AIR QUALITY MONITORING Hot Spot No 3

Hensley Foundry, Flinders Park

South Australia

ATR

Government of South Australia

Air Quality Monitoring at Hensley Foundry, Flinders Park

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Glossary

DOAS	Differential Optical Absorption Spectrometry
EPA	Environment Protection Authority
HVS	High Volume Sampling/ Sampler
NDIR	Non-dispersive Infrared Absorption
NEPM	National Environment Protection Measure
NHMRC	National Health & Medical Research Council
NPI	National Pollutant Inventory
TEOM	Tapered Element Oscillating Microbalance
TSP	Total Suspended Particulates
WHO	World Health Organisation

Summary

Hensley Industries Australia Pty Ltd is located at Hayward Ave, Torrensville, on the south bank of the Torrens River. The Hensley foundry is authorised under the *Environment Protection Act 1993* (the Act) to undertake the environmentally significant activities of abrasive blasting and ferrous and non-ferrous metal melting. Air quality monitoring was conducted on the northern side of the Torrens River on Mountbatten Terrace, Flinders Park, in an area comprising residential development. Monitoring commenced after complaints were lodged with the Environment Protection Agency[1] (EPA) regarding strong odours emanating from the foundry.

This report describes the results of air quality testing at the site. The assessment did not include odour.

Total suspended particulates (TSP) were measured every other day with sampling beginning on the 10 December 2000 at the Flinders Park site. Simultaneous measurements of TSP were also made at the EPA's air quality laboratory, 310 Richmond Road, Netley. Iron, as a proportion of TSP, was also considered in the assessment.

Chemical parameters were continuously measured, starting 23 March 2001. All monitoring was completed on 23 May 2001. The parameters measured continuously included oxides of nitrogen, ozone, sulfur dioxide, carbon monoxide, benzene, toluene, formaldehyde and particulate matter less than 10 micrometers in diameter (PM_{10}).

All measurements were compared to the NEPM standards and other recognised health related guidelines. All pollutants measured are well below those standards and guidelines, and the Department of Human Services advises that health impacts would not be anticipated.

[1] On 1 July 2002, the Environment Protection Agency became the Environment Protection Authority, and no longer a division of the Department for Environment and Heritage.

Introduction

The EPA began monitoring TSP every other day at Flinders Park on 10 December 2000 and began continuous monitoring of chemical parameters on 23 March 2001. Monitoring was completed on 23 May 2001.

Monitoring was conducted to determine whether there was a significant air pollution problem in the Flinders Park area due to emissions suspected to be emanating from Hensley's foundry. The residential premises closest to the foundry are located on the northern side of the Torrens River. The foundry lies about 100 metres south of the residences, with the River Torrens and linear park providing a small buffer between them.

The monitoring site was located on Mountbatten Terrace where pollutants coming from a southerly direction—the direction of the foundry—could potentially reach the residential area. Twenty-four hour measurements, every other day, were made for total suspended particulates (TSP) and total suspended particulate iron (Fe), using a high volume sampler. For comparison, simultaneous measurements of TSP and TSP iron were also made using the same method at the EPA's air quality laboratory, 310 Richmond Road, Netley.

Parameters that were measured continuously included particulate matter (PM_{10}) measured using the Tapered Element Oscillating Microbalance (TEOM) method; carbon monoxide (CO), measured using a non-dispersive Infrared (NDIR) absorption method; and nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), benzene (C_6H_6), formaldehyde (CH_2O) and toluene (C_7H_8), measured using Differential Optical Absorption Spectrometry (DOAS).

The air pollution parameters chosen in this study are commonly emitted from foundry operations (as well as other urban sources) and many studies have related time–concentration exposures to effects on human health (NEPC 1998, Holgate *et al* 1999 and Peach 1997). Benzene, formaldehyde and toluene are regarded as hazardous pollutants because of their potentially significant effects on the health of humans and the environment.

Based on data provided by the foundry, it was reported in the National Pollutant Inventory that Hensley Foundry's iron and steel casting and forging activities emit 21,000 kg of carbon monoxide and 2200 kg of nitrogen oxides to air each year.

'Hot spot' air quality monitoring

Ambient air quality refers to the quality of the surrounding outdoor air and its background parameters. The EPA conducts ambient monitoring at a number of permanent sites throughout Adelaide (EPA 2001a). The air quality at these sites is assessed to determine trends of urban air quality for the whole of Adelaide.

The EPA also conducts 'hot spot' monitoring using a mobile monitoring station. 'Hot spot' refers to monitoring that is designed to investigate pollution sources on a local scale. This allows for the assessment of air quality emanating from a point source. Rather than monitoring emissions directly from a stack or chimney, the air is measured as it moves towards areas where it may impact on human health or quality of life.

Air quality monitoring does not include the measurement of odour, which is a subjective process. Chemical analytical methods seldom reveal any association between concentrations and strength of odours as perceived by the human nose.

Sampling Site

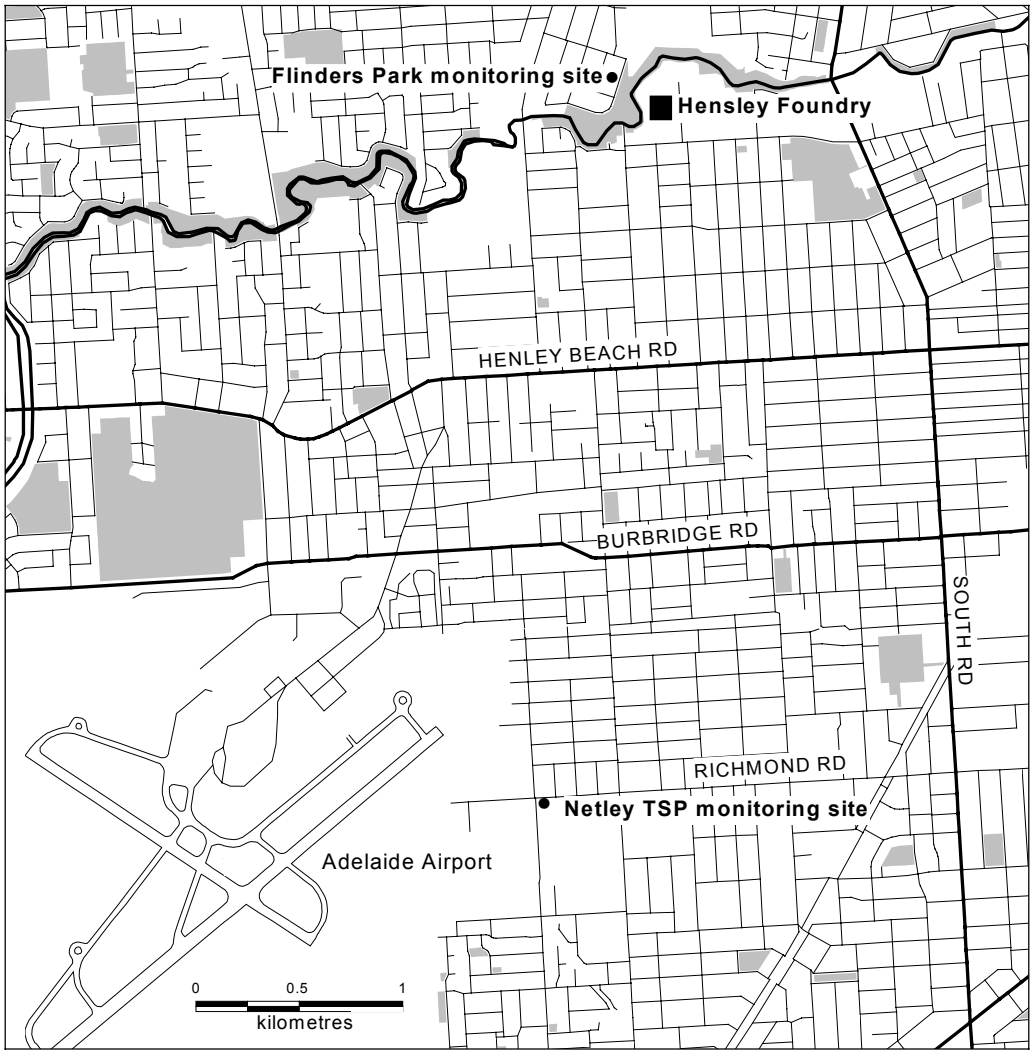

Figure 1 The Flinders Park and Netley air monitoring sites and the Adelaide Airport where meteorology was recorded

The Use of Statistics

Differences between sites

The non–parametric Wilcoxon signed–rank test was used to determine the relationship between TSP and iron concentrations at Flinders Park and Netley. The test is equivalent to the paired t test, but data violated the assumptions of the t test. The null hypothesis of the test is that concentrations do not differ between sites. There are limitations comparing the Netley site (ambient) with a hot spot site (Flinders Park). The results of hot spot sampling are only relevant at the point of sampling and cannot, unlike ambient monitoring sites, be deemed as representative of the wider surrounding area. The conclusion that is drawn from the results is whether or not there is a difference between sites. It does not show the effect of the Foundry, but it may show an association. Comparisons were conducted to determine whether there were any differences between the sites for iron associated with particles, as foundries are known to be a primary source.

Results

Results for all parameters, excluding total suspended solids, were measured at only one location—Mountbatten Terrace, Flinders Park—and not compared to a control site. Equipment currently exists to comprehensively measure only one site (Flinders Park).

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 enhance the response to allergens in some individuals. The National Environment Protection Measure (NEPM) short–term air quality standard is 0.120 ppm, measured as an hourly average. There is also a longer–term NEPM standard of 0.03 ppm measured over one year.

