major development and redevelopment proposals.

Vehicle Emissions Management (VEM)

1. VEM 5.4: Investigate and promote the benefits and feasibility of using CNG and LPG as fuel sources for the road passenger transport and freight sectors where appropriate.
2. VEM 3.3: Implement the committed outcomes of the (vehicle emissions testing) evaluation process and trial to reduce in-service emissions from the Perth motor vehicle fleet.
3. VEM 4.2: Regulate fuel quality standards.
4. VEM 5.5: Investigate the use of electric alternative fuel vehicles and ultra-light vehicles.
5. VEM 2.3: Assess and develop policies to reduce emissions from the light commercial vehicle sector.

Domestic Activities Emissions (DAE)

1. DAE 2.2: Promote effective greenwaste collection and reprocessing services and support a co-ordinated approach by all local government authorities in Perth.
2. DAE 2.1: Introduce a total ban on burning in all urban residential properties in the Perth metropolitan region by 2001, except for hazard reduction burning through development of appropriate legislation.
3. DAE 1.7: Recommend amendments to current legislation to ensure adequate powers are given to local government officers to deal with domestic smoke nuisance.
4. DAE 3.2: Support the establishment of minimum standards for energy efficiency for all new houses, major renovations and redevelopments by the adoption of the standards to be introduced into the Building Code of Australia.

5. DAE 3.3: Advocate the introduction of energy efficiency standards into the Building Code of Australia.

Burning Emissions Management (BEM)

1. BEM 4.6: Undertake studies on weather and smoke modelling to improve burn decision processes.
2. BEM 4.4: Establish a working group to raise awareness amongst agencies regarding smoke management issues.
3. BEM 5.2: Continue to promote and review risk assessment of bushfire impacts, taking into account air quality and other environmental impacts.
4. BEM 4.2: Support the development of agreed consistent approaches and procedures for smoke management in all burning activities.
5. BEM 1.2: Develop and distribute an information leaflet to be attached to all burning permits.

Industrial Emissions Management (IEM)

1. IEM 2.3: Implement appropriate action plans to address significant industrial sources of NO_x in Perth.
2. IEM 4.4: Work with industry to develop and implement cost-effective emission management plans for industrial ROC emissions.
3. IEM 2.1: Establish the impact of the Kwinana Power Station and other key NO_x emitters on air quality in the Perth airshed.
4. IEM 4.2: Identify the other major emitters of ROCs in the Perth airshed.
5. IEM 2.2: Establish the most cost effective emission reduction options for the Kwinana Power Station and other key NO_x emitters, pending conclusions of the updated inventory, and investigation of the impact of NO_x emitters on air quality in the Perth airshed.

Community Information and Education (CIE)

1. CIE 2.1: Encourage the use of travel alternatives within the community.
2. CIE 1.1: Review existing air quality community education programs.
3. CIE 1.2: Develop and implement a Community Education Strategy.
4. CIE 3.1: Educate the community on correct wood heater operation and maintenance.
5. CIE 2.2: Initiate an education campaign focussing on vehicle maintenance.

The AQCC considered the priorities put forward by the working groups, and those indicated by comments received from the community. The AQCC identified that of the 126 actions which will be implemented under the AQMP, the key areas considered to have the most impact on air quality in the short term are:

- changing commuter behaviour to reduce the reliance on private car use;
- reducing vehicle emissions; and
- managing industrial emissions.

A range of other actions support these key areas and are covered in the areas of research, community education, prevention and minimisation actions.

The six key actions identified by the AQCC are:

- LTP 1.8 combined with CIE 2.1
  Continue with travel behaviour programs, such as TravelSmart® and encourage the use of travel alternatives within the community;
- VEM 5.4
  Investigate and promote the benefits and feasibility of using CNG and LPG as fuel sources for the road passenger transport and freight sectors where appropriate;
- VEM 3.3
  Implement the committed outcomes of the (vehicle emissions testing) evaluation process and trial to reduce in-service emissions from the Perth motor vehicle fleet;
- VEM 4.2 and VEM 4.3
  Regulate fuel quality standards and encourage national moves towards regulating for cleaner fuel formulation;
- IEM 2.3
  Implement appropriate action plans to address significant industrial sources of NO_x in Perth; and
- IEM 4.4
  Work with industry to develop and implement cost-effective emission management plans for industrial ROC emissions.

While these actions will provide significant improvements in Perth's air quality, all sources of air pollutants need to be included, and information provided to the community about reducing emissions to the atmosphere if generally acceptable air quality is to be achieved.

Of the remaining actions, many support the key actions, for example by supplying additional information or ensuring information is supplied to

the public. Others have been completed or have commenced and will continue. Some key actions also depend on other actions occurring before they are able to be implemented, so a staged approach to these key actions is necessary.

The management of Perth's air quality over the next 30 years must work on the local and regional levels and across the entire Perth airshed. In addition, it is essential that the key sectors of land use and transport planning, vehicle, domestic, burning and industrial emissions are all addressed by this Plan, as all areas contribute to emissions which impact on Perth's air quality. Finally, this Plan must recognise that direct emission reduction, research, prevention and minimisation, and education and information are all essential when determining the most effective methods of improving and maintaining air quality. It has not been the intention of the prioritisation exercise to target one emission source above another, or to prioritise direct reductions against prevention, education or research elements.

Development of the Implementation Plan

It will not be possible to implement all actions within the AQMP in the immediate future. To have an effective plan, a staged approach is needed to take into account resourcing requirements, cost effectiveness and environmental benefit. The development of the priority actions as described above provides a framework for further developing the plan for implementation.

During the next year, the DEP will work closely with the relevant lead and supporting agencies to develop detailed project specifications for each action, which will include resourcing requirements and the expected impact on air quality, and to develop detailed plans for implementation.

The available funding resources allocated for each action will then be committed based on its priority, timeline requirements and cost effectiveness. Some actions which have already commenced may require continued resourcing and this will also be taken into account when discussing these actions with relevant agencies.

Each action will require an individual implementation plan to be developed. The process will consider:

- relevant references, issues and costs;
- timing and duration;
- necessary steps involved to complete the action; and
- resourcing, timing and costs for each step.

The actions which relate to key projects, are cost effective and present short and long term benefits to air quality will be implemented first. The Plan will be dynamic and will be reviewed annually to ensure actions remain appropriate and effective. The annual review will also have regard for new information and results as they become available. The development process will be staged as well, with input from the AQCC.

Interpreting the Proposed Implementation Schedule

Table 9 provides the timeline for implementation of the AQMP actions with explanations for columns as follows:

Code

This is the action's reference number, as used in Part 2 of the AQMP.

Description

This is the action statement, as used in Part 2 of the AQMP.

Output

This identifies the type of product delivered from the action. Eleven categories of outputs are used and described below:

- Air quality model, a computer model where various combinations of emission changes and meteorology can be simulated to assess changes in ambient air quality;
- Awards, a system of acknowledgment;
- Campaign, includes structured awareness-raising or educational activities targeted generally at the community, as well as specific groups. It also includes items such as information packages and leaflets that may be either general or specific in nature and are to be widely distributed;
- Guideline, this represents non-statutory documentation that provides guidance, such as environmental codes of practice and industry guidelines and non-statutory statements of government policy. It includes structured training courses and documentation prepared as training materials or manuals;
- Information centre, a central information facility accessible to the public;
- Inventory, refers to the publicly available collation of emission data;
- Monitoring program, refers to air quality monitoring, and includes stack emission, ambient and indoor air measurement;

- Program, refers to a group of integrated actions that will be implemented as a set, and includes site specific or issue specific plans (eg. indoor air quality plan), as well as extension or refinement of existing government programs, and includes individualised marketing;
- Regulation, means a legislative requirement (eg. an Act amendment, new Regulation or Local law) at either a State or Local Government level;
- Report, includes a one-off report or reports required on an annual, biennial, triennial or five yearly basis; and
- Trial, indicates a field activity undertaken to proof, clarify or refine an action before proceeding with full implementation, or to determine if full implementation will be appropriate.

Expected outcomes

This is currently a description of the perceived result from the action. The seven categories used are:

Basis for future decision making, refers to actions that will;

- deliver information crucial to making a scientifically informed decision, either at a policy or action level.

Behaviour change, refers to actions that;

- will influence a change in general community action or specific stakeholder activity, through the provision of general or targeted information, including specific programs and training courses, or
- aim to educate, create or improve awareness of the community in general or specifically.

Defining an air quality problem, refers to actions that are of an investigative or research nature that will;

- lead to clarification of an air quality problem, or
- quantification of an air quality problem.

Improvement to system, refers to actions that;

- bring about efficiencies in data or information gathering, or
- lead to additional information being accessed, or
- identify knowledge gaps or duplications in functions, or
- provide information not currently available, or
- reflect the State Government's support of actions occurring at a federal level, or
- bring about consistency across jurisdictions.

Preliminary step to research, refers to actions that;

- are an initial step to an action that will deliver a direct or indirect air quality impact.

Support action for modelling work, refers to actions that;

- are preliminary to modelling taking place.

Supporting action, refers to an action that;

- needs to take place before a subsequent action.

Expected impact on air quality

The expected impact is currently defined by a subjective statement. The two categories used are:

- Direct impact on air quality, an action that will directly influence emissions into the Perth airshed; and
- Indirect impact on air quality, an action that will influence air quality, but not directly (eg. changing community behaviour). It also includes supportive actions such as undertaking essential data gathering to manage an improvement in quality, or an action that will add to the understanding about the magnitude of an air quality issue.

Agency responsible

This identifies the State Government agency or authority responsible for ensuring that the action is undertaken. Details are taken directly from Part 2 of the Plan. In some circumstances two or more agencies may be identified (eg. Transport and MfP). This indicates that both agencies are responsible for the action and that co-operation between the named agencies has been agreed and arranged. Supporting agencies and/or organisations are included in brackets.

Timing - Start

This indicates the year in which the action is expected to commence.

Status after 5 years

This indicates the expected progress of each action in the first 5 years of implementation. Some actions will have been completed within this period.

Timing - End

This indicates the year in which the action is expected to be finalised. Where the year indicated is 2029, it should be interpreted that the action is ongoing throughout the life of the Plan. Where the completion date is 2005 or later, a "*" indicates that this action will be reviewed in the five yearly AQMP implementation review.

Table 9: Perth Air Quality Management Plan, Proposed implementation schedule.

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
HER 1.1	Investigate the relationship between Perth's daily air quality and mortality.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (HDWA)	Commenced 1999	Study and report completed.	End 2000
HER 1.2	Investigate the relationship between Perth's daily air quality and hospitalisation.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (HDWA)	Commenced 1999	Study and report completed.	End 2000
HER 1.3	Investigate the relationship between Perth's daily air quality and hospital emergency department attendance.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (HDWA, Curtin University)	2001	Study and report completed.	2002
HER 1.4	Undertake a project to trial the routine recording of GP health data in a standardised way.	Report.	Preliminary step to research.	Indirect impact on air quality.	HDWA (DEP, HRWG, GP Division of WA)	2001	Trial and report completed.	2002
HER 1.5	Investigate the relationship between re-admission of patients and daily air quality.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	HDWA (DEP, HRWG)	2002	Study and report completed.	2003
HER 2.1	Investigate the potential for local variations in Perth's daily air quality to have any impact on human health.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (Collaborative project with ARC SPIRT GRANT, HDWA)	2001	Study and report completed.	2004
HER 2.2	Develop a program to investigate exposure of Perth's residents to air toxics (specifically VOCs).	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP (HRWG, HDWA, Universities)	2001	Study and report completed.	2003
HER 2.3	Investigate the relationship between personal exposure, ambient air quality and defined health outcomes.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (HDWA)	2001	Study and report completed.	2004
HER 2.4	Develop a program to investigate the contribution of indoor air exposure to personal exposure.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	HDWA & DEP (HRWG)	2003	Study and report completed.	2005

