Air pollution & You

MAIN ROADS
Western Australia

Department of
Environmental Protection

A booklet about air pollution in Perth

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Department of
Environmental Protection

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Contents

Figure 1. Source of air pollution.

What is air pollution?

Air pollution occurs when the air contains gases, dust, fumes or odour in amounts that could be harmful to the health or comfort of humans and animals or could cause damage to plants or materials. The substances that cause air pollution are called pollutants.

Before the industrial revolution, nature's own air-conditioning managed to keep the air fairly clean. Wind mixed the gases and spread them out, rain washed the dust and other easily dissolved substances to the ground, and plants absorbed carbon dioxide and replaced it with oxygen. In the post-industrial revolution years, considerably more pollution has been added to the air by industrial, commercial and domestic sources. As these sources are usually found in or near Australian cities, the gases that are produced are usually concentrated in the air around them. It is when these concentrated gases exceed safe limits that we have a pollution problem. Nature can no longer manage air pollution without our help.

Pollutants which are pumped into our atmosphere and are polluting in their own right are called primary pollutants. Some examples are carbon monoxide from car exhausts and sulphur dioxide from the combustion of coal.

Further pollution can arise if primary pollutants in the atmosphere undergo chemical reactions. These are called derived or secondary pollutants. An excellent example is photochemical smog.

What is the atmosphere?

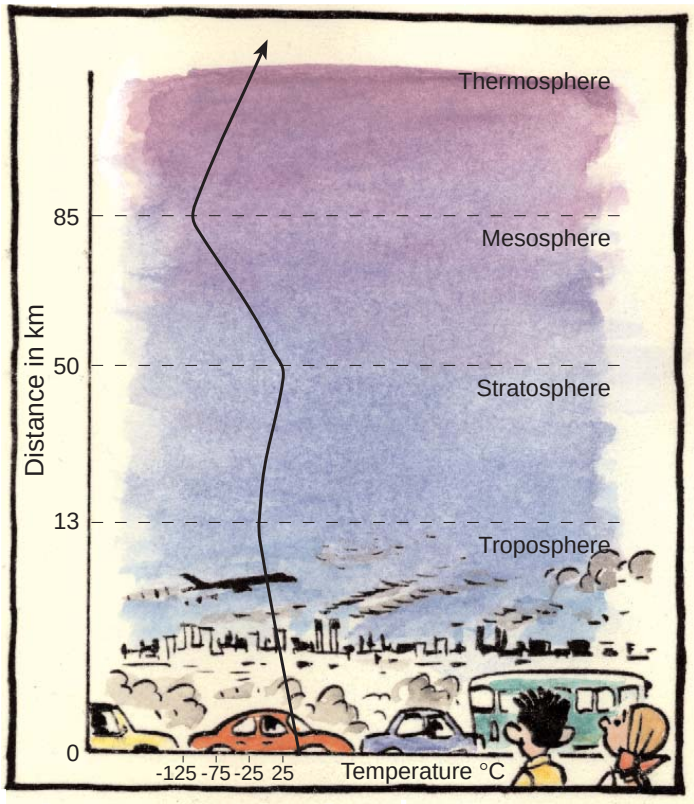


Figure 2. The layers of the atmosphere. (The distance axis is not to scale).

The gases surrounding the earth make up the atmosphere. It is many hundreds of kilometres thick and is composed of four layers, these resulting from the properties of the air within. Details of the names, thickness and temperature of each layer may be seen in Figure 2.

It is the troposphere, the lowest level of the atmosphere, which is the most important when we consider regional and local air pollution problems.

Ozone depletion and the enhanced greenhouse effect are global air pollution problems that affect the atmosphere. The greenhouse effect is a result of an overall heat gain by the atmosphere as a whole. Ozone depletion occurs in the second level of the atmosphere, the stratosphere.

What is the air?

The air is the substance around us which we breath in and out of our lungs. At the earth's surface, air consists of 78% nitrogen (N_2), 21% oxygen (0_2), less than 1% of argon (Ar), a very small amount (0.03%) of carbon dioxide (CO_2), and traces of other gases such as methane (CH_4) and oxides of nitrogen (NO_X). Water vapour is present in air in varying amounts. (In Perth this can vary from 0.3% on cold days to 1.0% on hot days.) The air also contains tiny particles such as dust, sea salt, volcanic ash and soot which are small enough to float in the air for a long time.

Ozone depletion

The ozone layer refers to an area within the stratosphere where the ozone gas absorbs potentially cell-damaging ultra violet light. The helpful ozone layer can be depleted when certain man-made pollutants make their way from the earth's surface to the stratosphere. The most serious ozone depleting substances are the halons and chlorofluorocarbons.

While ozone depletion is a worldwide phenomenon, it is particularly relevant for Australians. The rate of ozone depletion has been most rapid over the Antarctic and the southern regions of the world.

Greenhouse effect

Strictly speaking, the greenhouse effect is a natural phenomenon. Certain gases (we refer to them as greenhouse gases) absorb radiation that would otherwise escape from the atmosphere into space. This leads to a warming of the atmosphere. Without warmth, life can not be sustained on earth. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs).

Humans have altered the natural greenhouse effect. By increasing the concentration of the heat absorbing gases in the atmosphere we cause the temperature of the earth to rise a little bit. As the temperature increases more water is converted to the gaseous form. The water vapour may absorb even more of the solar radiation and this further contributes to the heating of the earth. As people continue to emit more greenhouse gases into the atmosphere, the temperature on the earth will continue to rise.

It is anticipated that the earth's temperature may increase between 1°C and 3.5°C over the next 100 years.

It is believed that Australians contribute between one and two per cent of the world's emissions of greenhouse gases into the atmosphere. These contributions are continuing to increase. Carbon dioxide is our largest emission (75%), followed by methane (23%). The nitrous oxides, volatile organic compounds (including chlorofluorocarbons) and photochemically derived ozone make up the remainder of the man-made greenhouse gases. Some of the gases which make up a tiny component of the greenhouse gas emissions are considerably more powerful at warming the atmosphere. For example, a single molecule of a common chlorofluorocarbon has the same warming effect as 10,000 carbon dioxide molecules.

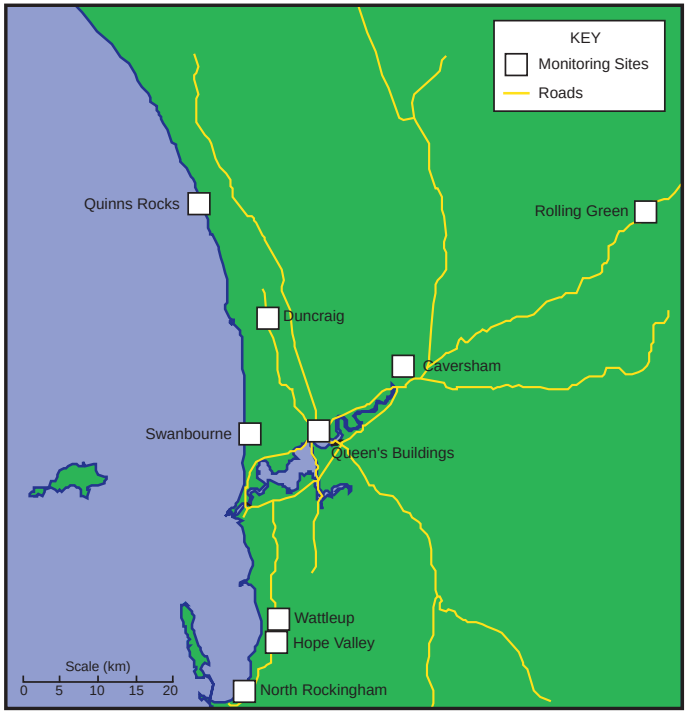


Figure 3. The sites of the Perth Air Quality Monitoring Stations.

Figure 4. A typical Air Quality Monitoring Station.

How and where is air pollution measured in Perth?

There are currently nine government funded air quality monitoring stations in use to collect data on air quality. The sites are as shown on Figure 3 and a typical monitoring station is shown in Figure 4. Data is collected on a variety of pollutants including ozone, nitrogen dioxide, nitric oxide, carbon monoxide, sulphur dioxide, air borne particles and lead.

Vehicles are a major source of our air pollution

Fossil fuel combustion, particularly by motor vehicles, has been identified as the largest single contributor to air pollution.

When considering Perth's air, it is the vehicles which are used for transport that are responsible for almost all of the lead and carbon monoxide pollution and around half of the hydrocarbons and oxides of nitrogen.

The impact of petrol vehicles

The pollution put out by petrol vehicles comes from two sources. The first group are the exhaust emissions and these include carbon monoxide, oxides of nitrogen, hydrocarbons and particulates.

The second type of pollution from cars are called evaporative emissions. Evaporative emissions are vapours of fuel which are released into the atmosphere, without being burnt.

Fuel vapour can be seen coming out of the car's petrol tank when you fill up at the service station. Fuel vapour emissions can be reduced if we avoid spilling petrol and overfilling our cars. Properly fitting fuel caps stop further leakage of fuel vapours. It may also be possible to reduce fuel vapour emissions if fuel formulations with a lower volatility level were made available to the general public.

In 1975, all new cars sold in Australia were required to be fitted with basic anti-pollution equipment. These cars were designed to run on leaded petrol. Since January 1986 all new cars have been built with catalytic converters and have been designed to run on unleaded petrol.

If a car is well tuned and maintained it is likely to emit between 9-25% less pollution into the atmosphere than a similar poorly maintained vehicle. In addition a well maintained car is between 1.5% and 5.0% more fuel efficient.

Cars which have been altered, and no longer conform to the original specifications, tend to put out considerably more pollution into the air. Such modifications include non-standard cylinder heads, pistons, valves, camshafts, fuel systems or exhausts.

How do catalytic converters work?

As illustrated in Figure 5, catalytic converters contain the rare metals platinum, palladium and rhodium. These substances promote the conversion of hydrocarbons, carbon monoxide and oxides of nitrogen in the vehicles exhaust to water, carbon dioxide and nitrogen.

It is not unusual for a catalytic converter to have a life greater than 150,000km. This can be shortened if:

- sulphur, lead or other heavy metals are in the fuel,
- there is phosphorus in the lubricating oil,
- the engine is misfiring,
- mechanical damage occurs.