Sources

All combustion processes in air produce oxides of nitrogen. Nitrogen dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen and together are referred to as NO_X (oxides of nitrogen). It is nitrogen dioxide that is associated with adverse effects upon human health. Motor vehicles account for about 70% of total Adelaide emissions of nitrogen oxides. Other sources include electricity generation and domestic wood burning. The Hensley Foundry, through its iron and steel casting activities, emits to air approximately 2200 kg of NO_X each year. NO_X is also a precursor in the production of ozone and photochemical smog.

Monitoring results

One–hour averages for nitrogen dioxide were within the range of 0 to 0.046 ppm and well within the NEPM air quality standard of 0.12 ppm (one hour). The average concentration for the sampling period was 0.012 ppm. If this value is representative of a whole year, then results also comply with the annual standard of 0.03 ppm.

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

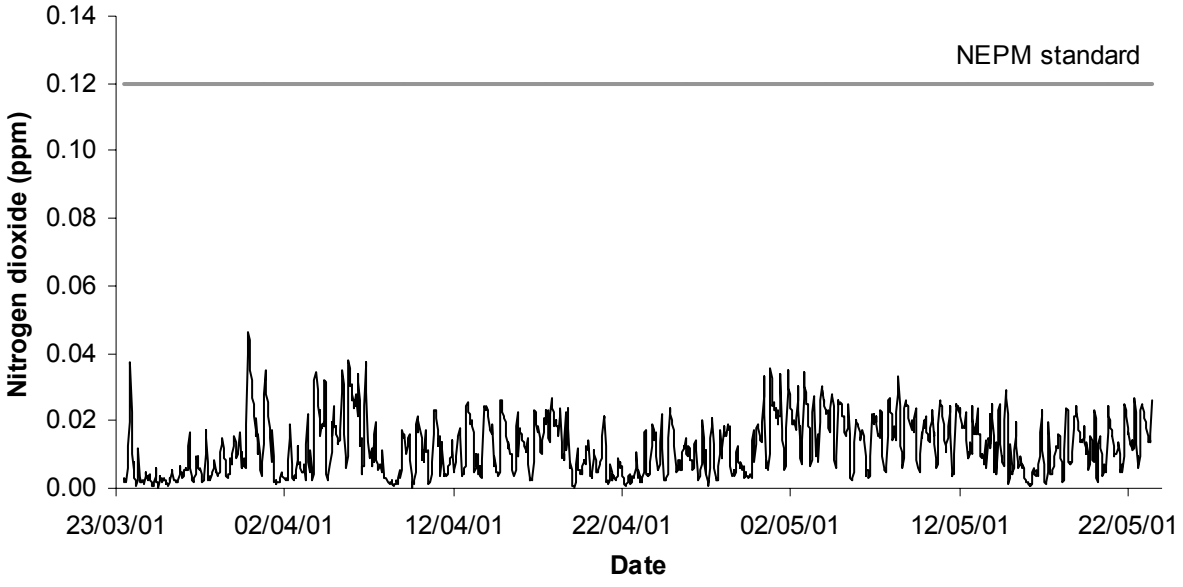

Figure 2 One-hour nitrogen dioxide concentrations and the NEPM air quality standard

Ozone (O_3)

Health effects

Exposure to elevated concentrations of ozone may cause slight irritation to 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 inflammatory reactions. Minor changes in the airways may occur at lower concentrations, down to about 0.08 ppm. The NEPM air quality standard for ozone is 0.1 ppm as a one-hour mean. A four-hour standard at 0.08 ppm has also been set—a level at which effects on healthy individuals have been demonstrated.

Sources

Ozone at ground level is primarily formed by a complicated series of chemical reactions initiated by sunlight. Oxides of nitrogen and volatile organic compounds (VOCs), derived mainly from man-made sources, react to form ozone. Combustion, industrial processes, and activities such as solvent use and petrol distribution and handling produce these substances. Oxides of nitrogen and VOCs are the most important precursors for the generation of ozone. Emissions from motor vehicles account for 40% of Adelaide's VOCs. Carbon monoxide, methane, or other VOCs that arise from plants, trees and other natural sources can also promote ozone production.

These chemical reactions do not take place instantaneously but over several hours or even days depending on the VOCs and meteorological conditions. Once ozone has been produced it may persist for several days. Ozone measured at a particular location may therefore have arisen from VOC and oxides of nitrogen emissions many kilometres away. Maximum concentrations of ozone, therefore, generally occur downwind of the source areas of the precursor pollutant emissions. Therefore, ozone measured at Flinders Park is not attributed to local industry. The pollutant was measured to assist the EPA in looking at overall local air quality issues at Flinders Park.

Monitoring results

One-hour averages for ozone were well below the NEPM air quality standard of 0.10 ppm (one hour). The range was between 0.01 and 0.043 ppm for one-hour averages. The average concentration for the sampling period was 0.016 ppm.

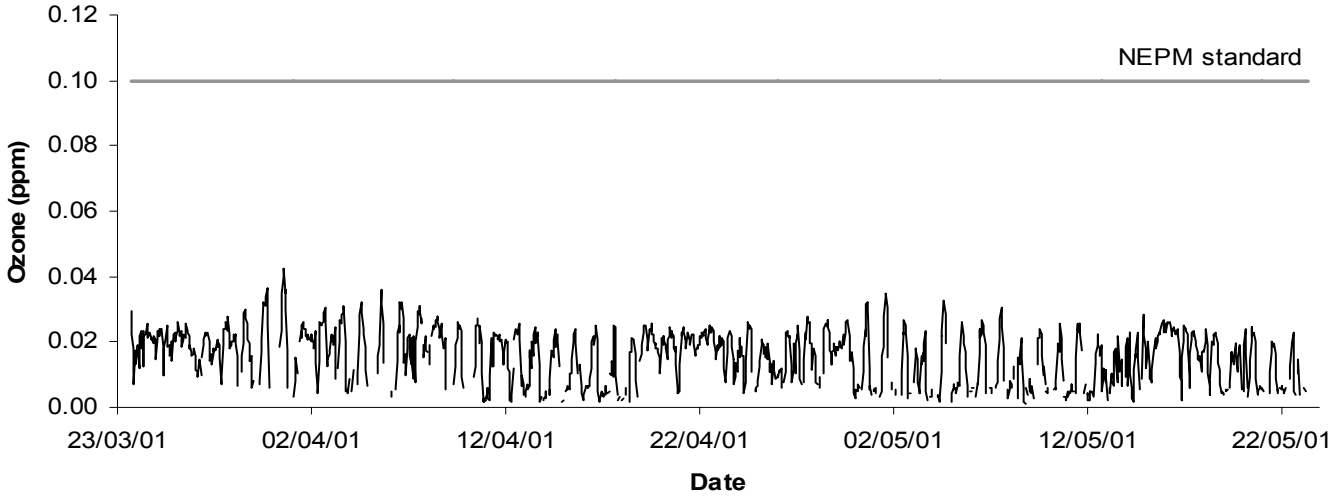

Figure 3 One-hour ozone concentrations and the NEPM air quality standard

Four–hour averages for ozone were well below the NEPM air quality standard 0.08 ppm (four hour). The range was between 0.01 and 0.038 ppm for four-hour averages.

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

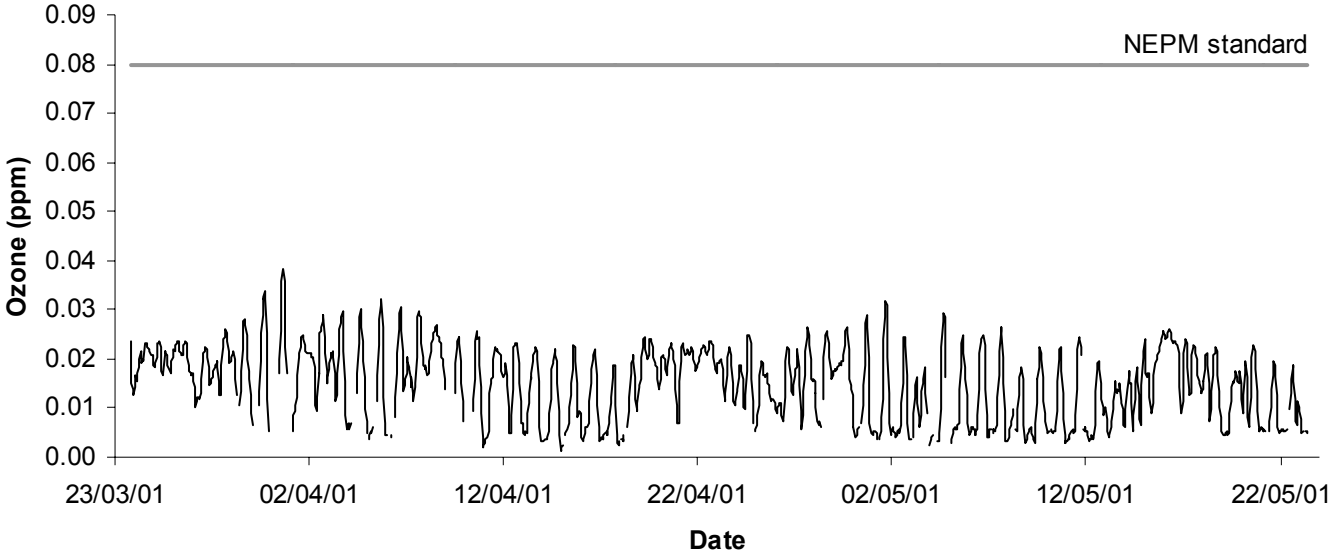

Figure 4 Four-hour ozone concentrations and the NEPM air quality standard

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. The constriction is particularly likely to occur in those suffering from asthma or other chronic lung disease. The NEPM air quality standard is 0.20 ppm measured over a one-hour averaging period. This standard is intended to reduce the exposure of the population, including individuals who may be particularly sensitive to sulfur dioxide, to a level at which harmful effects are unlikely to occur.