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
HER 3.1	Periodically review research needs and funding sources.	Report, triennial review.	Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (HDWA)	2000	Report and first review completed.	2029 *
HER 3.2	Periodically review the health impacts of air pollution or potential airborne contaminants.	Report, triennial review.	Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (HDWA)	Commenced 1999	Report and first review completed.	2029 *
HER 4.1	Assess the community health impacts of smoke from prescribed burning and bushfire.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (CALM, FESA, HDWA)	2002	Study and report completed.	2004
HER 4.2	Undertake a comparative risk assessment of mortality and morbidity influenced by smoke from prescribed burning and bushfire.	Report.	Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP & HRWG (CALM, FESA, Local government)	2004	Study commenced.	2006
MMR 1.1	Update the Perth air emissions inventory.	Inventory, triennial review.	Support action to modelling. Basis for future decision making.	Indirect impact on air quality.	DEP (Industry, Local government, Relevant government agencies)	1999 update completed. Next update 2002.	2002 inventory update complete. 2005 update commenced.	2029 *
MMR 1.2	Link data acquisitions of emissions inventories.	Inventory.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (Industry)	2002	Completed for 2002 inventory update.	2003
MMR 1.3	Quantify significant emissions sources outside the Perth metropolitan region contributing to Perth's air quality.	Report, triennial review.	Defining air quality problem. Support action to modelling. Basis for future decision making.	Indirect impact on air quality.	DEP (CALM, FESA, BoM, Local government)	2001	Study, initial report and first review completed.	2029 *
MMR 1.4	Validate emissions estimates within the Perth airshed.	Report.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (Local government, WAMA, BoM, CCWA, Industry, PAN)	2001	Study and report completed.	2003
MMR 2.1	Review current Perth ambient air quality monitoring data.	Report, 5 yearly review.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (WAMA, Industry, Universities, CCWA, PAN)	Commenced 2000	Report completed and review in progress.	2029 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
MMR 2.2	Review and improve current monitoring equipment.	Report.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (Local government, KIC)	Commenced 2000	Report completed and review ongoing.	2029 *
MMR 2.3	Encourage universities and other centres to be involved in air quality monitoring for educational purposes.	Campaign, annual review.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (EDWA, Universities, PAN)	2001	Campaign and reviews in progress.	2029 *
MMR 2.4	Evaluate the effectiveness of mobile monitoring stations.	Report, monitoring program, 5 yearly review.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (Local government, MRWA)	2001	Report completed, program in progress.	2006 *
MMR 2.5	Establish an effective VOCs monitoring program in Perth.	Monitoring program, Report, triennial review.	Support action to modelling. Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	DEP (Industry, Chemistry Centre (WA))	2002	Program established, report completed, reviews in progress.	2029 *
MMR 2.6	Establish an indoor air quality monitoring program in Perth.	Monitoring program, one-year trial, triennial review.	Support action to modelling. Defining air quality problem. Basis for future decision making.	Indirect impact on air quality.	HDWA & DEP (Universities, Local government)	2002	Monitoring program and trial report completed.	2005 *
MMR 3.1	Periodically review modelling development and maintenance requirements, and update models as necessary.	Report, biennial review.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (BoM, Industry)	2001	Report completed, reviews in progress.	2029 *
MMR 3.2	Refine the Perth haze model.	Air quality model & Report.	Basis for future decision making.	Indirect impact on air quality.	DEP	Commenced 1999	Model and report completed.	2005 *
MMR 3.3	Improve the graphical display of the Perth photochemical smog model.	Air quality model & Report, annual review.	Improvement to system.	Indirect impact on air quality.	DEP (EDWA, WA Museum, Industry)	2001	Model and graphical display completed.	2002

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
MMR 3.4	Use output from the BoM mesoscale as input to the photochemical smog model and other airshed models.	Air quality modelling improvements.	Improvement to system. Support action to modelling.	Indirect impact on air quality.	DEP (BoM, CALM)	2001	Modelling developments in progress.	2002 *
MMR 3.5	Use air quality models as an educational tool.	Educational package, annual review.	Improvement to system.	Indirect impact on air quality.	DEP (BoM, Industry, CALM, EDWA, Universities)	2001	Educational package completed, reviews in progress.	2029 *
MMR 4.1	Commission research into the improvement of biogenic emissions estimates relevant to the Perth metropolitan region.	Inventory & Report.	Support action to modelling.	Indirect impact on air quality.	DEP (Universities)	2001	Study and report completed.	2004
MMR 4.2	Commission research into air toxics (constituents, sources and impacts).	Inventory & Report. Biennial review.	Support action to modelling.	Indirect impact on air quality.	DEP (Industry, MRWA, HDWA, Universities)	2002	Study and report completed, reviews in progress.	2004 *
MMR 4.3	Commission research into fluoride and acid gas emissions (sources and impacts).	Inventory & Report.	Support action to modelling.	Indirect impact on air quality.	DEP (Industry, Local government)	2001	Study and report completed.	2002
MMR 4.4	Periodically review the status of emerging air quality issues and actions available to address these issues.	Annual review, publicly accessible information.	Basis for future decision making. Defining air quality problem.	Indirect impact on air quality.	DEP (Universities, Relevant government agencies, Industry councils and Community groups)	2001	Air quality information publicly available, annual reviews in progress.	2029 *
LTP 1.1	Assess the environmental impact of the *Perth Metropolitan Transport Strategy.*	Report, 5 year review.	Basis for future decision making.	Indirect impact on air quality.	DEP & EPA (Transport, MfP, MRWA)	Initial review completed 1999.	5 yearly review in progress.	2029 *
LTP 1.2	Prepare local Integrated Transport Plans within the framework of the *Metropolitan Transport Strategy.*	Reports, annual review.	Basis for future decision making.	Direct impact on air quality.	Transport & MfP (Local government, Land developers, MRWA, WAPC, MfP)	2000	Report completed, reviews in progress.	2029 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
LTP 1.3	Assess local and regional air quality impacts when considering road network planning.	Reports.	Basis for future decision making.	Indirect impact on air quality.	MRWA (DEP, Local government, Transport, MfP)	Commenced 2000	Ongoing assessment and reporting.	2029 *
LTP 1.4	Include transport impact assessment as performance criteria for new major development and redevelopment proposals.	Reports.	Basis for future decision making. Support action to modelling.	Indirect impact on air quality.	MfP & Transport (EPA, DEP, MRWA, Local government)	Commenced 2000	Ongoing assessment and reporting.	2029 *
LTP 1.5	Monitor the implementation of the *Better Public Transport: Ten-Year Plan for Transperth.*	Report, triennial review.	Basis for future decision making. Support action to modelling.	Indirect impact on air quality.	Transport (MRWA, Westrail, MfP, DEP, Local government, CCWA)	Commenced 2000	Report completed, reviews in progress.	2010 *
LTP 1.6	Encourage the further implementation of teleworking in government agencies.	Campaign, policy, annual review.	Improvement to system.	Direct impact on air quality.	Transport (DEP, WAMA, DLG, MfP)	Commenced 1999	Policy completed, campaign and reviews in progress.	2005 *
LTP 1.7	Facilitate the development of home-based employment and business through appropriate planning provisions.	Campaign, policies, annual review.	Improvement to system.	Direct impact on air quality.	WAMA & MfP (Local government, Transport, DLG, Business sector)	Commenced 2000	Policies completed, campaign and reviews in progress.	2005 *
LTP 1.8	Continue with travel behaviour programs such as TravelSmart®.	Campaign, reports, annual review.	Improvement to system.	Direct impact on air quality.	Transport (DEP, MRWA, Local government, Commercial & business sectors)	Commenced 1999	Reports, campaign and reviews in progress.	2005 *
LTP 1.9	Review and improve access within the Perth metropolitan region for pedestrians and cyclists.	Report, triennial review.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	Transport (WAMA, MRWA, MfP, Relevant community organisations, Local government)	2001	Report completed, reviews in progress.	2029 *
LTP 1.10	Manage regional parking in key destinations (CBD and strategic regional centres).	Program, report, annual review.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	Transport & Local government (MfP, WAMA, Business sector)	Commenced 2000	Report completed, program and reviews in progress.	2029 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
LTP 1.11	Assess the cost-effectiveness of public money spent on transport modes and services in terms of air quality benefits.	Report.	Basis for future decision making.	Indirect impact on air quality.	DEP & Transport (MRWA, MfP, Treasury)	2001	Report completed.	2003
LTP 2.1	Incorporate air quality issues in development of *Future Perth.*	One initial report, review period to be determined.	Basis for future decision making.	Indirect impact on air quality.	MfP (WAMA, MRWA, Transport)	Commenced 2000	Initial report completed, reviews in progress.	2029 *
LTP 2.2	Research and evaluate the application to urban consolidation strategies in Perth metropolitan region.	Report.	Basis for future decision making. Supporting action to LTP 2.3.	Indirect impact on air quality.	MfP (DEP, Transport, WAMA, Local government)	2001	Report completed.	2003
LTP 2.3	Develop a government policy position on increased levels of urban infill, density and renewal.	Report.	Basis for future decision making.	Indirect impact on air quality.	MfP (WAMA, DEP, Transport)	2003	Report completed.	2004
LTP 3.1	Identify the optimal public transport corridors and transport interchanges in Perth and undertake planning and reservation as a priority.	Report, annual review.	Basis for future decision making. Support action to modelling.	Indirect impact on air quality.	MfP & Transport (MRWA, DEP, Local government, Land developers)	2002	Report completed, reviews in progress.	2029 *
LTP 3.2	Implement Policy DC 1.6: *Planning to Enhance Public Transport Usage.*	Report, annual review.	Basis for future decision making.	Direct impact on air quality.	MfP & WAPC (Land developers, Local government, Transport)	2001	Report completed, reviews in progress.	2029 *
LTP 4.1	Support the development and implementation of an appropriate education campaign on energy efficiency and environmentally sensitive design.	Campaign, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	OoE (DLG, WAMA, MfP, HIA, MBA, DEP, CCWA, PAN)	2001	Campaign and reviews in progress.	2003 *
LTP 4.2	Support the preparation of energy efficiency requirements in the Building Code for the design of new commercial and residential buildings, major renovations and redevelopments.	Guideline.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DLG (WAMA, MfP, OoE, DEP, HIA, Transport)	2001	Guideline completed.	2006
LTP 4.3	Support an increase in the use of energy rating schemes for commercial and residential buildings.	Campaign.	Improvement to system. Behaviour change.	Indirect impact on air quality.	OoE (WAMA, Local government, DEP, HIA, DLG)	2001	Campaign completed.	2003

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
VEM 1.1	Introduce the 'Ten-second' regulations for visibly smoky vehicles.	Regulation & Report, one initial annual review.	Improvement to system.	Direct impact on air quality.	Transport (DEP, WAPS, RACWA)	Commenced 2000	Regulation, report and review completed.	2000
VEM 1.2	Review the DEP Smoky Vehicle reporting program.	One report.	Basis for future decision making.	Indirect impact on air quality.	DEP (Transport, RACWA)	2001	Report completed.	2002
VEM 2.1	Evaluate the potential for introducing a voluntary accelerated vehicle retirement (scrappage) program in Perth.	Report.	Basis for future decision making. Support action to VEM 2.2 and VEM 2.3.	Indirect impact on air quality.	DEP & Transport (RACWA)	2001	Report completed.	2002
VEM 2.2	Implement the committed outcomes of the evaluation process to encourage the removal of older vehicles from the Perth fleet.	Regulation.	Improvement to system.	Direct impact on air quality.	DEP & Transport (RACWA, Industry)	2002	Regulation completed.	2010 *
VEM 2.3	Assess and develop policies to reduce emissions from the light commercial vehicle (LCV) sector.	Report, five yearly review.	Basis for future decision making.	Indirect impact on air quality.	Transport (Commercial sector, DEP)	2003	Report completed.	2010 *
VEM 3.1	Evaluate the various emission testing options for their cost effectiveness and environmental benefits, for introduction into Perth.	Report.	Supporting action to VEM 3.2 and VEM 3.3.	Indirect impact on air quality.	DEP (RACWA, Transport)	2001	Review and report completed.	2002
VEM 3.2	Trial a random road-side emissions testing system as a screening method for comparison of on-road vehicle emissions against appropriate standards.	Trial of monitoring program, report.	Basis for future decision making.	Indirect impact on air quality.	DEP (Transport, WAPS, RACWA)	2003	Trial and report completed.	2004
VEM 3.3	Implement the committed outcomes of the evaluation process and trial to reduce in-service emissions from the Perth motor vehicle fleet.	Program.	Improvement to system.	Direct impact on air quality.	DEP (Transport, WAPS, RACWA)	2002	Program in progress.	2005 *
VEM 3.4	Establish a training program for the automotive industry to ensure sufficient expertise in emissions testing, maintenance and repairs.	Education program.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP (Chamber of Automotive Industries (WA), MTA, RACWA)	2001	Education program in progress.	2002 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
VEM 3.5	Periodically review emissions testing equipment and technology.	Report, triennial review.	Basis for future decision making.	Indirect impact on air quality.	DEP (Transport, RACWA, MTA, Chamber of Automotive Industries (WA))	2001	Report completed, reviews in progress.	2029 *
VEM 4.1	Develop a fuel formulation policy for locally produced and imported petrol and diesel automotive fuel.	Regulation, with review 2005.	Basis for future decision making.	Indirect impact on air quality.	DEP (Transport, Oil industry)	2001	Regulation completed, review in progress.	2002
VEM 4.2	Regulate fuel quality standards.	Regulation, with review 2005.	Basis for future decision making.	Direct impact on air quality.	DEP & EPA (Industry)	Completed 2000	Regulation completed, review in progress.	2000
VEM 4.3	Encourage stronger national moves towards regulating for cleaner fuel formulation.	Regulation.	Basis for future decision making.	Indirect impact on air quality.	DEP (MVEC, Transport, MTA, OoE)	Commenced 2000	Regulation completed, review in progress.	2029 *
VEM 4.4	Promote the introduction of Stage II vapour recovery through national forums.	Regulation.	Basis for future decision making.	Indirect impact on air quality.	DEP (MVEC, Industry)	2001	Forums and regulation in progress.	2029 *
VEM 5.1	Support the consistency and early adoption of Australian Design Rule emission standards with international best practice emission standards.	Regulation.	Basis for future decision making.	Indirect impact on air quality.	DEP (MVEC, Transport)	Commenced 1999	Regulation in progress.	2010 *
VEM 5.2	Support national moves to encourage the coordination of vehicle emission standards with automotive fuel standards.	Regulation.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	DEP (MVEC, Transport, NRTC)	Commenced 2000	Regulation in progress.	2005 *
VEM 5.3	Report on the effectiveness of the government fleet LPG trial.	Report.	Basis for future decision making.	Indirect impact on air quality.	DEP (CAMS, OoE, Transport)	2001	Report completed.	2002
VEM 5.4	Investigate and promote the benefits and feasibility of using CNG and LPG as fuel sources for the road passenger transport and freight sectors where appropriate.	Report.	Basis for future decision making.	Indirect impact on air quality.	DEP (Transport, HDWA, OoE, Alinta Gas, Industry)	2001	Report completed.	2003

