Air Quality Monitoring Hot Spot Report No 6

Jenkins Street, Birkenhead

EPA
South Australia

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October 2006

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Summary

The South Australian Environment Protection Authority began monitoring airborne pollutants at Jenkins Street, Birkenhead, in response to a proposed re-development of the Port River area at Birkenhead.

As no information about air pollutants was provided with the plan amendment report (PAR) the EPA needed baseline data to be able to respond to the application. A monitoring program was begun to provide this. It was set up on vacant land (a potential development site) directly opposite the Port Adelaide Sailing Club and, to sample through seasonal variation, was conducted between 6 December 2003 and 3 January 2005.

Substances measured throughout the survey were: particulate matter less than 10 µm in diameter (PM_{10}), nitric oxide, nitrogen dioxide, ozone, sulfur dioxide, carbon monoxide, benzene, toluene, formaldehyde and naphthalene. Meteorological data was collected from 6 April 2004. Data prior to this is from another EPA meteorological station located at Osborne, 4.5 km north north-east of the hot spot monitoring site.

Measurements were compared to the National Environment Protection (Air Quality) Measure (Air Quality NEPM) and other international health guidelines (WHO, EPAQS-UK). The Air Quality NEPM standard for PM_{10} was used as a guideline. It should be noted that the NEPM goal does not cover peak or hot spot sites, unless the site has been deemed a NEPM monitoring site by the National Environment Protection Council.

Results

- The PM_{10} NEPM standard of 50 µg/m^3 was exceeded 16 times during the monitoring period, making it the most affected area in metropolitan Adelaide so far identified.
- Ten minute average benzene levels greater than 100 µg/m^3 were measured on a number of occasions. Maximum 1-hour concentration of benzene exceeded 50 µg/m^3 on two occasions.
- Elevated toluene levels (below WHO guideline) were detected at the same time as high benzene levels were measured. This suggests the same source(s) for both pollutants.

All other pollutants monitored were at levels less than relevant guidelines.

From results, PM_{10} particulate pollution in the Birkenhead and Lefevre Peninsula region should be considered as part of the ambient monitoring program.

Introduction

The EPA Air Monitoring Unit began to monitor PM_{10} pollution on 6 December 2003 and gaseous pollutants on 11 December 2003. Monitoring continued until 3 January 2005.

Monitoring was performed after a plan amendment report (PAR) for the Port River re-development was submitted to the EPA for comment. As the application did not give details of airborne pollutant levels and the development is planned for a region that contains significant industrial facilities, air quality was surveyed. The survey was run for a full 12 months to ensure that a full year's seasonal variation in meteorological conditions was taken into account.

The monitoring also provided the opportunity to gather baseline data for ambient air pollutant levels before the construction of the Port River Expressway.

Monitoring was conducted opposite the Port Adelaide Sailing Club, Jenkins Street, Birkenhead. The site is vacant land, previously the site of a General Motors Holden factory. The monitoring site was bounded to the north and west by housing, referred to as the residential sector. North to north-east was the Adelaide Brighton Cement Pty Ltd premises, 400–500 m from the sampling location. Further north-east (approximately 2 km) were grain loading and storage facilities, while the Torrens Island Power Station was 4.2 km north-east. Penrice Soda Products was located 4 km north north-east of the sampling site. For the purpose of this report, the sector north to north-east is referred to as the industrial sector. East of the sampling site were wharfing storage facilities and to the south were the Port Adelaide shopping district and residential premises.

Pollutants measured included:

- particulate matter (PM_{10}), measured using a tapered element oscillating microbalance (TEOM)
- nitric oxide (NO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), benzene (C_6H_6), toluene (C_7H_8), formaldehyde (CH_2O), and naphthalene ($C_{10}H_8$), all measured using a differential optical absorption spectrometer (DOAS)
- carbon monoxide (CO), measured using the non-dispersive infrared (NDIR) gas correlation method.

In addition, wind speed and direction were measured using a standard cup anemometer and a wind vane.

Data was collected on these pollutants as they represent the main air pollutants and there are national or international standards for them. Naphthalene is an exception as it does not have an ambient air standard, but is a known irritant and could be measured continuously without additional cost.

Concentrations of PM_{10}, ozone, nitrogen dioxide and carbon monoxide at the Birkenhead site were compared to those for the same period at Netley (light industrial, residential), Kensington (residential) and Elizabeth (residential). These three sites are part of the ongoing Adelaide air monitoring network.

Hot spot air quality monitoring

Ambient air quality is the quality of outdoor air. It is assessed against standards. The EPA conducts an extensive monitoring program around metropolitan Adelaide and major regional centres. The monitoring sites are placed to allow observation of urban air quality trends and to ensure compliance with national standards for public safety.

Hot spot monitoring is used by the EPA to fill in the gaps in the ambient air quality monitoring program. Monitoring is performed using a mobile monitoring station to detect locally elevated air pollution.

Air quality monitoring at Birkenhead did not include an odour assessment. This is currently measured subjectively (odour panel). Measurement technologies available at present are not sensitive enough to accurately determine the components of odours at levels detectable by humans.

Sampling site

The sampling site was opposite the Port Adelaide Sailing Club, Jenkins Street, Birkenhead. Figure 1 shows the location of the site in relation to industrial and residential properties. The site was chosen to provide air quality information representative of the general area, including pollutants emanating from local sources as well as regional pollution.

The hot spot site uses a DOAS measurement system, for which a light path is needed. The light path spanned the vacant block (between the hot spot van and mirror), a length of approximately 100 m. The path did not cross any roads or pollutant sources and hence was not influenced by such sources.

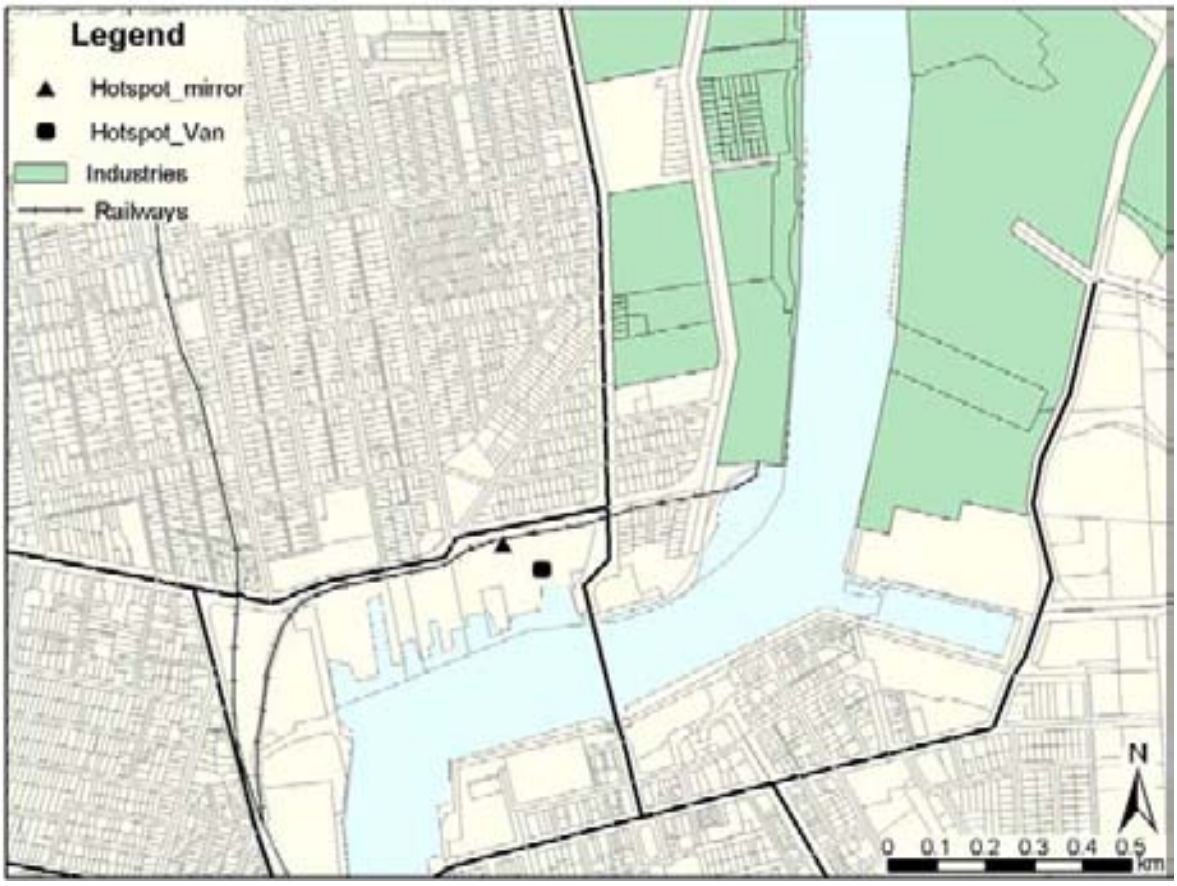

Figure 1: Map of the sampling site and nearby industrial sources

Results

Particulate matter (PM_{10})

Health effects

PM_{10} is particulate matter with a diameter of less than ten micrometres (µm). Particulate air pollution is associated with a range of health effects, including cardiovascular and respiratory difficulties such as asthma. Particulates can increase morbidity in susceptible groups.

Since most evidence relates daily average particulate levels to effects on health, PM_{10} was averaged over 24 hours. The NEPM air quality standard is 50 µg/m^3 averaged over 24 hours.

Sources

Unlike the gaseous pollutants that are single, well-defined substances, particles (PM_{10}) in the atmosphere are composed of a wide range of materials that come from a variety of sources. Particles can be soils, dusts, sea-salt; of biological origin; small particles produced by combustion (mainly from motor vehicles); and sulfate and nitrate compounds formed by atmospheric chemical reactions.

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

Monitoring results

Daily averages for PM_{10} particles (Figure 2) were within the range given in Table 1. Concentration of PM_{10} at Jenkins Street, Birkenhead exceeded the NEPM standard on sixteen occasions during the monitoring period—once in 2003, 14 times in 2004 and once in 2005 (Table 2). By comparison, PM_{10} was above the standard three times at the Netley and once at the Kensington ambient air monitoring sites during the monitoring program. Figure 3 shows daily averages of PM_{10} for Netley and Kensington for the same period.

Table 1: Summary of PM_{10} particulate levels measured at Birkenhead, Netley and Kensington

Site	Maximum µg/m³	Minimum µg/m³	Median µg/m³	Times exceeded 50µg/m³
Birkenhead	95.7	6.1	20.9	16
Netley	62.7	5.2	17.5	3
Kensington	53.7	4.8	13.2	1
Jenkins Street, Birkenhead				
2003 *	55.1	10.1	22.2	1
2004	95.7	6.1	20.8	14
2005 #	62.5	19.0	20.3	1

* monitoring for 26 days in 2003

\# monitoring for 3 days in 2005

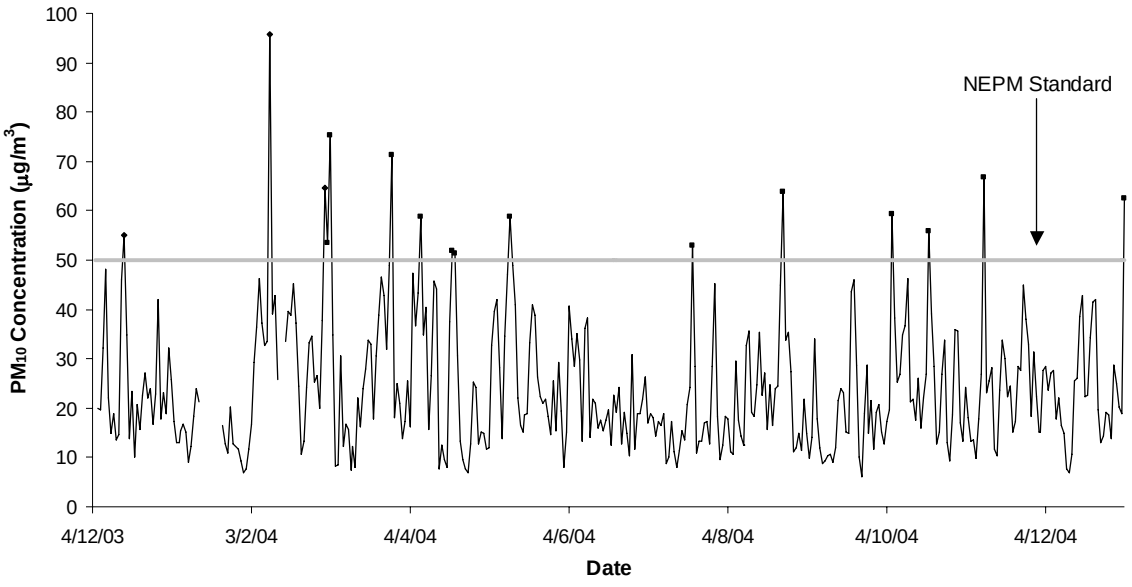

Figure 2: PM_{10} concentrations measured at Birkenhead (6 December 2003 to 3 January 2005)