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. Residual amounts can be ingested by eating preserved foods.

Monitoring results

One–hour averages for sulfur dioxide were within the range of 0 and 0.008 ppm and well below the NEPM air quality standard of 0.20 ppm (1 hour). The average concentration for the sampling period was 0.001 ppm. Daily averages ranged between 0 and 0.002 ppm, well below the NEPM air quality standard of 0.08 ppm (daily).

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

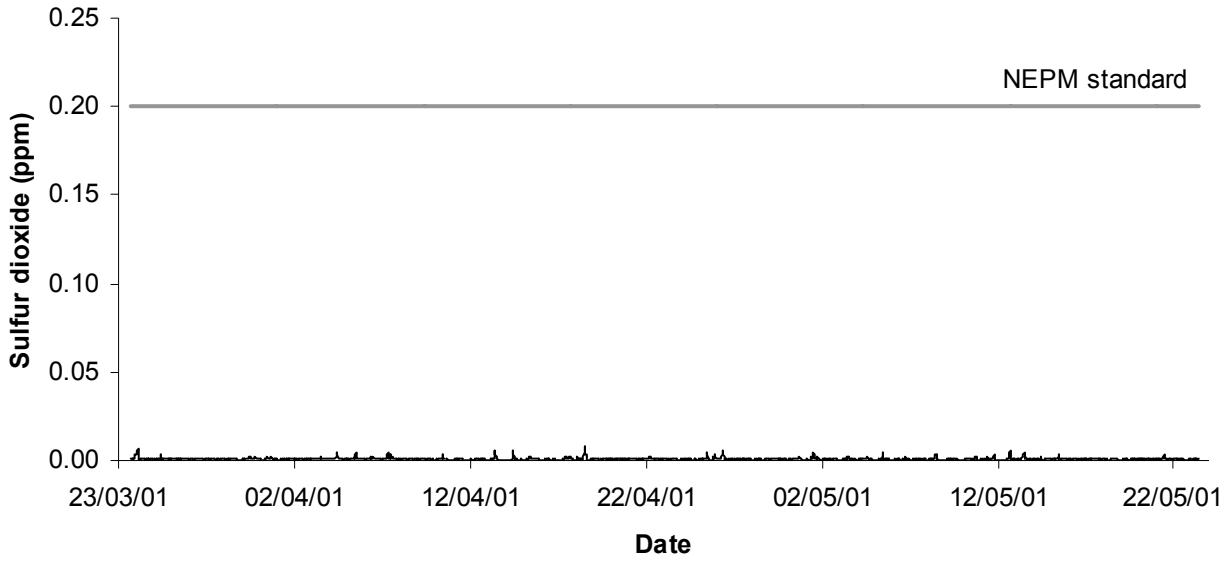

Figure 5 One-hour sulfur dioxide concentrations and the NEPM air quality standard

Benzene (C_6H_6)

Health effects

Benzene is a recognised human carcinogen. Studies of industrial workers exposed to high levels of benzene have demonstrated a greater risk of leukaemia, which increased in relation to their working lifetime exposure. Because it is a carcinogen, no absolutely safe level can be specified for ambient air concentrations of benzene and as yet, there is no ambient standard for benzene in Australia. The Expert Panel on Air Quality Standards (EPAQS) has recommended an air quality standard of 0.005 ppm (16.25 µg/m^3) as an annual mean, a level which they concluded represents an exceedingly small risk to health. In their report, EPAQS considered the advice of the Department of Health's Committee on Carcinogenicity, that exposure to benzene should be kept as low as practicable (DETR 1994).

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 process from aromatics in the petrol. Motor vehicles contribute up to 70% of emissions. Smoke from domestic wood fires and emissions from lawn mowers and some industries, such as foundries, are also significant contributors.

Monitoring results

One-hour averages for benzene were within the range of 0 to 0.008 ppm, with an average for the entire sampling period of 0.003 ppm. The UK air quality guideline (Department of the Environment, Transport and the Regions 1994) for benzene is 16 µg/m^3 (0.005 ppm measured as an annual average). The annual guideline was not included on the graph (figure 6) below that describes one-hour concentrations over two months. The average concentration measured in this study is lower than the average of 0.009 ppm measured by an EPA hot spot monitoring study along side a major Adelaide road (EPA 2001b). Ambient concentrations of benzene are expected to fall by 2005 after the introduction of the national fuel quality standard and motor vehicle Australian Design Rules (Environment Australia 2001).

The Department of Human Services advises that benzene levels averaged over the two months of monitoring were within the UK Air Quality Standard. If this monitoring is reflective of the ambient air values for the entire year then health risks would be minimal.

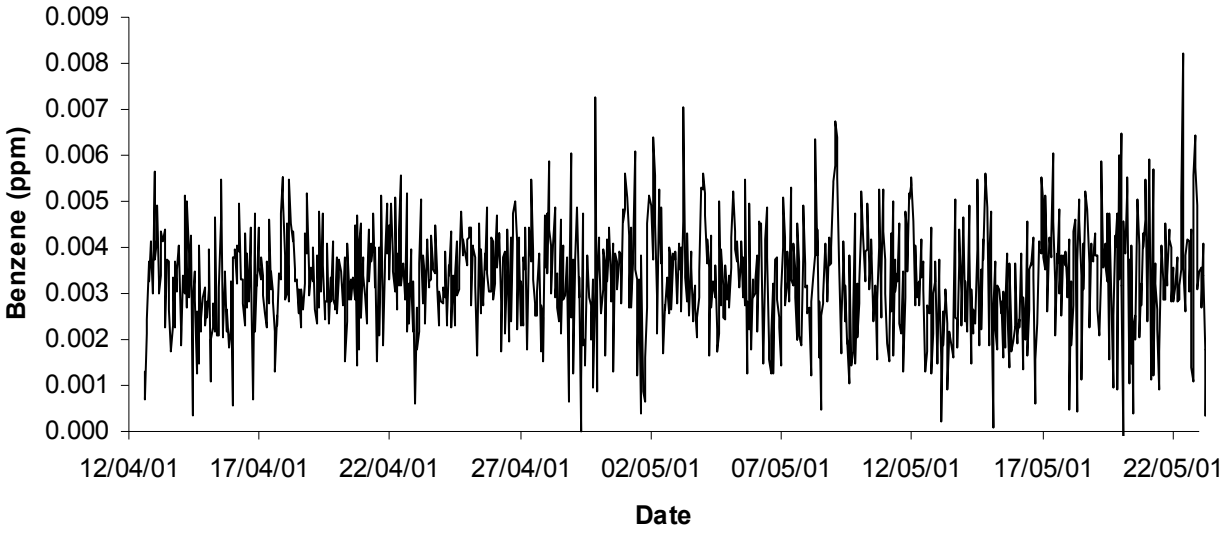

Figure 6 One-hour benzene concentrations

Toluene (C_7H_8)

Health effects

Low to moderate levels of long–term exposure can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, loss of appetite and hearing loss. Inhaling a high level of toluene in 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. The threshold for smelling toluene is about 8 ppm. The WHO guideline is 0.27 ppm measured as a thirty-minute average.

Sources

Toluene is a colourless liquid with a distinctive sweet and pungent smell. It occurs naturally in crude oil. Toluene is produced during the refining of crude oil to make fuel. Toluene is also a by-product of converting coal to coke and in the manufacture of styrene. It is also used in making paints, paint thinners, fingernail polish, lacquers, adhesives, rubber and in some printing and leather tanning processes.

Monitoring results

Thirty–minute averages for toluene were within the range of 0 to 0.038 ppm, with an average for the entire sampling period of 0.005 ppm. The WHO (2000) air quality guideline is 1000 $\mu g/m^3$ (0.27 ppm 30–minute average). Although there is considerable variability in the measurements, the peak result of 0.038 ppm is an order of magnitude lower than the WHO guideline.

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

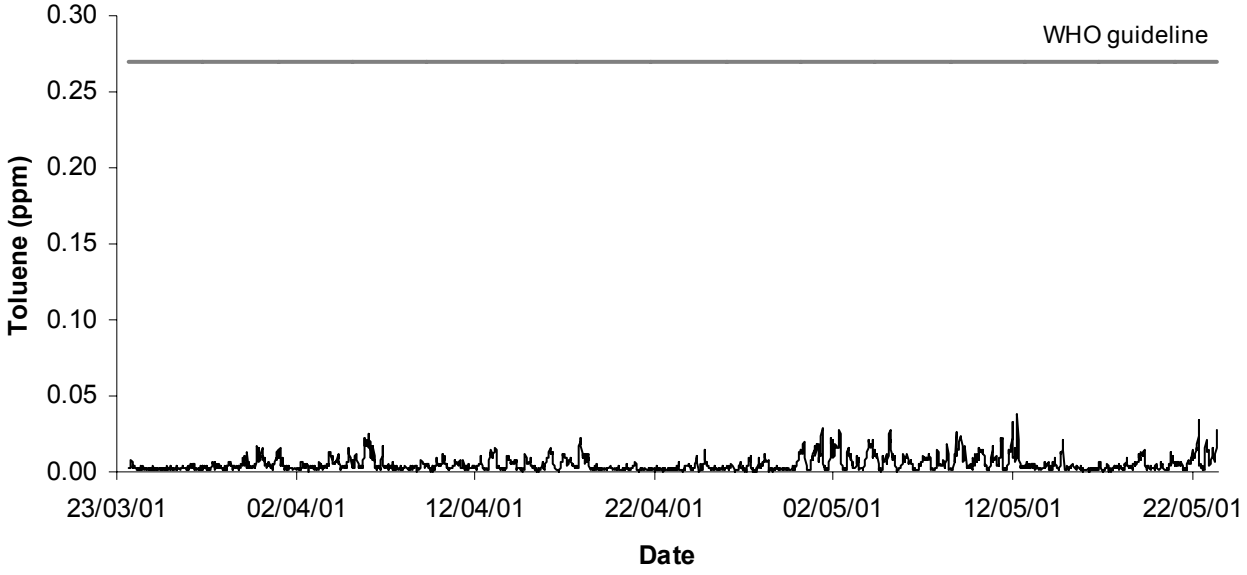

Figure 7 Thirty-minute toluene concentrations and the WHO air quality guideline

Formaldehyde (CH_2O)

Health effects

When present in the air at levels at or above 0.1 ppm, acute health effects can occur including watery eyes; burning sensations in the eyes, nose and throat; nausea; coughing, chest tightness and wheezing; skin rashes; and other irritating effects. Formaldehyde affects people in various ways. Sensitive people can experience symptoms at levels below 0.1 ppm. The World Health Organisation's guideline is 0.08 ppm 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 certain insulation materials. Incomplete combustion of fuel in motor vehicles, cigarette smoking, and burning wood, kerosene and natural gas release formaldehyde.

