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HealtheCare Pty Limited

Report for Hurstville Private Hospital Redevelopment

Technical Report - Air Quality

September 2012

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

This Report for HealtheCare Pty Limited - Hurstville Private Hospital Redevelopment –Site Analysis Plan – Air Quality ("Report"):

1. *Has been prepared by GHD Pty Ltd ("GHD") for* HealtheCare Pty Limited*;*

2. *May only be used for the purpose of informing the* Hurstville Private Hospital Redevelopment *(and must not be used for any other purpose); and*

3. *May be provided to the Department of Planning and Infrastructure for the purpose of public exhibition as part of the Environmental Assessment (EA).*

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section 3 of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), as specified in Section 3 and throughout this Report.

GHD excludes liability for errors in, or omissions from, this Report arising from or in connection with any of the assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation. GHD has not, and accepts no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was signed.

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Executive Summary

The Hurstville Private Hospital (HPH) which is owned by Continuum Healthcare Group Pty Limited currently has 12,000 in-patient admissions per year utilizing a 54 bed licence and proposes to redevelop the hospital to increase this to a 96 bed licence, equating to approximately 30,000 in-patients per year.

On 24 March 2011 the Director of Metropolitan and Regional Projects, as a delegate of the Minister for planning, classified the proposed development as a Major Development to which Part 3A of the *Environmental Planning and Assessment Act 1979* (EPPA) applies. Following this on 22 July 2011, Draft Director General Requirements were issued.

GHD Pty Ltd has been commissioned to provide HPH with an assessment of the noise, air quality and vibration impacts of the project during demolition, construction and operation (including any plant). This Report assesses air quality associated with the proposed redevelopment.

The air quality impact of the Project is influenced from two main emission sources, which are the dust emissions resulting from the construction activities and the boiler emissions resulting from the generation of hot water and for use as a backup generator.

A risk assessment of both construction and operation emissions was carried out in order to determine the likelihood and consequences of impact on the local environment and community. All of the identified risks are considered to be negligible or low provided that the identified mitigation measures are implemented.

Construction impacts have the potential to extend beyond the construction area. Construction dust is expected to be greatest during the preparation/demolition stage as opposed to the building stage. However, provided that the methods and management systems designed to maintain air quality during construction are implemented as outlined in the mitigation section, construction impacts are not expected to be any more than minor.

Construction and operational emissions are not expected to affect domestic water supplies. Dust from construction emissions are generally in the medium to higher size fractions greater than PM_{10} (Total Suspended Particulate as nuisance dust) and as such would fall out of the air column more readily than the smaller size fractions during construction. Hence, through management of the smaller particle size fractions (equal and less than PM_{10}), it follows that the nuisance dust would also be managed.

Operational air quality impacts are expected to be no more than minor. However, ambient particulate monitoring shows background particulate levels are often exceeding the NEPM (Air) goals of 50 ug/m^3. It is expected any contribution from the HPH boiler would be managed in order to achieve the best possible environmental outcome practical through the use of best practice techniques and efficient boiler selection.

Glossary

Abbreviation	Definition
Air NEPM	National Environment Protection (Ambient Air Quality) Measure (26 June 1998).
Airshed	An area in which air quality is subject to common influences from emissions, meteorology, and topography.
Ambient Air	The external air environment (does not include the air environment inside buildings or structures).
AWS	Automatic Weather Station.
B_{sp}	Light scattering coefficient results are expressed as b_{sp}, and reported in the units Mm^{-1} (inverse megametres).
Katabatic	Refers to movements of cold air; katabatic flows drain down a valley, analogous to stormwater flows.
Monitoring Station	A facility for measuring the concentration of one or more pollutants in the ambient air in a region or sub-region.
NATA	National Association of Testing Authorities.
NEPC	National Environment Protection Council.
NEPM	National Environment Protection Measure.
NPI	National Pollutant Inventory.
NO	Nitric oxide.
NO_2	Nitrogen dioxide.
NO_X	Oxides Of Nitrogen.
O_3	Ozone.
Pb	Lead.
PM_{10}	Particles that have an aerodynamic diameter less than or equal to 10 µm (micrometres).
$PM_{2.5}$	Particles that have an aerodynamic diameter less than or equal to 2.5 µm (micrometres).
ppm	Parts per million.

pphm	Parts per hundred million.
SO_2	Sulphur dioxide.
Sub Region	A populated area within a region in which air quality differs from other areas in the region due to topography, meteorology, and sources of pollutants.
TEOM	Tapered element oscillating microbalance particle monitor.
Trend Station	A performance monitoring station intended to remain in place for an extended period of at least ten years to observe long-term changes in pollutant levels.
TSP	Total suspended particulate matter.
VOC	Volatile organic compounds.
$\mu g/m^3$	Microgram (1 millionth of 1 gram) per cubic metre.

1. Introduction

1.1 Purpose of this Report

The purpose of this report is to:

- Summarise the existing air quality and meteorological conditions around the Hurstville Private Hospital (HPH), Sydney NSW.
- Provide HPH with an assessment of the air quality impacts of the project during demolition, construction and operation.

This is to inform a Project Approval Application (PAA) for redevelopment of the Hurstville Private Hospital on land currently zoned '*Special Uses 5A (Hospital)*', and owned by Hurstville Private Pty Ltd on behalf of HealtheCare Pty Ltd. (since January 2012).

1.2 Background & Project Description

The Hurstville Private Hospital was purchased by Continuum Healthcare Group Pty Limited in 2007 and has serviced the local area since the 1950s. The HPH currently has 12,000 in-patient admissions per year utilizing a 54 bed licence and proposes to redevelop the hospital to increase this to a 96 bed licence, equating to approximately 30,000 in patients per year.

The site also includes another property at 12 Millett Street which is owned and used by the hospital as a car parking facility (Colston Budd Hunt & Kafes Pty Ltd, 2012).

On 24 March 2011 the Director of Metropolitan and Regional Projects as a delegate of the Minister for planning, classified the proposed development as a Major Development to which Part 3A of the *Environmental Planning and Assessment Act 1979* (EPPA) applies for the purpose of section 75B of that Act.

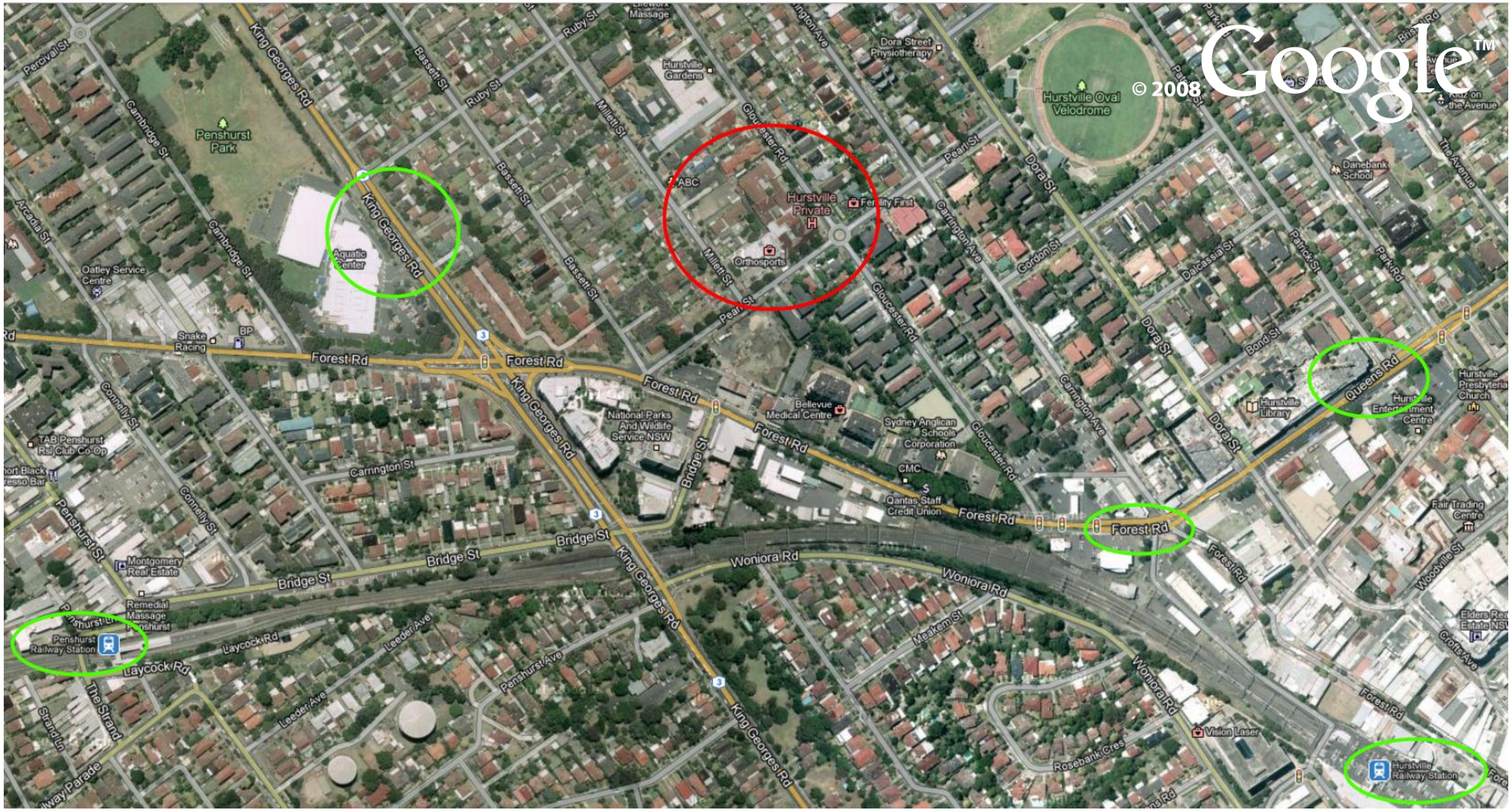
1.2.1 Site Location

The HPH postal address is 37 Gloucester Road, Hurstville, NSW 2220 and is located in the Hurstville suburb at the south eastern end of the block surrounded by:

- Ruby Street;
- Gloucester Road;
- Pearl Street; and
- Millett Street.