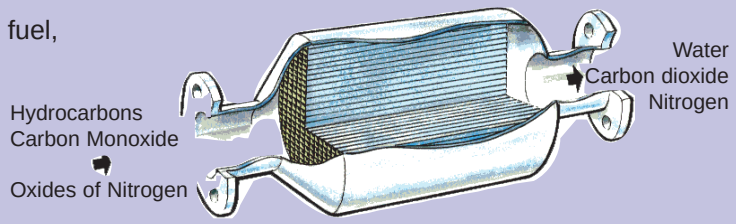


Figure 5. Diagram of a catalytic converter.

Figure 6. Smoke from vehicle exhausts is a source of fine particle matter.

The impact of diesel vehicles

Eighty-eight per cent of the heavy duty vehicles and five per cent of the light vehicles on our roads use diesel. While a diesel vehicle will emit less hydrocarbons and carbon monoxide than a similar sized petrol vehicle, it will give off more oxides of nitrogen and fine particles. Most of the particles are tiny (less than 0.01mm in size) and these can cause or exacerbate respiratory disorders. In addition, they contribute to haze and as a result the particles can soil our environment.

Figure 7. The total vehicle emissions of carbon monoxide and oxides of nitrogen going into Perth's air each day.

Data is taken from Air Quality gets a Black Mark, Australian Environment Review, Vol 11, No 4, May 1996.

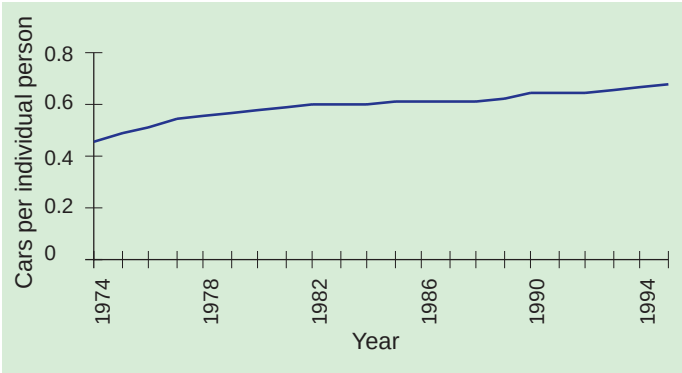


Figure 8. Cars owned per West Australian 1974-1995.

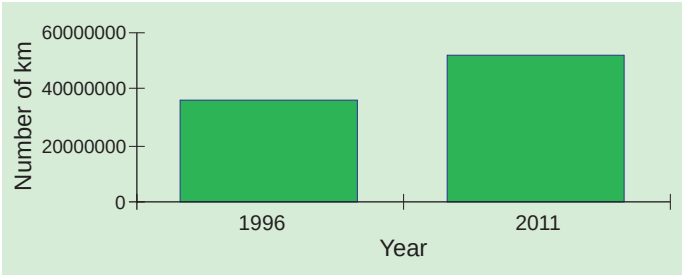


Figure 9. Current (1996) and predicted (2011) number of kilometres travelled in Western Australia per day.

The future impact of vehicles

Figure 8 indicates that over the past 21 years the number of cars licensed per individual West Australian has increased.

Should this trend continue and the population of Perth remain the same, the number of cars on the road will continue to increase.

But, our population is expected to increase. As the population grows, even if the level of car ownership remains the same as it is now, there will be even more cars on the road.

On top of this, the length of our vehicle trips is expected to increase as the size of Perth grows.

It is expected that for every one per cent increase in population there will be a 1.6% increase in the number of vehicle kilometres travelled.

Work completed by the Department of Transport indicates that over the next 15 years there will be a 45 per cent increase in the total number of kilometres travelled every day in Western Australia. This is represented in Figure 9.

Even if the pollution output from our individual cars were to be reduced, an increase in the total distances travelled will lead to an overall increase in the total pollution output from motor vehicles.

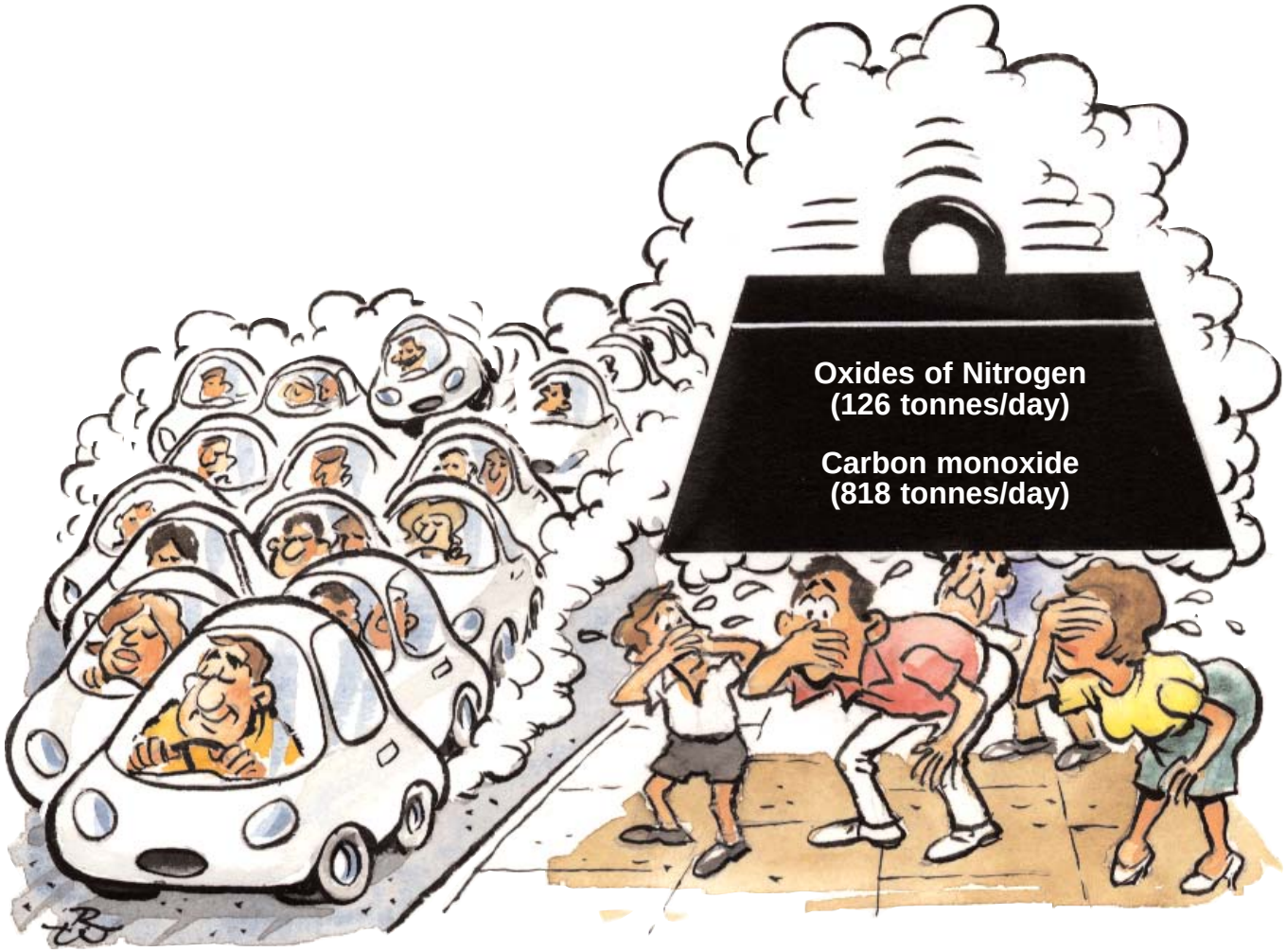


Figure 10. Predicted daily vehicle emissions of carbon monoxide and oxides of nitrogen for Perth in 2011 assuming there is no new anti-pollution technology used in the production of new cars.

Data is taken from Air Quality gets a Black Mark, Australian Environment Review, Vol 11, No 4, May 1996.

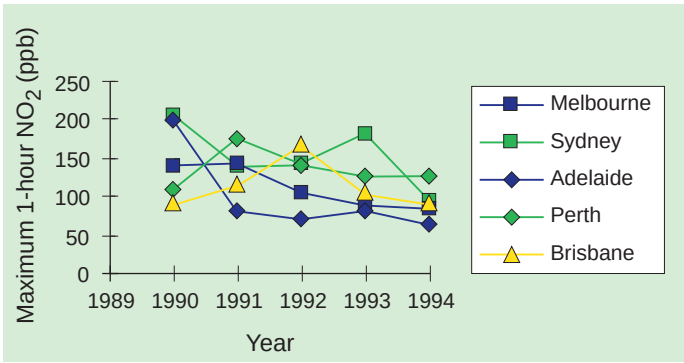


Figure 11. Comparison of the annual maximum 1-hour nitrogen dioxide concentrations for selected Australian cities for the period of 1990 -1994.

Do we have an air pollution problem in Perth?

Perth is on the threshold of an air quality problem.

The pollution problems of Perth and other Australian cities tend to come in episodes. These episodes are influenced by seasonal and meteorological factors.

While Perth has a relatively small population in comparison with some other Australian capital cities our air pollution is significant.

This is demonstrated in figures 11 and 12. Both figures are taken from Publication 468 of the Victorian Environmental Protection Authority.

Figure 13 shows the trends for Perth's air pollution over the past seven years.

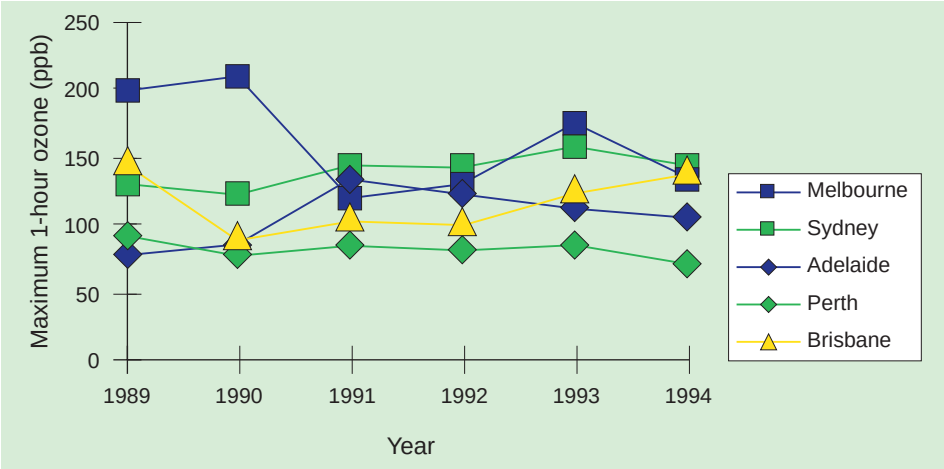


Figure 12. Comparison of the annual maximum 1-hour ozone concentrations for selected Australian cities for the period of 1989 -1994.