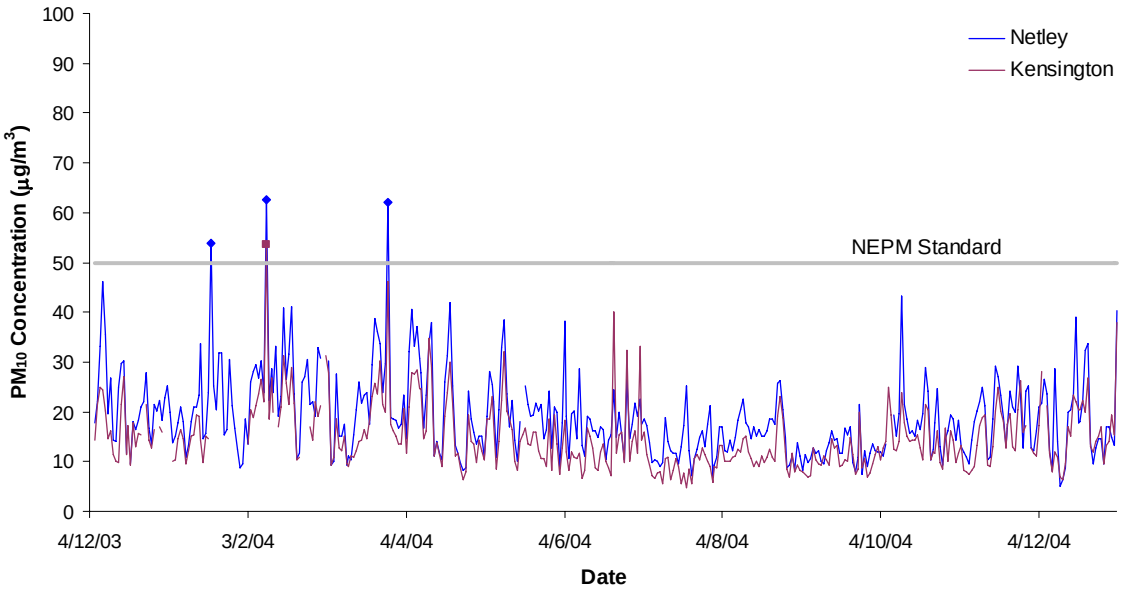

Figure 3: PM_{10} concentrations measured at Netley and Kensington (6 December 2003 to 3 January 2005)

A dust storm occurred on 10 February 2004, causing high PM_{10} levels to be recorded at Netley (62.7 µg/m^3), Kensington (53.7 µg/m^3) and Birkenhead (95.7 µg/m^3).

Similarly, on 28 March 2004, the standard was exceeded at Netley (62.1 µg/m^3) and at Birkenhead (71.4 µg/m^3), also due to a dust storm.

Pollution roses for PM_{10} are given in Appendix A (figures A-1 to A-16) for all times that PM_{10} levels were above the NEPM standard at Birkenhead. Wind data prior to 6 April 2004 was collected at the Osborne EPA meteorological mast.

When winds were from the industrial sector (north to northeast) particulate matter levels were higher than the standard on a significant number of occasions. This suggests that this area was contributing PM_{10} particles to the local airshed. Sources in the area include large industrial facilities and open land with minimal vegetative cover (Table 2). Significant quantities of dust appeared to have been emitted by the industrial sector on at least 10 occasions.

Table 2: Dates when daily averaged PM_{10} levels exceeded the 50 µg/m^3 standard—shaded rows indicate dust storms (note: values greater than 100 µg/m^3 are considered high)

Date level exceeded	PM_{10} µg/m^3	Details from pollution rose (See Appendix A)
16/12/03	55.1	High values detected from 0 to 68 degrees *
10/02/04	95.7	Sourced from south to easterly winds *
2/03/04	64.6	High values detected from 0 to 45 degrees *
3/03/04	53.5	High values detected from 0 to 45 degrees *
4/03/04	75.3	High values detected from 248 to 0 degrees *
28/03/04	71.4	High values detected from 248 to 22 degrees *
8/04/04	58.9	High values detected from 270 to 68 degrees
20/04/04	51.9	High values detected from 0 to 68 degrees
21/04/04	51.4	Most values in the northern sectors 270 to 90 degrees
12/05/04	58.7	Most values detected from 0 to 50 degrees
21/07/04	53.0	Most values detected from 45 to 90 degrees
25/08/04	63.7	Most values detected from 0 to 45 degrees
6/10/04	59.4	Most values detected from 22 to 45 degrees
20/10/04	55.9	Most values detected from 0 to 45 degrees
10/11/04	66.7	Most values detected from 0 to 45 degrees
3/01/05	62.5	Most values in the northern sectors 270 to 68 degrees

*Osborne wind data used

Benzene (C_6H_6)

Health effects

Benzene is a recognised human carcinogen. Studies of industrial workers exposed to a high level of benzene have demonstrated a greater risk of leukaemia, which increased in relation to their working lifetime exposure. As benzene is a carcinogen, no safe level can be specified for an ambient air concentration of benzene and, as yet, there is no ambient standard for benzene in Australia. The Expert Panel on Air Quality Standards (EPAQS-UK) has recommended an air quality standard of 0.005 ppm (16 $\mu g/m^3$) as an annual average [2].

Sources

Benzene is a volatile organic compound. In Adelaide, the main source is the combustion and distribution of petrol, of which benzene is a minor constituent. Benzene is also formed during the combustion of aromatics in petrol. Motor vehicles contribute up to 70% of benzene emissions. Smoke from domestic wood fires and emissions from lawn mowers and some industries are also significant contributors.

Monitoring results

One-hour averages for benzene (Figure 4) were within the range 0.0 to 53.4 $\mu g/m^3$. The average for the entire sampling period for was 7.8 $\mu g/m^3$. The UK air quality guideline (Department of the Environment, Transport and the Regions 1994) for benzene is 16 $\mu g/m^3$ (measured as an annual average). The annual average for 2004 was 7.8 $\mu g/m^3$, which does not exceed the UK air quality guideline.

Ambient concentrations of benzene are expected to fall by 2005 after the introduction of the national fuel quality standard. [1,3].

The three highest levels of benzene occurred on the same dates as some of the highest toluene measurements (25/2/2004, 23/3/2004 and 25/3/2004). Benzene pollution roses for these dates are shown in Appendix A (A-17 to A-19). The similarities of the high events suggest that the source is the same.

Ten-minute averaged values of benzene reached 149.6 $\mu g/m^3$ and showed high short-term events. It was also noted that all ten minute averaged benzene data greater than 40 $\mu g/m^3$ (15 events) occurred between midnight and 8:00 am.

The high level occurrences of benzene (25/2/05, 23/3/05 and 25/3/05) appear to come from the industrial sector. Other sources of benzene expected to affect the monitoring site included vehicle traffic along Semaphore Road and Victoria Drive.

Table 3: Dates of high benzene levels and the direction from which they were detected

Date	Benzene (µg/m^3) 1-hour averages	Comments from pollution roses 10-minute averages
25/2/04 0400 & 0500	27.5	Values greater than 20 µg/m^3 from north to east-north-east
	36.3	
23/3/04 0700 & 0800	53.4	Values greater than 20 µg/m^3 predominantly from north-west to north-north-east
	49.5	
25/3/04	51.9	Values greater than 20 µg/m^3 predominantly from north to north-north-east

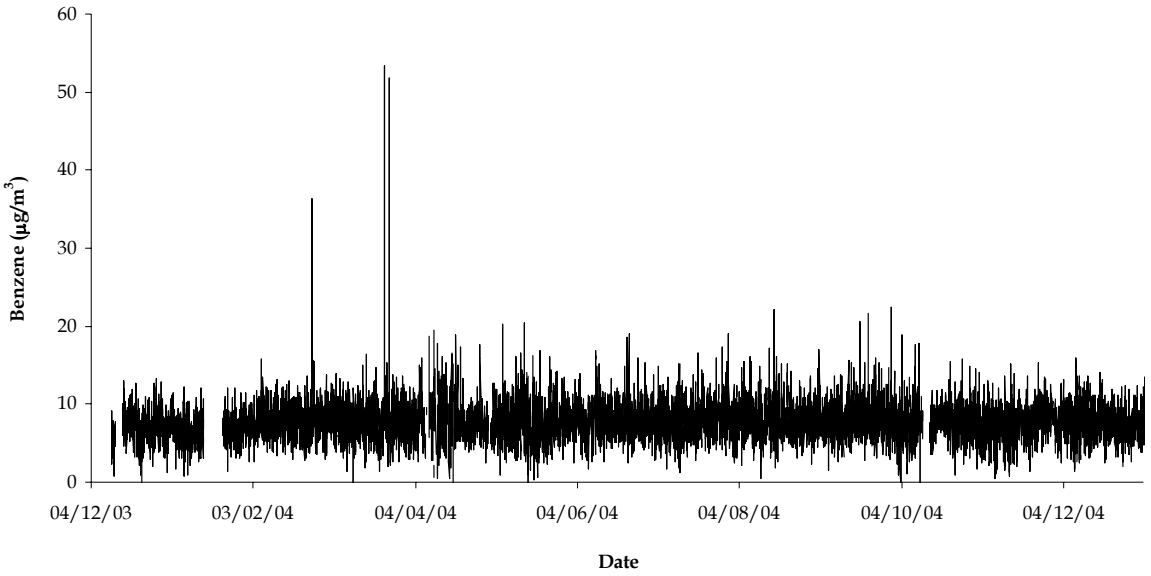

Figure 4: Benzene one-hour averages measured at Birkenhead (11 December 2003 to 3 January 2005)

Toluene (C_7H_8)

Health effects

Long–term exposure to low to moderate toluene levels can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, and loss of appetite and hearing. Inhaling high levels of toluene for a short time can make you feel light-headed, dizzy, or sleepy. Repeated exposure to high levels can cause permanent brain and speech damage, vision and hearing problems, loss of muscle control, and poor balance. Toluene can be detected by the nose at about 8 ppm (32.9 mg/m^3). The WHO guideline is 0.27 ppm (1000 μg/m^3) measured as a thirty-minute average.[6]

Sources

Toluene is a colourless liquid with a distinctive sweet and pungent smell. It occurs naturally in crude oil. It is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, rubber, and in some printing and leather tanning processes. As a component of fuel, emissions from incomplete combustion and vaporisation from fuel storage are also sources.

Monitoring results

Thirty–minute averages for toluene (Figure 5) were within the range of 0.0 to 559.4 μg/m^3. The average for the entire sampling period was 15.3 μg/m^3. The WHO air quality guideline is 1000 μg/m^3 (30–minute average).[6] There was a large variability in the data, but the peak value of 559.4 μg/m^3 is still well below the WHO guideline.

Toluene levels greater than 150 μg/m^3 were detected on seven occasions. Three of these occurred on the same day, 23 March 2004. Pollution roses for the seven high-level events are given in Appendix A (figures A-20 to A-23). Wind data for 6 February 2004 was not available at either the Osborne or Birkenhead site, hence no pollution rose could be produced.

Events and their incoming direction to the monitoring path are listed in Table 4.

Table 4: Toluene and the direction from which it came.