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
VEM 5.5	Investigate the use of electric alternate fuel vehicles and ultra-light vehicles.	Report.	Basis for future decision making.	Indirect impact on air quality.	Transport (RACWA, DEP, MRWA, Local government, OoE)	2002	Initial report completed.	2010 *
DAE 1.1	Conduct a full lifecycle analysis of all available domestic heating alternatives.	Report.	Basis for future decision making.	Indirect impact on air quality.	DEP (OoE, Alinta Gas, Western Power, Universities, Local government, AHHA)	2001	Report completed.	2003
DAE 1.2	Develop incentives to encourage home owners to use alternative forms of heating.	Campaign, review period to be determined.	Behaviour change.	Indirect impact on air quality.	DEP (AHHA, Local government, Industry, PAN, CCWA)	2001	Campaign and reviews in progress.	2005 *
DAE 1.3	Establish a mediating process for the resolution of domestic smoke nuisance complaints as a component of the annual "Halt the Haze" campaign.	Report, biennial review.	Improvement to system.	Indirect impact on air quality.	DLG in collaboration with DEP (AHHA, Local government)	Commenced 2000	Report completed, program and reviews in progress.	2005 *
DAE 1.4	Advocate and adopt the upgraded Australian Standards for solid fuel heater emissions when introduced.	Regulation.	Basis for future decision making.	Direct impact on air quality.	DEP (Local government)	2001	Regulation completed.	2001
DAE 1.5	Finalise and adopt an industry Code of Practice for the proper installation of wood heaters.	Guideline.	Improvement to system. Behaviour change.	Indirect impact on air quality.	WAMA, DLG & AHHA (Local government, Industry)	2001	Guideline completed.	2002
DAE 1.6	Implement an accredited course or equivalent for wood heater installers as a means of increasing industry awareness.	Campaign, review period to be determined.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP (Industry, AHHA, Training institutes)	2001	Campaign and reviews in progress.	2005 *
DAE 1.7	Recommend amendments to current legislation to ensure adequate powers are given to local government officers to deal with domestic smoke nuisance.	Regulation.	Improvement to system.	Indirect impact on air quality.	HDWA (Local government, WAMA, DLG)	2001	Regulation completed.	2001
DAE 1.8	Enhance the awareness of wood suppliers in the Perth metropolitan region with regard to the need for compliance with the *Environmental Protection (Firewood Supply) Regulations 1998 (WA).*	Campaign, review period to be determined.	Behaviour change.	Indirect impact on air quality.	DEP (Local government, AHHA, OoE)	Commenced 1999	Campaign and reviews in progress.	2029 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
DAE 2.1	Introduce a total ban on burning in all urban residential properties in the Perth metropolitan region by 2001, except for hazard reduction burning, through development of appropriate legislation.	Regulation.	Improvement to system. Behaviour change.	Direct impact on air quality.	DEP (Local government, FESA, HDWA, WAMA)	2001	Regulation completed.	2002
DAE 2.2	Promote effective green waste collection and reprocessing services and support a coordinated approach by all local government authorities in Perth.	Campaign, review period to be determined.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP & Local government (WAMA)	2001	Campaign and reviews in progress.	2029 *
DAE 3.1	Support the enhancement the existing voluntary program to promote energy efficiency in building design and the construction of new dwellings, major renovations and redevelopments.	Program, Report, one review at 5 years.	Improvement to system. Supporting action to DAE 4.1.	Direct impact on air quality	OoE (Local government, DLG, DEP, HIA, MBA)	2001	Report completed, program and review in progress.	2005 *
DAE 3.2	Support the establishment of minimum standards for energy efficiency for all new houses, major renovations and redevelopments by the adoption of the standards to be introduced into the Building Code of Australia.	Regulation.	Improvement to system.	Indirect impact on air quality	DLG in collaboration with DEP (Local government, OoE)	2001	Regulation in progress.	2005 *
DAE 3.3	Advocate the introduction of energy efficiency standards into the Building Code of Australia.	Regulation.	Improvement to system.	Indirect impact on air quality	DLG in collaboration with DEP (HIA, OoE, MBA)	2001	Regulation completed.	2005
DAE 4.1	Provide an information package for consumers regarding the pollution potential of domestic products.	Information package, biennial review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP (Australian Consumers Association, Industry)	2001	Information package completed, reviews in progress.	2029 *
DAE 4.2	Investigate the feasibility of developing a rating scheme for domestic appliances and recreational equipment according to relative impacts on air quality.	Program & report, biennial review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP (OoE, Australian Consumers Association, Industry)	2002	Program and report completed, reviews in progress.	2005 *
BEM 1.1	Implement an active community education campaign on burning and smoke management.	Campaign, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP (CALM, FESA, Local government, CCWA, PAN)	2001	Campaign and reviews in progress.	2029 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
BEM 1.2	Develop and distribute an information leaflet to be attached to all burning permits.	Information leaflet, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	FESA in collaboration with DEP (CALM, BoM, Local government)	2001	Leaflet completed, reviews in progress.	2029 *
BEM 1.3	Develop information on planned burning and smoke management activities to be included in local government information services.	Information package and advice, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	FESA (DEP, CALM, BoM, Local government)	2001	Information package completed, reviews in progress.	2029 *
BEM 2.1	Include air quality information in FESA/CALM training program and guidelines.	Guideline, training program.	Improvement to system. Behaviour change.	Indirect impact on air quality.	FESA (DEP, CALM, BoM, Local government)	Commenced 1999	Guideline and training program completed.	2000
BEM 2.2	Include air quality information in FESA and CALM run training workshops.	Workshop, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	FESA (CALM, DEP, BoM, Local government)	Commenced 2000	Workshop and reviews in progress.	2029 *
BEM 2.3	Develop environmental codes of practice for use of fire in horticultural and agricultural practices within the Perth metropolitan region.	Guideline.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP (Local government, FESA)	2002	Guideline completed.	2003
BEM 3.1	Require regulation of burning throughout the year in areas within and surrounding the Perth metropolitan region.	Regulation.	Improvement to system. Basis for future decision making.	Direct impact on air quality.	DLG & WAMA (FESA)	Commenced 2000	Regulation completed.	2029 *
BEM 3.2	Regulate the use of fire on development sites within the Perth metropolitan region.	Improvement to system.	Basis for future decision making.	Direct impact on air quality.	DEP (Local government, FESA, WAMA, Building industry)	Commenced 2000	Regulation completed.	2000
BEM 3.3	Promote the development of environmental management plans to incorporate fire hazard reduction strategies for regionally and locally significant bushland in the Perth metropolitan region.	Program, reports.	Improvement to system. Basis for future decision making.	Direct impact on air quality.	DEP & Land owners (Local government, CALM, FESA, Bushland Conservation Groups)	Commenced 2000	Reports completed, program in progress.	2005 *
BEM 4.1	Support the development of hazard reduction policies for adoption by local government to encourage consistency in smoke management.	Report.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	FESA in collaboration with DEP (Local government, CALM)	2001	Report completed.	2002

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
BEM 4.2	Support the development of consistent approaches and procedures for smoke management in all burning activities.	Report, review period to be determined.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	FESA in collaboration with DEP (Local government, CALM)	Commenced 2000	Report completed, reviews in progress.	2005 *
BEM 4.3	Support the development of a uniform approach to the assessment of smoke management conditions used to issue burning permits.	Trial, report, program.	Improvement to system. Basis for future decision making.	Direct impact on air quality.	FESA in collaboration with DEP (Local government, CALM)	2001	Trial and report completed, program in progress.	2002
BEM 4.4	Establish a working group to raise awareness amongst agencies regarding smoke management issues.	Program, annual review.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	DEP (CALM, FESA, Local government, Bush Fires Service)	2001	Program and reviews in progress.	2029 *
BEM 4.5	Include broader local government representation in the Smoke Management Liaison Group.	Program.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	DEP & FESA (CALM, BoM, WAMA)	Commenced 1999	Program in progress.	2029 *
BEM 4.6	Undertake studies on weather and smoke modelling to improve burn decision processes.	Air quality modelling improvement & report, annual review.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	CALM & BoM (DEP, FESA)	2001	Report completed, annual reviews in progress.	2005 *
BEM 5.1	Review the effectiveness of the existing CALM, DEP, FESA & BoM inter-agency agreement.	Report, annual review.	Basis for future decision making.	Indirect impact on air quality.	BoM (DEP, CALM, FESA)	2001	Report completed, reviews in progress.	2029 *
BEM 5.2	Continue to promote and review risk assessment of bush fire impacts, taking into account air quality and other environmental impacts.	Report, review period to be determined.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	DEP (CALM, FESA)	2001	Report completed, reviews in progress.	2029 *
IEM 1.1	Develop a series of emissions management guidelines in consultation with relevant industry sectors to be used jointly by the DEP and industry.	Guideline, review period to be determined.	Improvement to system. Basis for future decision making. Behaviour change.	Indirect impact on air quality.	DEP (Relevant industry representatives)	2001	Guideline completed, reviews in progress.	2005 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
IEM 2.1	Establish the impact of the Kwinana Power Station and other key NO_X emitters on air quality in the Perth airshed.	Reports.	Basis for future decision making.	Indirect impact on air quality.	DEP (Western Power, Relevant industries)	2001	Reports completed.	2003
IEM 2.2	Establish the most cost effective emission reduction options for the Kwinana Power Station and other key NO_X emitters, pending conclusions of the updated inventory, and investigation of the impact of NO_X emitters on air quality in the Perth airshed.	Reports.	Basis for future decision making.	Indirect impact on air quality.	DEP (Industry)	2002	Reports completed.	2003
IEM 2.3	Implement appropriate action plans to address significant industrial sources of NO_X in Perth.	Reports.	Basis for future decision making.	Direct impact on air quality.	DEP (Industry)	2003	Reports in preparation.	2010 *
IEM 3.1	Apply emission guidelines for future power generation in the Perth airshed.	Guideline, 5 yearly review.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	DEP (MfP, PAN)	Completed 2000	Guideline completed, ongoing application and reviews in progress.	2029 *
IEM 3.2	Develop and implement a position paper and policy on cogeneration and its implications for the Perth airshed.	Policy.	Improvement to system. Basis for future decision making.	Indirect impact on air quality.	DEP (OoE, Power generating industry, EPA, PAN)	2002	Policy completed, implementation ongoing.	2002
IEM 4.1	Encourage continuous improvement in ROC control measures for ROC emitters in Kwinana.	Program, review period to be determined.	Improvement to system. Basis for future decision making.	Direct impact on air quality.	DEP (Industry)	2001	Program and reviews in progress.	2029 *
IEM 4.2	Identify the other major emitters of ROCs in the Perth airshed.	Inventory.	Improvement to system. Supporting action to IEM 4.3 and IEM 4.4.	Indirect impact on air quality.	DEP (Industry)	2001	Inventory completed.	2002
IEM 4.3	Work with industry to identify and analyse the cost effectiveness of options for ROC management.	Reports, review period to be determined.	Basis for future decision making.	Indirect impact on air quality.	DEP & Industry	2002	Reports completed, reviews in progress.	2029 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
IEM 4.4	Work with industry to develop and implement cost-effective emission management plans for industrial ROC emissions.	Program, review period to be determined.	Basis for future decision making.	Direct impact on air quality.	DEP & Industry	2002	Program and reviews in progress.	2029 *
IEM 5.1	Amend the *Environmental Protection Act 1986* to include the principle of waste minimisation.	Regulation.	Improvement to system. Behaviour change.	Direct impact on air quality.	DEP (Industry)	Commenced 1999	Regulation in progress.	2000
IEM 5.2	Encourage the industrial use of solar and wind power in the Perth metropolitan region.	Program, review period to be determined.	Improvement to system. Behaviour change.	Direct impact on air quality.	OoE (DEP, Power generating industry, EPA, CCWA, PAN)	Commenced 2000	Program and reviews in progress.	2029 *
IEM 5.3	Develop a discussion paper on the range of financial and economic mechanisms available for industrial emission control.	Report.	Basis for future decision making.	Indirect impact on air quality.	DEP (Industry, Treasury)	2001	Report completed.	2003
IEM 5.4	Promote the awareness of industry achievements in atmospheric emission reductions through 'green industry' awards.	Awards.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP & independent sponsor (Industry, CCIWA)	2005	Commenced action.	2007
CIE 1.1	Review existing air quality community education programs.	Review and Report.	Basis for future decision making. Support action to CIE 1.2.	Indirect impact on air quality.	DEP (CCWA, Industry, relevent government agencies, Local government, PAN)	2001	Review and report completed.	2002
CIE 1.2	Develop and implement a Community Education Strategy.	Program, review annually.	Improvement to system. Behaviour change. Supporting action to all CIE actions.	Indirect impact on air quality.	DEP (CCWA, Industry, relevent government agencies, Local government, PAN)	2001	Report completed, reviews in progress.	2029 *
CIE 2.1	Identify and encourage the use of travel alternatives within the community.	Campaign, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	Transport & DEP (MRWA, MfP, Local government, CCWA, PAN)	Commenced 1999	Campaign and reviews in progress.	2010 *
CIE 2.2	Initiate an education campaign focussing on vehicle maintenance.	Campaign, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP & RACWA (Transport)	2003	Campaign and reviews in progress.	2010 *