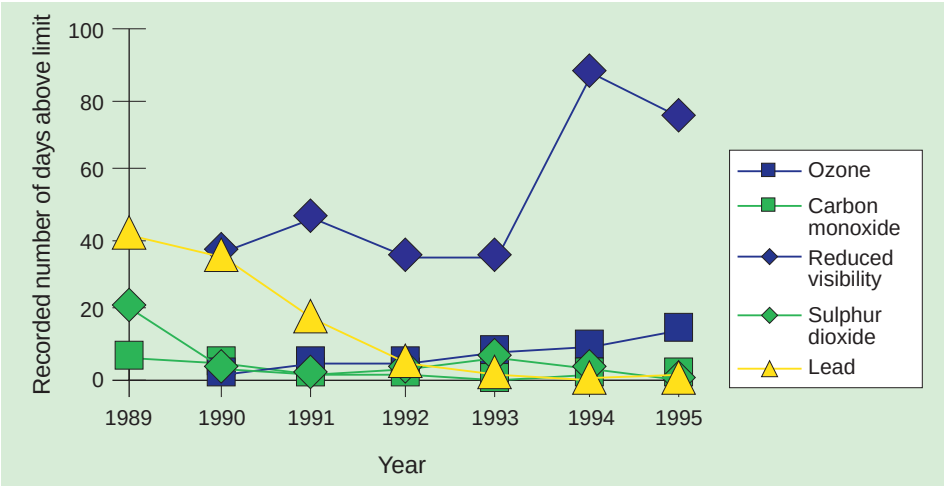
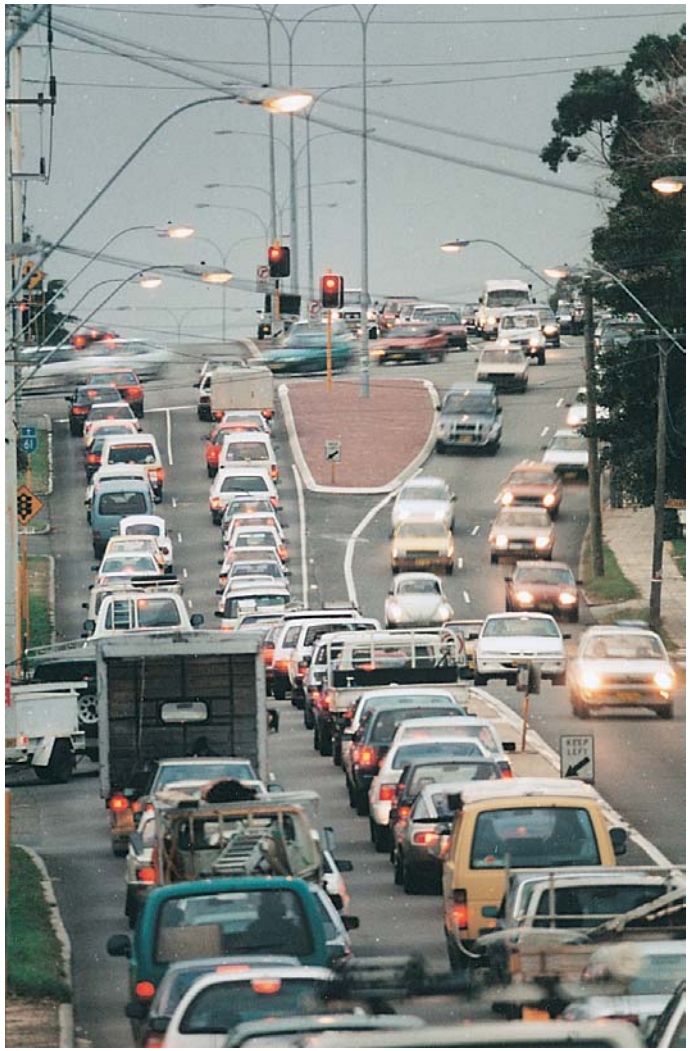


Figure 13. Recorded number of exceedences per year above recommended pollutant limit in Perth.



What are the major air pollution problems for Perth?

1. Photochemical smog

Photochemical smog is considered to be one of the most significant pollution problems facing many cities of the world and Perth is no exception. Cities which are particularly at risk have periods of time when there is an abundance of sunlight, moderate winds and high temperatures. In Perth, photochemical smog tends to occur in late spring, during summer and early in autumn.

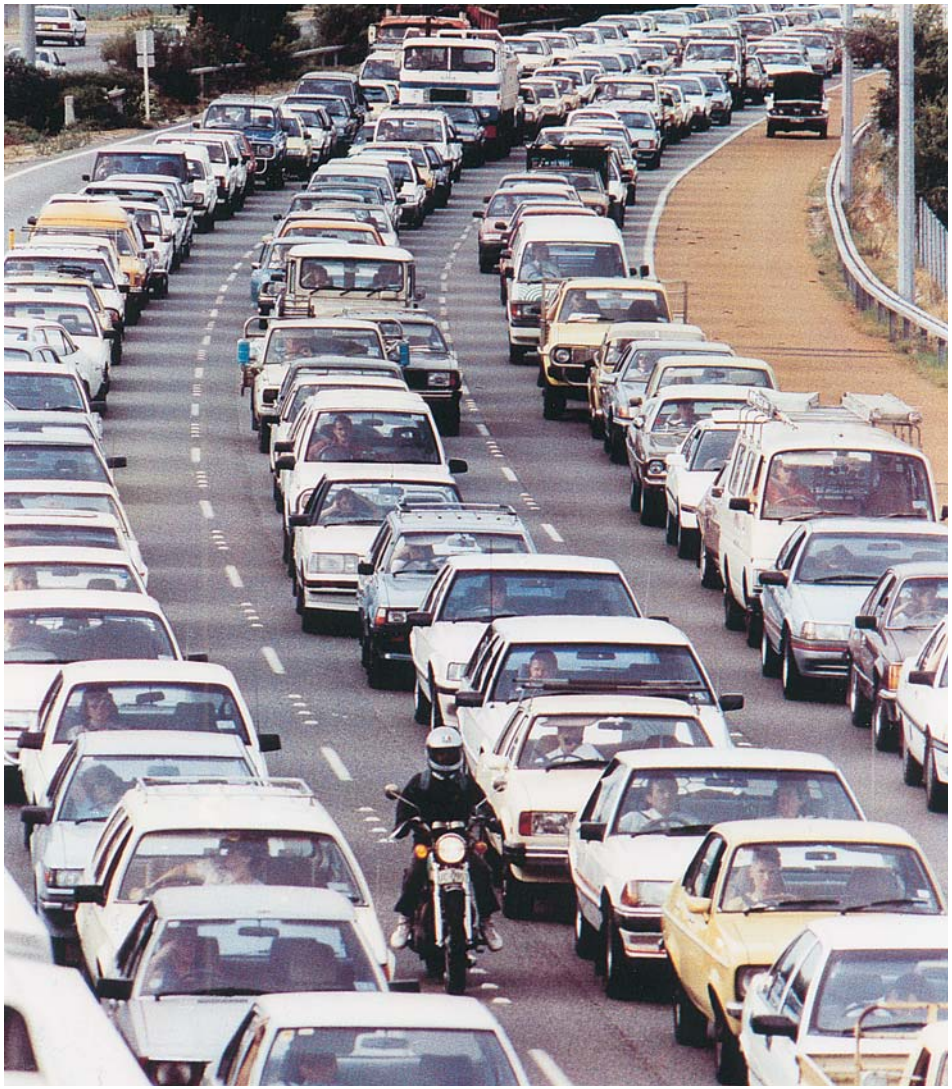
Photochemical smog, which may be invisible to the naked eye, is characterised by high concentrations of ground level ozone. Ozone is formed when oxides of nitrogen and reactive organic compounds, react together for a few hours under the influence of sunlight and high temperatures.

Figure 14 shows that motor vehicles are the major contributor to Perth's photochemical smog. Industry and area sources also make significant contributions.

Perth typically has 9 to 17 days per year when ozone levels exceed the World Health Organisation goal of 80 parts per billion (ppb). This is indicated by Figure 15.

High ozone levels have been measured from Rockingham in the south to Two Rocks in the north, Rottnest to the west and Rolling Green to the east.

Area sources refer to widespread, low-level sources of pollution. For example, there are a large number of homes in Perth. Individually, each home contributes only a little pollution, but in total all homes make a significant contribution. Other examples of area sources include fires, light industry, service stations, road works, gardens and horticultural properties.



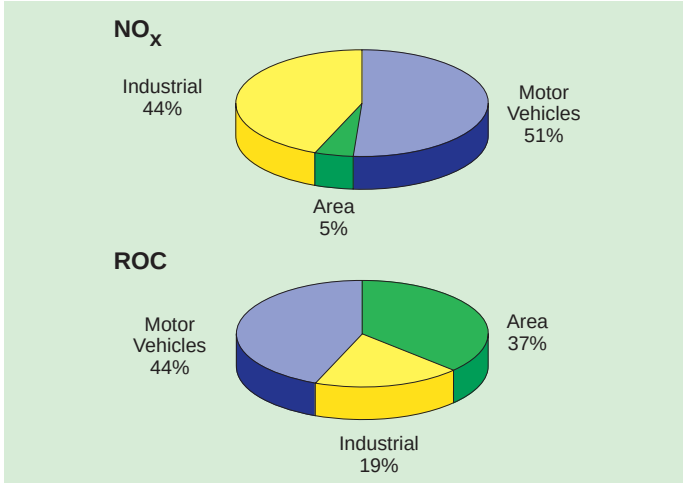


Figure 14. Contributions of vehicles, industry and area sources to oxides of nitrogen and reactive organic compounds. (Photochemical smog is produced when oxides of nitrogen and reactive organic compounds react in the presence of sunlight at high temperatures).

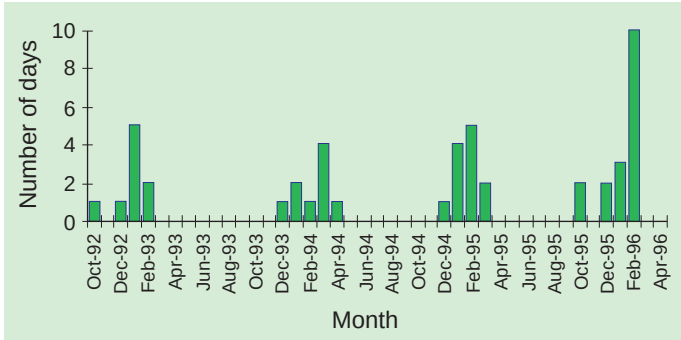


Figure 15. The number of days per month where peak ozone concentrations exceeded 80 parts per billion somewhere in the Perth region.