Monitoring results

Thirty–minute averages for formaldehyde were within the range of 0.005 to 0.030 ppm, with an average for the entire sampling period of 0.020 ppm. The WHO (2000) guideline has been established at 100 μg/m^3 (0.08 ppm 30–minute average). The results are well below this WHO guideline.

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

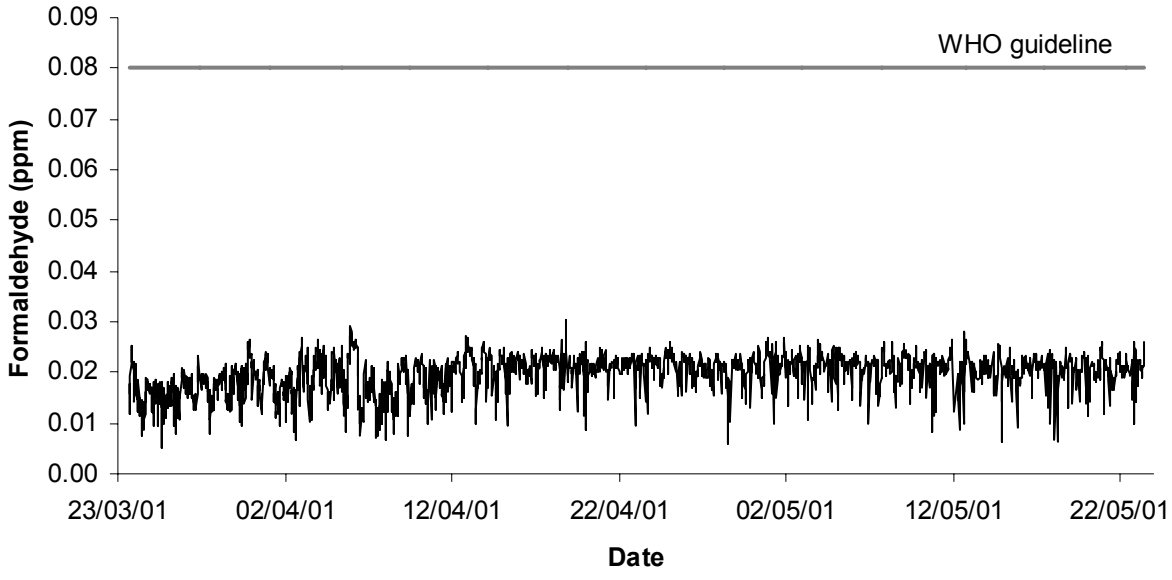

Figure 8 Thirty-minute formaldehyde concentrations and the WHO air quality guideline

Ten–minute averages are graphed below to determine whether there were any short–term peaks of the pollutant that might impact on health. The data were within the range of 0 to 0.032 ppm, with an average for the entire sampling period of 0.020 ppm. The values are well below the 30–minute averaged WHO guideline of 0.08 ppm.

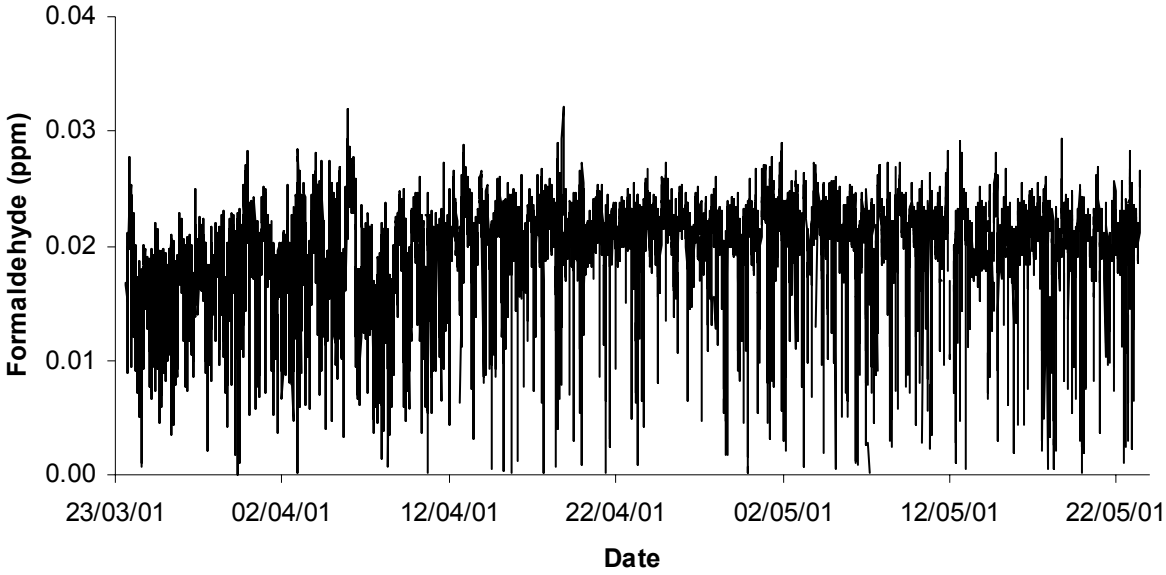

Figure 9 Ten-minute formaldehyde concentrations

Carbon monoxide (CO)

Health effects

The main threats to health from exposure to carbon monoxide are the formation of carboxyhaemoglobin, which substantially reduces the capacity of the blood to carry oxygen and deliver it to the tissues, and blockage of 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 delivery systems are further impaired by carbon monoxide. The NEPM air quality standard of 9 ppm as a running 8-hour mean is intended to limit the exposure of the population, including susceptible individuals.

Sources

Carbon monoxide is a gas formed by the incomplete combustion of fuels containing carbon. The main outdoor source of carbon monoxide is currently motor vehicles, in particular petrol-engined vehicles, which in Adelaide account for almost 90% of emissions.

Industrial sources include steel plants, foundries, oil refining, and chemical manufacturing facilities, such as the making of lime.

Monitoring results

Eight-hour averages of carbon monoxide were within the range of 0 to 2.5 ppm, with an average for the entire sampling period of 0.6 ppm and well below the NEPM air quality standard of 9.0 ppm.

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

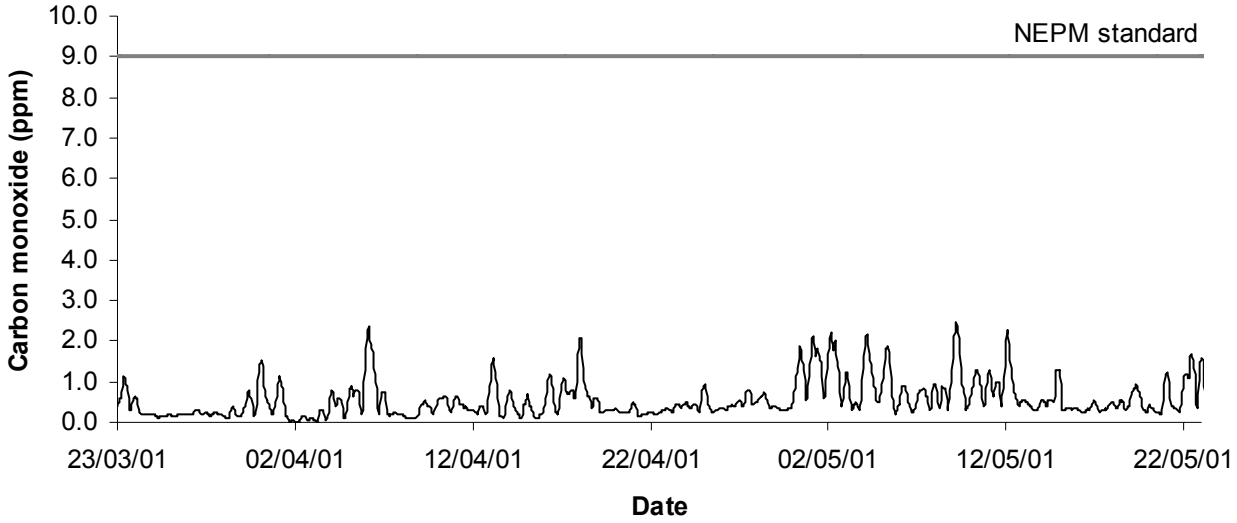

Figure 10 Eight-hour carbon monoxide concentrations and the NEPM air quality standard

Particulate matter (PM_{10})

Health effects

PM_{10} refers to particulate matter less than ten micrometres (μm) in diameter. Particulate air pollution is associated with a range of effects on health including respiratory and cardiovascular difficulties, asthma and mortality.