Table 9: *(continued).*

Code	Description	Output	Expected outcome	Expected impact on air quality (support agency)	Agency responsible	Timing-Start	Status after 5 years	Timing-End
CIE 2.3	Establish links between existing information centres and web sites for public dissemination of information regarding various air quality issues, transport modes, programs and actions.	Information centre, annual review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	Transport in collaboration with DEP, CCWA and OoE (MRWA, MTA, PAN)	2001	Information centre established, reviews in progress.	2029 *
CIE 2.4	Advise the community of the risk to drivers and passengers from exhaust emissions.	Campaign, 5 yearly review.	Behaviour change.	Indirect impact on air quality.	DEP & Transport (RACWA, HDWA)	2003	Campaign and reviews in progress.	2005 *
CIE 3.1	Educate the community on correct wood heater operation and maintenance.	Campaign and initial review in 2001.	Behaviour change.	Indirect impact on air quality.	DEP (AHHA, Local government, CCWA, PAN)	Campaign completed. Commence review 2001.	Campaign and review completed.	2001
CIE 3.2	Continue to inform and advise the community of the benefits of alternative heating options.	Campaign, review period to be determined.	Behaviour change.	Indirect impact on air quality	OoE (Alinta Gas, Western Power, DEP, Heating industry, CCWA, PAN)	Commenced	Campaign and reviews in progress.	2010 *
CIE 4.1	Develop an indoor air quality awareness program.	Program & Report, triennial review.	Improvement to system. Behaviour change.	Indirect impact on air quality.	DEP & HDWA (Universities, DLG)	2001	Report completed, program and reviews in progress.	2010 *
CIE 5.1	Review current curriculum materials and advise on how air quality issues can better be included.	Report.	Basis for future decision making. Improvement to system.	Indirect impact on air quality.	EDWA and DEP (Curriculum Council, CCWA, Industry, relevent government agencies, PAN)	2001	Report completed.	2002

Part 4

Appendices

Appendix 1

Glossary of terms

The following information draws heavily from the following sources:

- Australian Fire Authorities Council (1996) *Glossary of Rural Fire Terminology*. Mount Waverley, Victoria.
- Environment Protection Authority (1997) *Air Quality Management Plan: taking stock, Port Phillip Region*. Publication 535, Government of Victoria.
- Department of Environment (1998) *Draft Strategy for managing air quality in south-east Queensland*. Government of Queensland.
- Environmental Protection Authority (Unpublished) *Glossary (Definition and Terms)*. EPA Server Disk, Government of Western Australia.
- United States Environmental Protection Authority, Air and Radiation Division. (Internet:- http://www.epa.gov/reg5oair/enforce/r5airtm2.htm; Last modified:- August 7, 1996)
- United States Environmental Protection Authority, Air Quality Planning and Standards TTN (Internet:-http://www.epa.gov/ttnuatw1/ hapsec1.html Last modified:- November 24, 1998)

Absorption Barrier Any of the exchange barriers of the body that allow differential diffusion of various substances across a boundary. Examples of absorption barriers are the skin, lung tissue, and gastrointestinal tract wall.

Acute Exposure A single exposure to a toxic substance which results in severe biological harm or death. Acute exposures are usually characterised as lasting no longer than a day, as compared to longer, continuing exposure over a period of time.

Add-on Control Device An air pollution control device, such as a carbon absorber or incinerator that reduces the pollution in an exhaust gas. The control device usually does not affect the process being controlled, and thus is "add-on" technology, as opposed to a scheme to control pollution through altering the basic process itself.

Aerosol A suspension of particles, other than water or ice, in the atmosphere and ranging in size from approximately 10^{-3} micrometres (µm) to larger than 10 µm in radius; may be either natural or caused by human activity and most of the latter are usually considered to be pollutants.

Air Emissions Inventory A detailed listing of the amount of emissions to the atmosphere by type and source over time and space; used to establish emission standards. An air emissions inventory was prepared for the Perth metropolitan region in 1992, and subsequently updated in 1999.

Air Pollutant Any substance in air that could, in high enough concentration, harm humans, other animals, vegetation, or material. Pollutants may include almost any natural or artificial composition of airborne matter capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or in a combination thereof. Generally, they fall into two main groups: (1) those emitted directly from identifiable sources, and (2) those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents, with or without photo activation. Exclusive of pollen, fog, and dust, which are of natural origin, about 100 contaminants have been identified and fall into the following categories: solids, sulfur compounds, volatile organic chemicals, nitrogen compounds, oxygen compounds, halogen compounds, radioactive compounds, and odours.

Air Pollution The presence of contaminant or pollutant substances in the air that do not disperse and accordingly cause interference with human health or welfare, or produce other harmful environmental effects.

Air Quality The condition of the air we breathe, compared to measured acceptable guidelines (eg World Health Organisation guidelines).

Air Toxics A number of airborne compounds which may have adverse effects on human health even when they are present in very small amounts - they include compounds such as benzene, formaldehyde and 1,3-butadiene.

Airshed A body of air bounded by topography and meteorology in which a contaminant, once emitted, is contained. The Perth airshed is defined as the area contained within the Perth metropolitan region.

Alternative Fuels Substitutes for traditional liquid, oil-derived motor vehicle fuels such as gasoline and diesel. Examples include methanol, ethanol, and compressed natural gas.

Alternative Technology An approach that aims to use resources efficiently or to substitute resources in order to do minimum damage to the environment. This approach permits a large degree of personal user control over the technology.

Ambient Air Pollution Guideline A level to which atmospheric concentrations of a substance should be reduced to avoid undesirable effects on human health, well-being and/or vegetation; guidelines are generally regarded as advisory rather than mandatory requirements.

Ambient Air The surrounding outside air at a specified place. For example, this could relate to the outside air of Perth as a whole, a municipality, a suburb or a street.

Area Source Emission Any small source of air pollution that is released over a relatively small area but which cannot be classified as a point source. Such sources may include vehicles and other small engines, small businesses and household activities (see: Point Source Emission).

Background Level In air pollution control, the concentration of air pollutants in a definite area during a fixed period of time prior to the starting up or on the stoppage of a source of emission under control. In toxic substances monitoring, the average presence in the environment, originally referring to naturally occurring phenomena (see: Prevalent Levels).

'Backyard' burning All burning on urban residential properties except the use of planned fire for the removal of ground fuels aimed at reducing bush fire hazards.

Balanced Transport Concepts Achievement of a better balance of transport modes by the replacement of driver-only trips with car passenger, public transport, cycling and walking trips and by tele-access (Transport, 1995).

Best Available Control Measures (BACM) A term used to refer to the most effective measures for controlling small or dispersed particles from sources such as roadway dust, soot and ash from wood stoves and open burning of bush, timber, grasslands, or trash.

Best Available Control Technology (BACT) Emission controls or production methods, techniques, processes, or practices which are capable of achieving a very high degree of reduction in the emission of wastes from a particular source. Financial and economic considerations are excluded from this concept.

Best Practicable Environmental Option (BPEO) A term introduced by the Royal Commission on Environmental Pollution in its Fifth Report (1976) in order to take account of the total pollution from an enterprise or activity and the technical possibilities of dealing with it; possibly a successor to Best Practicable Means, which was primarily concerned with emissions to air. Apart from dealing with all pollutants, BPEO was to take into account the risk of pollutants transferring from one medium to another.

Best Practicable Means (BPM) A commonly used approach to pollution control requirements from industrial and other premises. The word 'practicable' is taken to mean 'reasonably practicable' having regard, among other things, to the state of technology, to local conditions and circumstances and to the financial implications. The concept is much easier to apply than the Air Quality Standards approach.

Best Practice A comprehensive, integrated and co-operative approach to the continuous improvement of all facets of an organisation's operations. It is the way leading edge companies manage their organisations to deliver world class standards of performance.

Groups of "best practice" characteristics:

- Leadership/Vision - shared vision and strategic plan, commitment and leadership of the Chief Executive Officer;
- Industrial Relations Reform - co-operative industrial relations;
- Focus on People Issues - commitment to continuous improvement and learning, innovative human resource management, integration of environmental management practices;
- Work Organisation - flatter organisational structures, pursuit of innovation in technology, processes and procedures;
- External Links - focus on customers, close relations with suppliers, development of networks; and
- Benchmarking - development of performance measurement systems and benchmarking.

Best Practice Environmental Licence (BPEL) Category of licence issued by the Department of Environmental Protection under provisions of the *Environmental Protection Act 1986*. The Department of Environmental Protection's working definition of best practice in environmental management is described in terms of meeting a series of criteria which encompass:

- the development of an environmental policy;
- environmental objectives;
- an environmental management plan and implementation program;
- preparation of a monitoring program;
- benchmarking environmental performance;
- community involvement and reporting; and
- regular audits to evaluate environmental performance.

This essentially embraces the principles of the International Standard ISO14000 series in the development of effective Environmental Management Systems (EMS) for the industrial and business sector.

Best Practice Environmental Management (BPEM) Management of an activity to achieve a continuing minimisation of the activity's environmental harm through cost-effective measures assessed against the measure currently used nationally or internationally for the activity.

Bioaccumulants Substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolised or excreted.

Biologically Effective Dose The amount of a deposited or absorbed chemical that reaches the cells or target site where an adverse effect occurs, or where that chemical interacts with a membrane surface.

Biosphere The portion of Earth and its atmosphere that can support life.

Burn Plan The plan which is approved for the conduct of prescribed burning. It contains a map identifying the area to be burnt and incorporates the specifications and conditions under which the operation is to be conducted.

Burning Program All the prescribed burns scheduled for a designated area over a nominated period of time.

Burning Rotation The period between re-burning of a designated area over a nominated period of time.

Burning Unit A specified land area for which prescribed burning is planned.

Bush Includes trees, bushes, plants, stubble, scrub, and undergrowth of all kinds whatsoever whether alive or dead and whether standing or not standing and also a part of a tree, bush, plant, or undergrowth, and whether severed there from or not so severed. The term does not include sawdust, and other waste timber resulting from the sawmilling of timber in a sawmill whilst the sawdust and other waste timber remains upon the premises of the sawmill in which the sawmilling is carried on (*Bush Fires Act 1954)*.

Bushfire A fire or potential fire, however caused, and includes a fire in a building (*Bush Fires Act 1954)*.

By-product Material, other than the principal product, generated as a consequence of an industrial process.

Carcinogen Any substance that can cause or aggravate cancer.

Catalyst A substance that changes the speed or yield of a chemical reaction without being consumed or chemically changed by the chemical reaction.

Catalytic Converter An air pollution abatement device that removes pollutants from motor vehicle exhaust, either by oxidising them into carbon dioxide and water or reducing them to nitrogen and oxygen.

Chlorofluorocarbons (CFCs) A family of inert, non-toxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere they drift into the upper atmosphere where their chlorine components destroy ozone.

Clean Fuels Blends or substitutes for gasoline fuels, including compressed natural gas, methanol, ethanol, liquefied petroleum gas, and others.

Cleaner Production Cleaner production focuses on the reduction of waste throughout the life cycle of a manufactured article, it is based on practices and technologies which minimise waste generation and energy design, cleaner technologies, processes and practices that minimise waste. The Commonwealth EPA has set up a program to demonstrate cleaner production processes.

Co-generation A means of simultaneously generating heat and electric power from the same energy source. The primary energy used to drive the co-generation plant is most commonly natural gas, but other renewable energy sources such as biogas, sewage gas and landfill gas have been used elsewhere

Combustion (1) Consumption of fuels by oxidation, accompanied by release of energy in the form of heat and light. A basic cause of air pollution. (2) Refers to controlled burning of waste in which heat chemically alters organic compounds, converting them into stable inorganics such as carbon dioxide and water.

Contaminant Any physical, chemical, biological, or radiological substance or matter that has an adverse affect on air, water, or soil.

Contamination Introduction into water, air and soil of micro-organisms, chemicals, toxic substances, wastes or wastewater in a concentration that makes the medium unfit for its next intended use. Also applies to surfaces of objects and buildings and various household and agricultural use products.

Continuous Sample A flow of air from a particular place in a processor or manufacturing plant to the location where samples are collected for testing; may be used to obtain grab or composite samples.

Cost/Benefit Analysis A quantitative evaluation of the costs which would be incurred versus the overall benefits to society of a proposed action such as the establishment of an acceptable dose of a toxic chemical.

Criteria Descriptive factors taken into account when setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year.

Cumulative Exposure The summation of exposures of an organism to a chemical over a period of time.

Dose The amount of a substance available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism. The potential dose is the amount ingested, inhaled, or applied to the skin. The applied dose is the amount of a substance presented to an absorption barrier and available for absorption (although not necessarily having yet crossed the outer boundary of the organism). The absorbed dose is the amount crossing a specific absorption barrier (eg: the exchange boundaries of skin, lung, and digestive tract) through uptake processes. Internal dose is a more general term denoting the amount absorbed without respect to specific absorption barriers or exchange boundaries. The amount of the chemical available for interaction by any particular organ or cell is termed the deliverable dose for that organ or cell.

Dose-response Curve A graphical representation of the quantitative relationship between the administered, applied or internal dose of a chemical or agent, and a specific biological response to that chemical or agent.

Ecosystem The interacting system of a biological community and its non-living environmental surroundings.

Emission Factor The relationship between the amount of pollution produced and the amount of raw material processed.

Emission Standard The maximum amount of air polluting discharge legally allowed from a single source, mobile or stationary.

Emissions Gases, particles or liquids being released into the environment by either natural or human means. Some emissions are of concern to human or environmental health or both, such as NO_2, PM2.5, and SO_2.