When at low concentrations ozone is colourless and odourless, but at higher concentrations it has a pungent odour and is bluish in colour.

Ozone impacts upon the healthy and the fit as well as the more susceptible members of the population. These include the very young, elderly and those with respiratory or cardiovascular problems.

Studies have found that our lung function may be reduced if we exercise while ozone levels are elevated.

When ozone levels are increased to around 100 parts per billion there is an increased incidence of eye, nose and throat irritations. Ozone causes damage to all parts of our respiratory tracts, particularly the cells which are involved in gas exchange. This may lead to people experiencing the symptoms of chest tightness and wheezing.

At levels of 120 parts per billion, ozone can cause changes in our airways which will increase our sensitivity to allergens such as pollen.

There is further evidence that elevated ozone levels can trigger asthma attacks and increase our susceptibility to infection.

When at elevated concentrations, ozone can damage the leaves of plants and reduce their ability to photosynthesise. This will lead to reduced growth rates and yields. At current levels the impact of ozone on plant life within Western Australia is not well understood, however, it has been estimated that photochemically produced ozone has lead to a five to 10 per cent decline in crop yields in the United States of America. It is also possible that plants become more susceptible to disease and less tolerant to cold temperatures. Genetic information within the seeds may also be altered.

Ozone also damages susceptible materials such as rubber, plastics, concrete, stone, cloth, dyes and paint work.

I thought ozone was good!

While ozone close to the ground is a real problem, the ozone found in the stratosphere is helpful. It absorbs potentially damaging ultra violet radiation.

Figure 16. While this photo shows a clear sky, this was a day with a high level of air pollution. The ozone reading was in excess of 80 parts per billion.

What can we do about smog?

Should emissions and the consequent photochemical smog concentrations increase by small amounts in the Perth region, it is expected that the number of days when ozone levels are above acceptable standards will increase considerably.

We are in the fortunate position of being able to reduce our photochemical smog emissions before the problem gets out of hand.

There are many things which we can do to reduce the amount and frequency of photochemical smog events in Perth. We must reduce our contributions of oxides of nitrogen and reactive organic compounds to the atmosphere. Suggested actions are outlined in the final section of this booklet, "What can I do to reduce air pollution".

Other cities have had considerable success at reducing their level of photochemical smog. An excellent example is San Francisco which in 1969 had 65 days over 120 parts per billion. Through regulatory and community action this was reduced to one day by 1994.

What causes a smog event for Perth?

Perth's worst photochemical smog days, are between late spring and early autumn, when there is a weak low pressure trough situated very close to the coast. Under these conditions, pollution created by the morning peak hour traffic is blown out to sea by north easterly winds. Here the pollution sits and if the temperature is warm enough, the smog reactions proceed rapidly. The smog is then returned over the metropolitan area with the sea breeze. The process is illustrated in Figure 17.

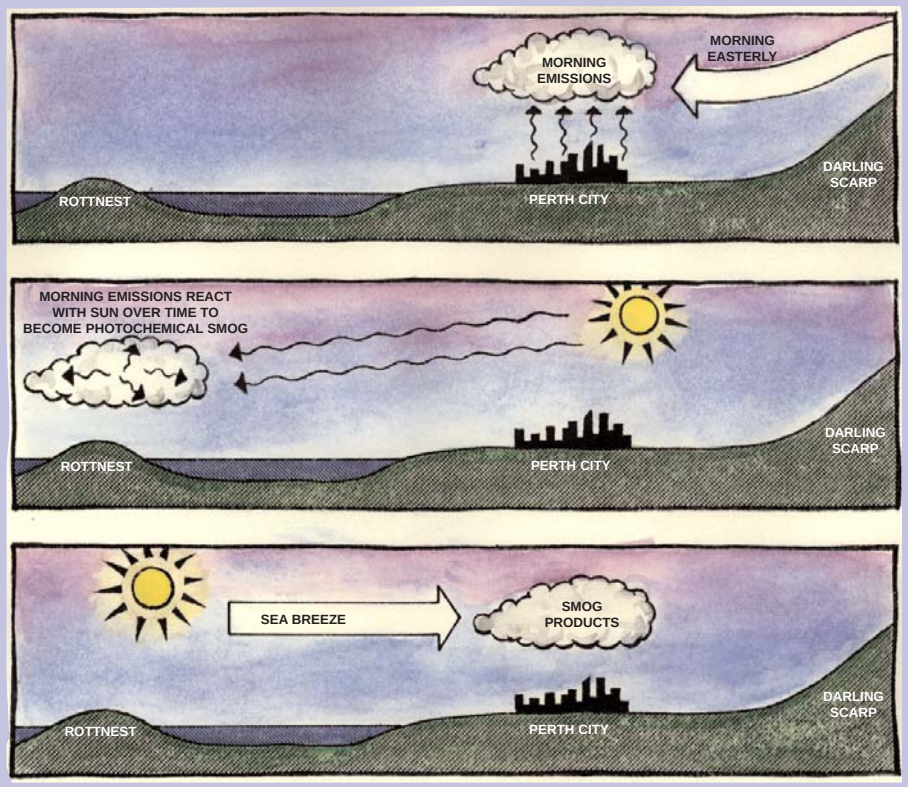


Figure 17. Formation of photochemical smog over Perth.

Photochemical smog may also be experienced if bushfire smoke is blown across the metropolitan region.

2. Haze

Haze is the name given to the collections of tiny particles from wood smoke and vehicle exhausts which make our skies look brown. Haze is most likely to be observed on cold, calm winter mornings.

The haze particles are so tiny that between 15,000 and 50,000 particles can be lined up side by side along a line one centimetre long.

Fine particle matter is sampled at the city centre and four metropolitan sites. Some areas have been found to have similar levels to those recorded in Sydney and Melbourne.

As shown by the Duncraig data, Figure 18, haze levels tend to be highest in winter and lowest in summer. The largest source of haze forming particles in winter is smoke from domestic wood heaters.

* Number of hours that Bsp is greater than 1.75 x10^{-4} m^{-1}. Bsp is a measure of the backscattering of light due to particles in the air. Refer to Table 1.

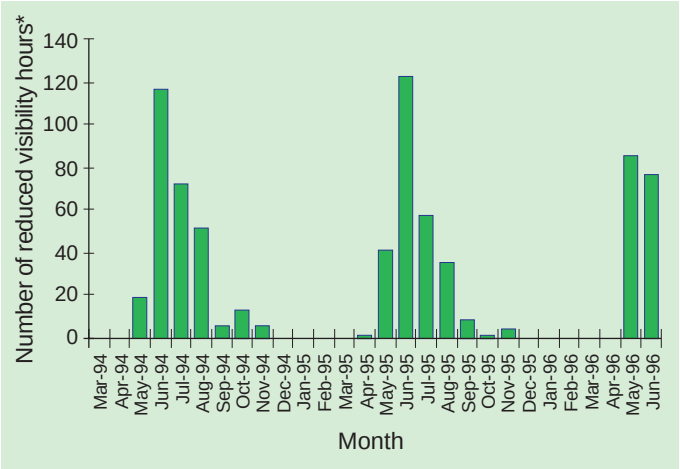


Figure 18. Reduction to visibility at the Duncraig Air Quality Monitoring Station, January 1994 - July 1996.

Table 1. Visibility scale.

Classification	Distance	Bsp scale (x10^{-4} m^{-1})
Clean	≥26 km	1.75 and below
Light	26 km to 20 km	1.76 to 2.35
Significant	19 km to 10 km	2.36 to 4.65
Heavy	≤10 km	4.66 and above

The burning of green wastes, forests, and paddocks contribute to haze formation at other times of the year, particularly autumn and spring.

Particles emitted from exhausts, particularly of diesel engines, also make significant contributions to haze.

Pollutants present in the atmosphere can react together and produce additional fine particle matter.

The smallest source of fine particle matter is naturally occurring dust and sea salts.

Figure 19. The largest source of fine particle matter during the winter months is smoke from domestic wood heaters.

Haze is worst on days of temperature inversions. How do temperature inversions form?

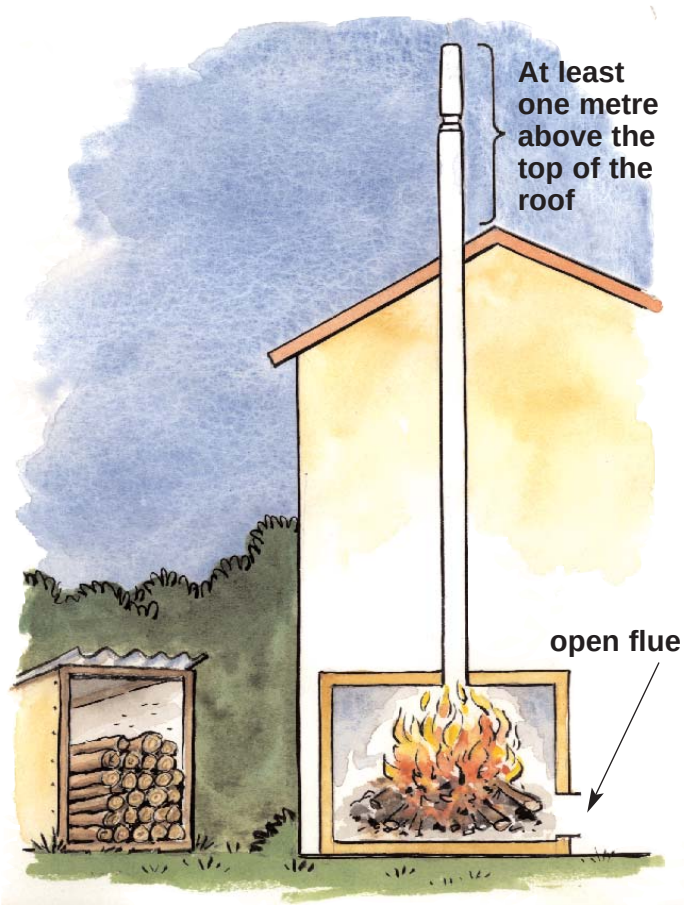
On cool, clear, calm nights the ground and the air next to the ground cool down. As the air cools, it becomes heavier and, as a result, the air does not mix with the warmer lighter air above.

How is this relevant to Haze?