Since the most applicable evidence relates daily average concentrations of particles to effects on health, the PM_{10} NEPM is also measured over 24 hours. The NEPM air quality standard is 50 μg/m^3 as a 24-hour average.

Sources

Unlike the individual gaseous pollutants that are single, well-defined substances, particles (PM_{10}) in the atmosphere are composed of a wide range of materials arising from a variety of sources. Concentrations of PM_{10} comprise coarse particles, suspended soils and dusts, sea-salt, biological particles and particles from construction work; smaller particles, arising from combustion sources (mainly motor vehicles—in Adelaide motor vehicles contribute 40% of PM_{10}); and particles, mainly sulfate and nitrate, that are formed by chemical reactions in the atmosphere.

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

Monitoring results

One–day averages for PM_{10} particles were within the range of 9 to 39 μg/m^3 and below the NEPM air quality standard of 50 μg/m^3. The Department of Human Services advises that health impacts would not be anticipated. The period of missing data in the PM_{10} measurement is due to an instrument malfunction. Total suspended particulate data give an indication of particle concentrations during this time (page 16).

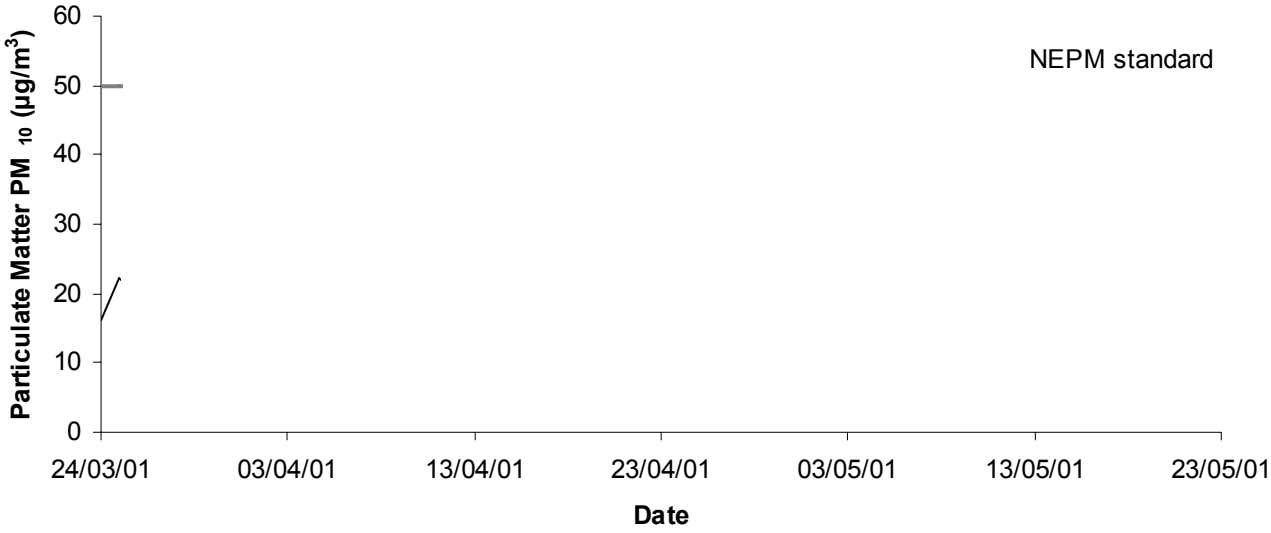

Figure 11 One-day particulate matter (PM_{10}) concentrations and the NEPM air quality standard

Total suspended particulate matter (TSP) and iron (TSP Fe)

Monitoring results

One–day concentrations for TSP particles at Flinders Park were within the range of 10.6 to 87.9 μg/m^3. The data were below the 24-hour average WHO air quality guideline of 120 μg/m^3. The NHMRC (1996) annual averaged guideline for TSP is 90 μg/m^3.

One-day concentrations for TSP particles at Netley were within the range of 12.2 to 108.6 μg/m^3. The data were below the 24-hour average WHO air quality guideline of 120 μg/m^3.

Table 1 TSP descriptive statistics at Flinders Park and Netley

Monitoring site	Average (μg/m^3)	Highest (μg/m^3)	2nd highest (μg/m^3)	90th percentile (μg/m^3)	Number of samples
Flinders Park	36.9	87.9	74.6	58.6	79
Netley	39.3	108.6	81.7	58.7	79

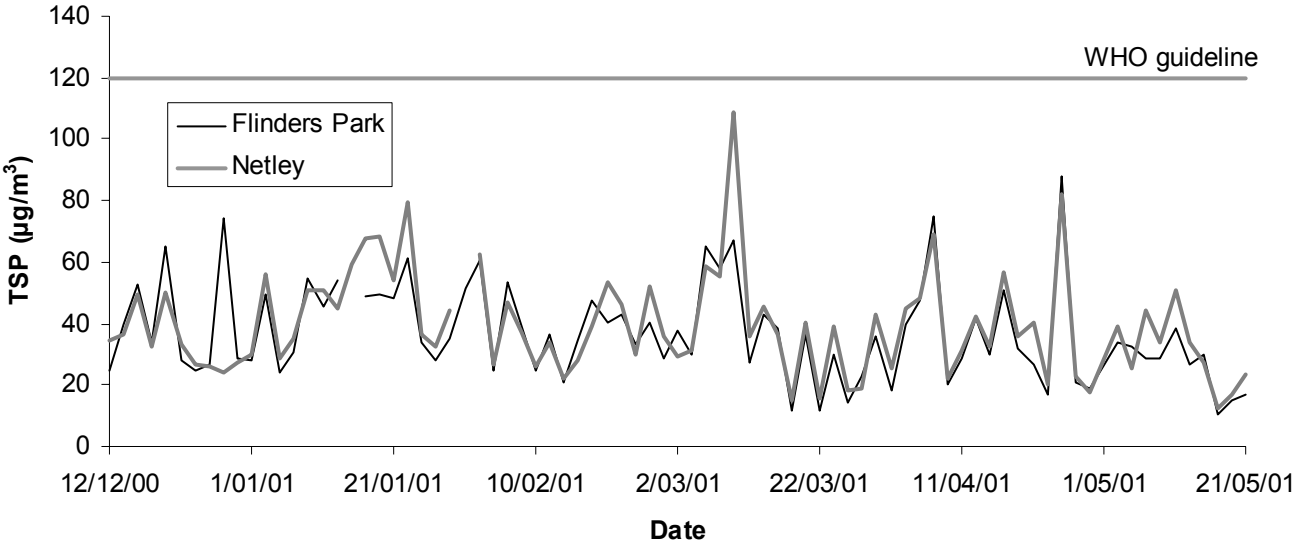

Figure 12 One-day TSP concentrations at Flinders Park and Netley and the WHO air quality guideline

One-day concentrations for TSP iron particles at Flinders Park were within the range of 0.1 to 2.2 μg/m^3. One-day concentrations for TSP iron particles at Netley were within the range of 0.1 to 2.0 μg/m^3.

There are no guidelines for particulate iron. Iron is measured, as it is a metal commonly emitted from foundries.

Table 2 TSP Iron descriptive statistics at Flinders Park and Netley

Monitoring site	Average (μg/m^3)	Highest (μg/m^3)	90th percentile (μg/m^3)	Number of samples
Flinders Park	0.7	2.2	1.2	79
Netley	0.6	2.0	1.0	79

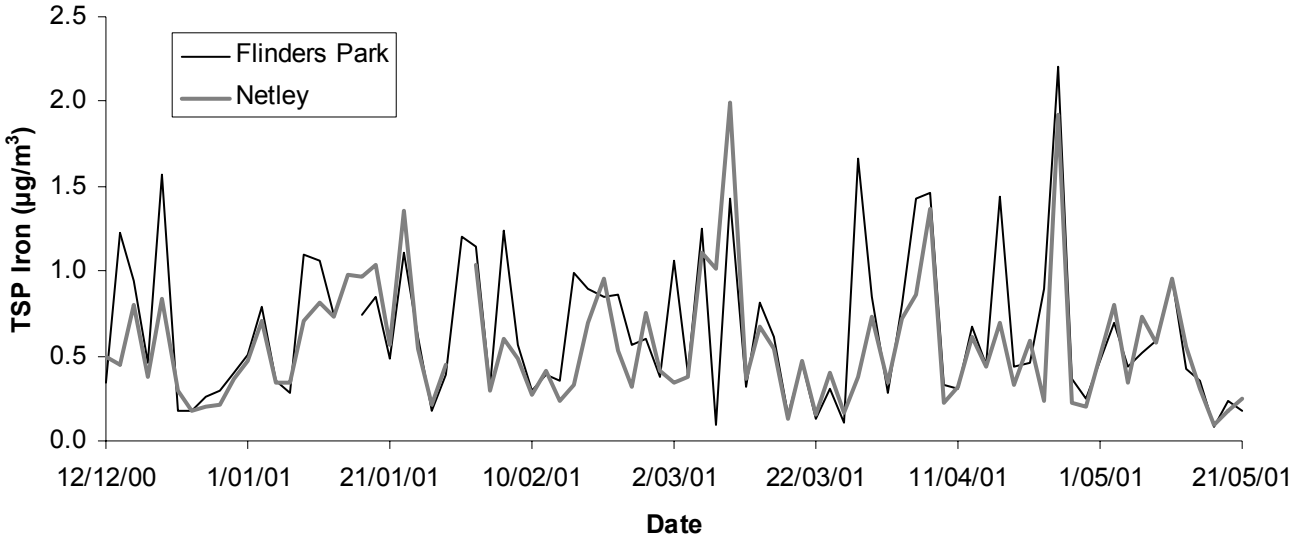

Figure 13 TSP Iron at Flinders Park and Netley

TSP and iron differences between sites

Wilcoxon signed–rank test, for two groups arranged as paired observations, were used to test for differences of TSP and TSP iron between Flinders Park and Netley. For both parameters, there was a significant difference between sites (TSP $P<0.005$, iron $P<0.05$).