Date	Toluene (μg/m^3) 30-minute averages	Comments from pollution roses 10-minute averages
6/2/04	163.9	Not available
25/2/04	155.6	Highest values from the north to north-north-east
23/3/04	366.4	Highest values scattered in the north-west to north-north-east
	217.8	
	304.1	
25/3/04	559.4	Peak values from the north to north-north-east
14/5/04	156.4	North to north-west

There is a large potential source of toluene (as for benzene) from the Birkenhead fuel storage depot, north north-east of the monitoring site. Data suggests that this depot contributed toluene and benzene (and presumably other volatile organic compounds—VOCs). As with benzene, toluene is expected to come from traffic along the major roads in the area.

The levels did not exceed the WHO guideline on any occasion and the highest 30-minute peak event was well below the guideline.

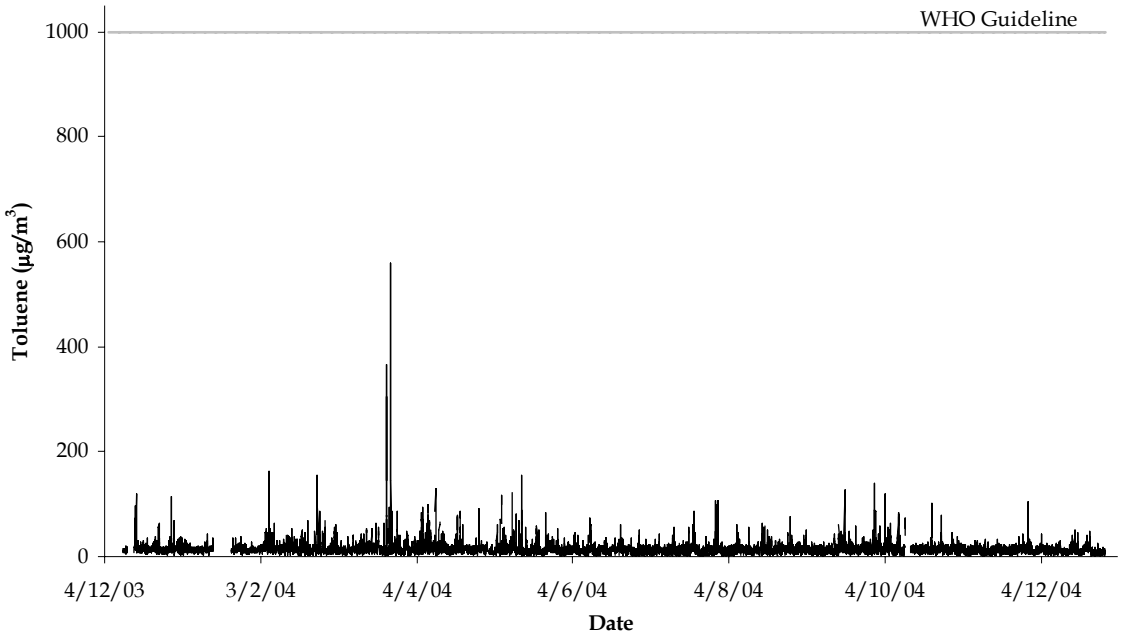

Figure 5: Toluene 30-minute averages at Birkenhead (11 December 2003 to 3 January 2005)

Nitrogen dioxide (NO_2)

Health effects

At relatively high concentrations, nitrogen dioxide causes inflammation of the airways. Long–term exposure to nitrogen dioxide may affect lung function and make some people more sensitive to allergens. The NEPM short–term air quality standard is 0.120 ppm, measured as an hourly average. There is also a longer–term NEPM standard of 0.030 ppm measured over one year.

Sources

Combustion processes in air produce oxides of nitrogen. Nitrogen dioxide (NO_2) and nitric oxide (NO) are referred to as NO_x (oxides of nitrogen). It is nitrogen dioxide that has adverse effects on human health. Motor vehicles account for about 70% of the total Adelaide emissions of NO_x. Other sources include burning fossil fuels, electricity generation and domestic wood fires. NO_x is also a precursor to the production of ozone and photochemical smog.

Monitoring results

One–hour averages for nitrogen dioxide (Figure 6) were within the range of 0.000 to 0.076 ppm, below the NEPM standard of 0.120 ppm (one–hour average). The annual average for 2004 was 0.010 ppm (which is one third of the annual NEPM standard for NO_2). The average concentration over the sampling period was 0.010 ppm.

The highest NO_2 concentration measured at an ambient monitoring station (Netley) in 2004 was 0.103 ppm for a one-hour average and 0.009 ppm for the annual average.

Past monitoring results suggest that the NO_2 levels at Netley and Birkenhead are comparable.

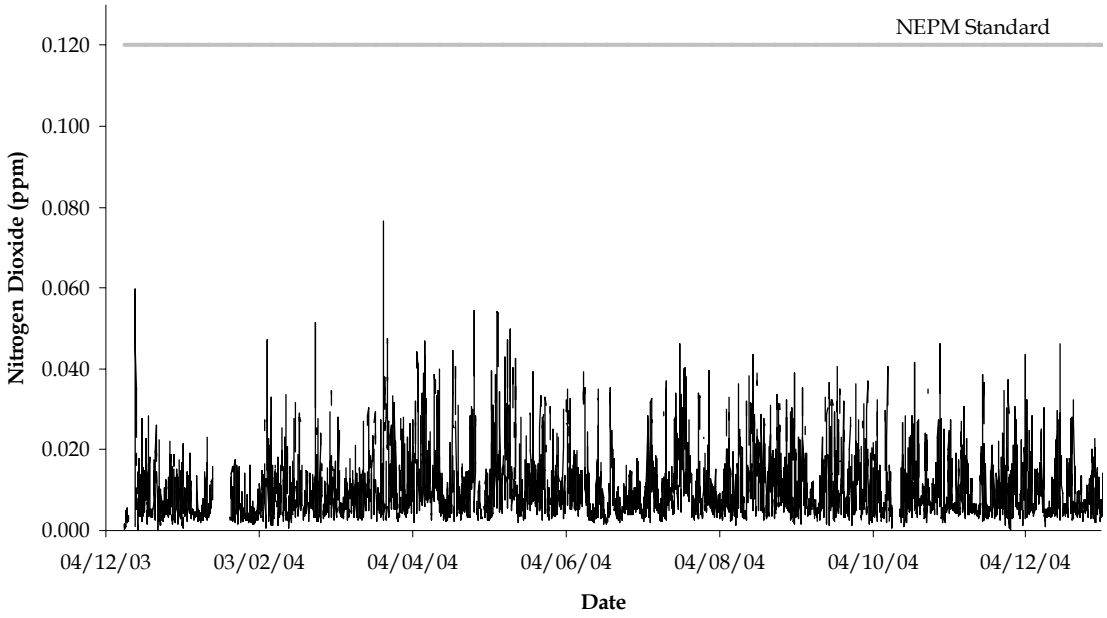

Figure 6: Nitrogen dioxide 1-hour averages at Birkenhead (11 December 2003 to 3 January 2005)

Ozone (O_3)

Health effects

Exposure to ozone may irritate the eyes and nose. If very high levels of exposure (0.5 to 1 ppm) are experienced over several hours, damage to the airway lining may occur, followed by inflammation. Minor changes to the airways may occur at a lower concentration, down to about 0.080 ppm. The NEPM air quality standard for ozone is 0.100 ppm as a one–hour average. A four–hour standard at 0.080 ppm has also been set—a level at which adverse effects on healthy people have been demonstrated.

Sources

Ozone at ground level is primarily formed by a series of chemical reactions initiated by sunlight. Oxides of nitrogen and volatile organic compounds (VOCs) are needed to form ozone. Combustion, industrial processes, and activities such as solvent use, petrol distribution and handling, release VOCs. Emissions from motor vehicles account for 40% of Adelaide's anthropogenic VOCs. Plants, trees and other natural sources also release VOCs that can promote ozone production.

These reactions do not take place instantaneously, but over several hours, depending on the reactivity of the VOCs and meteorological conditions. Ozone measured at a particular location may have been caused by emissions from many kilometres away. Maximum concentration of ozone, therefore, generally occurs downwind of the source of the precursor pollutants. Ozone was measured to assist the EPA to look at overall local air quality.

Monitoring results

One–hour averages for ozone (Figure 7) were within the range of 0.000 to 0.065 ppm; the average across the monitoring program was 0.024 ppm. The maximum value was lower than the NEPM standard of 0.100 ppm for a one-hour average. Four-hour averages for ozone (Figure 8) were within the range of 0.001 to 0.061 ppm, compared to the NEPM standard of 0.080 ppm for a four-hour average.

The levels of ozone at Birkenhead were significant as they reached approximately 65% of the NEPM one-hour standard and 75% of the four-hour standard.

By comparison, during the same period, ozone values at the Netley and Kensington ambient air monitoring stations were 0.067 and 0.078 ppm respectively for the one-hour averages and 0.059 and 0.071 ppm respectively for four-hour averages. These results suggest that the Birkenhead region is similar to the Netley and lower than Kensington ambient air monitoring sites as far as ozone is concerned.

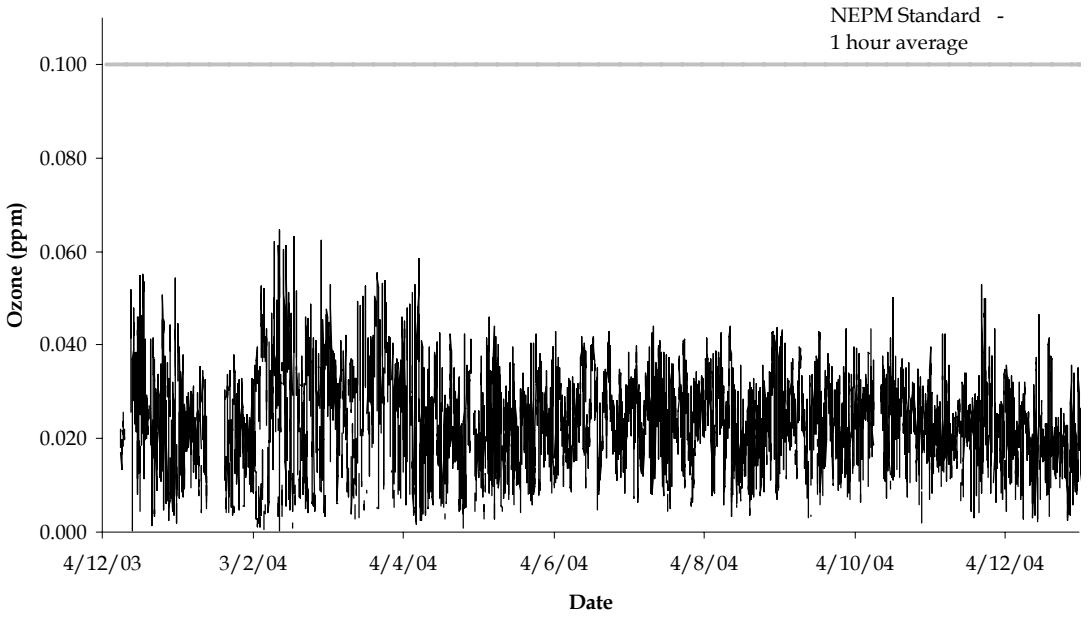

Figure 7: Ozone 1-hour averages at Birkenhead (11 December 2003 to 3 January 2005)