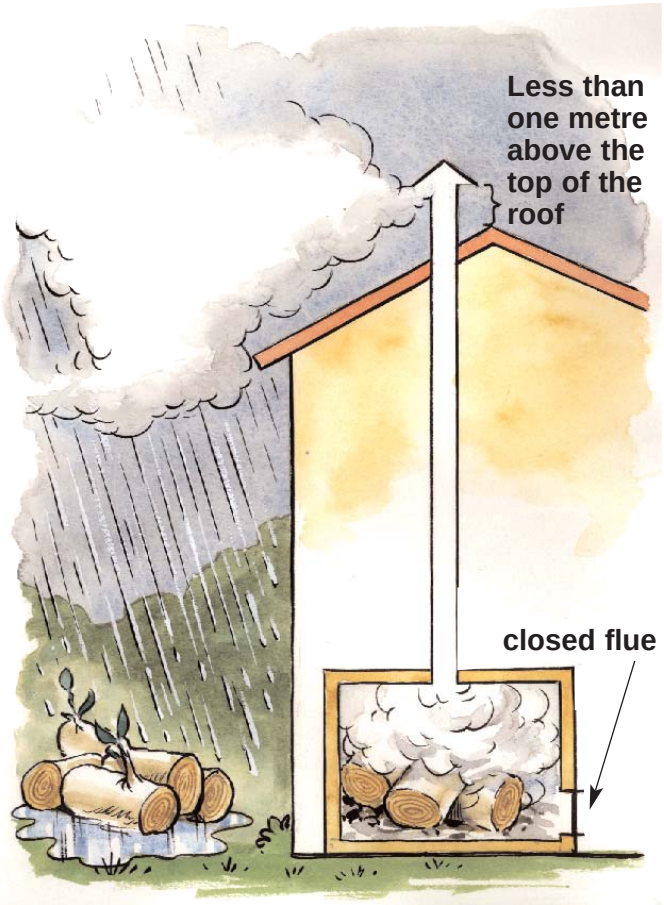
Haze is particularly evident on days of temperature inversions. The fine particle matter gets trapped in the layer of cold air close to the ground. With little vertical dilution due to the inversion, and little horizontal dilution because of light winds, continued production of particles (fires burning, exhaust emissions) causes accumulation in the air. The particles scatter the sunlight, making the sky in the direction of the sun appear bright, while away from the sun the sky looks brown.

Figure 20. Haze can be seen as a brown stain in the sky.

How to use a pot belly fire



How not to use a pot belly fire



Any material floating about in the air can be breathed in to our bodies. The larger particles are trapped by the fine hairs inside our noses and windpipes. These are passed from our bodies when we blow our nose or cough. Because of their smaller size, fine particle matter is inhaled deep into our lungs. While some of the particles are exhaled, a fraction are retained and these can have serious impacts on our health.

The people most at risk are the very young, the elderly, or people with lung or heart diseases. Fine particles are known to exacerbate problems experienced by bronchitis, emphysema and asthma sufferers. There is also evidence that fine particle matter can lead to premature deaths. The main group at risk are elderly people who suffer from chronic respiratory problems. We should also be aware that fine particle matter may also contain harmful chemicals which can damage our lungs, or even worse, cause cancer.

When airborne particles finally settle they add a film of "dirt" to the natural and physical environment.

What can we do to reduce the Haze problem?

1. Use our wood burning heaters and stoves so they produce as little smoke as possible. It is important to burn a hot fire with bright glowing coals. As a guide use small pieces of untreated and well dried wood. Control the heat output by regulating the amount of wood put in the fire rather than closing the flue. For more details, read the Department of Environmental Protection's pamphlet "Wood Heaters in the Home" or the Australian Solid Fuel and Wood Heating Association's pamphlet, "Getting the most from your wood heater...it's easier than you think".
2. Even if open burning is legal within your shire, avoid the temptation to add more smoke to the air. Compost your garden clippings and recycle them back into your garden as mulch. Alternatively take your garden waste to the nearest rubbish tip or waste transfer station.

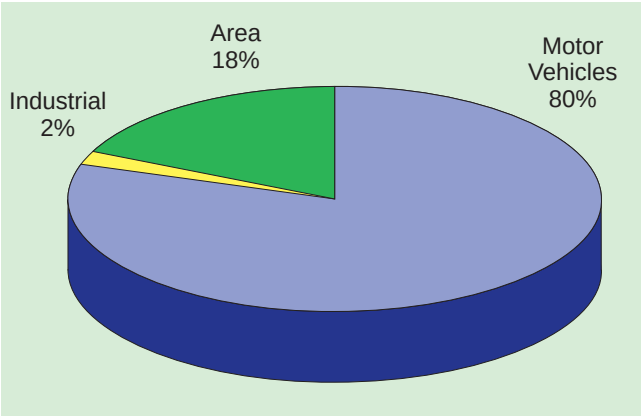


Figure 21. Sources of carbon monoxide in Perth.

3. Carbon monoxide

Carbon monoxide, a colourless, odourless, highly toxic gas, is one of the most common and widely distributed air pollutants. It arises from the incomplete burning of materials, industrial processes and biological decay.

Figure 21 shows the various contributions to carbon monoxide pollution.

The group referred to as "area sources" is diverse. It includes our homes and gardens, schools and office blocks, shops and service stations. Of particular interest to us is our own homes. Information about carbon monoxide sources in our homes is in the appendix.

One of the most significant individual sources of carbon monoxide is cigarette smoke. Scientific research indicates that smokers, and passive smokers, are exposed to up to four times more carbon monoxide than people in a smoke-free environment.

People who are exercising are more prone to carbon monoxide poisoning than people at rest.

Low level of carbon monoxide pollution can lead to a reduction in our ability to carry out exercise. As the concentration of carbon monoxide within our blood increases, our ability to receive information about our environment decreases. We become less able to concentrate and experience headaches.

Short term exposure to very high carbon monoxide levels can prove fatal. Carbon monoxide enters the bloodstream and considerably reduces our body's capacity to get oxygen to the cells. As our heart compensates and sends more blood to each cell, it is put under considerable strain. If vital organs such as the brain are starved of oxygen, some of the cells will die and brain damage can occur.

The health threat of carbon monoxide poisoning is greatest for people who suffer from cardiovascular disease. In some of the world's large cities it has been found that there is a correlation between carbon monoxide levels in the air and the admissions of elderly people to hospital with congestive heart failure.

Since 1990, carbon monoxide levels in Perth have been closely monitored in the central business district because of the high concentrations of motor vehicles found there. The results from the Perth CBD station are shown in Figure 22.

The carbon monoxide level within the air we breathe is currently believed to be within safe limits.

With our population increasing and the expected increase in the number of kilometres travelled per person in vehicles, it has been predicted, despite improved emission controls, carbon monoxide levels will rise in the future.

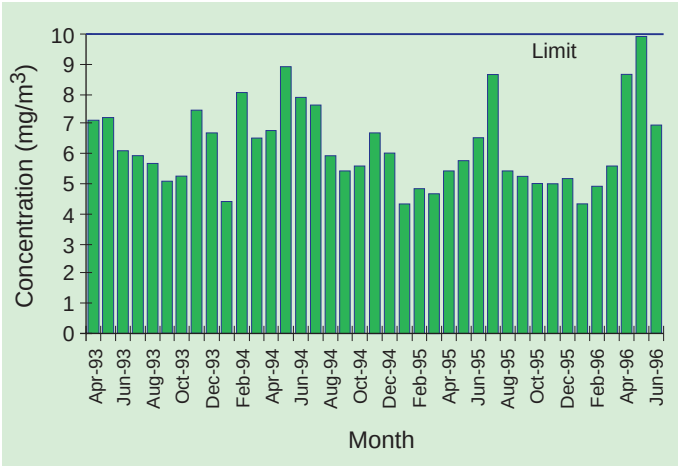


Figure 22. Maximum monthly 8-hour concentration of carbon monoxide, Queens Building, Perth, April 1993 - June 1996.

4. Oxides of Nitrogen

The most common oxides of nitrogen in the atmosphere are nitric oxide and nitrogen dioxide. Nitric oxide is a colourless, odourless gas while nitrogen dioxide is an orange-brown gas with a stinging smell.

The largest man-made source of the oxides of nitrogen is the combustion of fossil fuels. As shown in Figure 4, it is our motor vehicles which are responsible for 51 per cent of the emissions. Industry contributes approximately 44 per cent of the oxides of nitrogen emissions to Perth's air. Examples of such industries include power generation and the production of nitric acid. The remaining contributions of nitrogen oxides come from area sources, including our homes and workplaces. The use of gas appliances for heating and cooking and the smoking of cigarettes both lead to an increase in the oxides of nitrogen within indoor environments.

As previously described, oxides of nitrogen are one of the two groups of pollutants responsible for the formation of photochemical smog.

In addition, oxides of nitrogen can have significant impacts on health. While nitric oxide is a relatively safe gas, it is converted to nitrogen dioxide in the atmosphere.

At levels above 300 parts per billion, nitrogen dioxide can affect our respiratory systems and increase our susceptibility to infection. This is a real problem for new babies, older people, or for those people with problems such as bronchitis and asthma. There is evidence that nitrogen dioxide can trigger asthma attacks in known sufferers. If we are exposed to high levels of nitrogen dioxide for long periods of time, it is possible that cells on the interior surfaces of our lungs may be irreversibly changed. With this, our lung function is reduced.

Nitrogen dioxide is also known to prematurely age materials such as paint, metals, rubber, fabric, leather, paper and building materials. In addition the oxides of nitrogen can react with water and form weak solutions of nitric acid and this can contribute to a phenomenon known as wet acid deposition.

Nitrogen dioxide levels in Perth rarely exceed the West Australian standard of 150 parts per billion on average in any one hour.

What is the difference between acid deposition and acid rain?

Our air contains gases and fine particle matter. Some of these substances can form acidic compounds. If the compounds settle on the earth's surface in a dry form, dry acid deposition has taken place. However, if the compounds are washed to the ground with precipitation, the phenomenon is known as acid rain or wet acid deposition.

Pollutants emitted from high factory chimneys can be dispersed over large distances by wind. Some of these pollutants, including oxides of nitrogen and sulphur dioxide react to form acids. These acids may be deposited in either the wet or dry form.

Acid deposition is a phenomenon that can be very destructive to the environment. Air pollution from one country may lead to acid deposition in another country. This is evidenced in Scandinavia, a country with very little industry and severe acid deposition problems.

Is acid deposition a problem anywhere in Western Australia?