Although the average concentration of total suspended particles was higher at Netley compared with Flinders Park, the proportion of iron particles at Flinders Park was higher than that at Netley, suggesting that the foundry may be a source of particles.

Linear regressions of the paired samples of total suspended particles and iron are shown below to explain the trends of increasing iron with particle concentrations. The regressions are significant ($P<0.0005$). The r^2 value describes the percentage of all the variance in iron that can be explained by TSP. As P is significant (very small), the observed relationships are unlikely to be due to a coincidence or sampling error. Linear regressions of log transformed data were also performed at Flinders Park ($r^2 = 0.49$, $P<0.0005$) and at Netley ($r^2 = 0.83$, $P<0.0005$).

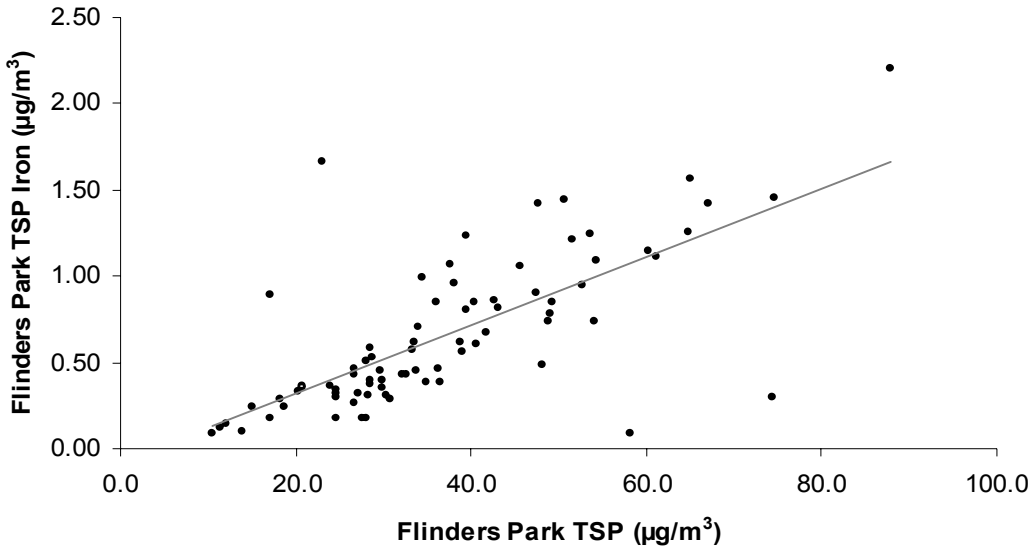

Figure 14 Regression of TSP and TSP Iron at Flinders Park

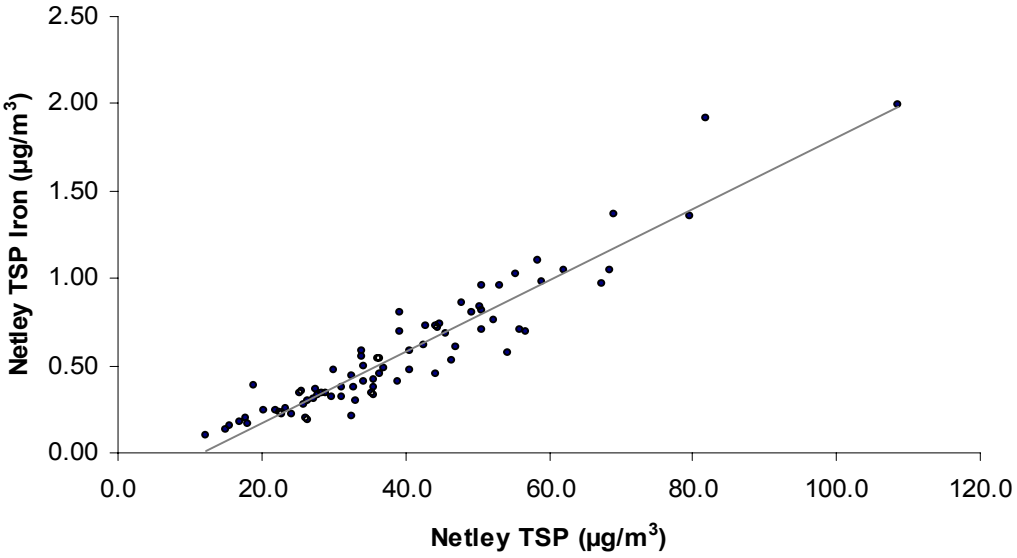

Figure 15 Regression of TSP and TSP Iron at Netley

There is higher variability in the relationship between iron and TSP concentrations at Flinders Park compared to Netley. As there are no major sources of iron near Netley the concentration of iron is expected to remain proportional to TSP irrespective of wind direction. On the other hand, Flinders Park does have a nearby source of iron—the Hensley Foundry. Therefore, the proportion of iron is likely to change depending on whether winds are coming directly from the foundry to the sampling site or not.

Linear regressions of TSP shows an association between the two sites. The regressions are significant ($P<0.05$). Linear regressions of log transformed data were performed for figure 16 ($r^2 = 0.77$, $P<0.0005$) and figure 17 ($r^2 = 0.54$, $P<0.0005$).

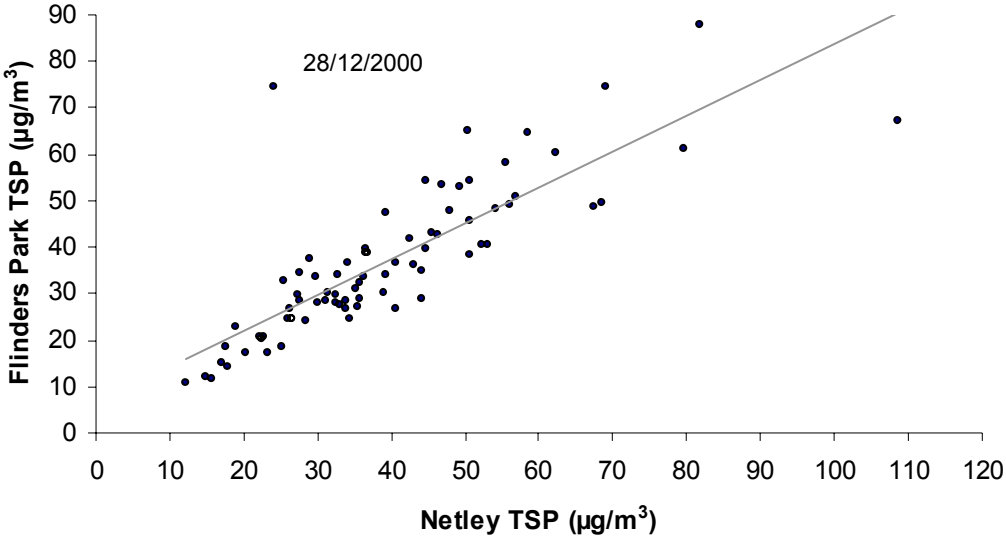

Figure 16 Regression of paired samples of TSP between Flinders Park and Netley

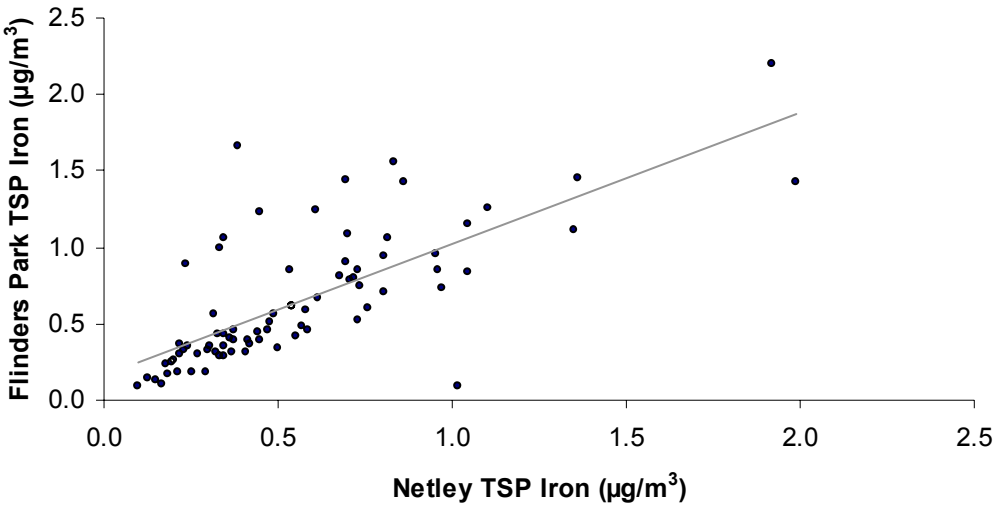

Figure 17 Regression of paired samples of TSP Iron between Flinders Park and Netley

Particulate iron was measured as it is produced as a result of foundry operations. We would therefore expect a weaker relationship between the two sites for iron (figure 17)—that is—greater scatter. The stronger correlation between the two sites for TSP (figure 16) suggests that the foundry may not always be the main contributor to total particulates at Flinders Park.