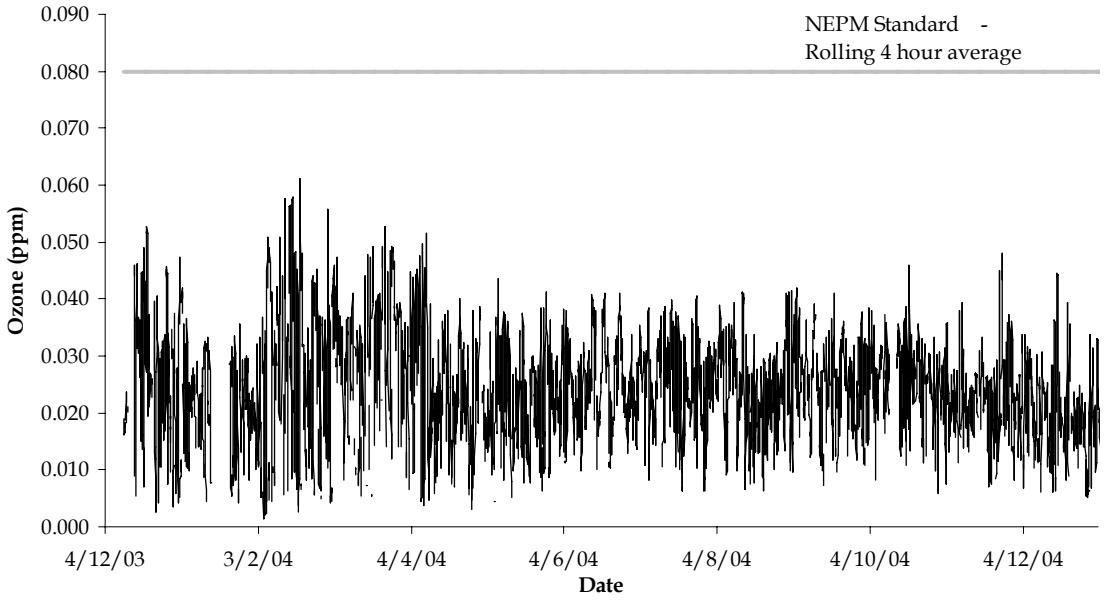

Figure 8: Ozone 4-hour averages at Birkenhead (11 December 2003 to 3 January 2005)

Carbon monoxide (CO)

Health effects

The main threat to health from exposure to carbon monoxide is the formation of carboxyhaemoglobin, which substantially reduces the capacity of the blood to carry oxygen, and blocks important biochemical reactions in cells. People who have an existing disease which affects the delivery of oxygen to the heart or brain, such as coronary artery disease or angina, are likely to be at particular risk if these systems are further impaired by carbon monoxide. The NEPM air quality standard is 9 ppm as a rolling 8-hour average.

Sources

Carbon monoxide is a gas formed by the incomplete combustion of fuels containing carbon. The main outdoor source of carbon monoxide is motor vehicles—in particular petrol vehicles, which in Adelaide account for almost 90% of emissions. Industrial sources include oil refining, steel plants, foundries, and chemical manufacturing activities such as the making of lime.

Monitoring results

Eight-hour averages of carbon monoxide (Figure 9) were within the range of 0.0 to 1.8 ppm; the average for the entire sampling period was 0.2 ppm, well below the NEPM standard of 9.0 ppm (eight-hour rolling average).

Carbon monoxide is monitored in the Adelaide CBD (peak site) and at Elizabeth (background site). The maximum 8-hour rolling average at these locations for 2004 were 4.9 and 0.8 ppm respectively, suggesting that CO levels at Birkenhead were slightly elevated compared to background carbon monoxide concentrations.

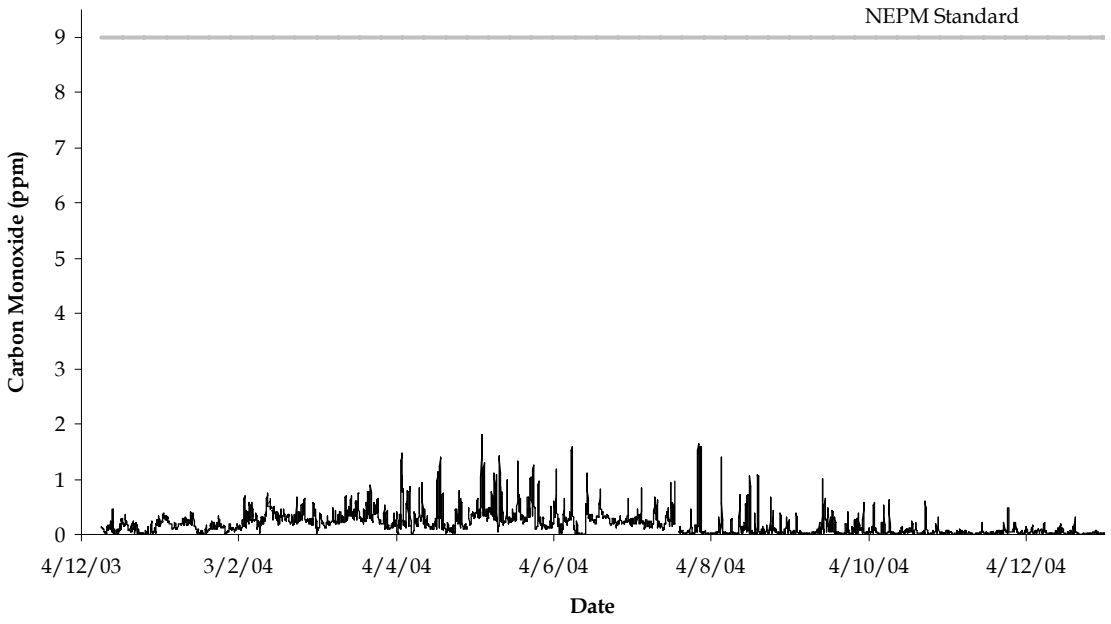

Figure 9: Carbon monoxide 8-hour rolling averages at Birkenhead (11 December 2003 to 3 January 2005)

Sulfur dioxide (SO_2)

Health effects

Sulfur dioxide causes constriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. Sufferers of asthma and other lung diseases are particularly susceptible. The NEPM air quality standard is 0.200 ppm averaged over one hour. This standard is intended to reduce the exposure of the population, including people sensitive to sulfur dioxide, to a level at which harmful effects are unlikely.

Sources

Motor vehicles contribute about 90% of sulfur dioxide in Adelaide. Other sources include fossil fuel combustion, particularly coal–burning power plants; industrial processes such as wood pulping, paper manufacture, petroleum and metal refining and metal smelting, particularly from ores containing sulfide. However, many of these activities do not occur in the Adelaide airshed. Other sources of SO_2 include the manufacture of fumigants, use of food preservatives, bleaches and wine making. Until July 2003, the Mobil Oil Refinery (O'Sullivan Beach) was the single largest point source for sulfur dioxide in metropolitan Adelaide. It has now ceased operations.

Monitoring results

One–hour averages for sulfur dioxide (Figure 10) were within the range of 0.001 to 0.048 ppm, well below the NEPM air quality standard of 0.200 ppm (one–hour average). The average concentration for the sampling period was 0.003 ppm.

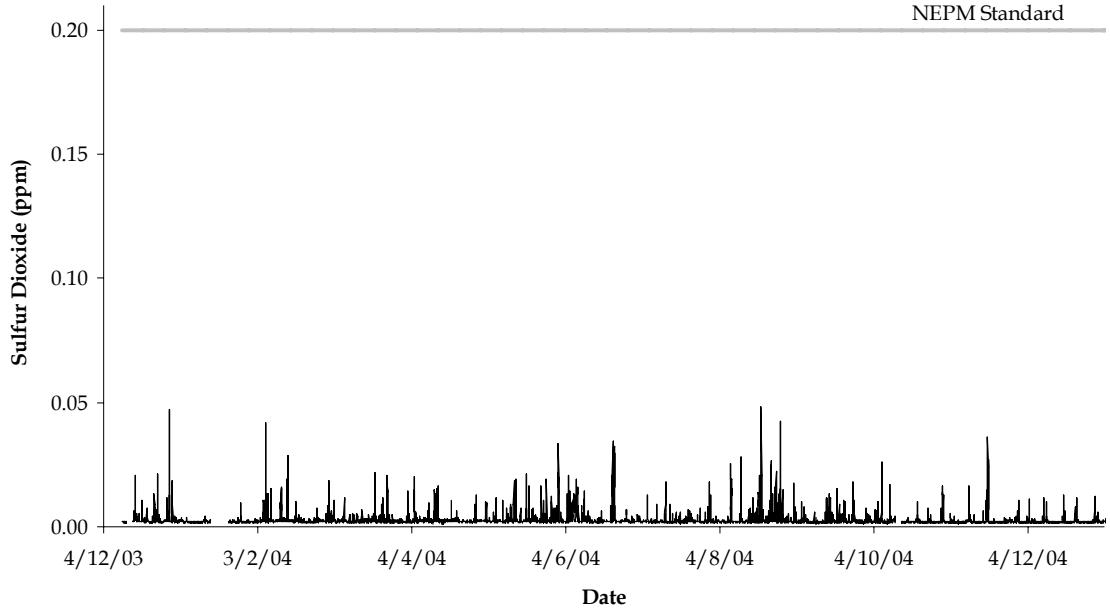

Figure 10: Sulphur dioxide 1-hour averages at Birkenhead (11 December 2003 to 3 January 2005)

Formaldehyde (CH_2O)

Health effects

Formaldehyde affects people in various ways. When present in the air at levels at or above 0.1 ppm, acute health effects can include watery eyes; burning sensations in the eyes, nose and throat; nausea; coughing; chest tightness and wheezing; skin rashes and other irritations. Sensitive people can experience symptoms at levels below 0.1 ppm. The World Health Organization's (WHO) guideline is 0.08 ppm (100 $\mu g/m^3$) measured as a thirty-minute average.

Sources

Formaldehyde is an important industrial chemical used to make other chemicals, building materials, and household products. It is used in glues, wood products, preservatives, permanent press fabrics, paper product coatings, and some insulation materials. Other sources of formaldehyde include incomplete combustion of fuel in motor vehicles, cigarettes, wood, kerosene and natural gas.

Monitoring results

Thirty–minute averages for formaldehyde (Figure 11) were within the range of 0.0 to 47.3 $\mu g/m^3$. The average measurement for the entire sampling period was 15.5 $\mu g/m^3$. The WHO guideline has been established at 100 $\mu g/m^3$ (30–minute average)[6]. The results are well below the WHO guideline.

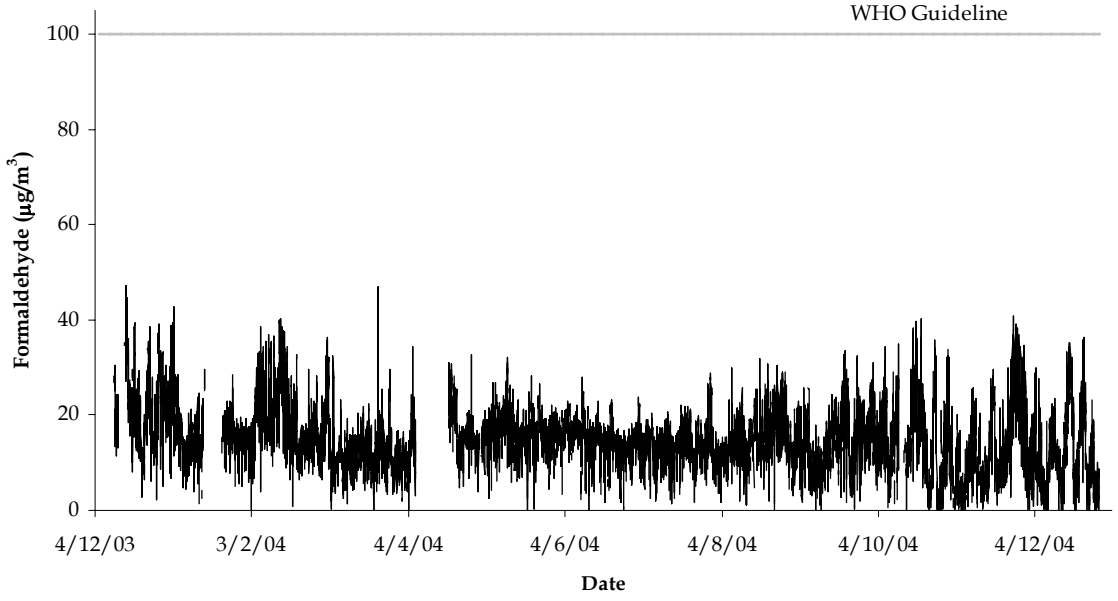

Figure 11: Formaldehyde 30-minute averages at Birkenhead (11 December 2003 to 3 January 2005)

Naphthalene ($C_{10}H_8$)

Health effects

Currently there are no national standards for naphthalene in ambient air. Available information indicates that health effects may vary—from irritation of the eyes, skin and respiratory system to chronic effects including cataracts, inflammation of the lungs, and anaemia. [5,6] However, the data is inconclusive as studies are scarce and may be inadequate due to methodology. [5]

Sources

Naphthalene is used in mothballs, and is produced during coal tar production, wood preserving, tanning, and ink and dye production. It is also released from the burning of fossil fuels. Typical concentrations are approximately 1 μg/m^3 in ambient air. [5]

Monitoring results

Thirty-minute averages for naphthalene (Figure 12) were within the range of 0.0 to 55.4 μg/m^3. The average for the entire sampling period was 8.2 μg/m^3. These results are above ambient background levels according to USEPA information. Figure 12 shows the levels of naphthalene as measured during the monitoring period as 30-minute averages.