At the moment, because of our relatively low industrial base, acid rain is not a problem.

5. Air toxics

One hundred and eighty nine air toxic substances have been identified by the United States Environmental Protection Agency. The list of air toxics includes benzene, 1,3 butadiene and the polycyclic aromatic hydrocarbons.

Benzene, 1,3 butadiene and polycyclic aromatic hydrocarbons are emitted from internal combustion engines including motor vehicles. Diesel vehicles are known to emit particularly high concentrations of polycyclic aromatic hydrocarbons. It is therefore not surprising to learn that the levels of air toxics will be higher near busy roads.

While cars are the major source of air toxics for people with limited exposure to cigarette smoke, this is not always the case for smokers and their associated sidestream smokers.

Benzene is readily released into the atmosphere in fuel vapour. This occurs if our vehicle has a leaky fuel cap and as we fill up at the petrol station. Smoke produced by incomplete combustion of wood and fossil fuels is another source of air toxic substances.

Table 2 shows the estimated daily intake of airborne benzene for people of England. While the figures can not be directly transferred to Western Australia, we can use this data to build an understanding of our own level of exposure.

Table 2. Estimated Daily Intake Of Airborne Benzene.

Source		Level of exposure in micrograms
Air we breathe	rural urban	15 400
Cigarette smoke	10/day 20/day	300 600

Both benzene and 1,3 butadiene are gaseous substances which are a part of the air we breathe. Once they travel into the lungs, they can pass into the bloodstream and travel to the cells of the body. Benzene accumulates in fat rich areas of our bodies.

At excessively high levels benzene may act like an anaesthetic leading to reduced levels of consciousness. Deaths have occurred when people have been exposed to extreme levels of benzene when trapped within confined spaces. Our exposure is however at much lower levels.

Researchers do have concerns about long term low level exposure to benzene. It has been recognised that this can lead to a slight increase in the incidence of leukaemia.

Short term, high level exposures to 1,3 butadiene can lead to an increased incidence of eye, nose and throat irritation.

Of more relevance to us, although this has not been proven, long term low level exposures have been associated with increased cancers of the lymphatic and blood forming tissues. Such cancers include lymphomas and leukaemia.

The polycyclic aromatic hydrocarbons readily attach to very tiny particles, which are easily breathed in and can settle deep within our lungs. Certain polycyclic aromatic hydrocarbons have also been linked to cancer. There is also evidence that this group of substances can also lead to irreversible changes in genetic material.

It is only the post 1986 petrol vehicles which are fitted with functional catalytic converters that are effective at reducing the emission of air toxics into the atmosphere.

The growth of Perth

It is no doubt a direct result of our long hot summers that the people of Perth have a love affair with the ocean. Not only is the beach a nice place to swim; it is the suburbs closest to the coast that are the first to gain the cooling influence of the sea breeze.

People also enjoy living close to recreational areas such as the Swan and Canning rivers and near the open spaces of the various parklands, wetlands and the hills.

There is a tendency for the people of Perth to live in single residential homes surrounded by private gardens. This leads to large areas being used for housing.

Transport is another factor people consider when choosing where they live.

These factors have all contributed to Perth becoming a sprawling city. The satellite image shows the growth of Perth to date, which tends to be in corridors in a north-south direction. The beach provides the western boundary and the Darling Scarp forms the eastern boundary.

This pattern of development is expected to lead to people travelling greater and greater distances so they may satisfy their work and social requirements.

Figure 23. Satellite photo of Perth.

6. Odour

As can be seen in Figure 24 the majority of air pollution complaints to the Department of Environmental Protection are odour related. Odour causes a great deal of concern for many people. Generally, odours are annoying. In rare cases, the compound causing the odour may be poisonous and lead to illness in people.

Most odour complaints are related to industries which deal with animals or animal by-products. Examples include poultry farms, piggeries, cattle feedlots and tanneries.

While many people choose to move away from the odour source, it is possible to control odour emissions at their source. This may be done by pumping the odour high into the air through an elevated chimney, passing the odour through a chemical or biological removal medium or by incinerating the odour-producing material at high temperatures.

Currently the Department of Environmental Protection, is preparing guidelines for buffer zones between odour production sites and new residential areas. To reduce odour complaints in the future it is important that there is adherence to these guidelines when building urban and industrial developments.

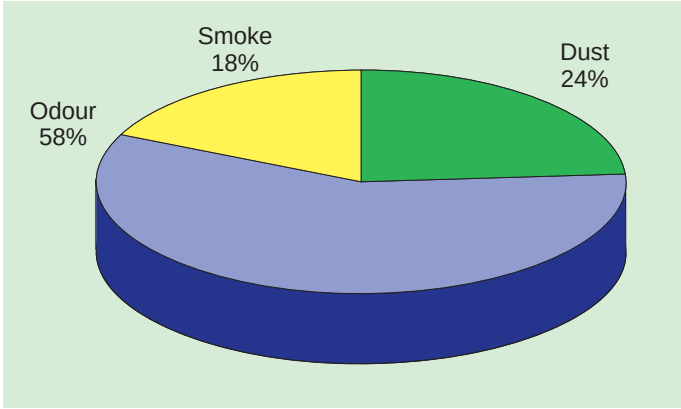


Figure 24. Air Pollution complaints for Perth and Kwinana, July 1 1995 - June 30 1996.

So what is the good news.....

1. Sulphur dioxide

Sulphur dioxide is a colourless gas which is soluble in water. The presence of sulphur dioxide is usually indicated by a strong acrid odour.

While a lot of sulphur dioxide is put into the atmosphere by volcanoes, it is the man-made sources which have been a real concern. These emit significant quantities of the gas, they are close to us, and the sources can control their output.

The burning of petroleum, coke, oil and coal release sulphur dioxide into the atmosphere. Sulphur dioxide is a common emission from industry, the sources including coal and oil fired power stations, oil refineries, chemical manufacturing and the smelting of sulphur-containing ores. For Perth, 90 per cent of sulphur dioxide is derived from industrial activity. The majority is produced in the Kwinana industrial area. Motor vehicles (in particular diesels) and the burning of wood also contribute to sulphur dioxide emissions.

What is City Diesel?

In the United Kingdom a new type of fuel called City Diesel is being developed. While City Diesel is more expensive than regular diesel it is a cleaner fuel with a considerably lower sulphur content. Vehicles using this fuel will have reduced sulphur dioxide emissions.

Sulphur dioxide has the potential to affect our health. Exposure to high concentrations causes painful irritation to the eyes, nose, mouth and throat and can lead to coughing, and feelings of chest tightness. Sulphur dioxide can also cause severe damage to the interior surfaces of our lungs, resulting in serious difficulty with breathing.

Sulphur dioxide pollution, as found in many industrialised cities, is most likely to affect people who are exercising or those who have a respiratory condition. Short term low level exposure can lead to a narrowing of the airways in susceptible people, and in the case of an asthmatic, may induce an asthma attack.

It has also been suggested that exposure to sulphur dioxide may lead to people becoming more sensitive to allergy-causing substances such as pollen and dust mites.

The corrosive abilities of sulphur dioxide can damage plants and animals, as well as lead to the general breakdown of non-living things such as brickwork, limestone buildings and metals.

Considerable effort has been made by both industry and the Department of Environmental Protection to reduce the amount of sulphur dioxide in our air. In the mid 1980s many of Kwinana's industries switched to the cleaner energy source of natural gas. In 1992, the Department of Environmental Protection published the Kwinana Environmental Protection Policy which addressed sulphur dioxide emissions. This set air quality standards and led to the setting of emission limits for each industry.

The amount of sulphur dioxide in our air has decreased considerably over recent years. Wattleup, an area very close to the Kwinana industrial area, has experienced a considerable improvement in air quality.

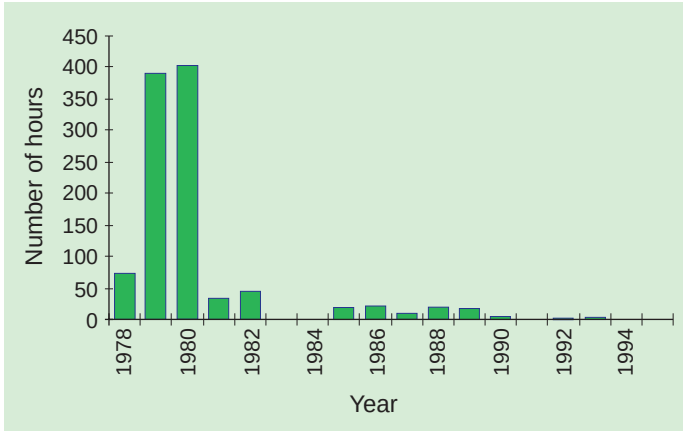


Figure 25. The number of hours each year that the 1-hour average sulphur dioxide concentration exceeded 350 µg/m³ at Wattleup. (No data was recorded in 1983 and 1984).

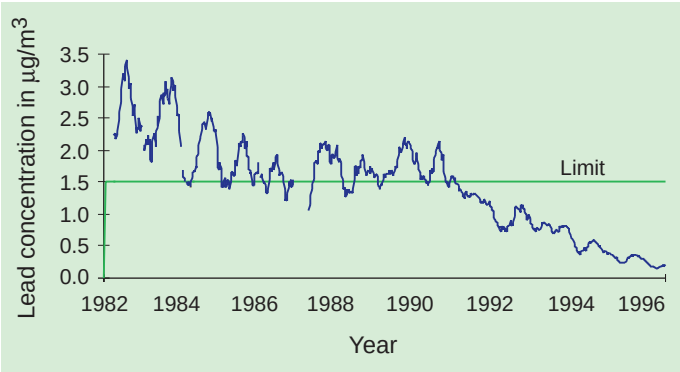


Figure 26. Atmospheric lead levels (90 day average), Queens Building, Perth.

2. Lead

Cars which run on leaded petrol are responsible for the majority of lead found in Perth's air.

Adding lead to petrol was once considered a cost effective method of increasing the efficiency of engines. In more recent years petroleum companies have modified petrol formulations to allow for a reduction in the lead content. All new cars built and imported into Australia since 1986 have been designed to run on unleaded petrol. In December 1993 an amendment was introduced under the Environmental Protection Act to reduce lead in super grade petrol sold in Western Australia to 0.4 grams per litre in 1994, 0.3 grams per litre in 1995 and 0.2 grams per litre from 1 January 1996. As a result there have been significant reductions in lead levels in the atmosphere of Perth. This is illustrated in Figure 26. Further falls are expected as the use of leaded petrol decreases.