The main roads Forest Road and Queens Road lie to the south and southeast, while King Georges Road lies to the West. The metropolitan railway is situated south of the HPH with the closest stations being Penshurst and Hurstville stations, see Figure 1 below.

Figure 1 Study Area - Showing Hurstville Private Hospital in Red and Local Roads and Metro Stations in Green



1.3 Scoping Requirements

GHD Pty Ltd has been commissioned to provide an assessment of the noise, air quality and vibration impacts of the project during demolition, construction and operation (including any plant). Those impacts relevant to air quality are:

- Preparation of a preliminary Site Analysis Plan which should provide an overview of existing conditions and constraints and clearly identify existing sources of air emissions;
- Preparation of a full technical report which will form part of the Environmental Assessment Report which itself forms part of the Part 3A Major Project Application;
- Address any relevant Director General's Requirements in the full technical report;
- Assess potential air quality impacts of the proposed development during demolition, construction and operation and determine strategies for compliance with the relevant environmental protection criteria;
- Assess and document the existing and proposed activities on the site that may impact on air quality within or surrounding the development; and
- The preparation of reports should specifically address all of the relevant legislation including current State Environmental Planning Policies.

1.4 Director Generals Requirements

There are currently no specific Director Generals Requirements (DGRs) with regards to Air Quality.

2. Legislation, Guidelines and Policies

2.1 Commonwealth

2.1.1 National Environment Protection Council Act 1994

The object of the *National Environment Protection Council Act 1994* is to ensure that people enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live in Australia and businesses are treated equally across all states and territories within Australia. The Act also establishes the National Environment Protection Council, its structure, and provides guidelines for the creation of national environment protection measures and reporting on their effectiveness (Commonwealth Government of Australia, 1994).

2.1.2 National Environment Protection Measures (Implementation) Act 1998

The object of *National Environment Protection Measures (Implementation) Act 1998* is to apply state laws to the activities of the Commonwealth within those states, where applicable, and to protect, restore and enhance the quality of the environment in Australia. The Act also has regard to the need to maintain ecologically sustainable development; and to ensure that the community has access to relevant and meaningful information about pollution (Commonwealth Government of Australia, 1998).

2.1.3 National Environment Protection (Ambient Air Quality) Measure

The overall goal of the *National Environment Protection (Ambient Air Quality) Measure* (NEPM (Air)) is to ensure that the ambient air quality of a region provides for the adequate protection of human health and well-being. Schedules 1 and 2 of the NEPM (Air) define the pollutants, national standards and goals for “indicator” pollutants for air quality in Australia. These pollutants are ever-present in urbanised areas and are general gauges of air quality. The six key air pollutants are:

- Carbon monoxide;
- Nitrogen dioxide;
- Photochemical Oxidants (as Ozone);
- Sulphur dioxide;
- Lead; and
- Particles (particulate matter).

In May 2003 the National Environment Protection Council made a variation to the NEPM (Air) to include monitoring for $PM_{2.5}$ which is known to produce respiratory and cardiovascular illness. Advisory reporting standards and goals for particles as $PM_{2.5}$ were included as part of this variation.

The following table presents the six indicator pollutants as well as the advisory standards for $PM_{2.5}$ laid out in in Schedule 2 – *Standards and Goals*.

Table 1 NEPM (Air) Standards and Goals for Pollutants

Column 1 Item	Column 2 Pollutant	Column 3 Averaging period	Column 4 Maximum concentration	Column 5 Goal within 10 years Maximum allowable exceedences
1	Carbon monoxide	8 hours	9.0 ppm	1 day a year
2	Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
3	Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
4	Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
5	Lead	1 year	0.50 µg/m³	none
6	Particles as PM_{10}	1 day	50 µg/m³	5 days a year
Advisory Reporting Standards and Goal for Particles as $PM_{2.5}$				
	Particles as $PM_{2.5}$	1 day 1 year	25 µg/m³ 8 µg/m³	Goal is to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards as part of the review of this Measure scheduled to commence in 2005

Source: (Commonwealth Government of Australia, 2003)

2.1.4 National Environment Protection (Air Toxics) Measure

The overall goal of the *National Environment Protection (Air Toxics) Measure* (NEPM (Air Toxics)) is to improve the information base regarding ambient air toxics within the Australian environment in order to facilitate the development of standards and management of air toxics in ambient air that will allow for the protection of human health and well-being. The NEPM (Air Toxics) establishes 'monitoring investigation levels' for five air toxics:

- Benzene;
- Formaldehyde;
- Benzo(a)pyrene as a marker for Polycyclic Aromatic Hydrocarbons (PAHs);
- Toluene; and
- Xylenes (as total of ortho, meta and para isomers).

The following table presents the five monitoring investigation levels laid out in in Table 2 of Schedule 3 - *Methods for monitoring and assessment of Air Toxics,* and are for use in assessing any air monitoring data, assessing the significance of the monitored levels of air toxics with respect to the protection of human health, and to prompt l further investigation if exceedances warrant such action.

Note: The monitoring investigation level values are levels of air pollution below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short-term it does not mean that adverse health effects automatically occur.

Table 2 Monitoring investigation levels (Air Toxics)

Column 1 Pollutant	Column 2 Averaging period	Column 3 Monitoring investigation level	Goal
Benzene	Annual average*	0.003 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Benzo(a)pyrene as a marker for Polycyclic Aromatic Hydrocarbons	Annual average*	0.3 ng/m^3	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Formaldehyde	24 hours#	0.04 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Toluene	24 hours# Annual average*	1 ppm 0.1 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Xylenes (as total of ortho, meta and para isomers)	24 hours# Annual average*	0.25 ppm 0.2 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.

*For the purposes of this Measure the annual average concentrations in Column 3 are the arithmetic mean concentrations of 24-hour monitoring results.

For the purposes of this Measure monitoring over a 24 hour period is to be conducted from midnight to midnight.

Source: (Commonwealth Government of Australia, 2011)

The above NEPMs set Commonwealth standards for the achievement of ambient air quality goals but are legislated separately in each state jurisdiction. The following section outlines the New South Wales legislation relevant to air pollutants.

2.1.5 The Fuel Quality Standards Act 2000

The *Fuel Quality Standards Act 2000* (the Act) provides a legislative framework for setting national fuel quality and fuel quality information standards for Australia. Fuel quality standards have been made for petrol, diesel, biodiesel, autogas and ethanol E85 (Commonwealth Government of Australia, 2000). If diesel is used to fuel the boiler, sulphur content is limited by the Act.

2.2 State

2.2.1 National Environment Protection Council (New South Wales) Act 1995 (NSW)

The Commonwealth, the States, Territories, and the Australian Local Government Association entered into an agreement known as the *Intergovernmental Agreement on the Environment* setting out certain responsibilities of each party in relation to the environment. That Agreement provides for the establishment of a body to determine national environment protection measures known as the National Environment Protection Council (NEPC). This Act establishes the NEPC within NSW legislation and corresponds with its counterpart the *National Environment Protection Council Act 1994* (Government NSW, 1995 No 4).

2.2.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* is a key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA) and establishes a system of environment protection licensing for 'scheduled' activities which have the potential to significantly impact on the environment (Government NSW, 2012). Schedule 1 of the Act lists these scheduled activities, which are licensed by the EPA. Most 'non-scheduled' activities are regulated by local councils and other local authorities. Part 5.4, sections 124-135, of the Act deals specifically with air pollution and includes a general obligation for the occupiers of non-residential premises to not cause air pollution by failing to operate or maintain plant, carry out work or deal with materials in a proper and efficient manner (Government NSW, 2012).

2.2.3 Protection of the Environment Operations (Clean Air) Regulation 2010

The *Protection of the Environment Operations (Clean Air) Regulation 2010* is made under the *Protection of the Environment Operations Act 1997* and provides for regulation of domestic solid fuel heaters, the control of burning, emissions from motor vehicles and motor vehicle fuels, emissions from activities and plant (such as hospital boilers), the control of volatile organic liquids, and limits on the sulphur content of liquid fuel (used in diesel boilers). This becomes relevant if diesel is used for fuel in the boiler; while the use of gas will be sulphur free (Government NSW, 2010).

2.2.4 Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales

The *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* lists the statutory methods for use in sampling and subsequent analyse of air pollutant emissions from stationary sources and ambient air. This document is referred to in Part 5: Air impurities from emitted activities of the *Protection of the Environment Operations (Clean Air) Regulation 2010*.

2.2.5 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales 2005

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales 2005* lists the statutory methods for use in modelling and assessment of emissions of air pollutants from stationary sources and pollutants in ambient air in NSW. This document is referred to in Part 5: Air impurities emitted from activities and plant, of the *Protection of the Environment Operations (Clean Air) Regulation 2010*.

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales 2005* lists pollutant sources of interest and those relevant for this impact assessment are:

- Sulphur dioxide (SO2);
- Nitrogen dioxide (NO2);
- PM10;
- Total suspended particulate (TSP);
- Deposited dust;
- Carbon monoxide (CO);

Table 3 presents the pollutants of interest and their relevant impact assessment criteria which are then applied at the nearest existing or likely future off-site sensitive receptor in units and averaging periods consistent with the impact assessment criteria. Total impact (modelled incremental impact plus background) are then reported as 100th percentile concentrations or deposition units and compared with the relevant impact assessment criteria (Government NSW, 2005).