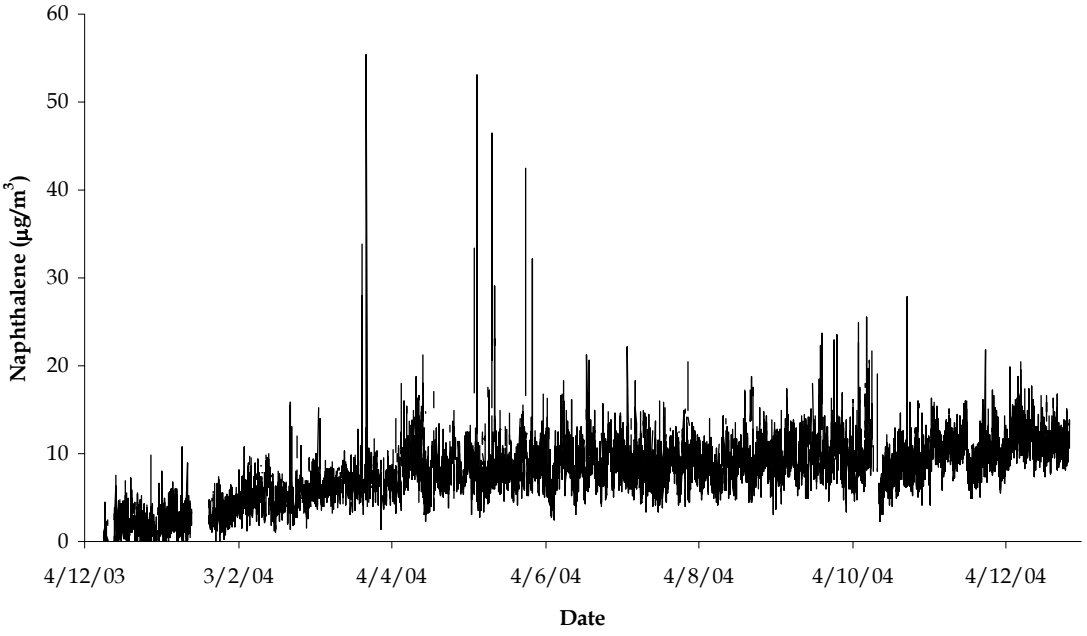

Figure 12: Naphthalene levels measured at Birkenhead (11 December 2003 to 3 January 2005)

Conclusion

That particulate pollution at Birkenhead exceeded the PM_{10} NEPM air quality standard 16 times highlights Birkenhead as the most affected area in metropolitan Adelaide that has been monitored. Including the region in the ambient particle monitoring program should be considered. The standard was exceeded twice due to dust storms that affected the entire Adelaide airshed. Ten events were potentially due to local facilities in the industrial sector north to northeast of the monitoring location. Land with minimal vegetative cover in the region may also have an impact, although not necessarily focused in the industrial sector.

Average annual benzene levels were below the EPAQS-UK standard of 16 $\mu g/m^3$, but there were significant short-term spikes, probably coming from a source in the north to north-northeast. Elevated levels of toluene were observed at the same time, suggesting that they came from the same source. Toluene levels did not exceed the WHO guideline.

All other pollutants were at levels below NEPM standards or other health-based guidelines.

An odour assessment was not carried out.

Overall it should be noted that the Birkenhead area has a number of conflicting land uses. Residential premises are next to large industrial operations and a fuel storage and distribution depot. The area also includes a large number of transport-related combustion sources—in particular rail, heavy vehicle transport, shipping and domestic vehicles.

All of these sources reduce the air quality around the Birkenhead, Jenkins Street monitoring location when compared to a standard residential location. This should be taken into account when assessing development applications in this area.

References

1 Department of the Environment and Heritage, *Fuel Quality Standards Act 2000* *www.deh.gov.au/atmosphere/fuelquality/standards/index.html*

2 DEFRA—UK Environment Protection, Expert Panel on Air Quality Standards *www.defra.gov.uk/environment/airquality/aqs/index.htm#fr*

3 *Environment Protection (Motor Vehicle Fuel Quality) Policy 2002* *www.parliament.sa.gov.au/dbsearch/regs-list.htm*

4 US Environmental Protection Agency, Integrated Risk Information System (IRIS). *www.epa.gov/iriswebp/iris/index.html*

5 US Environmental Protection Agency Technology Transfer Network Air Toxics web site—Naphthalene *www.epa.gov/ttn/atw/hlthef/naphthal.html*