Emissions Trading The creation of surplus emission reductions at certain stacks, vents or similar emissions sources and the use of this surplus to meet or redefine pollution requirements applicable to other emission sources. This allows one source to increase emissions when another source reduces them, maintaining an overall constant emission level. Facilities that reduce emissions substantially may "bank" their "credits" or sell them to other industries.

Environment The sum of all external conditions affecting the life, development and survival of an organism.

Environmental Audit An independent assessment of the current status of a party's compliance with applicable environmental requirements or of a party's environmental compliance policies, practices and controls.

Environmental Exposure Human exposure to pollutants originating from facility emissions. Threshold levels are not necessarily surpassed, but low level chronic pollutant exposure is one of the most common forms of environmental exposure (See: Threshold Level).

Environmental Indicators (1) A physical, chemical, biological or solid-economic measure that can be used to assess natural resources and environmental quality. (2) A measurement, statistic or value that provides a proximate gauge or evidence of the effects of environmental management.

Environmental Management The efficient administration of environmental policies and standards. It involves the identification of objectives, the adoption of appropriate mitigation measures, the protection of ecosystems, the enhancement of the quality of life for those affected and the minimisation of environmental costs.

Environmental Planning The identification of desirable objectives for the physical environment, including social and economic objectives, and the creation of administrative procedures and programs to meet those objectives. Matters embraced include: city and regional planning; land use; transport; employment; health; growth centres and towns; population and national settlement policies; location problems; industrial and urban development; national, regional, and local environmental policies; planning permission and development consent procedures; zoning ordinances and development controls; subdivision regulations; building codes; housing standards; urban renewal; community development programs; welfare policies; living-resource conservation; landscape conservation; heritage conservation; wilderness, national and marine parks; pollution-control strategies; environmental impact statements and assessments; public hearings and inquiries; appeal mechanisms and procedures; and the application of international conventions and agreements.

Epidemiology Study of the distribution of disease, or other health-related states and events in human populations as related to age, sex, occupation, ethnic and economic status in order to identify and alleviate health problems and promote better health.

Episode (Pollution) An air pollution incident in a given area caused by a concentration of atmospheric pollutants under meteorological conditions that may result in a significant increase in illnesses or deaths. May also describe water pollution events or hazardous material spills.

Exposure Assessment Identifying the pathways by which toxicants may reach individuals, estimating how much of a chemical an individual is likely to be exposed to and estimating the number likely to be exposed.

Exposure Indicator A characteristic of the environment measured to provide evidence of the occurrence or magnitude of a response indicator's exposure to a chemical or biological stress.

Exposure Level The amount (concentration) of a chemical at the absorptive surfaces of an organism.

Exposure Scenario A set of facts, assumptions and inferences about how exposure takes place that aids the exposure assessor in evaluating estimating, or quantifying exposures.

Exposure The amount of radiation or pollutant present in a given environment that represents a potential health threat to living organisms.

Fire Hazard Any fuel that, if ignited, may be difficult to extinguish.

Fire Intensity The rate of energy release per unit length of fire front. Intensity (I, in kW/m/hr) is calculated by I = ROS x FW x 0.5, where ROS = forward rate of spread of the fire in metres per hour, and FW = fuel weight in tonnes per hectare.

Fire Management All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.

Fire Regime The history of fire in a particular vegetation type or area including the frequency, intensity and season of burning. It may also include proposals for the use of fire in a given area.

Fixed-location Monitoring Sampling of an environmental or ambient medium for pollutant concentration at one location continuously or repeatedly over some length of time.

Fluorocarbons (FCs) Any of a number of organic compounds analogous to hydrocarbons in which one or more hydrogen atoms are replaced by fluorine. Once used in the United States as a propellant for domestic aerosols, they are now found mainly in coolants and some industrial processes. FCs containing chlorine are called chlorofluorocarbons (CFCs). They are believed to be modifying the ozone layer in the stratosphere, thereby allowing more harmful solar radiation to reach the Earth's surface.

Fly Ash Non-combustible residual particles expelled by flue gas.

Fossil Fuel Fuel derived from ancient organic remains, eg. peat, coal, crude oil, and natural gas.

Fuel Load The oven dry weight of fuel per unit area. Commonly expressed as tonnes per hectare.

Fugitive Emissions Substances that escape to air from a source not associated with a specific process but scattered throughout the plant, eg. leaks from equipment, dust blown from stockpiles.

Geographic Information System (GIS) A computer system designed for storing, manipulating, analysing and displaying data in a geographic context.

Greenhouse Effect A term used to describe the role of atmospheric trace gases - water vapour, carbon dioxide, methane, nitrous oxide and ozone, in-keeping the Earth's surface warmer than it would be otherwise.

Guidelines Non-regulatory principles and procedures to set basic requirements for general limits of acceptability for assessments.

Hazardous Substance Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive or chemically reactive.

Haze The term used to describe the presence of very small airborne particles in concentrations large enough to impede vision. Particles in the size range of 0.1 to 0.5 microns are principally responsible for the scattering of light. Their size and typical density allows them to remain suspended in the air despite the influence of gravity.

High Risk Community A community located within the vicinity of numerous sites or facilities or other potential sources of environmental exposure/health hazards which may result in high levels of exposure to contaminants or pollutants. In determining risk or potential risk, factors such as the total weight of toxic contaminants, toxicity, routes of exposure and other factors may be used.

Hydrocarbons (HC) Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogen Sulfide (HS) Gas emitted during organic decomposition. Also a by-product of oil refining and burning. Smells like rotten eggs and, in heavy concentration, can kill or cause illness.

Incineration A treatment technology involving destruction of waste by controlled burning at high temperatures, eg. burning sludge to remove the water and reduce the remaining residues to a safe, non-burnable ash that can be disposed of safely on land, in some waters, or in underground locations.

Indicator (1) In biology, an organism, species, or community whose characteristics show the presence of specific environmental conditions. (2) In chemistry, a substance that shows a visible change, usually of colour, at a desired point in a chemical reaction. (3) A device that indicates the result of a measurement, eg. a pressure gauge.

Indirect Source Any facility or building, property, road or parking facility that attracts motor vehicle traffic and, indirectly, causes pollution.

Indoor Air The breathable air inside a habitable structure or conveyance.

Indoor Air Pollution Chemical, physical or biological contaminants in indoor air.

Intake The process by which a substance crosses the outer boundary of an organism without passing an absorption barrier, eg. through ingestion or inhalation.

Internal Dose The amount of a substance penetrating across the absorption barriers (the exchange boundaries) of an organism via either physical or biological processes.

Inversion A layer of the atmosphere in which temperature increases with increasing elevation. A condition of strong atmospheric stability. Can cause an air pollution episode.

Irritant A substance that can cause irritation of the skin, eyes or respiratory system. Effects may be acute from a single high level exposure, or chronic from repeated low-level exposures to such compounds as chlorine, nitrogen dioxide and nitric acid.

ISO 14000 series Internal standards on environmental management systems and environmental management tools.

Latency Time from the first exposure of a chemical until the appearance of a toxic effect.

Level of Concern (LOC) The concentration in air of an extremely hazardous substance above which there may be serious immediate health effects to anyone exposed to it for short periods.

Licence A statutory document, issued by an environmental agency, permitting a person or organisation to discharge, emit, or deposit wastes into the environment subject to a variety of conditions relating to control measures, monitoring, volume, timing, nature, and composition of the waste. Licences may often be varied or rescinded at any time. Breaches of licensing conditions may result in prosecution. Licences are granted and in force under Part V of the Western Australian Environmental Protection Act 1986.

Life-cycle Analysis The study of the effects of a product or activity on the environment from inception, manufacture, distribution, use, and final disposal, with all the direct and indirect effects on the environment such as the effects of mining raw materials and the problems of disposal of discarded plant and products. Thus it is possible to examine the life cycle of the automobile, the power station, the oil rig, the drink container, the household appliance, detergents, fertilisers or the progress of individual minerals and metals through the fabric of society.

LOAEL (lowest-observed-adverse-effect level) The lowest dose of a chemical in a study or group of studies that produce statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

Local Visual Distance (LVD) A measurement of visibility, quantifying the visibility-reducing property of haze. LVD reduces as the quantity of haze increases. This is measured by a nephelometer (See: Opacity, Nephelometer).

Lowest Achieveable Emission Rate The rate of emissions that reflects (a) the most stringent emission limitation in the implementation plan of any state for such source unless the owner or operator demonstrates such limitations are not achieveable; or (b) the most stringent emissions limitation achieved in practice, whichever is more stringent. A proposed new or modified source may not emit pollutants in excess of existing new source standards.

Mesoscale Description of fine resolution computer models used in meteorological modelling and prediction.

Mobile Source A source of waste which is in motion during its normal operation mode; any non-stationary source of air pollution, such as cars, trucks, motorcycles, buses and aircraft.

Monitoring Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants and animals.

Morbidity A measure of an adverse health outcome that excludes mortality (see below).

Mortality The number of deaths in a given period (death rate).

National Environment Protection Council (NEPC) A Ministerial Council with statutory powers to make national environment protection measures on a cooperative basis - the Inter-governmental Agreement of the Environment provided for the establishment of the NEPC.

National Environment Protection Measure (NEPM) A legal instrument which sets agreed national objectives for protecting particular aspects of the environment. NEPM are made by the NEPC.

National Pollutant Inventory (NPI) A database designed to provide the community, industry and government with information on the types and amounts of certain chemicals being emitted to the environment.

Nephelometer An instrument that measures the visibility-reducing property of haze. It measures the backscatter of light which can be converted into "local visual distance" (LVD). (See: Local Visual Distance).

Nitrogen Dioxide (NO_2) The result of nitric oxide combining with oxygen in the atmosphere; major component of photochemical smog.

NOAEL (no-observed-adverse-effect level) That dose of chemical at which there are no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Nitrogen Oxide (NO_x) Product of combustion from transportation and stationary sources and a major contributor to the formation of ozone in the troposphere and to acid deposition.

Non-Road Emissions Pollutants emitted by combustion engines on farms and construction equipment, gasoline-powered lawn and garden equipment, and power boats and outboard motors.

Opacimeter An instrument used to quantify the opacity, or concentration of particles matter in a given volume of air, of exhaust gases emitted by motor vehicles.

Opacity The amount of light obscured by particle pollution in the air; clear window glass has zero opacity, a brick wall is 100% opaque. Opacity is an indicator of changes in performance of particle control systems. (See: Local Visual Distance).

Oxidant A substance containing oxygen that reacts chemically in air to produce a new substance; the primary ingredient of photochemical smog.

Oxygenated Fuels Gasoline which has been blended with alcohols or ethers that contain oxygen in order to reduce carbon monoxide and other emissions.

Ozone (O_3) Found in two layers of the atmosphere, the stratosphere and the troposphere. In the stratosphere (the atmospheric layer 15 km or more above the earth's surface) ozone is a natural form of oxygen that provides a protective layer shielding the earth from ultraviolet radiation. In the troposphere (the layer extending up 15 km from the earth's surface), ozone is a chemical oxidant and major component of photochemical smog. It can seriously impair the respiratory system. Ozone in the troposphere is produced through complex chemical reactions of nitrogen oxides, which are among the primary pollutants emitted by combustion sources; from hydrocarbons, released into the atmosphere through the combustion, handling and processing of petroleum products; and sunlight.

Ozone Depletion Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or-bromine containing compounds (chlorofluorocarbons or halons), which break down when they reach the stratosphere and then catalytically destroy ozone molecules.

Ozone Hole Thinning break in the stratospheric ozone layer. Designation of amount of such depletion as an "ozone hole" is made when detected amount of depletion exceeds 50%. Seasonal ozone holes have been observed over both the Antarctic region and the Arctic region and parts of Canada and the extreme north-eastern United States.

Ozone Layer The protective layer in the atmosphere, about 20 km above the ground, that absorbs some of the sun's ultraviolet rays, thereby reducing the amount of potentially harmful radiation reaching the earth's surface.

Particle/Particulate Any substance except pure water that exists as a liquid or solid in the atmosphere, of microscopic or submicroscopic size.

Passive Solar Design Designing a building's architectural elements to collect, store and distribute solar resources for heating, cooling and daylighting.

Permit An authorisation, license, or equivalent control document issued by an approved agency to implement the requirements of an environmental regulation; eg. a permit to operate a facility that may generate harmful emissions.

Personal measurement A measurement collected from an individual's immediate environment using active or passive devices to collect the samples.

Perth Metropolitan Region The area contained within the Shires of Kalamunda, Mundaring, Peppermint Grove, Serpentine-Jarrahdale, the Towns of Bassendean, Cambridge, Claremont, Cottesloe, East Fremantle, Kwinana, Mosman Park, Victoria Park, Vincent, and the Cities of Armadale, Bayswater, Belmont, Canning, Cockburn, Fremantle, Gosnells, Melville, Nedlands, Perth, Stirling, Subiaco, Swan and Wanneroo.

Photochemical Oxidants Air pollutants formed by the action of sunlight on oxides of nitrogen and hydrocarbons.

Photochemical Smog Photochemical smog is made up mainly of ozone, nitrogen dioxide and peroxy acetyl nitrate (PAN). The constituents of

photochemical smog that have an adverse effect on people and the environment are known collectively as oxidants or photochemical oxidants. Photochemical oxidant is formed by the action of sunlight on mixtures of nitrogen oxides and non-methane hydrocarbons, for example VOCs. High temperatures can increase the rate of formation.

Planned burn/fire The controlled application of fire under specified environmental conditions to a predetermined area and at the time, intensity and rate of spread required to attain planned resource management objectives.