Table 3 Impact assessment criteria for SO_2, NO_2, PM_{10}, TSP, deposited dust and CO, Source: (Government NSW, 2005)

Pollutant	Averaging period	Concentration		Source
		pphm	µg/m^3	
Sulfur dioxide (SO_2)	10 minutes	25	712	NHMRC (1996)
	1 hour	20	570	NEPC (1998)
	24 hours	8	228	NEPC (1998)
	Annual	2	60	NEPC (1998)
Nitrogen dioxide	1 hour	12	246	NEPC (1998)

Pollutant	Averaging period	Concentration		Source
(NO_2)	Annual	3	62	NEPC (1998)
PM_{10}	24 hours	-	50	NEPC (1998)
	Annual	-	30	EPA (1998)
Total suspended particulates (TSP)	Annual	-	90	NHMRC (1996)
		g/m^2/month[a]	**g/m^2/month[b]**	
Deposited dust [c]	Annual	2	4	NERDDC (1988)
		ppm	**mg/m^3**	
Carbon monoxide (CO)	15 minutes	87	100	WHO (2000)
	1 hour	25	30	WHO (2000)
	8 hours	9	10	NEPC (1998)

a Maximum increase in deposited dust level.

b Maximum total deposited dust level.

c Dust is assessed as insoluble solids as defined by AS 3580.10.1–1991 (AM-19).

d General land use, which includes all areas other than specialised land use.

e Specialised land use, which includes all areas with vegetation sensitive to fluoride, such as grape vines and stone fruits.

The approved methods also list several other compounds associated with fuel burning emissions. These have associated criteria to be used in a modelling assessment.

3. Existing Conditions

For a development project such as the HPH, the air quality considerations are emissions from both the construction phase and operational phase. The prevailing meteorology and climate affects both the generation of emissions and the dispersion of generated gasses and particulates. Ambient air quality data are useful in defining background levels and may be required in modelling assessments for the construction and operation phases.

3.1 Method

To provide a firm and reliable basis for prediction of environmental effects as they relate to air quality, the general climate and atmospheric dispersion characteristics of the study area need to be characterised and existing pollutant levels from HPH and the surrounding community assessed.

An overview of the regional environmental setting includes the prevailing climate and any variations across the extent of the project. Rainfall does not have a direct influence on dispersion but is an important aspect during construction as it will affect dust generation and contingencies for construction days lost. A more detailed description of local atmospheric dispersion requires knowledge of wind and stability patterns, both of which are important for distribution of pollutants such as dust (construction) and gases (boiler emissions during operation).

Climatic data is used to define the relevant meteorology that has the potential to influence the air quality of the area, and includes temperature, wind and rainfall:

- Bureau of Meteorology (BoM) long-term climatic information is used to define meteorological elements within the study area;
- Dispersion meteorology is defined by examining the local wind patterns and derived parameters inclusive of atmospheric stability classification;
- The BoM Automatic Weather Station (AWS) sites at Sydney Airport (Mascot) and at Bankstown Airport are compared to allow site specific determination of prevailing winds for the project area.

Background ambient levels of pollutants are described herein as these have relevance for demonstrating existing conditions and also in any modelling of air quality impacts should these be required. Background pollutant levels need to be considered so that the addition of any project-generated emissions do not cumulatively exceed policy levels. The project is in an urban location approximately 5 km southwest of the Earlwood ambient monitoring station which will provide suitable ambient (default background) air quality data for the development.

An overview of the existing emissions from equipment/plant being used at the HPH for the generation of hot water, back up electricity and any other sources that generate emissions to air are described.

3.2 Meteorology

Two stations were identified as having climate data relevant to the study, namely Bankstown Airport automatic weather station (AWS) which is located approximately 10.5 km northwest of HPH and the Sydney Airport (AWS) which is located approximately 7 km northwest of HPH, see Figure 2.

The Bankstown Airport has been a Bureau of Meteorology (Site number: 066137) climatic observing site since 1968, located at Latitude 33.9181°S and Longitude 150.9864°E (elevation: 6.5 m). The rainfall and temperature records both date back 44 years.

The Bankstown Airport area averages 874 mm of rainfall annually, with monthly mean temperatures ranging from 5.1 to 28.2 degrees Celsius. Annual average 9 am and 3 pm relative humidity values are 72 and 52 percent respectively. Wind speeds are on average higher in the afternoon, averaging 18 km/hr at 3 pm compared to 8.1 km/hr in the morning (9 am).

The Sydney Airport has been a Bureau of Meteorology (Site number: 066037) climatic observing site since 1929, located at Latitude 33.9465°S and Longitude 151.1731°E (elevation: 6 m) with the rainfall record dating back 83 years and the temperature record dating back 73 years.

The Sydney Airport area has a higher average rainfall (1085 mm) compared to Bankstown Airport, due to its more coastal location. Monthly mean temperatures range from 7.1 to 26.5 degrees Celsius with annual average 9 am and 3 pm relative humidity values of 69 and 57 percent respectively. Wind speeds are higher than those measured at Bankstown Airport, averaging 21.6 km/hr at 3 pm and 14.2 km/hr in the morning (9 am).

The Sydney Airport site is more coastal and has been collecting BoM data for approximately 83 years (since 1929) while Bankstown Airport has been recording since 1968 (approximately 44 years). The Sydney Airport climate data was used for detailed characterisation of atmospheric stability due to availability of data.

3.2.1 Climate

In order to describe the climate of this area, meteorological data was used from either side of the study area at Bankstown Airport and Sydney Airport. The climate in and around both the Bankstown Airport and Sydney Airport areas is classified as ‘temperate’ with ‘no dry season (warm summer)’. This classification is based on the Australian objective classification system set out on the BoM website (Stern, Hoedt, & Ernst, 2000).

3.2.2 Meteorological Site Descriptions

The Bankstown Airport has been a Bureau of Meteorology (Site number: 066137) climatic observing site since 1968, located at Latitude 33.9181°S and Longitude 150.9864°E (elevation: 6.5 m). The rainfall and temperature records both date back 44 years.

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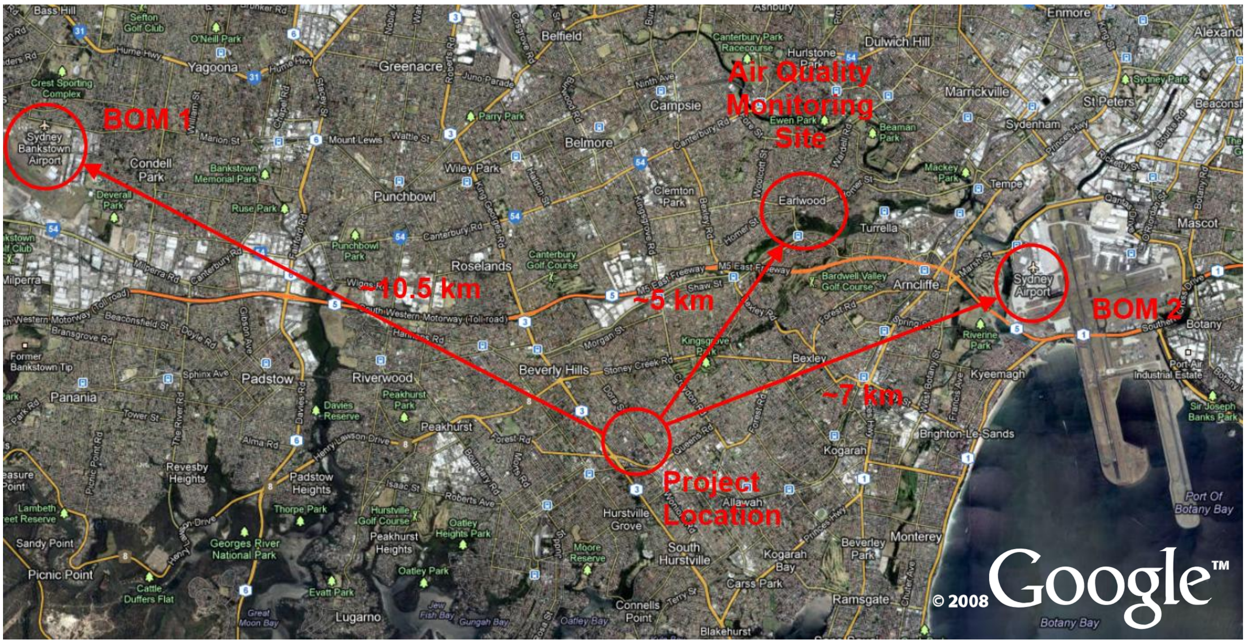
Figure 2 Climate Site Locations



3.2.3 Temperature

Monthly mean temperatures for Bankstown Airport and Sydney Airport are displayed in Figure 3 and Figure 4 respectively, these show the seasonal variation one would expect for the temperature range of a temperate climate. Monthly mean minimums with their associated upper and lower 10 percentiles (deciles 1 and 9) are shown in blue while monthly mean maximums with their associated deciles are shown in red.

Monthly mean temperatures for Bankstown Airport show daytime summer temperatures are between 23 and 34 degrees with winter overnight temperatures most commonly between 2 and 9 degrees. The temperature record of approximately 44 years shows values ranging from -4 to 44.8 degrees. 'Hot days', with temperatures exceeding 35 degrees, can be expected on average up to 9 days per year. 'Frost days' with screen temperatures below 2 degrees occur on average 8.5 days per year.

Monthly mean temperatures for Sydney Airport show daytime summer temperatures are between 21 and 32 degrees with winter overnight temperatures most commonly between 4 and 11 degrees. The temperature record of approximately 73 years shows extreme values ranging from -0.1 to 45.2 degrees. 'Hot days', with temperatures exceeding 35 degrees, can be expected on average up to 5 days per year. 'Frost days' with screen temperatures below 2 degrees occur on average less than one day per year. These frost days occur less frequently than at Bankstown Airport as Sydney Airport is buffered more by the coastal influence of significant water bodies.