6 World Health Organization Air Quality Guidelines *www.euro.who.int/air/activities/20050222_2*

Appendix A—Pollution Roses

PM_{10} pollution roses

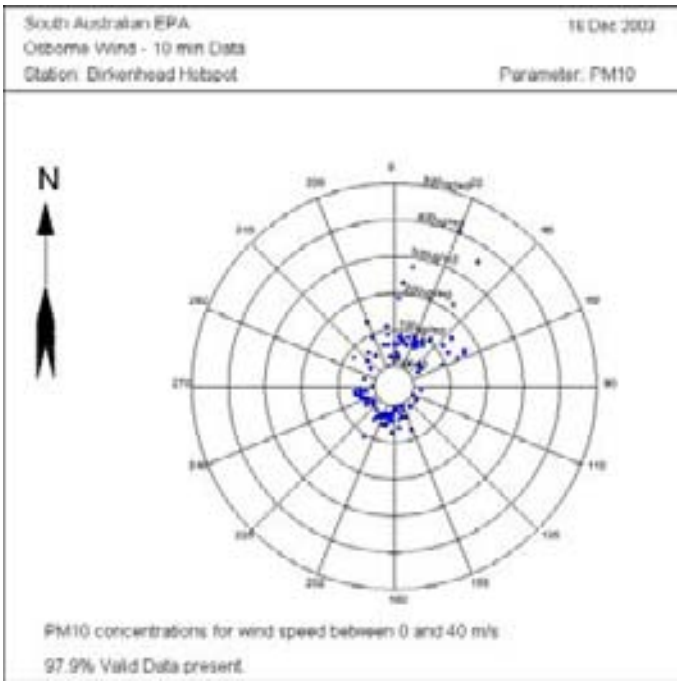

Figure A-1: Pollution rose for when PM_{10} exceeded the NEPM standard 16/12/03

Figure A-2: Pollution rose for when PM_{10} exceeded the NEPM standard 10/2/04

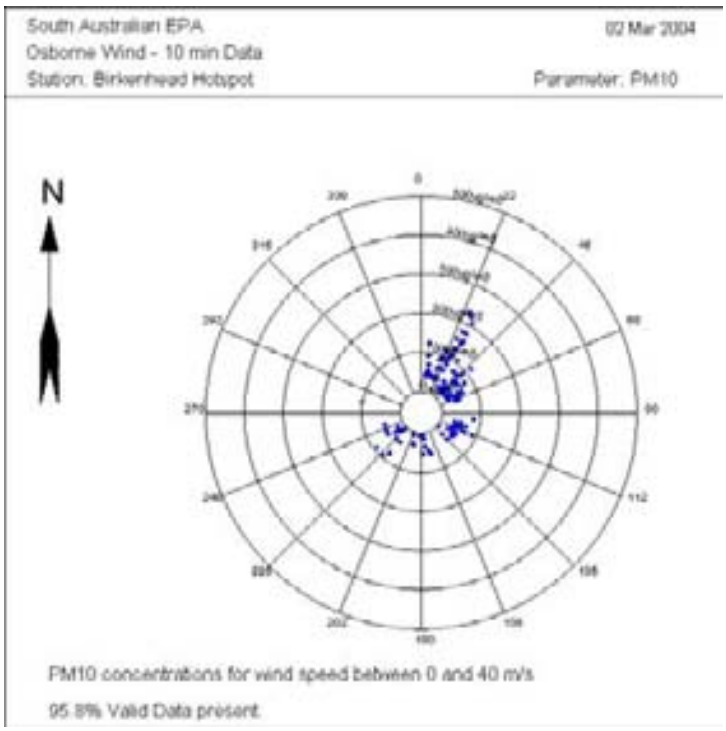

Figure A-3: Pollution rose for when PM_{10} exceeded the NEPM standard 2/3/04

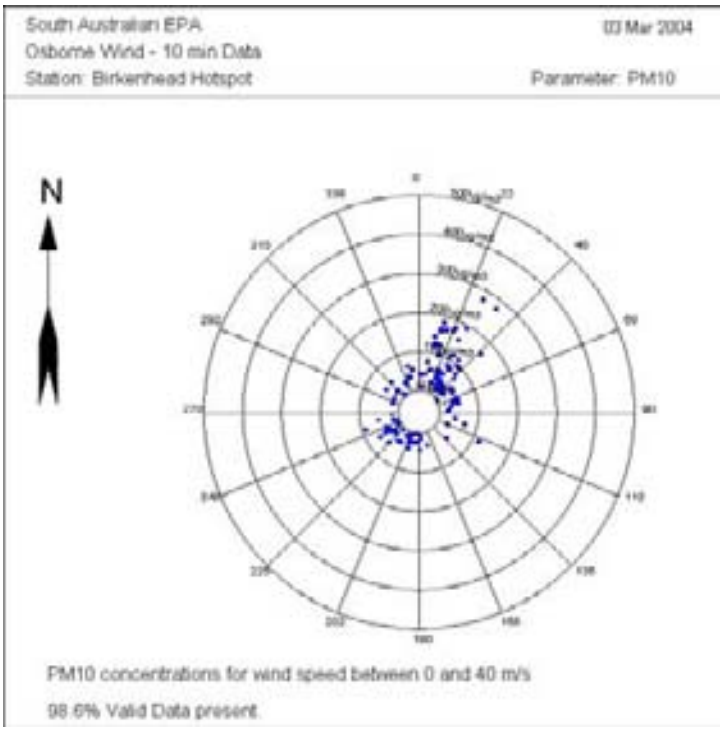

Figure A-4: Pollution rose for when PM_{10} exceeded the NEPM standard 3/3/04

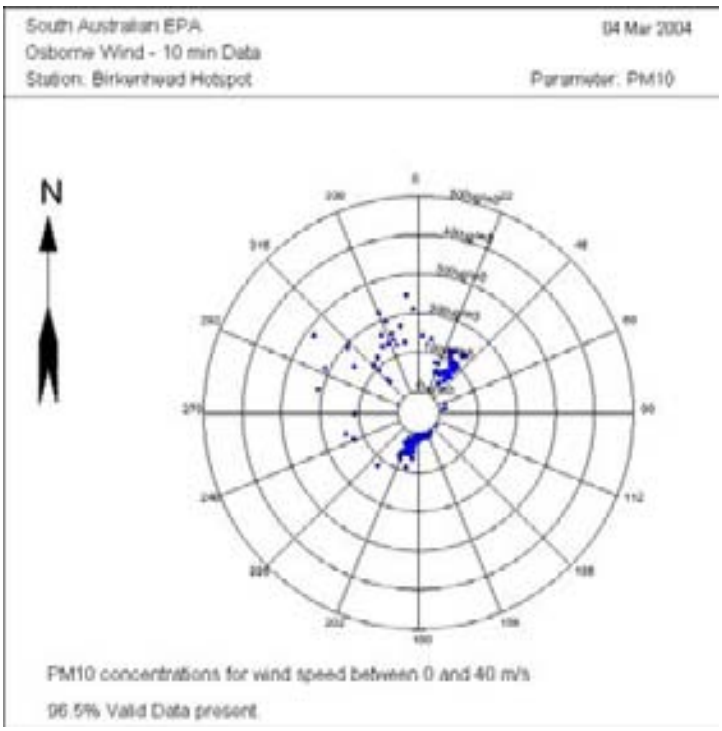

Figure A-5: Pollution rose for when PM_{10} exceeded the NEPM standard 4/3/04

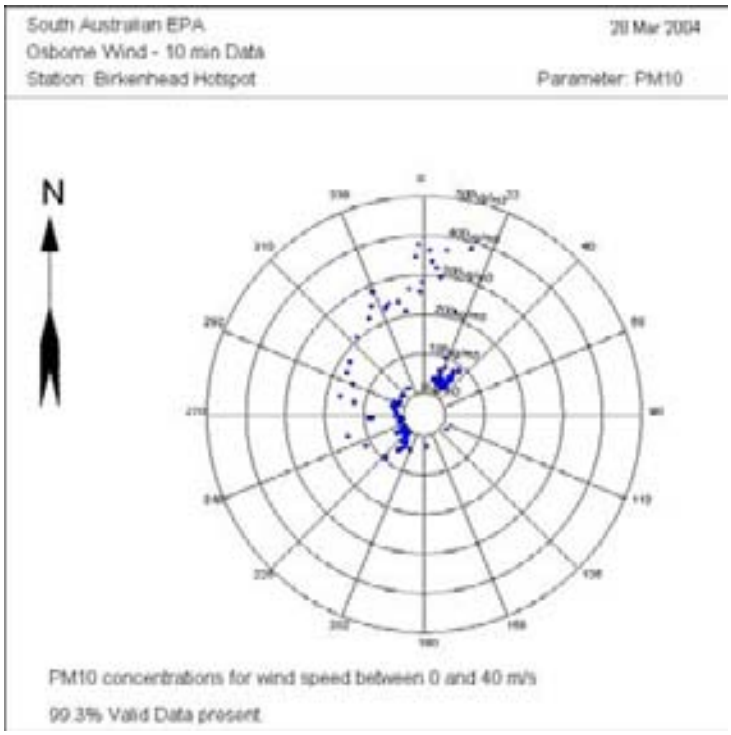

Figure A-6: Pollution rose for when PM_{10} exceeded the NEPM standard 28/3/04

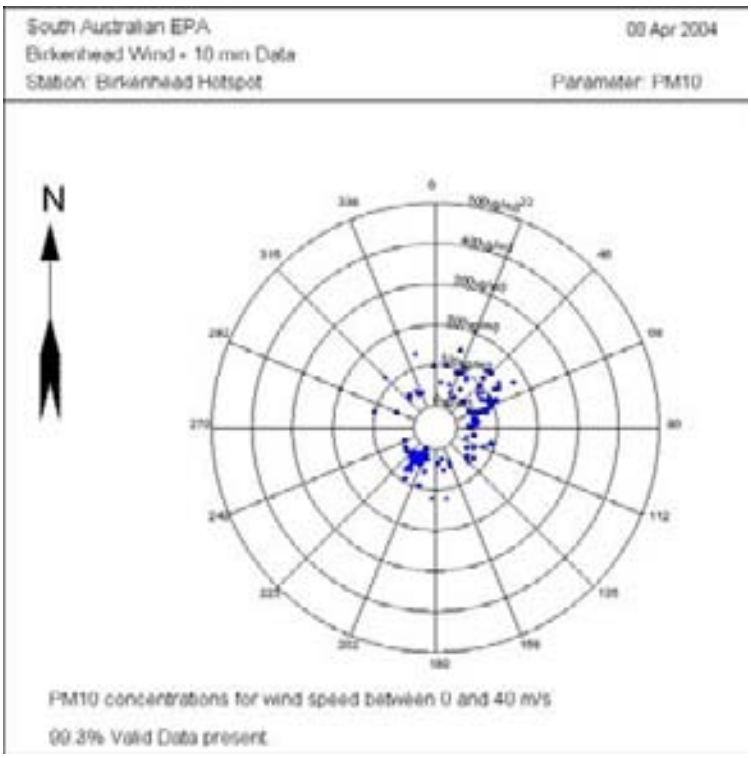

Figure A-7: Pollution rose for when PM_{10} exceeded the NEPM standard 8/4/04

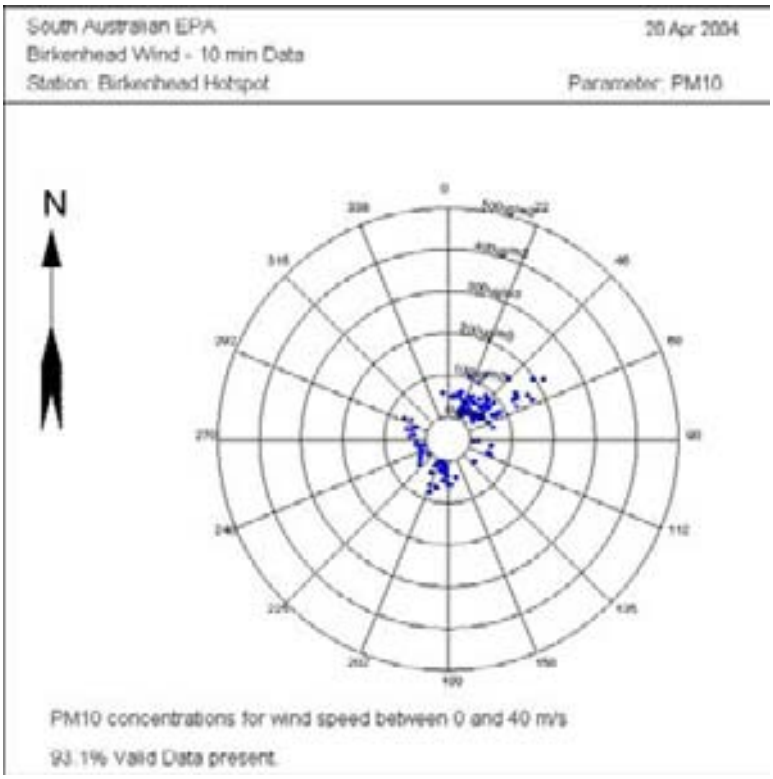

Figure A-8: Pollution rose for when PM_{10} exceeded the NEPM standard 20/4/04

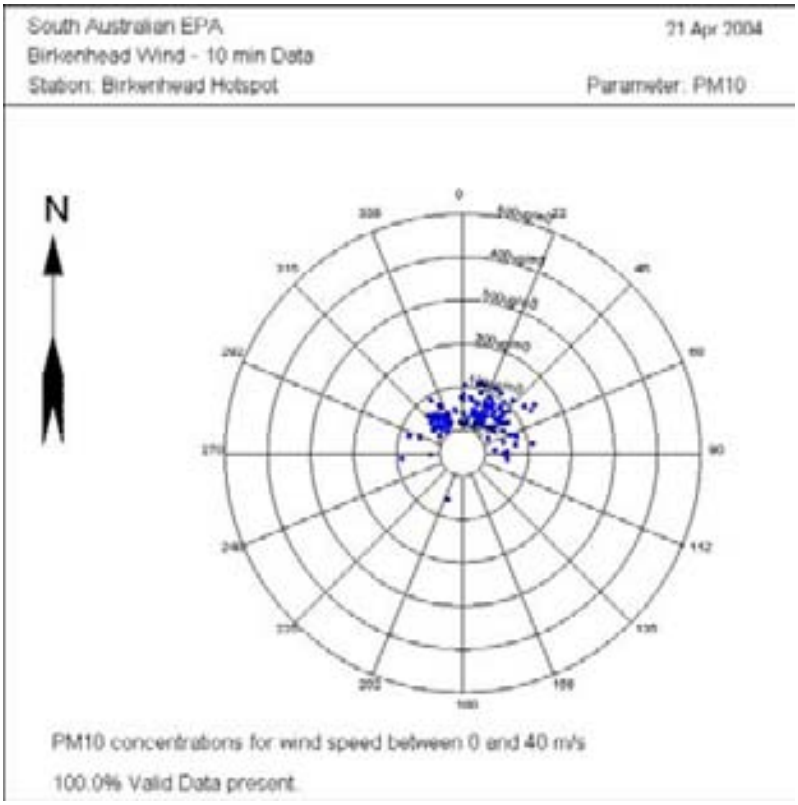

Figure A-9: Pollution rose for when PM_{10} exceeded the NEPM standard 21/4/04

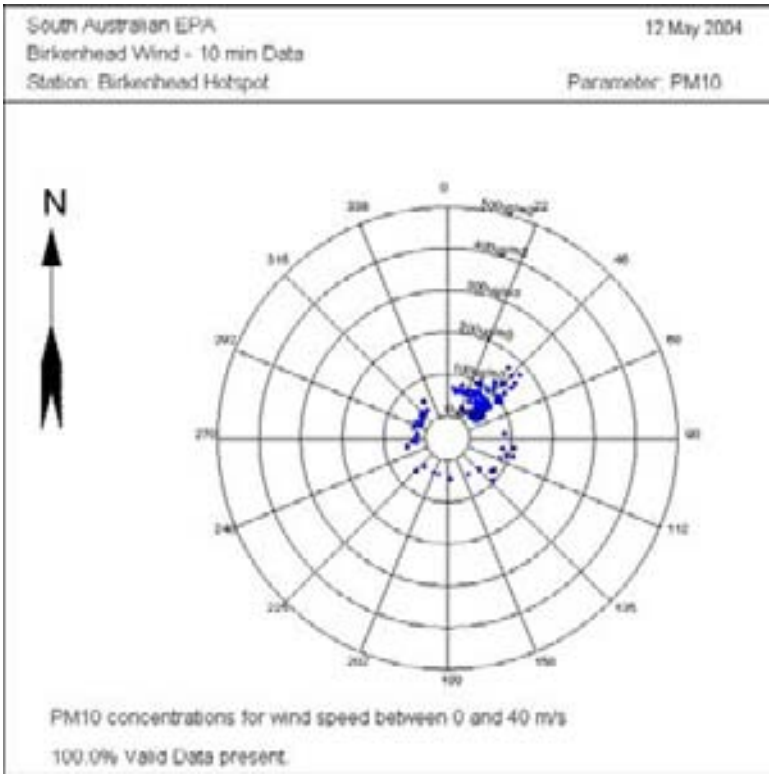

Figure A-10: Pollution rose for when PM_{10} exceeded the NEPM standard 12/5/04

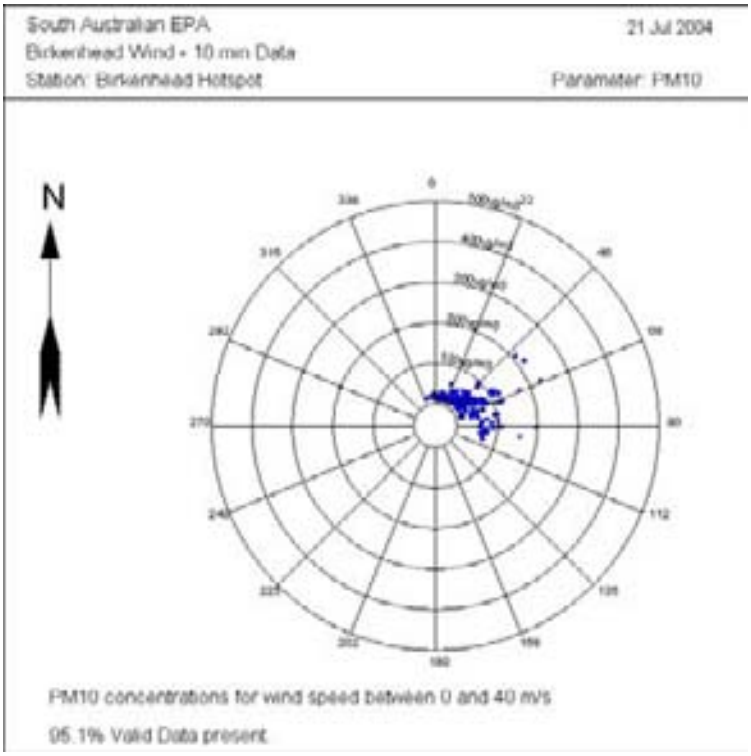

Figure A-11: Pollution rose for when PM_{10} exceeded the NEPM standard 21/7/04

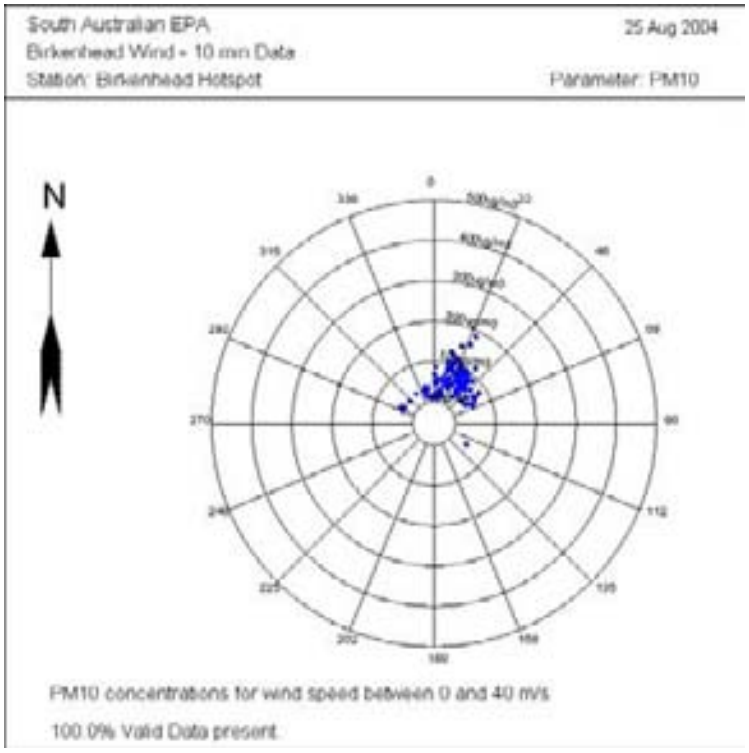

Figure A-12: Pollution rose for when PM_{10} exceeded the NEPM standard 25/8/04

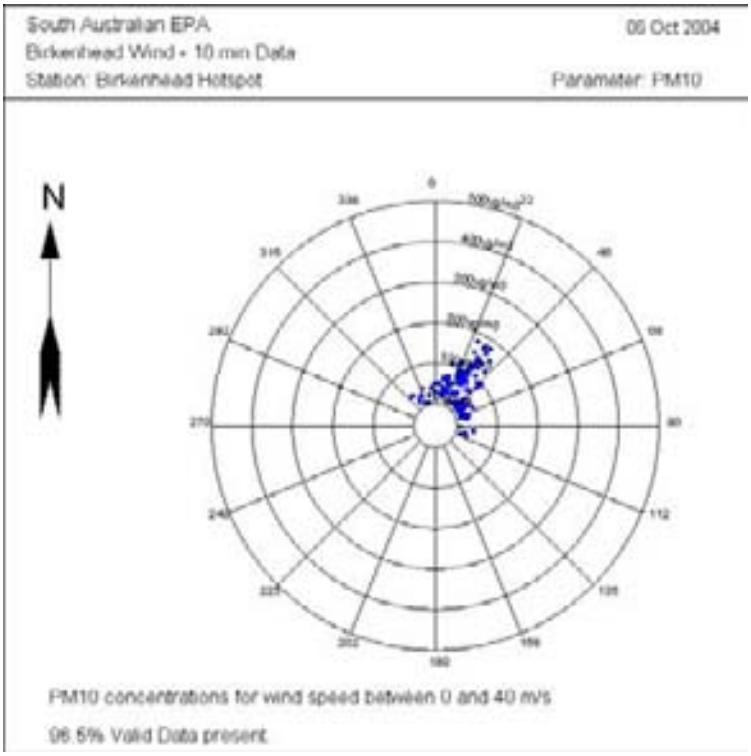

Figure A-13: Pollution rose for when PM_{10} exceeded the NEPM standard 6/10/04

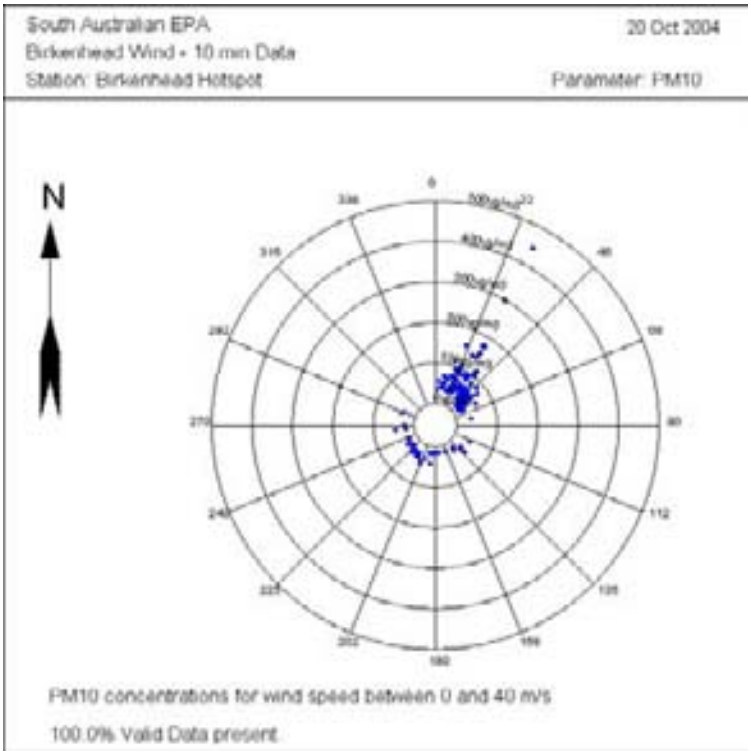

Figure A-14: Pollution rose for when PM_{10} exceeded the NEPM standard 20/10/04