Plume (1) A visible or measurable discharge of a contaminant from a given point of origin. Can be visible or thermal in water as it extends downstream from the pollution source, or visible in air as, for example, a plume of smoke. (2) Area downwind within which a release could be dangerous for those exposed to leaking fumes.

PM10 A standard for measuring the amount of solid or liquid matter suspended in the atmosphere, ie. the amount of particles matter over 10 micrometres in diameter; smaller PM10 particles penetrate to the deeper portions of the lung, affecting sensitive population groups such as children and individuals with respiratory ailments.

Point Source Emission Emissions from a localised, well-defined source of contaminants, such as from an industrial outfall.

Pollutant Generally, any substance introduced into the environment that adversely affects the usefulness of a resource.

Pollution Any direct or indirect alteration of the physical, chemical, biological, thermal or radioactive properties of any part of the environment by discharging, emitting or depositing wastes or substances so as to affect any beneficial use adversely; to be hazardous or potentially hazardous to public health, safety or welfare; or to be detrimental to fauna or flora or endangered species.

Pollution Prevention The active process of identifying areas, processes and activities which create excessive waste by-products for the purpose of substitution, alteration or elimination of the process to prevent waste generation.

Potential Dose The amount of a chemical contained in material ingested, air breathed or bulk material applied to the skin.

Precursor In photochemistry, a compound antecedent to a volatile organic compound (VOC). Precursors react in sunlight to form ozone or other photochemical oxidants.

Prescribed Burn/Fire see planned burn/fire.

Prevalent Level Samples Air samples taken under normal conditions.

Prevalent Levels Levels of airborne contaminant occurring under normal conditions (See: Background Level).

Protocol A series of formal steps for conducting a test.

Random Samples Samples selected from a statistical population such that each sample has an equal probability of being selected.

Reasonable Maximum Exposure The maximum exposure reasonably expected to occur in a population.

Reasonably Available Control Measures (RACM) A broadly defined term referring to technological and other measures for pollution control.

Reasonably Available Control Technology (RACT) Control technology that is both reasonably available, and both technologically and economically feasible. Usually applied to existing sources in non-attainment areas; in most cases is less stringent than new source performance standards.

Refuelling Emissions Emissions released during vehicle refuelling.

Remediation Clean-up or other methods used to remove or contain a toxic spill or hazardous materials from a site.

Residual Amount of a pollutant remaining in the environment after a natural or technological process has taken place, eg. particles remaining in air after it passes through a scrubbing process.

Risk A measure of the probability that damage to life, health, property and/or the environment will occur as a result of a given hazard.

Risk Assessment Qualitative and quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence and/or use of specific pollutants.

Risk Management The process of evaluating and selecting alternative regulatory and non-regulatory responses to risk. The selection process necessarily requires the consideration of legal, economic and behavioural factors.

Route of Exposure The avenue by which a chemical comes into contact with an organism (eg. inhalation, ingestion, dermal contact, injection).

Sample A small unbiased representative group of something designed to exhibit the same characteristics and trends of the whole. Exposure-related measurements are usually samples of environmental or ambient media, exposures of a

small subset of a population for a short time, or biological samples, all for the purpose of inferring the nature and quality or parameters important to evaluating exposure.

Smog Air pollution associated with oxidants (See: Photochemical Smog.)

Smoke Particles suspended in air after incomplete combustion.

Soot Carbon dust formed by incomplete combustion.

Source Reduction Reducing the amount of materials entering the waste stream by redesigning products or patterns of production or consumption (eg. using returnable beverage containers). Synonymous with waste reduction.

Stack A chimney, smokestack or vertical pipe that discharges used air.

Stack Effect Air, as in a chimney, that moves upward because it is warmer than the ambient atmosphere.

Stage II Controls Systems placed on service station petrol pumps to control and capture vapours during refuelling.

Standard Operating Procedure (SOP) A procedure adopted for repetitive use when performing a specific measurement or sampling operation.

Standards Legally prescribed limits of pollution which are established under statutory authority.

Stationary Source A fixed-site producer of pollution, mainly power plants and other facilities using industrial combustion processes.

Stratosphere The region of the atmosphere roughly 15 to 20 km above the Earth's surface where typically the temperature changes little or increases with height; its thermal structure is determined by radiation balance and is generally very stable.

Sulfur Dioxide (SO_2) A pungent, colourless, gaseous pollutant formed primarily by the combustion of fossil fuels.

Synergism An interaction of two or more chemicals which results in an effect that is greater than the sum of their effects taken independently.

Threshold The lowest dose of a chemical at which a specified measurable effect is observed and below which it is not observed.

Time-weighted Average (TWA) In air sampling, the average air concentration of contaminants during a given period.

Total Suspended Particles A method of monitoring particles matter by total weight.

Toxic Cloud Airborne plume of gases, vapours, fumes or aerosols containing toxic materials.

Toxic Pollutants Materials that cause death, disease,or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Toxicity A physiological or biological property that enables a chemical to do harm, or create injury, to a living organism by other than mechanical means; the ability of a chemical to cause poisoning when the chemical is administered to a living organism in an appropriate form and manner. Some chemicals have a high-toxicity potential while others have a low-toxicity potential.

Toxicity Assessment Characterisation of the toxicological properties and effects of a chemical, with special emphasis on establishment of dose response characteristics.

Travel Demand Management Intervention (excluding provision of major infrastructure) to modify travel decisions so that desirable social, economic and environmental objectives can be achieved and adverse impacts of transport reduced.

Troposphere The lower layer of the atmosphere extending to roughly 15 km above the Earth's surface where typically the temperature decreases with height; nearly all clouds form and weather processes are found in this region.

Ultraviolet Rays Radiation from the sun that can be useful or potentially harmful. UV rays from one part of the spectrum (UV-A) enhance plant life and are useful in some medical and dental procedures; UV rays from other parts of the spectrum (UV-B) can cause skin cancer or other tissue damage. The ozone layer in the atmosphere partly shields us from ultraviolet rays reaching the Earth's surface.

Urban Form The characteristic morphology of settlement represented by the key physical infrastructures of a city, ie. roads and rail networks, ports and airports, telecommunications and hydraulic networks. These are durable and relatively stable infrastructures that tend to retain their form for many decades. Periodically, sections may undergo more rapid changes at times.

Urban Structure The manner in which residential and industrial land uses are distributed throughout a city. Highly dynamic and can change radically in the space of a decade or so.

Urban System An urban system considers the combined process of urban form and urban structure.

Vapour Plumes Flue gases visible because they contain water droplets.

Vehicle Emissions Gases, particles or liquids being released into the environment directly from vehicles such as automobiles, buses, trucks, trains or motorcycles.

Vehicle Kilometres Travelled (VKT) A measure of the extent of motor vehicle operation; the total number of vehicle kilometres travelled within a specific geographic area over a given period of time.

Volatile Any substance that evaporates readily.

Volatile Organic Compound (VOC) Any organic compound that participates in atmospheric photochemical reactions except those designated as having negligible photochemical reactivity.

Waste (1) Unwanted materials left over from a manufacturing process. (2) Refuse from places of human or animal habitation.

Waste Minimisation/Reduction Measures or techniques that reduce the amount of waste generated during industrial production processes; term is also applied to recycling and other efforts to reduce the amount of waste going into the waste stream.

Wildfire (See: bushfire).

Appendix 2

Acronyms

A	
ADRs	Australian Design Rules (for vehicles)
AHHA	Australian Home Heating Association
AMA	Australian Medical Association
ANZEC	Australia and New Zealand Environment Council
APHEA	Air Pollution and Health European Approach protocol
AQCC	Air Quality Co-ordinating Committee
AQMP	Air Quality Management Plan
ARC SPIRT	Australian Research Council Strategic Partnerships with Industry - Research and Training
AS	Australian Standard
B	
BEM	Burning Emissions Management
BoM	Bureau of Meteorology
BPEL	Best Practice Environmental Licence
BPEM	Best Practice Environmental Management
Bsp	Co-efficient with units of m^{-1} indicating the back scatter of light at a reference wavelength due to the presence of particles in the air
C	
CALM	Department of Conservation and Land Management
CAMS	Department of Contract and Management Services
CBD	Central Business District
CCIWA	Chamber of Commerce and Industry Western Australia
CCWA	Conservation Council of Western Australia
CFA	Country Fire Authority of Victoria
CIE	Community Information and Education
CNG	Compressed natural gas
CO	Carbon monoxide
CRC	Co-operative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth of Australia
D	
DAE	Domestic Activities Emissions
DEP	Department of Environmental Protection
DLG	Department of Local Government
DME	Department of Minerals and Energy
DoT	Department of Training
E	
E2D	Euro 2 Diesel
EDWA	Education Department of Western Australia
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPA	Environmental Protection Authority
EU	European Union
F	
F	Fluorine
FESA	Fire and Emergency Services Authority of Western Australia
FORS	Federal Office of Road Safety, Australia
G	
g/kg	grams per kilogram
g/L	grams per litre
GP	General Practice
H	
HC	Hydrocarbon
HDWA	Health Department of Western Australia
HER	Health Effects and Research
HF	Hydrogen Fluoride
HGV	Heavy Goods Vehicle
HIA	Housing Industry Association
HOV	High Occupancy Vehicle
HRWG	Health Research Working Group
I	
I/M	Inspection and Maintenance
IEM	Industrial Emissions Management
ISO	International Standards Organisation

K

KIA	Kwinana Industrial Area
KIC	Kwinana Industry Council
kPa	Kilopascals
KPS	Kwinana Power Station

L

LCV	Light Commercial Vehicle
LGA	Local Government Agency
LPG	Liquefied petroleum gas (commercially known as Autogas)
LTP	Land Use and Transport Planning

M

MBA	Master Builders Association
MfP	Ministry for Planning
MMR	Monitoring, Modelling and Research
MoU	Memorandum of Understanding
MRWA	Main Roads Western Australia
MTA	Motor Trades Association
MTS	Metropolitan Transport Strategy
MVEC	Motor Vehicle Environment Committee

N

NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NO_x	Nitrogen oxides
NRTC	National Road Transport Commission
NPI	National Pollutant Inventory
NSW EPA	New South Wales Environment Protection Authority

O

O_3	Ozone
OECD	Organisation for Economic Co-operation and Development
OoE	Office of Energy

P

PAN	Pollution Action Network
PAH	Polycyclic aromatic hydrocarbon
PM10	Particle matter (sub 10 microns)
PM2.5	Particle matter (sub 2.5 microns)
ppm.w	parts per million (10^6) by weight

R

RACWA	Royal Automobile Club of Western Australia
RBT	Random Breath Test
ROCs	Reactive organic compounds
RVP	Reid Vapour Pressure

S

SO_2	Sulfur dioxide
SOP	Standard Operating Procedure

T

TDM	Travel Demand Management
TSP	Total Suspended Particles
TWA	Time-weighted Analysis

U

µg	Micrograms (10^{-6} grams)
µm	Micrometres (10^{-6} metres)
ULP	Unleaded Petrol
UN ECE	United Nations Economic Commission for Europe

V

VEM	Vehicle Emission Management
Visi	Visibility
VKT	Vehicle Kilometres Travelled
VOCs	Volatile Organic Compounds

W

WADOT	Western Australian Department of Training
WAMA	Western Australian Municipal Association
WAPC	Western Australian Planning Commission
WAPS	Western Australian Police Service

Appendix 3

Air Quality Co-ordinating Committee

Terms of reference

Terms of Reference for the Air Quality Co-ordinating Committee

The Air Quality Co-ordinating Committee was established by the Government of Western Australia as part of its response to the recommendations of the Parliamentary Select Committee on Perth's Air Quality.

The Committee comprises 15 representatives of Government, Local Government, industry, business and the community, seven from Government and seven from outside Government, approved by the Minister for the Environment, and one from the Select Committee on Perth's Air Quality.

The Committee's Terms of Reference are:

To oversee the development of the Perth Air Quality Management Plan (AQMP).

To monitor the implementation of the actions to which the Government gave commitment to undertake in its Response to the report of the Select Committee on Perth's Air Quality.

To monitor the implementation of the Perth Air Quality Management Plan and review progress towards achieving the aims of the Plan.

In fulfilling these tasks, the Committee will:

- meet at regular intervals to review progress with the development and subsequent implementation of the Perth AQMP;
- review draft documents, such as task specifications, discussion papers, and so on, prepared by the Department of Environmental Protection in the course of the development of the AQMP;
- provide input and comment on the initial and final drafts of the AQMP prior to their release for community consultation;
- act as a conduit for the flow of reliable information to the community on Perth's air quality and its management and to the Government on issues of concern to the community in relation to these matters;
- report at regular intervals through its chairperson to the Minister for the Environment on progress with developing the AQMP, and with implementation of the commitments given in the Government Response to the Select Committee's recommendations; and
- after the commencement of implementation of the AQMP, report annually to the Government through the Minister for the Environment on the degree of implementation of the AQMP and progress in achieving the performance targets set in the AQMP.