Note: The 'screen temperature' is measured in a double louvered Stevenson screen (white wooden box) between 1 and 1.2 m above the ground. The ground temperature during calm pre-dawn morning conditions can be up to two degrees lower than the minimum temperature measured in the screen, therefore two degrees can be considered the 'frost' point, see: http://www.bom.gov.au/climate/cdo/about/definitionstemp.shtml

Figure 3 Monthly mean and decile (10% and 90%) maximum and minimum temperatures (^{0}C) at Bankstown Airport (site number 066137)

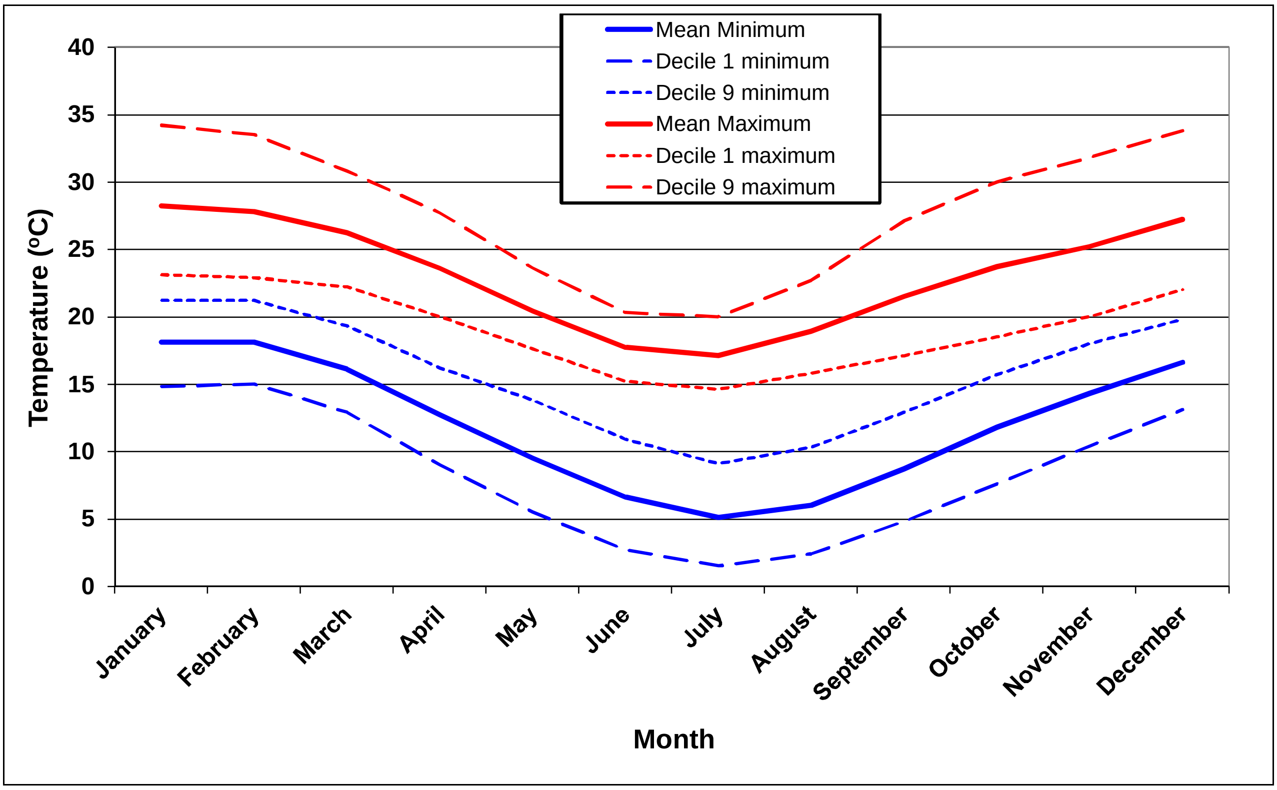
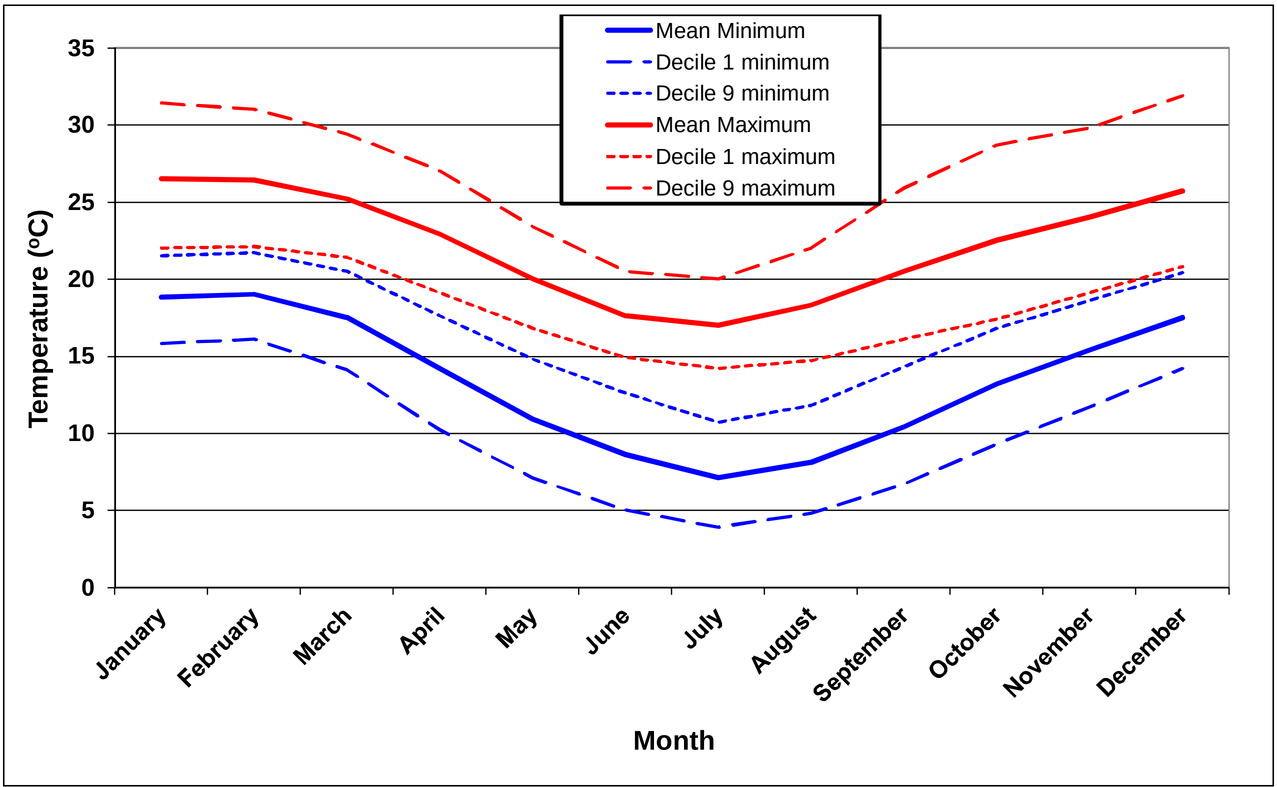


Figure 4 Monthly mean and decile (10% and 90%) maximum and minimum temperatures (^{0}C) at Sydney Airport (site number 066037)



3.2.4 Rain

Rain is important during the construction phase of the Project as during and after rain events, construction dust will be reduced. Additionally, if it is too wet, construction may be required to halt for the day. Hence, the contractor should have sufficient contingency days built into the construction timeline.

The annual mean rainfall at Bankstown Airport is just over 874 mm and is relatively evenly spread throughout the year by proportion, which is consistent with a temperate climate. However, there is a bias toward a pattern of heavier summer and autumn rainfall occurring. A similar spread with a pattern of heavier autumn and early winter rainfall occurs at Sydney Airport. The annual average rainfall of 1085 mm at Sydney Airport is higher than Bankstown Airport, The wettest month at the Bankstown Airport on average is February, with a mean of 107.5 mm and the driest month is September, with a mean of 45.1 mm. The wettest month at Sydney Airport is June, with a mean of 199.8 mm and the driest month is also September with a mean of 60.8 mm. The annual rainfall from the Bankstown Airport site ranges from 493 to 1398 mm while at Sydney Airport rainfall ranges from 523 to 2025 mm. The mean numbers of rain days per year are 114.8 and 128.8 respectively. Figure 5 and Figure 6.

The wettest month at the Bankstown Airport on average is February, with a mean of 107.5 mm and the driest month is September, with a mean of 45.1 mm. The wettest month at Sydney Airport is June, with a mean of 199.8 mm and the driest month is also September with a mean of 60.8 mm. The annual rainfall from the Bankstown Airport site ranges from 493 to 1398 mm while at Sydney Airport rainfall ranges from 523 to 2025 mm. The mean numbers of rain days per year are 114.8 and 128.8 respectively.