Lead is a toxic chemical which can enter the bloodstream of humans via substances consumed or inhaled. Exposure to excessive amounts of lead can cause health problems. Problems include affecting the ability of the body to make blood components and impairing the intellectual development of people, particularly if exposed to high doses before birth and as young children. There is also some evidence that increased lead levels lead to increased blood pressure.

The effects of high lead levels on plants and animals has not been researched extensively and therefore is not well understood.

Lead in Paints

In past years, many household paints contained lead. Fortunately, this is no longer the case.

The flaking and chalking of old house paints which contain lead continues to be a health risk. People are most likely to be exposed to lead during renovations. Those most at risk of lead poisoning are children who are not yet born and those who are under the age of five.

It is possible for you to minimise the potential of exposure to lead in your home. Details are provided in the series of "Lead Alert" brochures available from the Health Department of Western Australia. (Phone: 09 3884997).

Is there an indoor air pollution problem?

Indoor air quality is important. A good indoor climate reduces illness. It also helps us to feel more comfortable so we are able to work more efficiently.

It may come as a surprise to learn that the quality of air indoors is often poorer than that outdoors. It is therefore important that we understand the impact of indoor air quality on our health. It is particularly important to consider the impact of indoor air pollution when we learn that the majority of people spend between 85 and 95 per cent of their time indoors and that elderly, sick and very young people spend nearly all of their time indoors.

The use of synthetic building materials, household products, gas for cooking and a variety of fuels for heating can lead to pollutants being at excessively high levels indoors. Carpets have also been identified as being a major source of indoor air pollution. This problem is exacerbated by building design and room partitioning which does not allow a good flow of fresh air.

Smoking of cigarettes in indoor and enclosed areas is a considerable health risk for all people using the area. As a result, smoking has been banned in all government offices in Western Australia.

There are a number of substances which have been recognised as indoor pollutants. The sources, health effects and a variety of methods for reducing the concentration of indoor pollutants are shown in the Appendix.

To maintain good air quality within indoor spaces we must minimise the number of pollution sources and encourage the movement of plenty of fresh air into our homes.

I live alongside a major road and I am concerned about the air quality. Are my concerns valid?

While it is known that air quality declines adjacent to busy roads, insufficient work has been done to determine the health impacts of the levels of pollution which are experienced. This is the focus of a future study soon to be undertaken by Main Roads WA.

If you wish to do something to reduce your exposure, you may find these suggestions helpful:

1. Open the windows and air your home when the pollution levels are at their lowest, eg. night time.
2. If you have an air conditioner make sure its air intake is from the side of the house least exposed to air pollution.
3. Have the rooms in which you spend the most hours of your day (bedrooms, living rooms) away from the busy road.
4. Plant vegetation between your home and the source of pollution. Some pollution may be absorbed by plants.

How to reduce the level of volatile organic compounds in new furniture and floor coverings.

Many new household products contain lots of volatile organic compounds (VOCs). When unwrapped, the VOCs vaporise and move into the air. It is these vapours which give new products that brand new smell. Unfortunately, the vapours can also affect our health.

Its easy to reduce the level of VOCs in your new purchase. The first thing you need to do is unwrap the item and put it in an enclosed area which will not be needed for the next few days. A spare bedroom or an enclosed garage is good. More VOCs will dissipate at higher temperatures, so its best if you can put a heater on high in the room with the new item. Leave the heater on for at least one day, then return to the room briefly, turning off the heater and opening up the room to the outside air. Leave the room open for as long as you can to reduce the level of the VOCs in the air. Once you have done this you can enjoy your purchase and feel satisfied that you are breathing healthier air.

What are the economic costs of air pollution?

Air pollution has a real health cost. Various attempts have been made to convert this to a dollar value. A number of broad assumptions have been made in an effort to quantify the costs.

In 1994, a study was completed by the Brisbane City Council to find the health cost of air pollution. The study was considered to be particularly relevant for the people of Perth as Brisbane has a similarly sized population and levels of air pollution.

Given that those carrying out the study estimated a human life to be worth $5 million, the cost of fine particle matter pollution was calculated as being between $230 million and $415 million per year. This translates to between 46 and 83 premature deaths per year. In addition, the authors costed illness caused by fine particle matter and ozone at between $23 million and $45 million per year.

Another study, the Victorian Transport Externalities Study, attempted to estimate the cost of air toxics and ozone on the health of Melbourne's population. The population of Melbourne is two and a half times larger than Perth.

As a result of Melbourne having more traffic, more air toxics are emitted into the atmosphere. During 1990, the estimated cost of cancer caused by air toxics to the Melbourne population was calculated as between $26 and $45.2 million.

Melbourne tends to have more days than Perth when ozone levels exceed the one hourly World Health Organisation's goal of 80 parts per billion. In a 12 month period spanning 1992 and 1993, Melbourne had 13 days exceeding 80 parts per billion of ozone in one hour. The cost associated with premature deaths, asthma attacks and the reduced activity of people, as a result of ozone-related illness, was given an average estimate of $2.5 million dollars.

The two studies considered three aspects of air pollution. No consideration was given to the health costs of carbon monoxide, nitrogen dioxide, sulphur dioxide or lead by the studies.

Even though we are mindful that there were a number of assumptions made by the researchers, it is evident that there are significant health costs associated with air pollution.

To get the total picture of the cost of air pollution we must look beyond human health and consider environmental costs. What is the cost of damage to plants, animals and ecosystems as a whole? What value is placed on the premature deterioration of monuments and buildings or other pollution sensitive materials such as rubber, plastics, cloth and paint work?

At this stage, specific estimates for these costs have not been calculated. It is important however, that we keep in mind that these are important components as we consider the overall cost of air pollution and pollution reduction.

What can we do to reduce our air pollution?

To improve the quality of the air we breathe we must think about our individual contribution to pollution. Each of us add to the air pollution in some way or another.

If we all make an effort and reduce our contribution to air pollution, this will make a big difference to the air we breathe.

In the following pages some suggestions are made as to how we can reduce air pollution from private vehicles, our homes and gardens, through recreation and by working together as a community.

Pollution from private vehicles

Think about the types of trips for which you use your car.

Don't drive if you don't have to

You may find that you do some very short trips where you don't have to carry much luggage. Perhaps you can have fun and breathe some fresher air at the same time. Walking is great for our physical well being, and we often find that other family members, including the dog, also enjoy the trip. Our push bikes allow us to travel a little bit further in the same amount of time. If we have a basket, some panniers or a backpack, we can even carry cargo at the same time as we work on our fitness.

Often there are others who live near us who travel in the same direction at about the same time of the day. If you don't know someone who you could share travelling with, but you are keen to give car pooling a go, try putting a notice on the board at the local shopping centre or your place of work or study.

You have no doubt experienced the frustration of seeing a bus or train sail past, while you are sitting in a car which has come to a grinding halt in a traffic jam. Public transport allows us to get into the city centre quickly, find some time to read, and gives us the opportunity to get a little exercise at each end of our trip. If you have not used public transport for a while you may find it all a bit daunting. The biggest step for most people is getting hold of the appropriate timetable. If you are wanting to travel within Perth, this can be easily solved by ringing the friendly Transperth staff on 132213. They will give you timetable information over the phone, or should you prefer, they will send the correct timetables to you.

With our improved telecommunications systems, more and more people are finding it possible and convenient to change their work practices and do more of their work from home.

Every kilometre you don't drive will make the air a little bit healthier for you and your family to breathe.

Sometimes there is no choice. We just have to drive

At times, we do not have a lot of alternatives to driving, but with a little forward planning we can do a number of car-based tasks in one day. In addition to reducing the distance we drive and our contribution to air pollution, we will also save time.

On those days you drive try to avoid excessive acceleration and breaking. Smooth driving leads to less air pollution.

By avoiding traffic jams we reduce our time wastage and the amount of pollution our cars put into the atmosphere. For many people this can be easily altered by changing the times and the routes on which they travel.

What can we vehicle owners do to make our cars pollute less?

Consider buying a small, fuel efficient, four cylinder car next time you change. They produce considerably fewer emissions. Refer to Appendix B for a guide to vehicle running costs. The most important thing we can do is keep our car well maintained. It is important that we include the emission control gear and the fuel cap in the maintenance program. Well maintained emission control gear leads to a lot less toxic substances passing out the exhaust pipe into the atmosphere. A well maintained car produces, on average, 25% less carbon monoxide and 16% less nitrogen oxides than a poorly maintained car.

Well fitted fuel caps keep the vapour in our petrol tanks rather than letting them waft away into the air where they can be breathed in and contribute to photochemical smog.

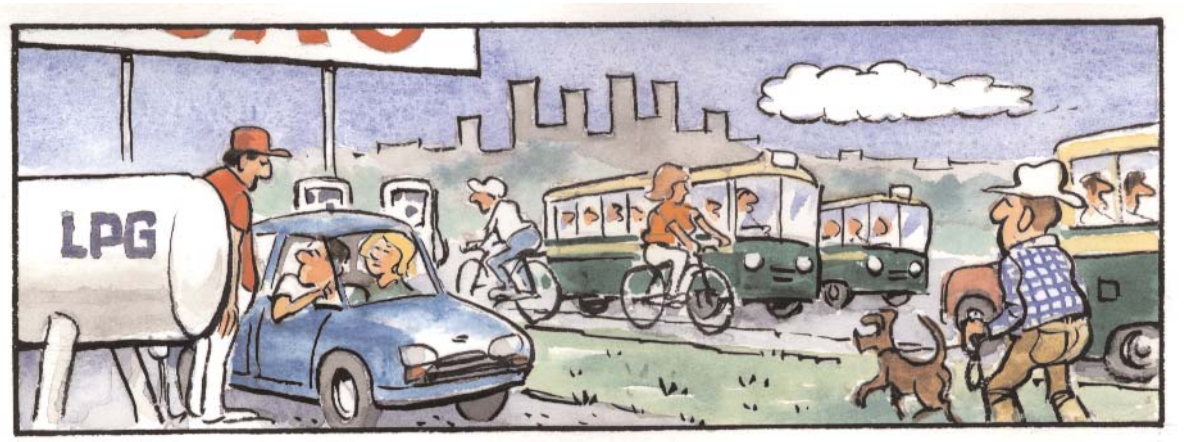
Perhaps you are thinking about making your vehicle a little more cost effective. By converting to liquid petroleum gas (LPG) you will also reduce your contribution to air pollution.

By removing any extra wind resisting items from your car, such as the roof rack, and by reducing the load that is carried to the essentials, you will save on fuel and at the same time improve the air quality.