Membership

State Government (7 representatives)

Dr Bryan Jenkins, Chief Executive Officer Department of Environmental Protection (AQCC Chair)

Mr Emmerson Richardson, Director Metropolitan Strategy, Transport

Mr Paul Frewer, A/Chief Executive Officer, Ministry for Planning

Dr Paul Psaila-Savona, Executive Director Public Health, Health Department of WA

Mr Ian Cowie, Director Local Government Development, Department of Local Government

Mr Denis Smedley, Manager Built Environment, Office of Energy

Mr Rick Sneeuwjagt, Manager CALMfire, Department of Conservation and Land Management

Parliament (1 representative)

Mr Fred Tubby, MLA, Parliamentary Select Committee on Perth's Air Quality

Non-government (7 representatives)

Local Government

Cr Roni Oma

Cr Barry McKenna

Proxies - Mr Geoff Glass and Ms Lillias Bovell

Business and Industry

Mr John Yates, BP Kwinana Refinery (Kwinana Industries Council)

Mr Martin Taylor, Chamber of Commerce and Industry

Community

Ms Rachel Siewert, Conservation Council of WA

Dr Sue Graham-Taylor, Pollution Action Network

Mr Mike Upton, Royal Automobile Club of WA

Appendix 4

Working Groups

Air monitoring and research

Mr Andrew King, BP Refinery (Kwinana) Pty Ltd

Dr Rod Lukatelich, BP Refinery (Kwinana) Pty Ltd

Mr Roger Tapp, Bureau of Meteorology

Mr Robert Kleinfelder, Department of Environmental Protection

A/Professor Frank Murray, Murdoch University (Chamber of Commerce and Industry)

Dr Sue Graham-Taylor, Pollution Action Network (Conservation Council of WA)

Mr Owen Pitts, Sinclair Knight Merz (Clean Air Society of Australia and New Zealand)

Dr Roman Mandyczewsky, Western Power Corporation (Kwinana Industries Council)

Mr Geoff Park, Western Power Corporation (Kwinana Industries Council)

Bushfire prevention and other burning

Mr Gary Foley, Bureau of Meteorology

Mr Jim Johnson, City of Cockburn

Mr John Iles, City of Gosnells

Mr Ross Wells, City of Gosnells

Mr Mick Austin, City of Joondalup

Mr Drew Haswell, Department of Conservation and Land Management

Mr Malcolm Cronstedt, Fire and Emergency Services

Ms Sue Davies, Fire and Emergency Services

Mr Bruce Telfer, Shire of Mundaring

Dr Sue Graham-Taylor, Pollution Action Network (Conservation Council of WA)

Mr Tony Pestell, Shire of Swan

Mr John Erceg, Shire of Swan

Community education and information

Mr Malcolm Young, Bureau of Meteorology

Mr Martin Taylor, Chamber of Commerce and Industry

Ms Adele Foote, Conservation Council of WA

Mr Nigel Hicks, Department of Conservation and Land Management

Mr Greg Allen, Department of Environmental Protection

Ms Jennie Anderton, Department of Environmental Protection

Mr Glen Bennett, Education Department of WA

Mr Mike Baker, Kwinana Industries Council

Mr Mike Upton, Royal Automobile Club of Western Australia

Mr Bruce James, Transport

Sgt Walter Brierley, WA Police Service

Domestic activities

Ms Susan Dixon, Alinta Gas

Mr David Sweet, Alinta Gas

Ms Brigette Tighe, Alinta Gas

Mr Philip Henderson, Australian Wood Heating Association

Mr Alan Scott, Bureau of Meteorology

Mr John Hardy, City of Cockburn

Mr Ross Wells, City of Gosnells

Mr Mick Austin, City of Joondalup

Mr Philip Oorjitham, City of Melville

Mr Anthony Stuart, Coffey Engineering (Clean Air Society of Australia and New Zealand)

Ms Adele Foote, Conservation Council of WA

Mr Greg Allen, Department of Environmental Protection

Mr Danny Delle Coste, Shire of Mundaring

Mr Adrian Dyson, Shire of Mundaring

Mr Simon Denniss, Shire of Swan

Mr John Erceg, Shire of Swan

Mr Peter McKenzie, Town of Kwinana

Associate Professor John Todd, University of Tasmania

Health Research (specialists)

Prof Jeff Spickett, Curtin University

Dr Andrea Hinwood, Department of Environmental Protection

Dr Bryan Jenkins, Department of Environmental Protection

Dr Paul Vogel, Department of Environmental Protection

Ms Pierina Otness, Health Department of WA

Dr Francis Quadros, Health Department of WA

Dr Nick de Klerk, University of WA

Dr Peter Di Marco, Health Department of WA

Prof Tom Lyons, Murdoch University

A/Professor Frank Murray, Murdoch University

Dr Quentin Summers, Royal Perth Hospital (Asthma Foundation)

Prof Louis Landau, University of WA

Dr Bill Musk, University of WA

Industrial emissions

Dr John Bromly, Alinta Gas

Dr Rod Lukatelich, BP Refinery (Kwinana) Pty Ltd (Kwinana Industries Council)

Mr Martin Taylor, Chamber of Commerce and Industry

Mr Darren Walsh, City of Cockburn

Professor Philip Jennings, Conservation Council of WA

Ms Sophie Wallis, Department of Environmental Protection

Ms Tracey Colley, Institution of Engineers, Australia

Mr Robert Griffiths, Ministry for Planning

Mr Keith James, Stack-Air (Clean Air Society of Australia and New Zealand)

Mr Peter McKenzie, Town of Kwinana

Mr Kerry Roberts, Western Power Corporation

Land use and transport planning

Mr Darren Walsh, City of Cockburn

Mr David Wake, Smogbusters (Conservation Council of WA)

Mr Adrian Vlok, Department of Environmental Protection

Mr Gary Williams, Department of Environmental Protection

Mr Paul Trichilo, Main Roads WA

Mr Ian Macrae, Ministry for Planning

Ms Birgit Allen, Shire of Swan

Mr Nic Perrella, Shire of Swan

Mr Doug Smith, Town of Kwinana

Mr Richard McKellar, Transport

Ms Dianne Stewart, Transport

Mr Cameron Schuster, Wesfarmers CSBP (Kwinana Industries Council)

Mr Geoff Glass, Western Australian Municipal Association

Ms Roni Oma, Western Australian Municipal Association

Transport emissions

Dr Rod Lukatelich, BP Refinery Kwinana (Kwinana Industries Council)

Mr Brian Butterworth, Chamber of Automotive Industries of Western Australia (Inc)

Mr Terry Wood, Chamber of Automotive Industries of Western Australia (Inc)

Mr Bob Fitzjohn, City of Perth

Mr Greg Ryan, City of Perth

Mr David Wake, Smogbusters (Conservation Council of WA)

Ms Jennie Anderton, Department of Environmental Protection

Mr John Guld, Department of Environmental Protection

Mr Fred Tromp, Department of Environmental Protection

Mr Dennis Stubberfield, Main Roads WA

Mr Mike Upton, Royal Automobile Club of Western Australia

Mr Doug Smith, Town of Kwinana

Mr John Dombrose, Transport

Mr Trevor McDonald, Transport

Mr Richard McKellar, Transport

Mrs Shelley Shepherd, Transport

Supt Bob Coops, WA Police Service

Sgt Walter Brierley, WA Police Service

Mr David Pitt, Welker Consulting (Clean Air Society of Australia and New Zealand)

Department of Environmental Protection

Dr Henry Berko

Mr Adrian Blockley

Mr Bob Crowe

Ms Sarah Dawson

Mr Drew Farrar

Ms Simone Finlay

Mr James Forrest

Mr Arthur Grieco

Mr David Griffiths

Dr Andrea Hinwood

Mr Robert Kleinfelder

Mr Tim Mitchell

Dr Phil Morgan

Mr Peter Mountford

Mr Steven Price

Dr Ken Rayner

Dr Tina Runnion

Dr Peter Rye

Mr Glenn Sowerbutts

Ms Carla Spelt

Mr Martyn Summers

Ms Deanna Tuxford

Dr Paul Vogel

Mr Bruce Watson

Mr Tim Whiteman

Ms Barbara Witon

Appendix 5

Submissions

Public	Submission Number
Anonymous	8
Anonymous	16
Tim Argus	1
Jane Bremmer	44
Jennifer Catalano	14
Brigit Cosgrove	40
JA Ffarrington	27
Ian Greenham	6
J Harradine	35
Astrid Herlihy	33
Philip Jennings	39
Barry Jones	24
Emma Jones	25
Keith Jones	4
David Karr	2
Robert Lipowiec	13
JC Lissiman	5
Janet Marsh	41
ML Miller	11
P Molloy	38
Sandi Nielsen	26
Gabrielle Payne	42
J Parker	22
John Radford	7
E Reith	9
Terry Sanchez	23
John Schindler	34
Mr HL Sharam	3
Ray Sousa	18
Gene Taylor	12
Andrew G Thompson	15
AL Thorstensen	10
Dr Patricia K Weaver	21

Business, Industry and Associated Organisations	Submission Number
Bicycle Transportation Alliance Richard Stallard	31
Brian J. O'Brien and Associates Brian J. O'Brien	19
BP Refinery Kwinana Dr R J Lukatelich	37
Conservation Council of WA	45
Kwinana Watchdog Group Dot Hesse	28
Midland FROGS P and F Irwin	7
Pollution Action Network Dr Sue Graham-Taylor	36
Royal Automobile Club of WA Mike Upton	43
Educational Institutions	
Central Metropolitan College of TAFE Managing Air Quality Students	20
Local Government Authorities and Associations	
City of Joondalup John Goldsmith	29
Eastern Metropolitan Regional Council	30
State Government	
Health Department of WA Brian Devine	32

Appendix 6

Legislation relevant to managing Perth's air quality

Western Australian Legislation

Aerial Spraying Control Act 1966

Agriculture and Related Resources Protection Act 1976

Bush Fires Act 1954

Conservation and Land Management Act 1984

East Perth Redevelopment Act 1991

Electricity Corporation Act 1994

Energy Co-ordination Act 1994

Energy Operators (Powers) Act 1979

Energy Corporations (Transitional and Consequential Provisions) Act 1994

Environmental Protection Act 1986

(Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1992 established under the *Environmental Protection Act 1986*)

Fuel, Energy and Power Resources Act 1972

Gas Corporation Act 1994

Gas Standards Act 1972

Gas Undertakings Act 1947

Health Act 1911

Industry and Technology Development Act 1998

Land Administration Act 1997

Liquefied Petroleum Gas Subsidy Act 1980

Liquid Petroleum Gas Act 1956

Local Government Act 1995

Main Roads Act 1930

Marine and Harbours Act 1981

Metropolitan Region Scheme (Fremantle) Act 1994

Metropolitan Region Town Planning Scheme Act 1959

Metropolitan (Perth) Passenger Transport Trust Act 1957

Motor Vehicle Dealers Act 1973

National Environment Protection Council (Western Australia) Act 1996

Occupational Safety and Health Act 1984

Perth Parking Management Act 1999

Perth Parking Management (Consequential Provisions) Act 1999

Perth Parking Management (Taxing) Act 1999

Petroleum Products Subsidy Act 1965

Planning Legislation Amendment Act 1994

Poisons Act 1964

Reserve (Kwinana Freeway) Act 1975

Road Traffic Act 1974

Soil and Land Conservation Act 1945

State Energy Commission (Validation) Act 1978

Subiaco Redevelopment Act 1994

Town Planning and Development Act 1928

Transport Co-ordination Act 1966

Western Australian Planning Commission Act 1985

Western Australian Regulations

Aerial Spraying Control Regulations 1971

Agriculture and Related Resources Protection (Spraying Restrictions) Regulations 1979

Bush Fires (Infringements) Regulations 1978

Bush Fires Regulations 1954

Clean Air (Control of Dust in Concrete Plants) Regulations 1982 (repealed)

Clean Air (Determination of Air Impurities in Gases Discharged to the Atmosphere) Regulations 1983
Clean Air Regulations 1967

Conservation and Land Management Regulations 1992

Dangerous Goods (Transport) (Explosives by Road and Rail) Regulations 1999

Dangerous Goods (Transport) (Explosives by Water) Regulations 1999

Dangerous Goods (Transport) (General) Regulations 1999

Dangerous Goods (Transport) (Road and Rail) Regulations 1999)

Electricity Act Regulations 1947

Electricity Corporation (Charges) By-laws 1996

Electricity Distribution Regulations 1997

Electricity (Energy Efficiency Labelling) Regulations 1997

Electricity (Licensing) Regulations 1991

Electricity Transmission Regulations 1996

Environmental Protection Regulations 1987

Environmental Protection (Diesel and Petrol) Regulations 1999

Environmental Protection (Firewood Supply) Regulations 1998

Environmental Protection (Firewood Supply) Amendment Regulations 1998

Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992

Environmental Protection (NEPM-NPI) Regulations 1998

Environmental Protection (Recovery of Vapours from the Transfer of Organic Liquids) Regulations 1995

Fire Brigades Regulations 1943

Forest Management Regulations 1993

Gas Distribution Regulations 1996

Gas Corporation (Charges) By-laws 1996

Gas Standards (Gas Supply and System Safety) Regulations 2000

Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999

Gas Transmission Regulations 1994

Gas Undertakings Act Regulations 1947

Health Act (Carbon Monoxide) Regulations 1975

Land Administration Regulations 1998

Liquid Petroleum Gas Regulations 1957

Local Government Model By-laws (Petrol Pumps) No.10

Marine and Harbours (Fuelling) Regulations 1985

Metropolitan (Perth) Passenger Transport Trust Regulations 1977

Model By-laws Series "A"