Figure 5 Monthly mean rainfall at Bankstown Airport (site number 066137)

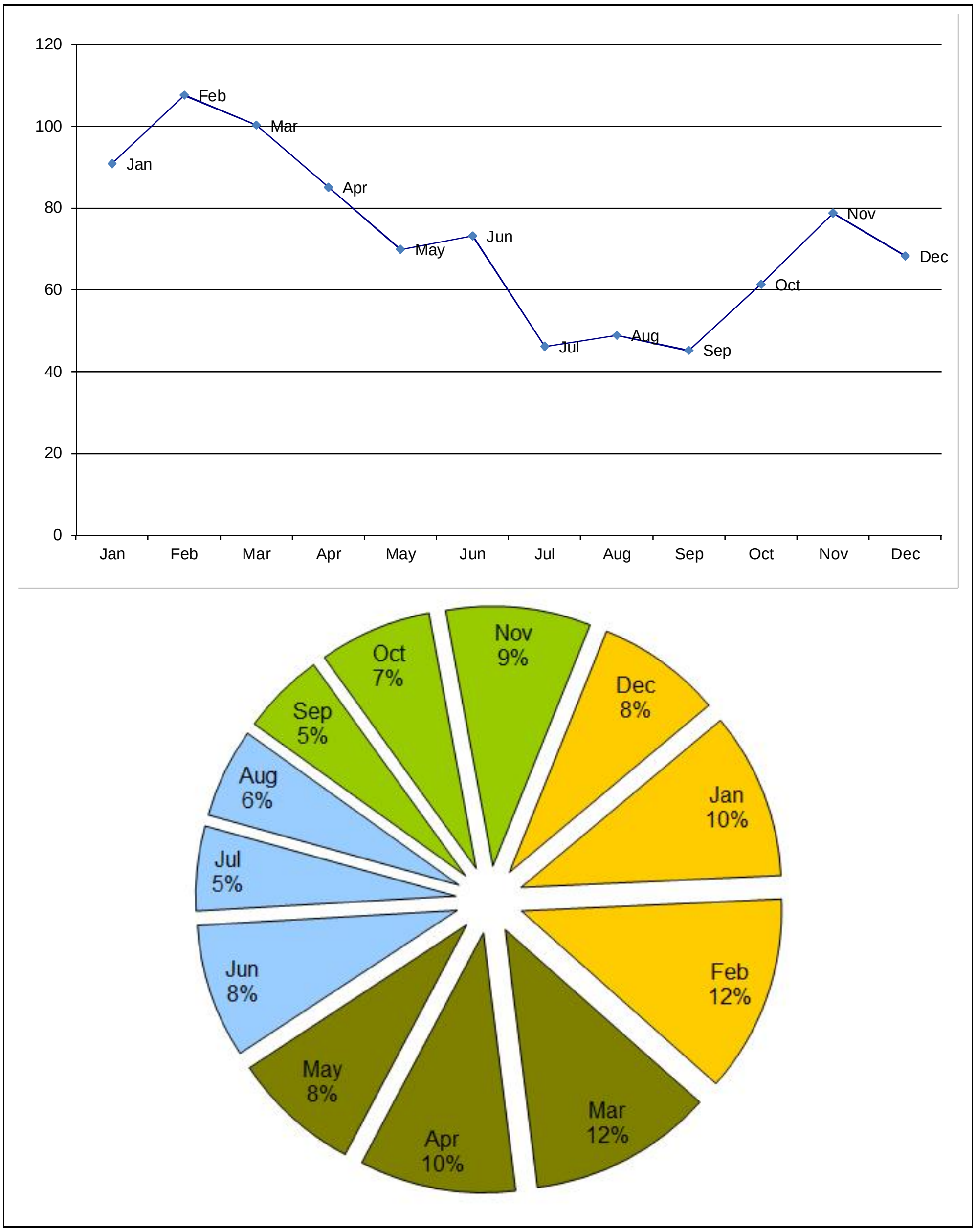
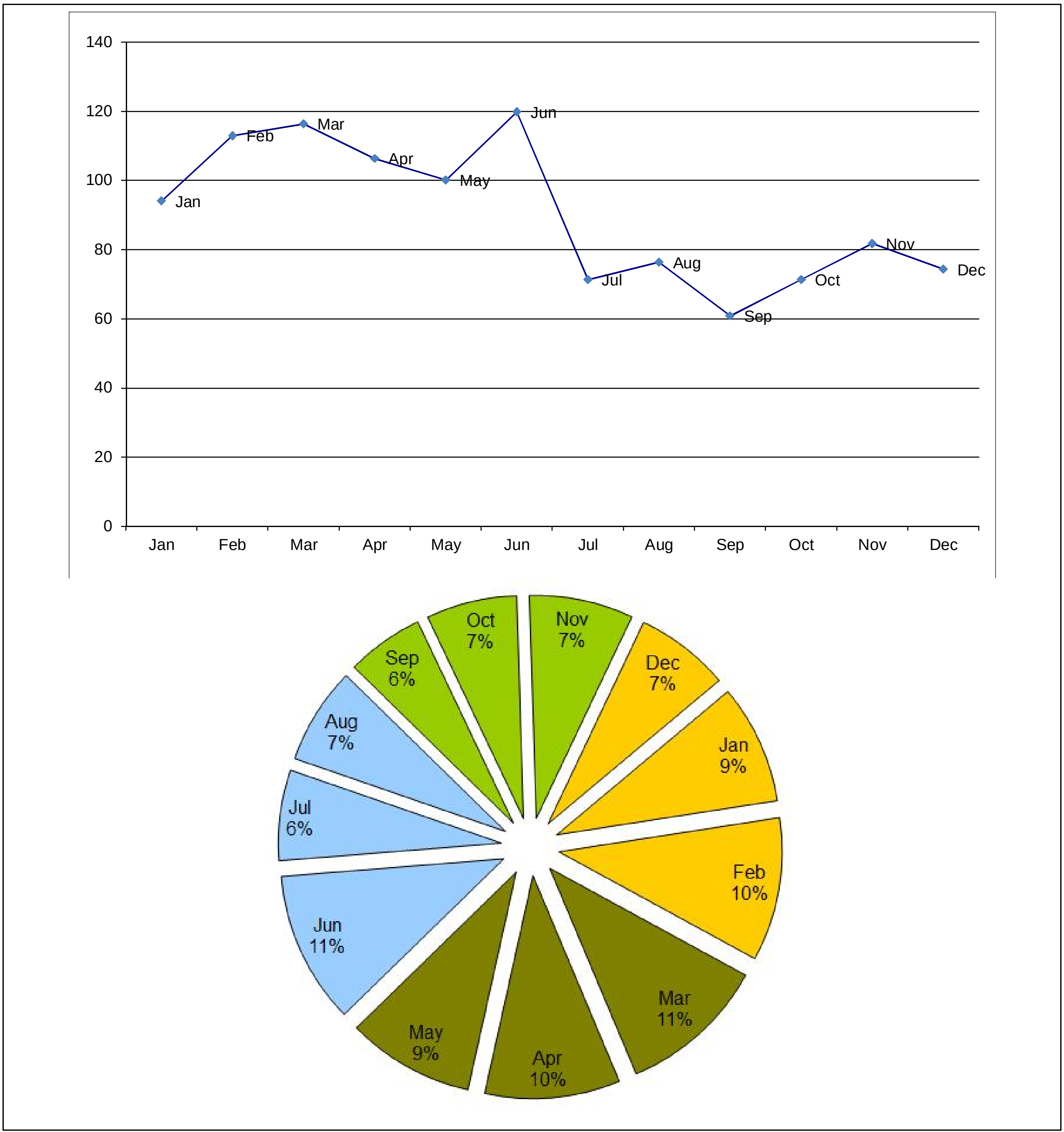


Figure 6 Monthly mean rainfall (mm) at Sydney Airport (site number 066037)

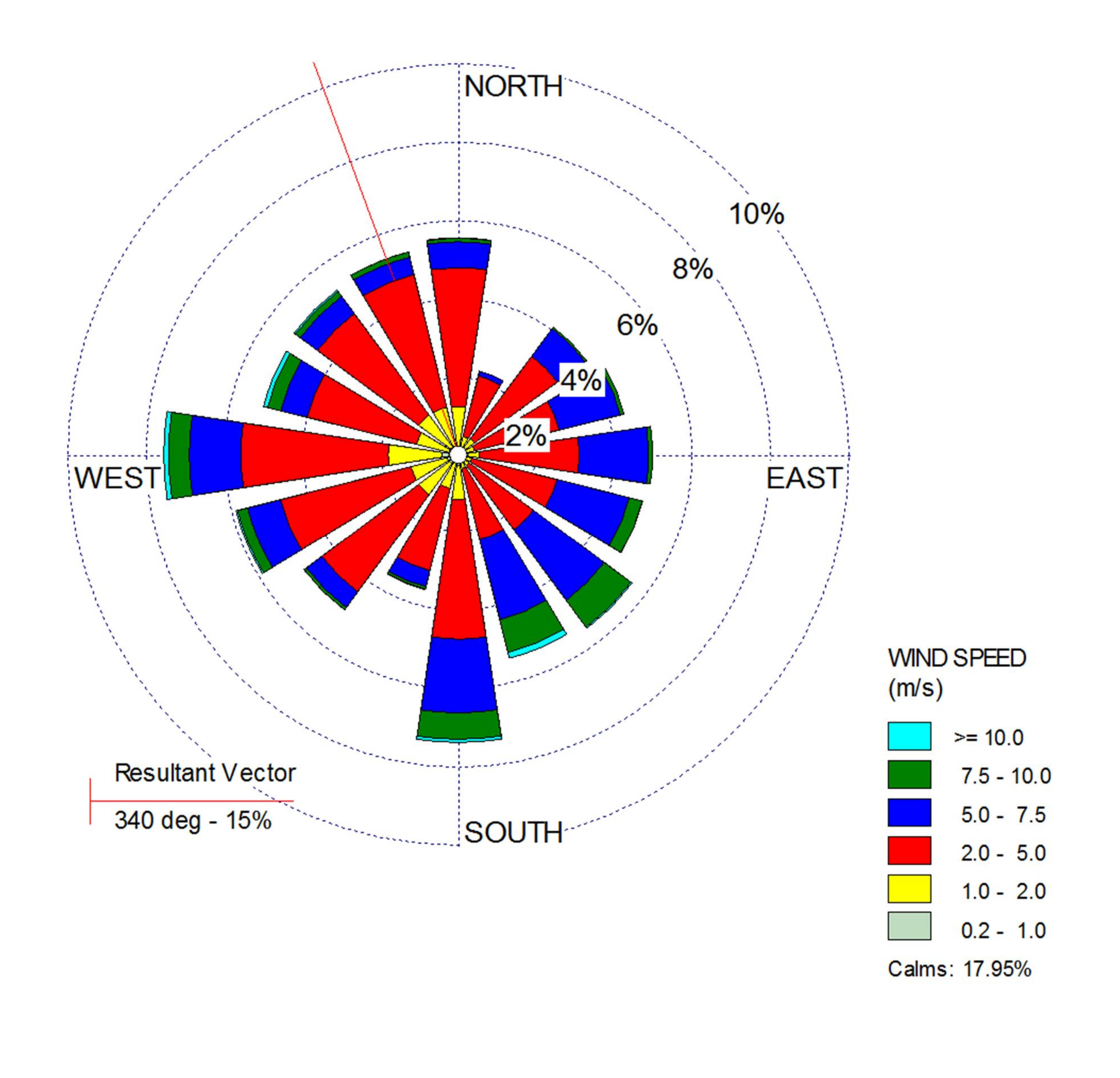


3.2.5 Wind

In order to describe the wind and atmospheric dispersion patterns around the Hurstville Private Hospital redevelopment, a meteorological data file was constructed from regional weather observations including temperature and winds from the BoM Automatic Weather Stations (AWS) at both Bankstown and Sydney Airports. Figure 7 and Figure 9 show the average annual windroses for the Bankstown Airport and Sydney Airport sites for the period 01 January 2007 to 09 May 2012. While Figure 8 and Figure 10 show the seasonal windroses for the Bankstown Airport and Sydney Airport sites respectively.