For example, on one day when the wind was coming from a mostly south east direction (the direction of the foundry) on the 28 December 2000 (see figure 18), a relatively high concentration of TSP was measured at Flinders Park (74.4 µg/m^3). The foundry, however, assured the EPA that it was not working on this day. The concentration of TSP iron on 28 December 2001 was 0.3 µg/m^3. This is not high, and below the average of 0.7 µg/m^3.

Wind roses (figures 18 & 19) describe the prevailing wind for the area (Adelaide Airport data) on days that exhibited relatively high concentrations of total suspended particulates at Flinders Park. On the two days of highest concentrations, the prevailing wind was generally from the north for 50% or more of the time. These days were 25 April 2001 (87.9 µg/m^3) and 7 April 2001 (74.6). On the next two highest TSP days—28 December 2000 (74.4) and 10 March 2001 (67.1)—the wind was coming from a south-south easterly direction for more than 50% of the time. This wind would carry any pollutants from the direction of the foundry into Flinders Park and Allenby Gardens. This does not suggest, however, that pollutants are exclusively from the foundry. The next four days with total suspended particle concentrations greater than 60 µg/m^3 exhibited highly variable wind directions. The four highest TSP days are shown below.

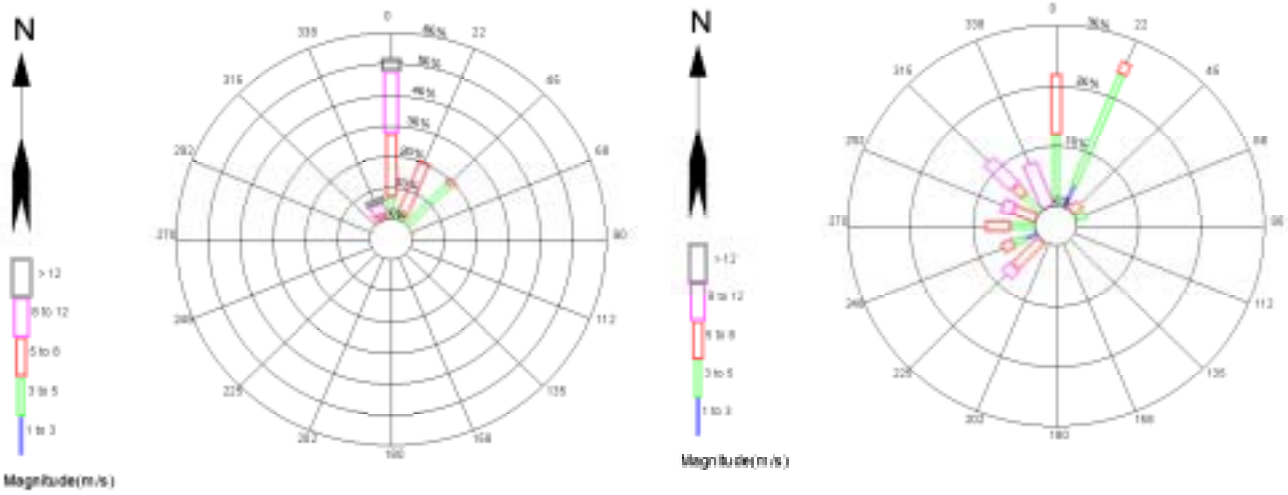

Figure 18 Wind Rose for two highest TSP days (24 hours—left 25 April 2001, right 7 April 2001)

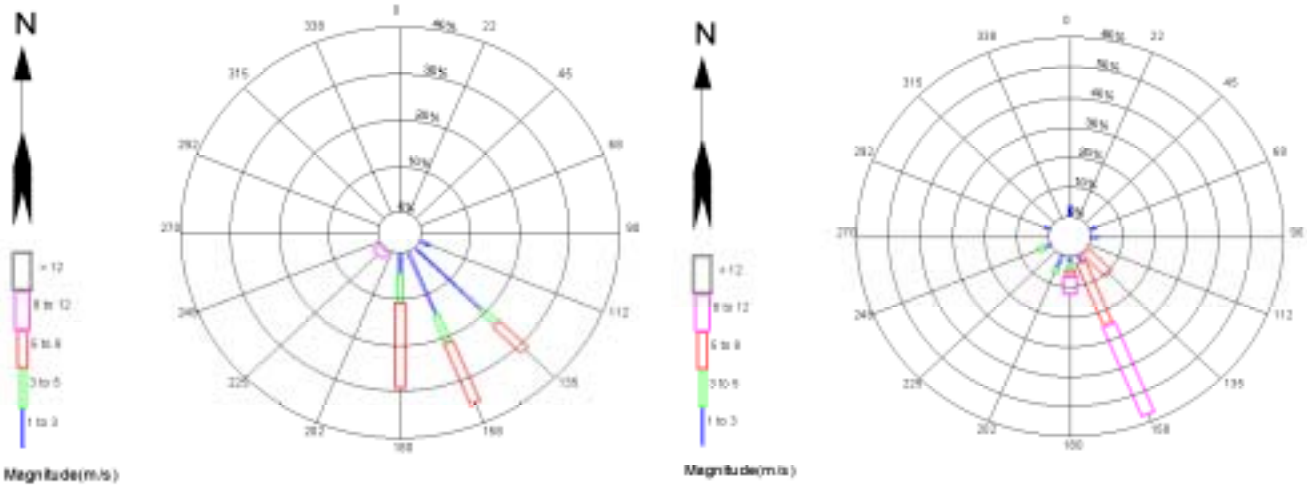

Figure 19 Wind Rose for third and fourth highest TSP days (24 hours—left 28 December 2000, right 10 March 2001)

The wind data is an approximation of the area as it was measured from the Adelaide Airport and not at the sampling site. Nevertheless, days when nearby residents complained of odour were, with one exception, on days when winds were coming from the foundry. Figure 22 below describes the number of complaints from the Flinders Park and Allenby Gardens area and the percentage of time 30–minute average wind comes from the direction of the foundry (south east, 90–180 degrees) between April and May 2001 (time of continuous sampling).

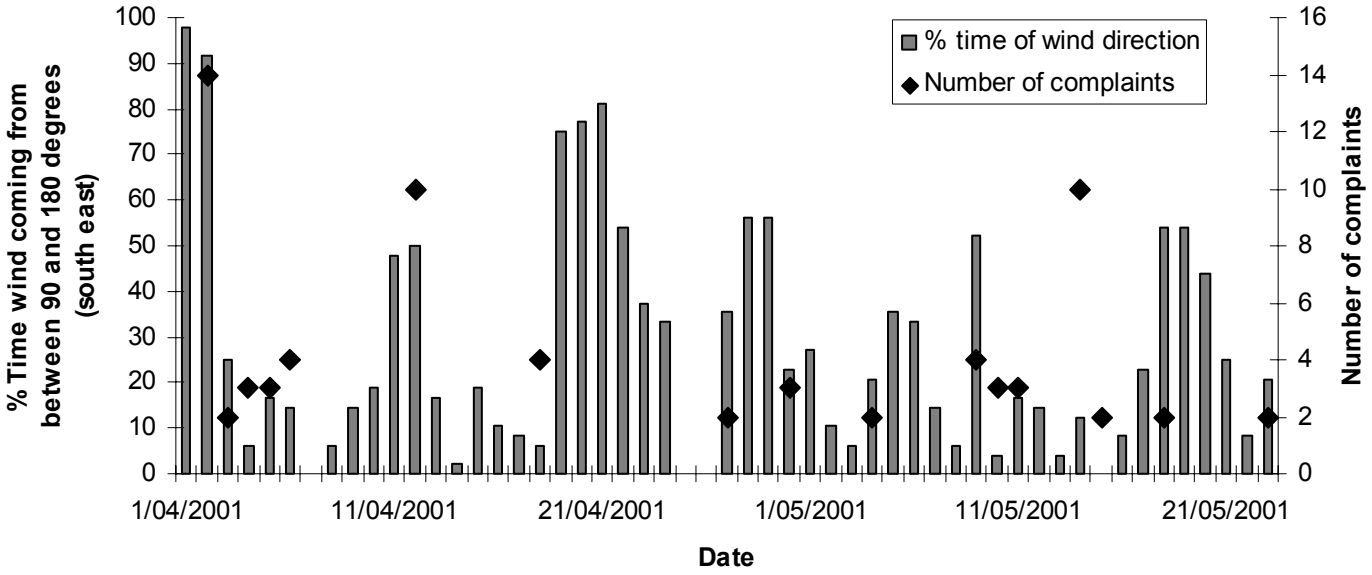

Figure 20 Foundry odour complaints and % time wind direction coming from the general direction of the foundry

The number of complaints and daily PM_{10} concentrations are shown below (including four days of extrapolated data). The complaints were all attributed to problems of offensive odour. The fact that there is no clear relationship between odour (as determined by the number of complaints) and the concentration of pollutants highlights the complexity of the odour problem.