Keeping your tyres inflated to the specified pressure also helps to reduce resistance.

Recent research has demonstrated that cars altered beyond manufacturer's specifications do not run as well and are considerably worse polluters. If you avoid the temptation to "hot" your car up, you will help to keep our air clean.

Many pre-1986 cars have been identified as being able to run on unleaded petrol. If this is the case for your car, you can help to further reduce the lead in Perth's air. Information on your cars suitability is available in the RAC brochure "Pre-1986 cars suited to Unleaded Petrol"



What sorts of things can I do at home?

Indoor pollution

As detailed in the Appendix, there are many sources of indoor air pollution. With some small changes to the types of appliances we use and by thinking carefully about the products we purchase, we can improve the quality of air within our homes.

Many people hate using oil-based paints as they find cleaning the brushes hard work. By painting with a water-based paint you will not only find that it is possible to clean up fast, you will also contribute less pollution to the atmosphere.

Throwing open of the doors and windows within the home is one of the best ways to reduce the level of indoor pollutants. If we put floor rugs and bedding out in the sunshine to air them on a regular basis we also reduce the number of dust mites, fungi and bacteria.

Garden pollution

Two-stroke motors are not only noisy, they put a lot of pollution into the atmosphere. If you need to buy or hire a machine for your garden, remember, electric motors are a lot cleaner.

A little maintenance work in the back shed may also help reduce the amount of pollution drifting into the atmosphere.

Containers used for the storage of volatile substances, including paints, thinners, petrol, pesticides and cleaning agents, need firmly fitting lids.

Burning contributes to the amount of fine particle matter and photochemical smog. Composting garden materials or taking them to the tip or waste transfer station is a much cleaner alternative. Gas BBQs, as well as being less polluting, are more convenient than wood-fired BBQs.

Recreational pollution

Some forms of recreation, including rowing, bushwalking and rock climbing, make little or no contribution to air pollution. Other pursuits however, affect the quality of our air. Trail bikes, jet skis and power boats all put toxic emissions into the atmosphere.

It is possible for us to continue to enjoy all forms of recreation and at the same help improve our air quality. For example, improved technology is currently being used to build outboard motors which will produce less emissions. The technology comes in the form of four-stroke and modified two-stroke engines.

A community approach

Many work places are now helping to make it easier for their staff to be environmentally friendly. The provision of bike lockers and shower facilities means that staff can gain some exercise and be ready for their day at work. Some businesses provide child-care facilities, this means that busy mums and dads can reduce the distances they drive, or even better, enjoy some time with their children as they travel together on public transport.

Some people are provided with a car by their work place. Incentive schemes are being used to encourage people to limit their use of the vehicles. An example includes equivalent mileage payments for work-related travel completed by bike.

A method for improving air quality is vehicle emission checks. In both the United States and British Colombia the issuing of the vehicles annual licence is dependent on a car conforming to predetermined emission levels. At the current time, this practice has not been instituted in Australia. If such a testing program were to be introduced, considerable community support would be needed.

In some large cities, including Sydney, potential photochemical smog days are forecast and announced to the public. Members of the public can then make appropriate decisions about the activities they have planned for the day. At the current time, no such service is available in Western Australia.

Perhaps we can practise our daily air pollution forecasting abilities! On days of high pollution risk we could make an all out effort to reduce our personal contributions. We could walk, bike or catch public transport. Our lawn mower could get a well earnt rest and we could have a salad for lunch rather than a BBQ.

Now is the time to act

If we make comparisons between Perth and other cities of the world we may conclude that Perth's air pollution is not that bad. While this is good, we must not relax. At this point in time we have the opportunity to prevent Perth becoming seriously polluted.

Our population is growing and our use of private vehicles is showing an increasing trend. If no change is made more toxic emissions will be pumped into the air. Some of these will cause immediate affects for us and our environment, while others will show their effects at later stages.

Scientists have identified that only a small increase in emissions of reactive organic compounds and oxides of nitrogen will lead to a considerable increase in the number of days when ozone levels exceed what are currently considered to be acceptable limits.

Air pollution has its costs. It affects the health and quality of life of people, animals and plants. Buildings, monuments and artworks are damaged by a variety of pollutants.

By reducing our air pollution emissions, we are contributing to a cleaner and healthier environment.

Appendix A

Indoor Pollutants, their health impacts, sources and what can be done to minimise their concentration

Toxic Substance	Health Impacts	Sources	What can you do
Carbon Monoxide	Lethargy and headaches at low concentrations. Lack of ability to concentrate. Suffocating gas which impairs the functioning of the nervous system.	The running of motor vehicles adjacent to indoor spaces. This is a real problem with indoor parking and carports directly adjacent to indoor spaces. Unflued combustion heaters. Gas appliances (eg. cooktops). Tobacco smoke.	Close doors and windows along side garages and carports at times when cars are running to prevent fumes entering indoor areas. Keep garages and carports well ventilated. If a vehicle is left to idle, ensure its fumes are not blowing into the house. When choosing a new heater consider the installation of a flue. Use an externally vented exhaust fan. Request smokers smoke out doors.
Oxides of Nitrogens	Reduces our lungs ability to function. May induce asthma attacks in known sufferers. Weakens our bodies defence system against infections. Irritates eyes, nose and skin when levels are high. May cause irreversible damage to cells on the interior surfaces of the lungs.	Gas appliances and leaking gas pipes. Kerosene heaters and wood fires. Tobacco smoke.	Maintain gas appliances and their flues. Use externally vented exhaust fans. Open windows and doors of the house on a daily basis to allow indoor pollutants to escape. This is particularly important in winter. Request smokers smoke out doors.

Toxic Substance	Health Impacts	Sources	What can you do
Volatile Organic Compounds (VOCs) eg. Formaldehyde	May cause sleepiness, lack of ability to concentrate, irritability, inflammation of eyes and respiratory problems. Some are known to weaken our bodies defence system so we are more vulnerable to infections. Some cause cancer and lead to irreversible changes to the genetic materials of our cells.	A wide variety of sources. Includes carpets, particle board and plywood, paper products, pesticides, disinfectants, air fresheners, cleaning agents, foam insulation, glues, paints and solvents, tobacco smoke.	Reduce use of VOC containing substances. Maintain a high degree of air flow between indoor and outdoor environments. Healthy indoor plants are known to be efficient at taking up and therefore reducing the level of a variety of air pollutants within indoor spaces. Request smokers smoke out doors.
Particles	Reduce the functional ability of our lungs. Exacerbation of respiratory problems such as asthma. Some particles cause cancer and lead to irreversible changes of genetic material within our cells.	Cooking (particularly if food is burnt). Open fires and combustion stoves. Smoking.	Use an externally vented exhaust fan. Wet dusting and thorough vacuuming will reduce the level of settled particles. Open windows and doors to allow indoor pollutants to escape. Request smokers smoke out doors.
Biological Materials	Symptoms vary. These range from those experienced when suffering from various allergies, common colds and the flu.	Fungi and their spores. Bacteria and viruses. Pollen and other plant materials. Invertebrates (mites, spiders and insects). Pet hair and dandruff.	Regular opening and airing of the space. Thorough regular vacuum cleaning. This is particularly beneficial if the vacuum has an effective air filter to trap very tiny particles. Routine airing of floor mats and bedding. Cleaning and disinfection of air conditioning units.

Toxic Substance	Health Impacts	Sources	What can you do
Asbestos	Asbestosis, lung cancer, mesothelioma.	Disturbance and weathering leads to the release of dangerous asbestos fibres from asbestos containing materials.	For information on the safe treatment and handling of asbestos containing products read the Environmental Health Guide “How Safe is Asbestos Cement”. The pamphlet is available from the Health Department of Western Australia. (Ph 388 4997)
Ozone	Irritation to eyes and nose. Increased incidence of headaches, nausea, respiratory and cardiovascular disease. May trigger asthma attacks, increase susceptibility to infection and contribute to premature death.	Photocopiers, laser printers, air purifiers, negative ion generators.	Keep well maintained. Use of ozone trapping devices on photocopiers and printers. Maintain a high degree of air flow within the indoor environment.
Radioactive by-products of Radon decomposition	Radon gas emits alpha particles, a damaging and low penetrating form of radiation. Alpha particles can give rise to mutations and cancer. The effects are generally confined to the lungs.	Buildings with a low degree of airflow which are built on soils with a high uranium content. Work done by the Health Department of Western Australia indicates the risk of a Western Australian’s exposure to radon gas within their home environment is minimal.	If you wish to test the radon level of your home a service is offered at minimal cost by the Australian Radiation Laboratories. (Ph: 1 800 678 112) Should your home be found to have high radon levels it is advised you seal cracks in the sub-surface area of the home and increase the degree of air flow between internal and external environments.

Appendix B

The Royal Automobile Club of W.A. (Inc)

Private running costs, new - 5 years @ 15,000 km per year (All costs in cents per km unless otherwise stated)	Hyundai Excel 1.5 GLX Auto	Toyota Corolla Conquest 1.8 Auto	Toyota Camry CSI 2.2 Auto	Mitsubishi Magna 2.6 Executive Auto Sedan	Holden Commodore Executive 3.8 Auto Sedan	Ford Fairlane V8 Sedan	Mitsubishi Starwagon GLX Manual	Mitsubishi Pajero V6 GLX Manual	Toyota Landcruiser GLX Diesel Manual
Standing cost									
Depreciation	14.01	16.11	18.04	18.49	18.91	33.14	28.44	29.77	36.18
Interest	8.18	9.40	10.22	10.47	10.75	18.84	16.16	16.92	20.56
Registration	2.05	2.08	2.14	2.18	2.34	2.55	2.20	2.41	2.45
Insurance	2.60	3.02	2.85	2.89	2.92	4.39	3.98	4.09	4.67
RAC Membership	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Running costs									
Fuel	6.62	7.40	8.70	10.00	10.00	12.62	10.00	11.63	9.53
Tyres	1.11	1.16	1.06	1.06	1.67	1.99	1.41	2.27	2.78
Service/Repairs	4.78	5.20	6.51	5.03	4.25	4.80	7.47	5.51	7.18
Total cost									
Average cents per km	39.61	44.63	49.78	50.38	51.10	78.59	69.32	72.86	83.61
Average dollars per week	114.26	128.74	143.60	145.33	147.41	226.70	201.70	210.18	241.19

Calculations are based on private running cost at an annual distance of 15,000 km per year. For 'Vehicles 6 years and older' we have assumed the vehicles are fully owned so no loan repayments have been included. Depreciation is also significantly lower than for the first 5 years.

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