Annual average wind speeds are greater at the Sydney airport site with values of 3.09 m/s and 5.66 m/s for Bankstown Airport and Sydney Airport sites respectively. These increased wind speeds are clearly demonstrated in Figure 7 and Figure 9 with a greater proportion of light blue and green windspeed classes present in the Sydney Airport windrose.

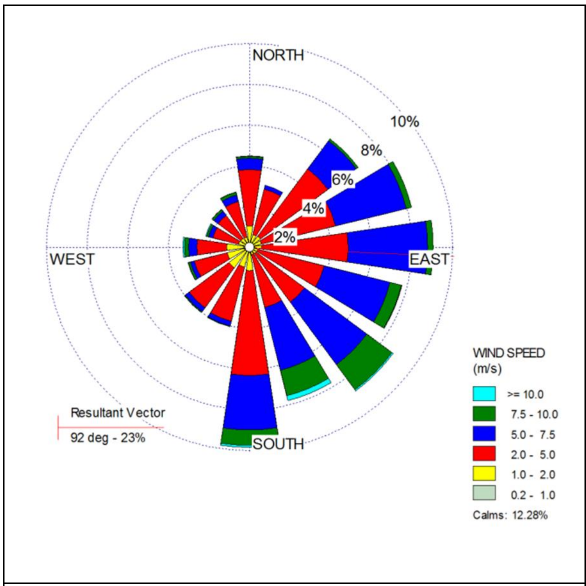
Figure 7 Annual Windrose for Bankstown Airport from 01 January 2007 to 09 May 2012



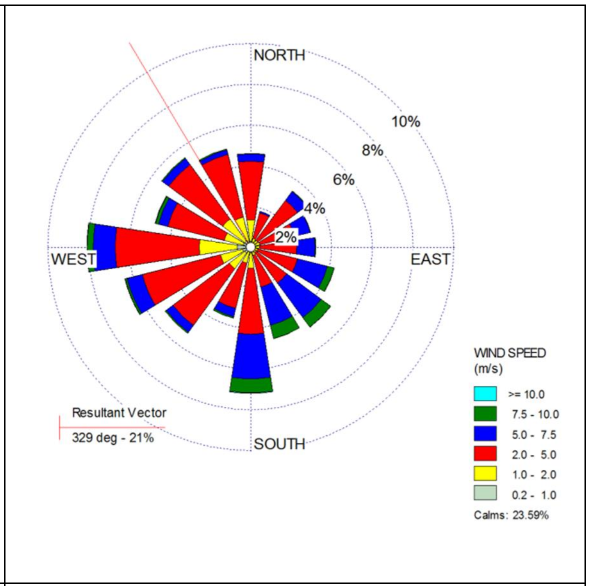
It can be seen that there is a broad distribution of flows with a slight dominance from the south and westerly directions and less flow from the north-northeast and south-southwest directions.

Figure 8 presents seasonal wind roses for Bankstown Airport showing the average wind distribution during the period from 2007 to 2012. Prevailing wind directions from the south and west switch to the west during winter. Winds are lightest during the late autumn and winter months with easterlies during the summer due to sea breeze.

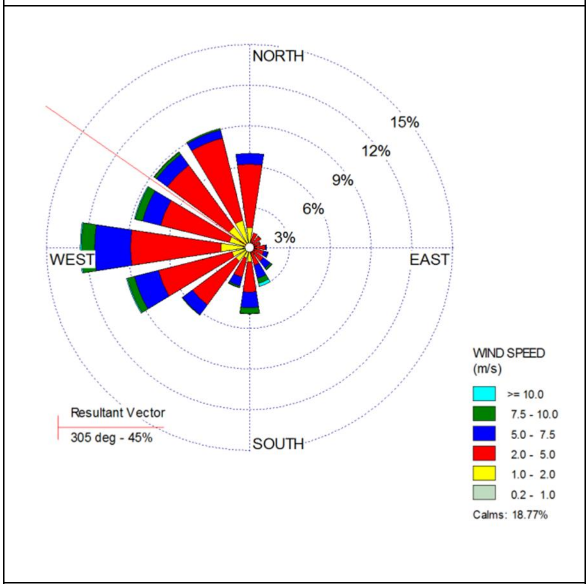
Figure 8 Seasonal Windroses for Bankstown Airport from 01 January 2007 to 09 May 2012