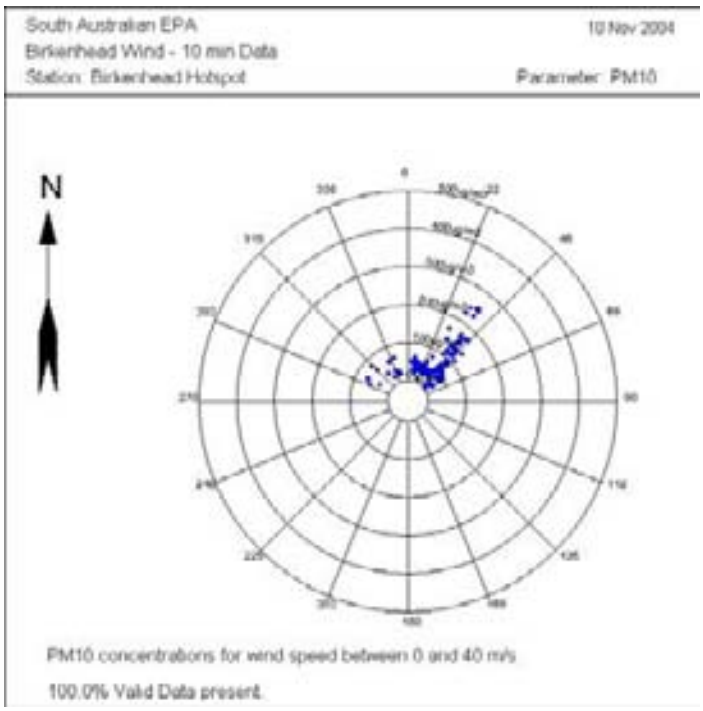

Figure A-15: Pollution rose for when PM_{10} exceeded the NEPM standard 10/11/04

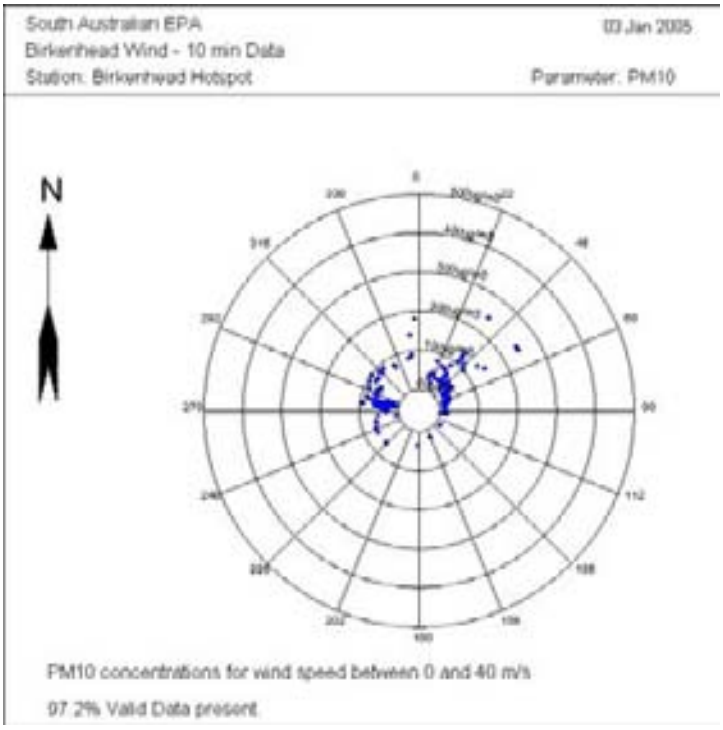

Figure A-16: Pollution rose for when PM_{10} exceeded the NEPM standard 3/1/05

Benzene pollution roses

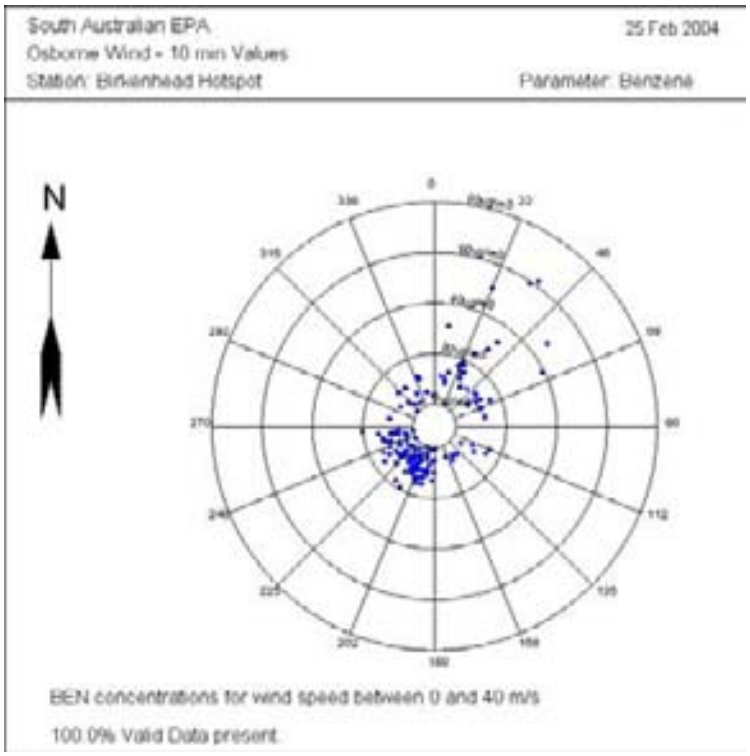

Figure A-17: Benzene pollution rose—25/2/04

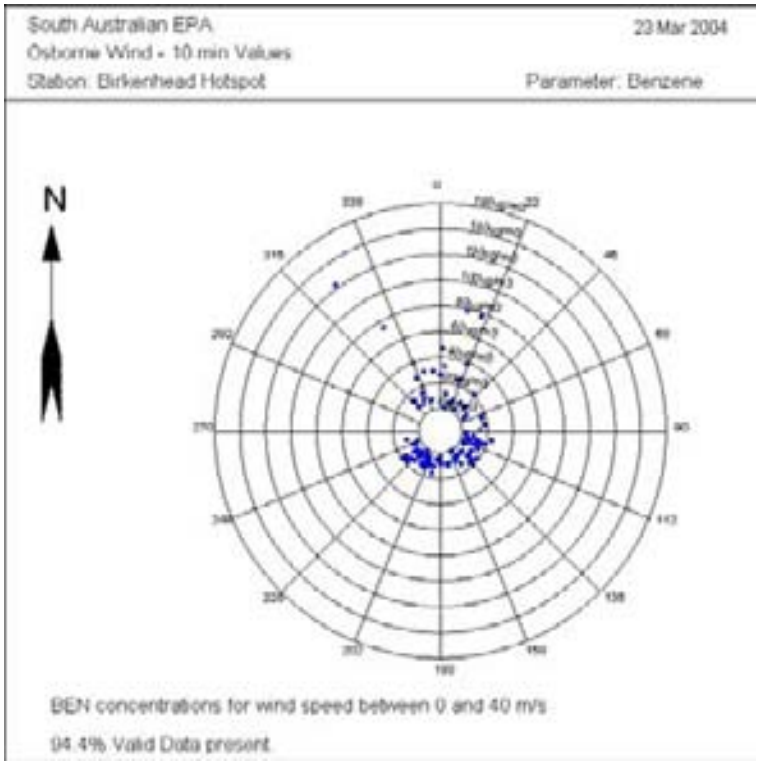

Figure A-18: Benzene pollution rose—23/3/04

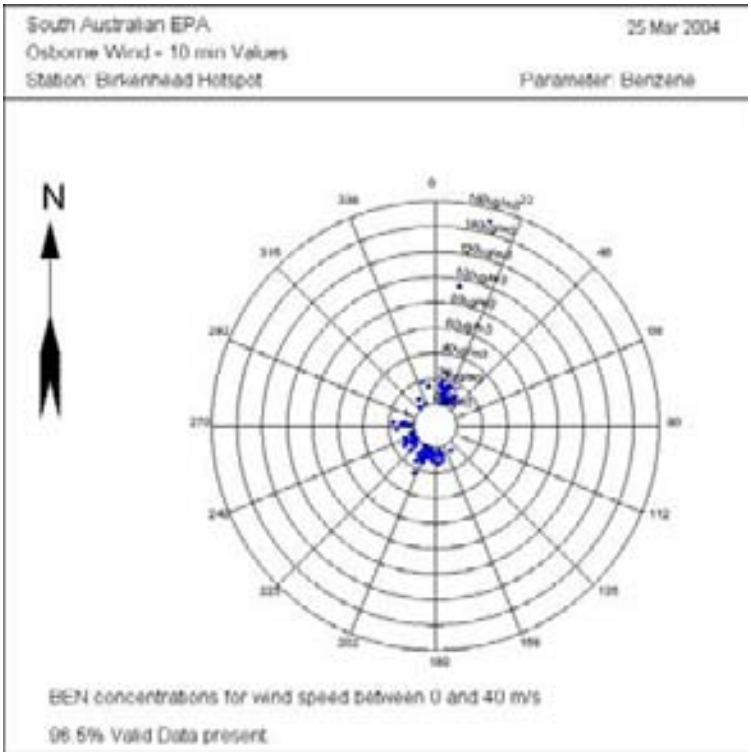

Figure A-19: Benzene pollution rose—25/3/04

Toluene pollution roses

Figure A-20: Toluene pollution rose—25/2/04

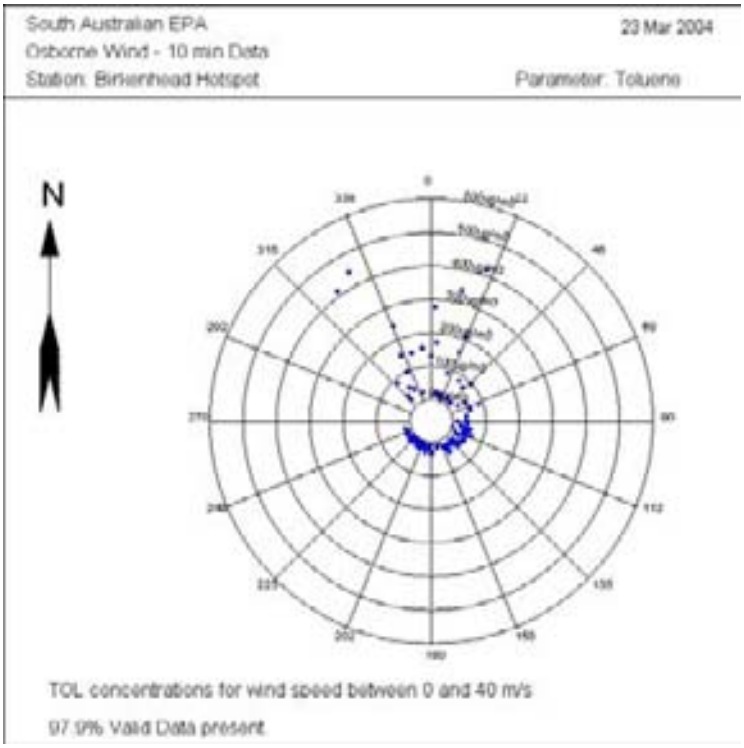

Figure A-21: Toluene pollution rose—23/3/04

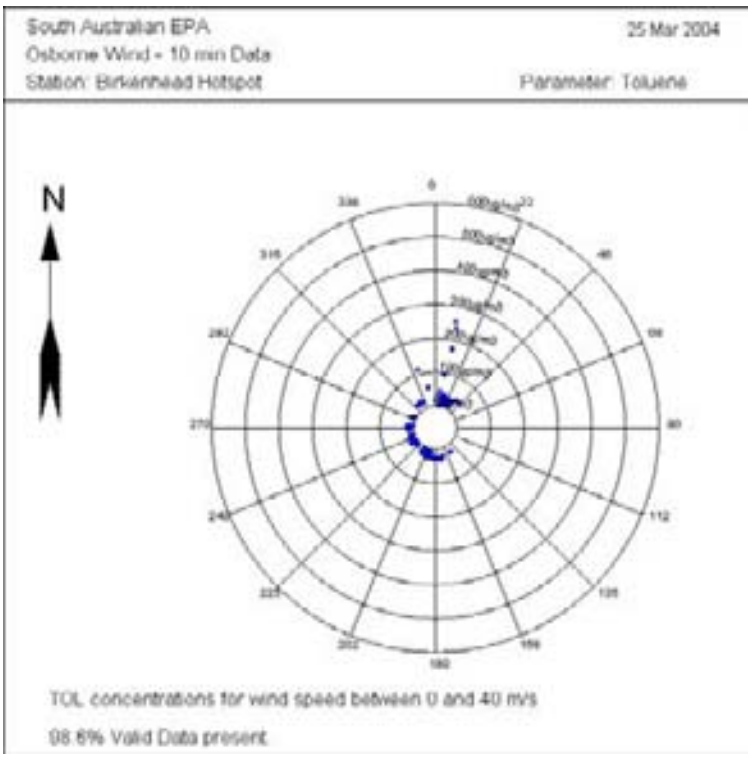

Figure A-22: Toluene pollution rose—25/3/04

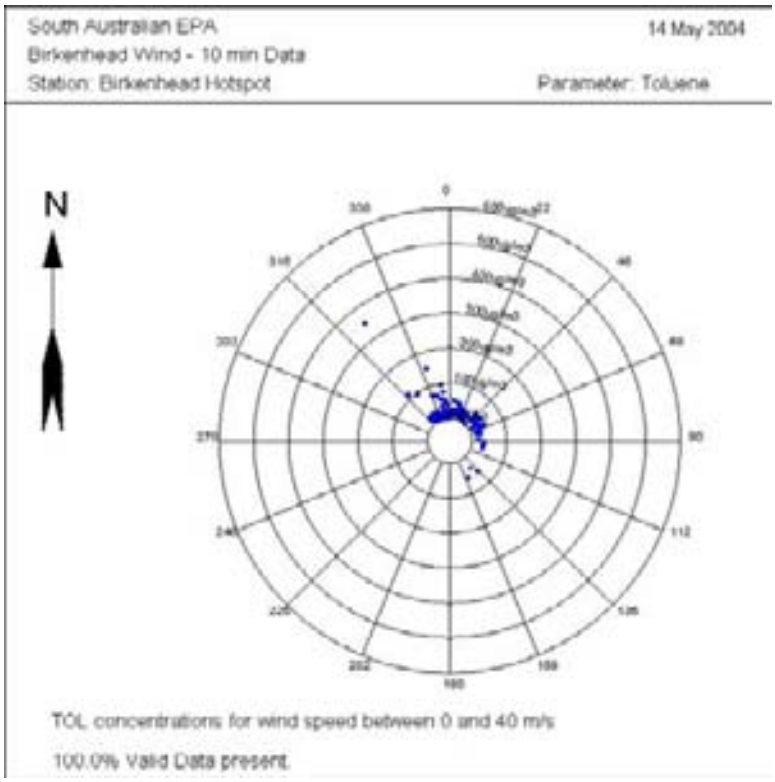

Figure A-23: Toluene pollution rose—14/5/04

Appendix B—Metadata

Site information (metadata)	
Site name	*Birkenhead Hot Spot*
Site details	
Street address	*Jenkins Street, Birkenhead*
Date established	06/12/03
Date terminated	03/01/05
Siting guidelines (AS 2922-1987) exceptions	None
Description of local land use	Residential and industrial.
Description of nearby emission sources	Cement works, soda products plant bulk fuels depot, heavy transport, motor vehicles, small industry
Map coordinates	
Datum	GDA 94
Projection	AMG Zone 54
Easting	0271431
Northing	6141817

Notes on data validation and assessment

Zero, span, calibration equation parameters and quality assurance procedures

CO: zero corrections: (maximum adjustment +0.1 ppm, minimum adjustment –0.3 ppm)

OPSIS parameters:

Baseline corrections (SO_2 nil) (NO_2 +45 µg/m^3) (O_3 +15 µg/m^3 pre 7/4/04, –25 µg/m^3 post 7/4) (FOR –70 µg/m^3) (TOL +30 µg/m^3) (BEN -3 µg/m^3) (NAP +34 µg/m^3 pre 7/4/04, +41 µg/m^3 post 7/4)