Motor Vehicle Dealers (Prescribed Vehicles) Regulations 1974

Occupational Safety and Health Regulations 1996

Perth Parking Management Regulations 1999

Petroleum Regulations 1987

Petroleum Products Subsidy Regulations 1966

Poisons Regulations 1965

Road Traffic (Vehicle Standards) Regulations 1977

Road Traffic (Infringements) Regulations 1975

Road Traffic (Licensing) Regulations 1975

Soil and Land Conservation Regulations 1992

State Planning Commission Regulations 1962

State Supply Commission Regulations 1991

State Energy Commission (Common Seal) Regulations 1990

State Energy Commission (Purchase of diesel powered generating units) Regulations 1980

Subiaco Redevelopment Regulations 1994

Town Planning Regulations 1967

Transport Co-ordination Regulations 1985

Transport Co-ordination (Petroleum Products Licensing) Regulations 1985

Federal Legislation

Environment Protection and Biodiversity Conservation Act 1999

Motor Vehicle Standards Act 1989

National Environment Protection Council Act 1994

National Road Transport Commission Act 1991

States Grants (Urban Public Transport) Act 1978

Urban and Regional Development (Financial Assistance) Act 1974

Urban Public Transport (Research and Planning) Act 1974

Federal Regulations

Environment Protection and Biodiversity Conservation Regulations 2000

Motor Vehicle Standards Regulations

Federal Measures

National Environment Protection Measure for Ambient Air Quality

Appendix 7

Management responsibilities for controlled burning activities in Australia

State or Territory	Responsibility	Committees	Plans, Policies or Program	Legislation
ACT	ACT Bushfire Council. ACT Emergency Services Bureau. ACT Parks & Conservation Service.	Bushfire Fuel Management Committee.	Bushfire Fuel Management Plan. Rural Fire Control Manual (under Bushfire Act 1936).	Bushfire Act 1936 (Amended 1997). Fire Brigade Act 1957. Environmental Protection Act 1997.
NSW	State Forestry NSW. NSW National Parks & Wildlife Service.	District Fire Management Committees.	State Forests Hazard Reduction Burning Program. Fire Management Plans. Operational Plans.	Protection of the Environment Administration Act 1991. Rural Fires Act 1997. Protection of the Environment Operations Act 1997. Forestry Act 1916. National Parks and Wildlife Act 1974.
NT	NT Bushfires Council. NT Parks & Wildlife Commission.	Regional Bushfires Committees.	Draft Regional Fire Plans. Bushfire Management Strategy. Fire Safety Education Program. Parks & Reserves Programs. Bushfires Protection Program. Fire Management Plans.	Bushfires Act 1996.
QLD	Department of Primary Industry (forestry). Department of Natural Resources. Qld Fire & Rescue Authority. Qld National Parks & Wildlife Service.	Interdepartmental Committee on Bushfires.	Fire Management Policies (DPI & NPWS). Fire Management Plans.	Emergency Services Legislation Amendment Act 1998. Fire and Rescue Authority Act 1990. Nature Conservation Act 1992.
SA	Country Fire Service. Dept of Environment & Natural Resources.	District Bushfire Prevention Committees.	Prescribed Burning Policy.	Country Fires Act 1989.
TAS	State Fire Management Council. Forestry Tasmania. Tasmanian Parks & Wildlife Service. Tasmania Fire Service.	Fire Management Area Committees. Special Fire Area Committees.	Forestry Smoke Management Program. NPWS Fire Management Policy. NPWS Fire Management Plans.	Fire Service Act 1979. Local Government Act 1993. Environment Management and Pollution Control Act 1994.
VIC	Dept of Conservation and Natural Resources & Environment. Victorian National Parks & Wildlife Service. Country Fire Authority of Victoria (CFA).	Regional and Municipal Fire Prevention Committees.	Code of Practice for Fire Management on Public Land. Regional Fire Management Plans. Fire Training Management System.	Forest Act 1958. National Parks Act 1975. Conservation Forests and Lands Act 1987.
WA	Dept of Conservation & Land Management (CALM). Fire & Emergency Services Authority of WA (FESA).	Regional Operations Advisory Committee. State Rural Fire Consultative Committee. Smoke Management Consultative Committee.	Regional & Area Management Plans. CALM Fire Management Policy. CALM Fire Operations Manual. CALM Prescribed Burning Program. Draft Hazard Reduction Burning Management Policy (FESA).	Bush Fires Act 1954. Environmental Protection Act 1986. Conservation & Land Management Act 1984.

Appendix 8

Agreed arrangements for smoke management decision making in Western Australia

Part 1: Agreed processes for determining burn program on the day.

Time	Process	AGENCY ROLE			
		Department of Conservation and Land Management	Bureau of Meteorology	Department of Environmental Protection	Fire and Emergency Services Authority
Previous afternoon and evening	Monitor impacts of yesterday's burn on Perth air quality.	CALM Spotter/Tower to notify of smoke accumulation likely to affect population centres. Regions/Branch to collate. CALM fireComo to advise DEP, Minister if there is a problem.	Monitor weather patterns and changes in synoptic situation. Advise CALM, DEP, FESA of potential for smoke accumulation based on general synoptic assessment.	Monitor haze levels at Metro and Regional sampling sites. Data to be made available to CALM & BoM. Public complaints data to be forwarded to CALM.	Public complains data to be forwarded to FESA.
1600 hrs	Haze Alert (1600 hrs).	Receive Haze Alert, if issued and consider changes in tomorrow's burn program accordingly.	Issue Haze Alert to all approved recipients (incl. Swan LGA's).	Monitor whether or not Haze Alert issued.	Monitor whether or not Haze Alert issued.
1630 to 1700 hrs previous day	Predict Smoke Trajectory.		BoM to model smoke trajectory at 2000 hrs for next day.		
0500 hrs	Haze Alert (1700 hrs).	Receive 5.00am Haze Alert if issued.			Monitor whether or not Haze Alert issued.
0745 hrs	Provide forecast of weather (winds, atmosphere, stability, synoptic situation).	Receive forecasts etc from BoM via Fire Support network.	Obtain weather data (0700 hrs) and distribute forecasts to CALM at 0745 hrs. Verbal advice on smoke trajectory as required.	Monitor whether or not Haze Alert issued and consult with BoM as necessary.	FESA to obtain weather forecast and Fire Danger Ratings from BoM through current link. Distribute to Regions.
0800 to 0830 hrs	Analysis of data on fire weather, fire behaviour.	CALM calculate Fire Danger, Fire Behaviour for prescribed burns at each District Centre.	When requested by CALM, BoM to provide further information on haze development potential for specific areas.	When required DEP assist with Mesoscale Modelling development.	FESA to advise Swan Region LGA's (Chief FCO's) of Fire Danger suitable burn conditions.
0845 hrs	Proposed Burn Program determined.	District burn requests collated by Burn Coordinator. Burn Program determined based on the Decision Tree outcome and other external factors.			

		AGENCY ROLE			
Time	**Process**	**Department of Conservation and Land Management**	**Bureau of Meteorology**	**Department of Environmental Protection**	**Fire and Emergency Services Authority**
0900 to 0930 hrs	Burn Program Decision by Burn Co-ordinator to be forwarded to CALMfire Como	Dept Fire Co-ordinator to review decision prior to forwarding advice to DEP, BoM, and Minister.			
0930 to 1000 hrs	Advice of Burn Program proposed and factors affecting decision to be circulated to relevant authorities.	CALM to disseminate burn program decision and relevant information to Minister, DEP, FESA, and BoM by fax.	BoM to be advised of Program decision.	DEP to ensure Burn Program Decision is available for answering public queries etc.	LGA's to ensure Burn Program Decision is available for answering public queries etc as they see fit.
1000 to 1700 hrs	Monitor Smoke emission and possible impacts on Perth metropolitan area and selected Regional Centres	• CALM spotters/towers, to provide CALMfire Branch with information on smoke accumulation, likely to effect Perth and Regional Centres • CALM to advise DEP of potential smoke incidents (eg. bushfires, burns).	BoM to advise CALM/FESA of unexpected changes in weather (particularly winds) likely to affect burn program.	Monitor air quality impacts from bushfire smoke in/near metro and regional areas. Feedback to CALM/FESA.	LGA's to advise DEP if any large smoke resulting from private/Brigade burn operations may impact residential areas.
As required	Media alert on unpredicted smoke accumulation.	CALM to develop Media alert (where CALM burns are main culprit).	To be consulted prior to finalising Media alert, and receive final Media Statement.	To be consulted prior to finalising Media alert, and receive final Media Statement.	To be consulted prior to finalising Media alert, and received final Media Statement.

Appendix 9

WA greenhouse initiatives corresponding to the strategies and actions of the Perth Air Quality Management Plan (Consultation draft)

Strategy and action in the Perth AQMP	National greenhouse strategy measure	WA greenhouse gas abatement recommendation	Responsible technical panel (WA greenhouse strategy)
Health Effects and Research (HER).		No correlating actions identified.	
Monitoring, Modelling and Research (MMR).		No correlating actions identified.	
Land Use and Transport Planning (LTP).			
LTP 1.4 Include transport impact assessment as performance criteria for new major development and redevelopment proposals.	5.2	Investigate the potential to include transport impact assessment as performance criteria for new development and redevelopment proposals.	Transport, Urban Land Use and Planning.
LTP 1.8 Continue with travel behaviour program, such as TravelSmart®.	5.13	Extend the TravelSmart® individualised marketing program to include the inner suburbs of the Perth metropolitan area.	Transport, Urban Land Use and Planning.
LTP 2.2 Research and evaluate the application of urban consolidation strategies in the Perth metropolitan region.	5.3	Consider developing a research program on potential policy responses to support more efficient outcomes from decisions on urban land development.	Transport, Urban Land Use and Planning.
LTP 2.3 Develop a government policy position on increased levels of urban infill, density and renewal.	5.2	Undertake a study similar to the Victorian Urban Villages project in Western Australia to identify possible sites for urban redevelopment where the Community Design Code can be applied. Development plans for these sites should then be prepared.	Transport, Urban Land Use and Planning.
LTP 3 Integration of land use and transport planning.	5.2, 5.3	Actively pursue the development of measures to promote best practice in integrated urban land use and transport planning including: • policy guidelines for integrated urban land use and transport planning; and • a "Good Practice Guide" on integrated urban land use and transport planning.	Transport, Urban Land Use and Planning.
LTP 4 Encourage the adoption of energy efficiency principles in planning, building design and construction.	4.9(ii)	The Western Australian Government should participate in the national program for developing appropriate building standards, with particular reference to the commercial buildings sector.	Energy Supply and Use.
Vehicle Emission Management (VEM).			
VEM 4.3 Encourage national moves towards regulating for cleaner fuel formulation.	5.11	Actively participate in the oversighting of fuel efficiency and fuel technology investigations through MVEC.	Transport, Urban Land Use and Planning.
VEM 5.1 Support the consistency and early adoption of Australian Design Rule emission standards with international best practice emission standards.	5.10	Encourage the Australian Government to adopt emission standards that are compatible with the UN ECE standards as soon as is practically possible.	Transport, Urban Land Use and Planning.
VEM 5.4 Investigate and promote the benefits and feasibility of using CNG and LPG as fuel sources for the road passenger transport and freight sectors where appropriate.	5.12	Investigate the potential for compensating subsidies to encourage development and use of alternative fuels.	Transport, Urban Land Use and Planning.
VEM 5.5 Investigate the use of electric, alternate fuel vehicles and ultra-light vehicles.	5.12	Investigate the potential for compensating subsidies to encourage development and use of alternative fuels.	Transport, Urban Land Use and Planning.

Strategy and action in the Perth AQMP	National greenhouse strategy measure	WA greenhouse gas abatement recommendation	Responsible technical panel (WA greenhouse strategy)
Domestic Activities Emissions (DAE). DAE 2.2 Promote effective greenwaste collection and reprocessing services and support a co-ordinated approach by all local government authorities in Perth.	7.3	Continue implementation of the Green and Organic Waste Management Strategy.	Industry and Waste Management.
DAE 3.1 Support the enhancement of the existing voluntary program to promote energy efficiency in building design and the construction of new dwellings, major renovations and redevelopments.	4.9(i)	The Western Australian Government should participate in the national program for developing appropriate building standards, with particular reference to the commercial buildings sector.	Energy Supply and Use.
DAE 3.2 Support the establishment of minimum standards for energy efficiency for all new houses, major renovations and redevelopments by the adoption of the standards to be introduced into the Building Code of Australia.	4.9(i)	The Western Australian Government should participate in the national program for developing appropriate building standards, with particular reference to the commercial buildings sector.	Energy Supply and Use.
DAE 3.3 Advocate the introduction of energy efficiency standards into the Building Code of Australia.	4.9(i)	The Western Australian Government should participate in the national program for developing appropriate building standards, with particular reference to the commercial buildings sector.	Energy Supply and Use.
DAE 4.2 Investigate the feasibility of developing a rating scheme for domestic appliances and recreational equipment according to relative impacts on air quality.	4.10	The national programs of labelling and minimum energy performance standards for domestic appliances and commercial and industrial equipment are worth supporting by appropriate legislation and funding from the State.	Energy Supply and Use.
Burning Emissions Management (BEM).		No correlating actions identified.	
Industrial Emissions Management (IEM). IEM 3.2 Develop and implement a position paper and policy on co-generation and its implications for the Perth airshed.	4.5	Access arrangements should be liberalised to enable electricity from small co-generation projects and from renewable sources to be wheeled through the grid to service small discrete loads.	Energy Supply and Use.
IEM 5 Promote and provide incentives for the broader adoption of “cleaner technologies” in all industrial activities.	7	Continue implementation of the National Strategy for Cleaner Production.	Industry and Waste Management
Community Information and Education (CIE).		No correlating actions identified.	

Appendix 10

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