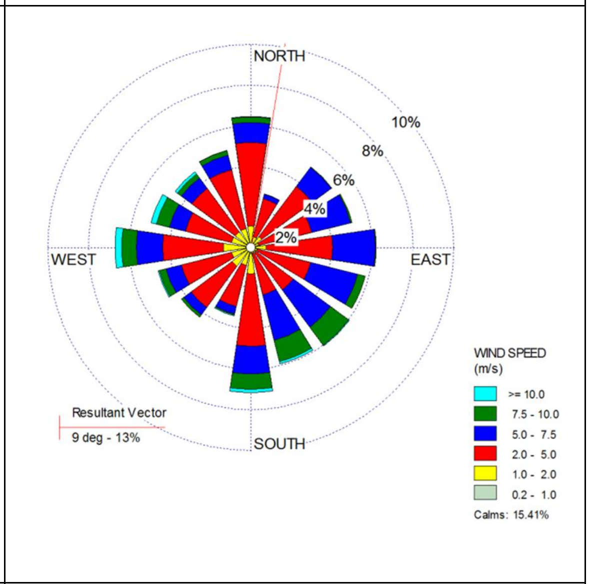
Summer



Autumn



Winter



Spring

Figure 9 Annual Windrose for Sydney Airport from 01 January 2007 to 09 May 2012

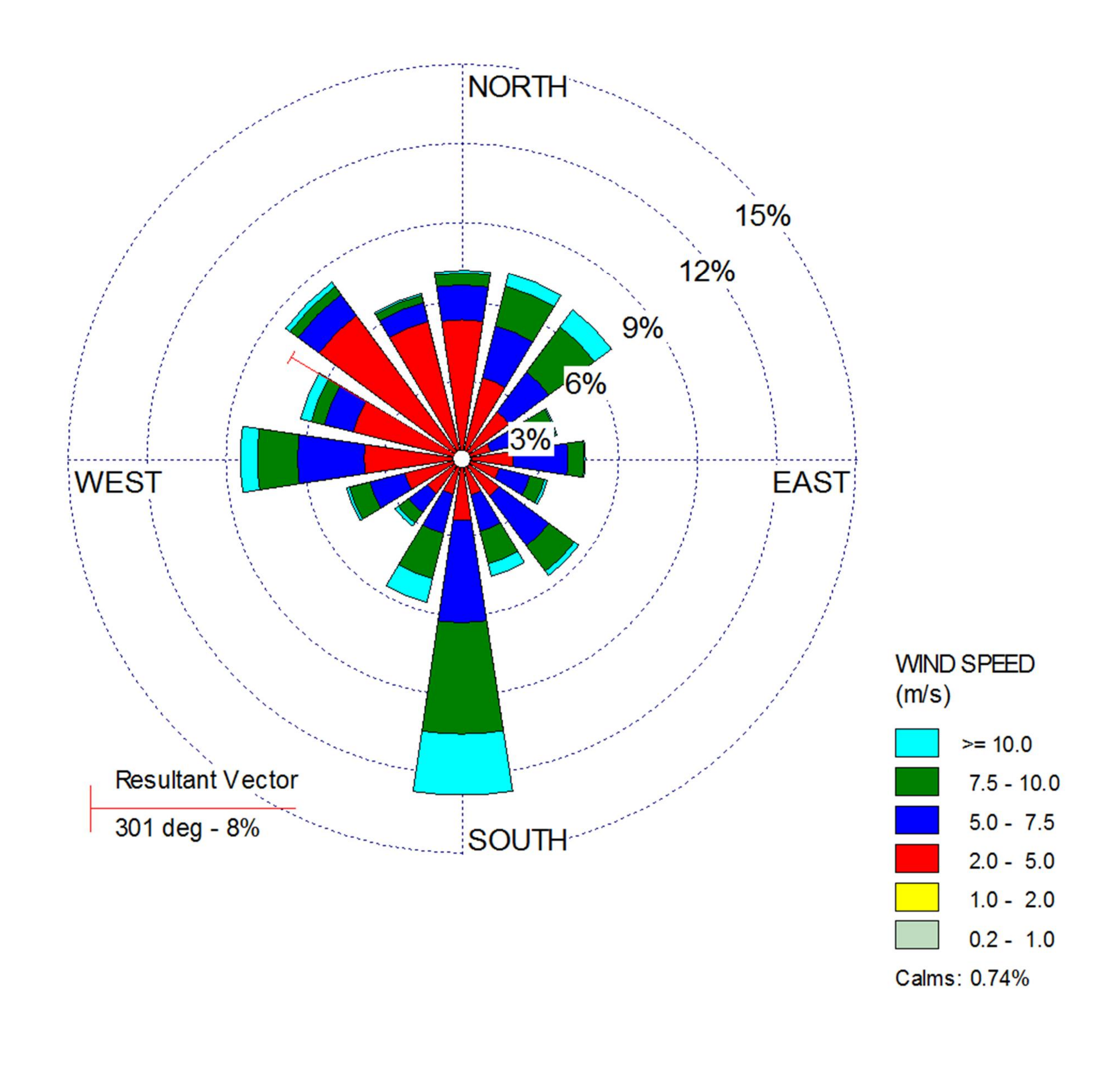
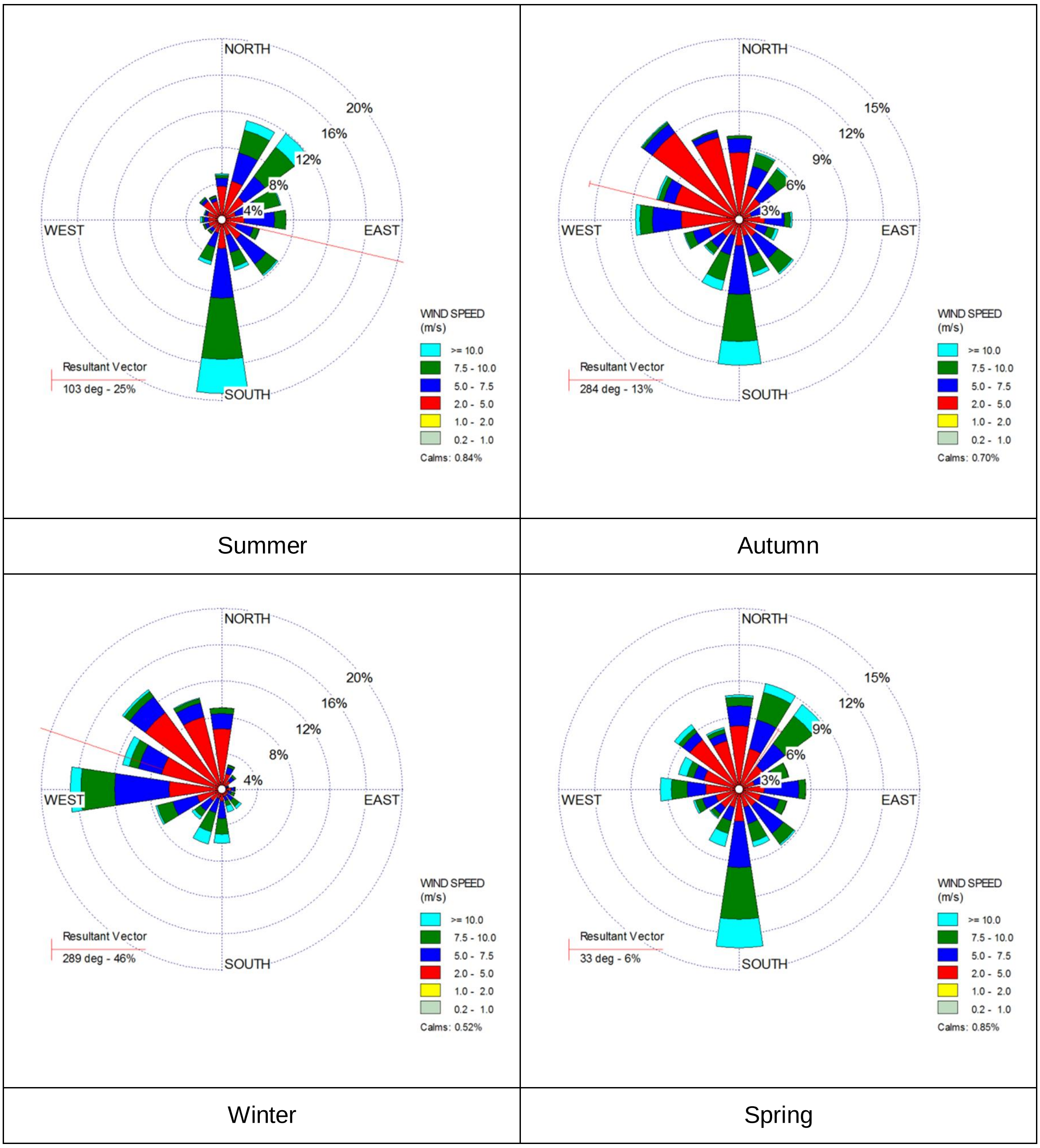


Figure 10 presents seasonal wind roses for Sydney Airport showing the average wind distribution during the period from 2007 to 2012. Prevailing wind directions from the south during spring and summer and switch to the west during late autumn and winter. Winds are lightest during the late autumn and winter months.

Figure 10 Seasonal Windroses for Sydney Airport from 01 January 2007 to 09 May 2012



3.2.6 Stability

Atmospheric stability describes the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a function of the amount of turbulent energy in the atmosphere. For a redevelopment project such as the HPH, dust from construction activity and gases from boiler emissions may need to be assessed for their environmental impact away from the source.

There are generally six Pasquill–Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). A seventh class, ‘G’, can also be utilised in cases where climate data are highly stable, although this is not commonly used in describing Australian climates due to their greater variability. The climate parameters of wind speed, cloud cover and solar insolation are used to define the stability category as shown in Table 4, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of stability category. Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table 4 Stability Category Relationship to Wind Speed, and Stability Characteristics

Stability Category	Wind Speed Range (m/s)	Stability Characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occur near the middle of day, with very light winds, no significant cloud.
B	0 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud.
C	0 – 6	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud.
D	0 – ≥6	Neutral atmospheric conditions. Occur during the day or night with stronger winds, or during periods of total cloud cover, or during the twilight period
E	1.9 – 5.4	Slightly stable atmospheric conditions occur during the night-time with significant cloud and/or moderate winds
F	0 – 3.3	Moderately stable atmospheric conditions occur during the night-time with no significant cloud and light winds

From both figures it can be seen that annually Sydney Airport’s average atmospheric stability lies within the neutral condition (class D) at 55.9 percent of the time with a lesser amount of time spent in the stable classes of E and F for 23.5 percent. Atmospheric instability does occur however, with classes A, B and C experienced for 20.5 percent of the year. Categories E and F denote slightly and moderately stable atmospheres when dispersion is poorest for ground based emissions (such as hospital construction and plant operation) as vertical mixing of air is suppressed. Stable atmospheric conditions occur in the absence of strong gradient winds, and mostly on nights with clear skies. They are often associated with ground-based radiation forced temperature inversions, sometimes with frost, mist or fog.

Mechanically generated dust emissions from construction equipment will have a larger range of impact under these stable conditions.

Figure 11 below shows the average annual stability rose for the Sydney Airport for the period 01 January 1997 to 31 December 1997. Further information can be gained by looking at a frequency histogram of the same data such as in the lower portion of Figure 12 below.

From both figures it can be seen that annually Sydney Airport’s average atmospheric stability lies within the neutral condition (class D) at 55.9 percent of the time with a lesser amount of time spent in the stable classes of E and F for 23.5 percent. Atmospheric instability does occur however, with classes A, B and C experienced for 20.5 percent of the year. Categories E and F denote slightly and moderately stable atmospheres when dispersion is poorest for ground based emissions (such as hospital construction and plant operation) as vertical mixing of air is suppressed. Stable atmospheric conditions occur in the absence of strong gradient winds, and mostly on nights with clear skies. They are often associated with ground-based radiation forced temperature inversions, sometimes with frost, mist or fog.

Mechanically generated dust emissions from construction equipment will have a larger range of impact under these stable conditions.

Figure 11 Annual Stability Rose for Sydney Airport from 01 January 1997 to 31 December 1997