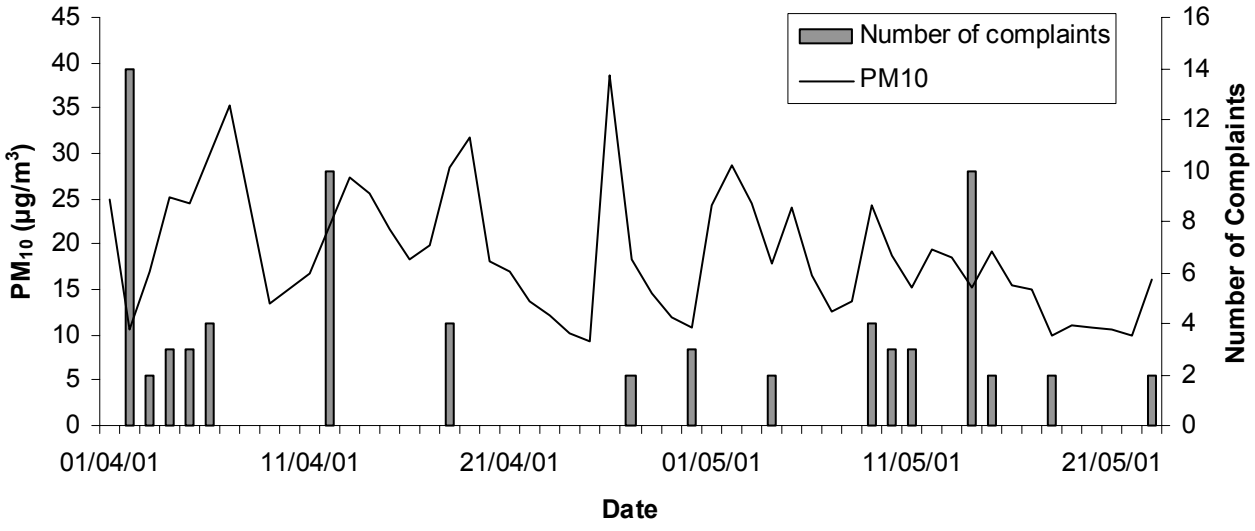

Figure 21 Foundry odour complaints and PM_{10} particle concentrations

Conclusion

The monitoring results show that all measurements of pollutants were below the NEPM standard and other air quality guidelines at Flinders Park.

- Concentrations of common pollutants, including nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone and PM_{10} were all low and below the NEPM standards. The Department of Human Services advises that health impacts would consequently not be expected within the constraints established by the NEPM criteria.
- Concentrations of total suspended particles were below the WHO guideline.
- Concentrations of hazardous air pollutants, including toluene and formaldehyde, were low and below the WHO guidelines. The Department of Human Services advises that health impacts would not be anticipated.
- The Department of Human Services advises that benzene levels averaged over the two months of monitoring were within the UK Air Quality Standard, which is an annual average. If this monitoring reflects the ambient air values for the entire year, then health risks would be minimal.

Higher concentrations of TSP iron at Flinders Park, compared with Netley, suggest that Hensley Foundry is likely to be a source of particles.

Further Reading

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APPENDIX 1 – Sampling Methods

High volume sampling

Particulate matter as TSP was measured using a high volume sampler. The sampler draws air through a filter paper in an evenly distributed pattern at a known constant rate for 24 hours. The resulting increase in the weight of the filter paper is the total airborne particulates in the air of volume (flow rate x time). The flow rate is automatically controlled to within ±1 standard cubic metre per hour.

Total suspended particulates were collected on a glass fibre filter over a continuous 24-hour high volume-sampling period at 2-day intervals and at a flow rate of 1.6 m^3/minute. After 24 hours, the filter is removed and weighed. Collected particles in the filter were analysed for iron as described in Australian Standard AS 2800.

The high volume sampler conforms to Australian Standard AS 2724.3. For details of siting, operation and calibration of the sampler refer to Australian Standards AS 2922 and AS 2724.3 and details given in the Appendix.

Differential optical absorption spectrometry (DOAS)

Gaseous compounds such as ozone, nitrogen dioxide, sulfur dioxide and hydrocarbons were measured using the OPSIS (DOAS) analyser. The system utilises the light absorbing properties of gaseous species to determine concentrations along a designated path. A beam of light is projected across a path where the pollutants in the path adsorb light at particular wavelengths. A comparison is made between the adsorption wavelength with the known absorption properties of measured compounds. The concentration of the gaseous species is then determined. The almost simultaneous measurement of many pollutants is possible using this technique.

Tapered element oscillating microbalance (TEOM)

The TEOM mass measurement system was used for the continuous measurement of particulate mass (PM_{10}) concentrations. It relies on an instrument that draws air through a filter at a constant flow rate and constant temperature, continuously weighing the filter and continuously calculating the mass concentration. Mass is determined from the measured change in frequency at which the element attached to the filter is oscillating.

The TEOM is an instrument that measures PM_{10} as an equivalent aerodynamic diameter (EAD) as it uses an impacting mechanism to separate particles**.**

Non-dispersive infrared (NDIR)

Carbon monoxide is measured using a non-dispersive infrared (NDIR) analyser, of the gas filter correlation type. A pre-filtered air sample is drawn through a sample cell. Infrared radiation is passed through the sample cell and a carbon monoxide free reference cell. The detector measures the infrared light absorbed by carbon monoxide in the sample. By comparing the light intensity received by the detector through the cell with a similar cell containing reference gas, the concentration of carbon monoxide is determined.

APPENDIX 2 – Site Metadata

Metadata Hensley Foundry, Flinders Park (Continuous Sampling Site)

Site Information (Metadata)	
Site name	Hensley Foundry, Flinders Park
Site Details	
Street address	Mountbatten Terrace, Flinders Park
Date established	22/03/2001
Date terminated	23/05/2001
Siting guidelines (AS 2922-1987) exceptions	None
Description of surrounding land use	Recreational, residential and industrial
Description of nearby emission sources	Steel foundry, motor vehicles
Map Coordinates	
Datum	GDA 94
Projection	AMG Zone 54
Easting	276498
Northing	6134058

Notes on data validation and assessment

Zero, span, calibration equation parameters & quality assurance procedures

Zero corrections: (CO 22/3/01-6/4/01 +0.2 ppm) (SO_2 12/4/01-23/5/01 –2 µg/m³) (NO_2 22/3/01-12/4/01 +23 µg/m³– 12/4/01-23/5/01 +65 µg/m³) (O_3 22/3/01-23/5/01 +12 µg/m³) (FOR 22/3/01-12/401 –30 µg/m³– 12/4/01-23/5/01 –133 µg/m³) (TOL 10/4/01-23/5/01 +12 µg/m³)

Correcting measurement results from µg/m³ to ppm. See OPSIS (1999) *Analyser Software, version 7.2 User's Guide*. OPSIS, Sweden.

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

No events that influenced data.

Path length for the OPSIS analyser was found to be too long - affecting some pollutant measurements. The path was shortened from 340 metres on the 12/4/2001 to a more suitable path length of 134 metres.

Date adjusted for PM_{10} data to represent day of sampling for comparison with TSP data.

Pollutants Measured

NO, NO_2, SO_2, O_3, benzene, toluene, formaldehyde		**Particulate matter (PM_{10})**		**Carbon monoxide (CO)**	
Instrument Types					
Make	OPSIS	Make	Rp	Make	Thermo Electron
Model	ER130 & AR500	Model	TEOM PM_{10}	Model	NDIR analyser
Serial number	E672	Serial number	140AB221849807	Serial number	48-16574-162
Minimum detection level	1-10 ppb (dependant on path length 340m & 134m)	Minimum detection level	N/A	Minimum detection level	0.05 ppm or 2%
Units	µg/m³ (converted to ppm)	Units	µg/m³	Units	ppm
Measurement cycle	10 minutes	Sampling rate	10 minutes	Sampling rate	20 seconds
Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes	Logging interval of raw data	10 minutes
Data return	100 %	Data return	100 %	Data return	100 %
Clock adjustment	Period ending	Clock adjustment	Period ending	Clock adjustment	Period ending

Metadata Hensley Foundry, Flinders Park (High Volume Sampling Site)

Site Information (Metadata)	
Site name	Hensley Foundry, Flinders Park (HVS)

Site Details	
Street address	Mountbatten Terrace, Flinders Park
Date established	12/12/2000
Date terminated	21/05/2001
Siting guidelines (AS 2922-1987) exceptions	None
Description of surrounding land use	Recreational, residential and industrial
Description of nearby emission sources	Steel foundry, motor vehicles

Map Coordinates	
Datum	GDA 94
Projection	AMG Zone 54
Easting	276465
Northing	6133973

Notes on data validation and assessment

Zero, span, calibration equation parameters & quality assurance procedures

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

No events that influenced data.

Run on same days as Netley (HVS) site.

Pollutants Measured

Total Suspended Particulate Matter (TSP) and TSP Iron (Fe)

Instrument Types

Make	TSP High Volume Sampler
Model	Control Engineering Services
Serial number	N/A
Minimum detection level	N/A
Units	µg/m3
Measurement cycle	Continuous for 24 hours
Logging interval of raw data	One in every 2 days
Data return	99%
Clock adjustment equation	Day of 24 hr sample

Metadata Netley (High Volume Sampling Site)

Site Information (Metadata)	
Site name	Netley (HVS)

Site Details	
Street address	310 Richmond Rd, Netley
Date established	12/12/2000
Date terminated	21/05/2001
Siting guidelines (AS 2922-1987) exceptions	None
Description of surrounding land use	Residential and industrial
Description of nearby emission sources	Motor vehicles, light industry, residential, airport

Map Coordinates	
Datum	GDA 94
Projection	AMG Zone 54
Easting	276205
Northing	6130461

Notes on data validation and assessment

Zero, span, calibration equation parameters & quality assurance procedures

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

No events that influenced data.

Run on same days as Flinders Park (HVS) site.

Pollutants Measured
Total Suspended Particulate Matter (TSP) and TSP Iron (Fe)

Instrument Types	
Make	TSP High Volume Sampler
Model	Control Engineering Services
Serial number	N/A
Minimum detection level	N/A
Units	µg/m³
Measurement cycle	Continuous for 24 hours
Logging Interval of raw data	One in every 2 days
Data return	99%
Clock adjustment equation	Day of 24 hr sample