Note : baseline movement due to lamp change can affect some parameters.

Data return OPSIS parameters: SO_2 95%, NO_2 88%, O_3 86%, FOR 87%, TOL 94%, BEN 94%, NAP 82%

Note : data returns varies due to parameter measured (wavelength of light used)

TEOM PM_{10} data was collected as per the Australian Standard AS 3580.9.8-2001. Instruments were changed when due for calibration.

Data validated and checked in accordance with the National Environment Protection (Ambient Air Quality) Measure—Peer Review Committee (2001) *Technical Paper No. 5—Data Collection and Handling. NEPC, Canberra.*

Notes of time and nature of events that may influence data validation or interpretation

Dust storm (10/2/04), CO TECO instrument was replaced with Monitor Labs (ML) during monitoring due to minor baseline drift events.

Pollutants measured

NO, NO_2, SO_2, O_3, benzene, toluene, formaldehyde, naphthalene	Particulate matter (PM_{10})	Carbon monoxide (CO)

Instrument types

Make	OPSIS	Make	RP	Make	TECO / ML
Model	ER130 & AR500	Model	TEOM PM_{10}	Model	NDIR analyser
Serial number	E672	Serial number	See notes section	Serial number	See notes section
Minimum detection level	7ppb-200m (1-10 ppb dependant on path length 340m & 134m)	Minimum detection level	N/A	Minimum detection level	0.05 ppm or 2%
Units	µg/m^3 (converted to ppm where applic.)	Units	µg/m^3	Units	ppm
Measurement cycle	10 minutes	Sampling rate	10 minutes	Sampling rate	10 seconds
Logging interval of raw data	10 minutes	Logging Interval of raw data	10 minutes	Logging Interval of raw data	10 minutes
Data return	See notes section	Data return	98%	Data return	99%
Clock adjustment	Period ending	Clock adjustment	Period ending	Clock adjustment	Period ending