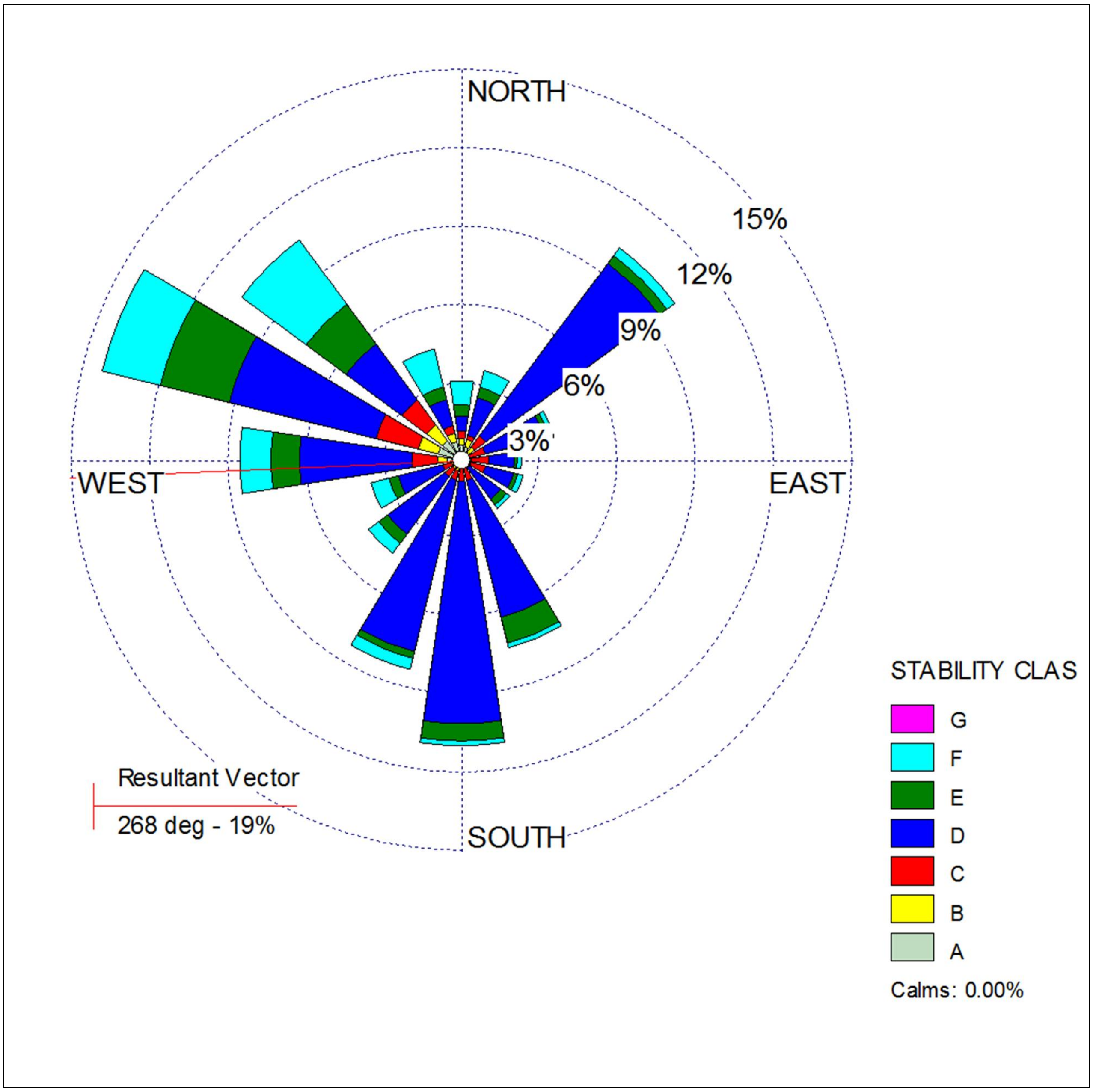
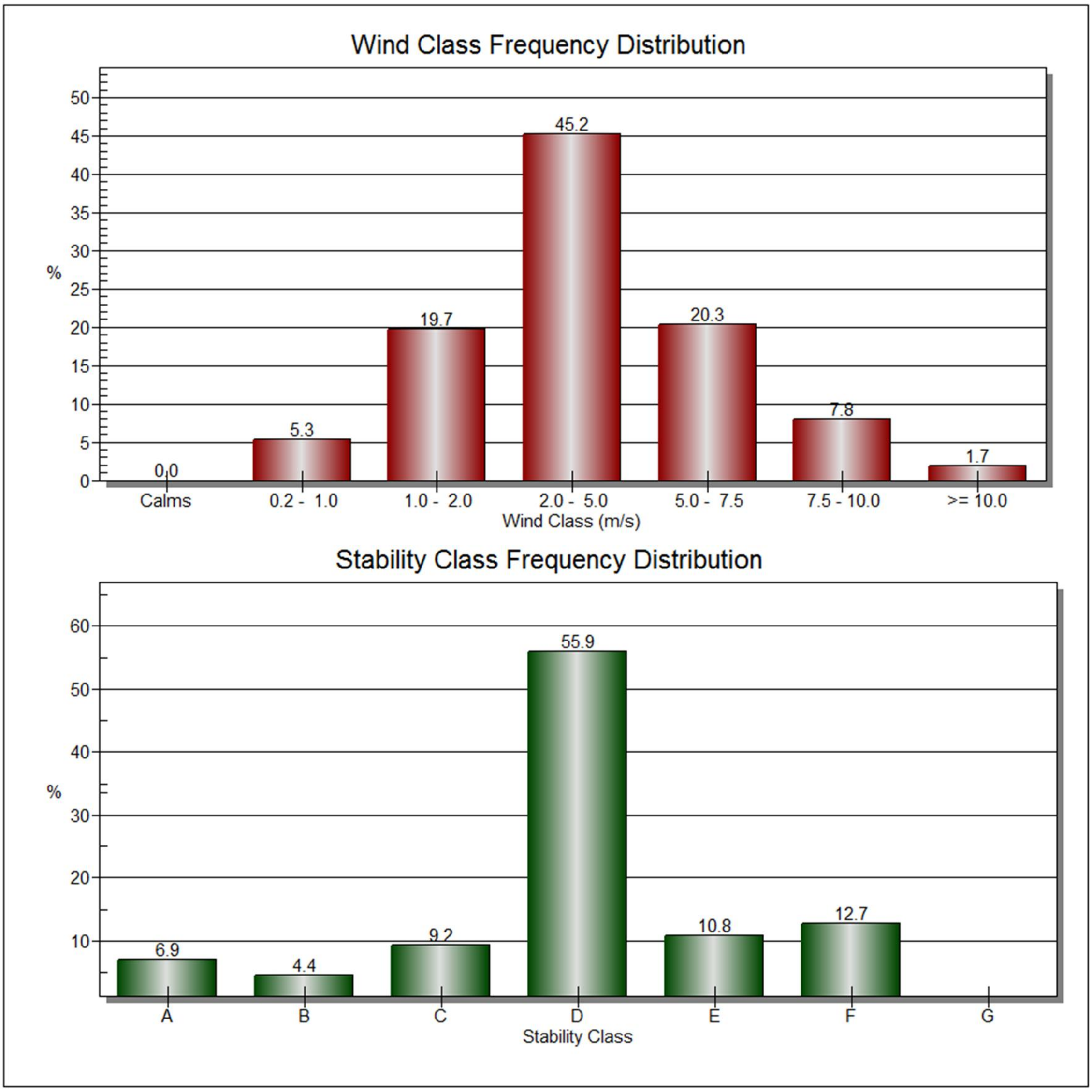


Figure 12 Annual Frequency Distributions for Sydney Airport from 01 January 1997 to 31 December 1997

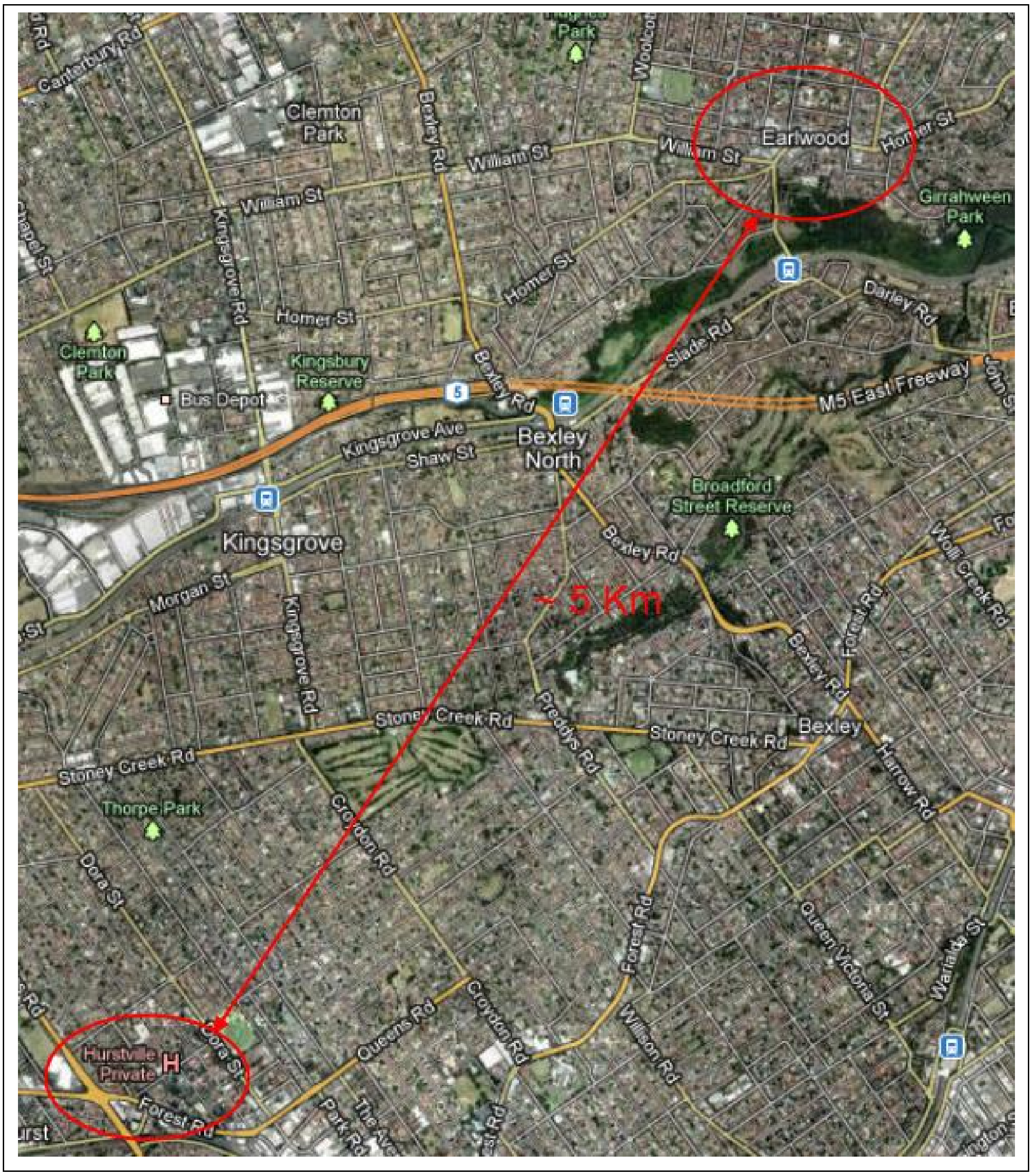


3.3 Ambient Air Quality

3.3.1 Monitoring Sites

The closest OEH air quality monitoring site to the Hurstville Project is the Earlwood site which is located approximately 5 km northeast of the proposed redevelopment and is considered representative of the Project, see Figure 13.

Figure 13 Location of the Earlwood Air Quality Monitoring Station



The Earlwood air quality monitoring site is located in Beaman Park, off Riverview Road, Earlwood and is situated in a residential area in the Cook's River valley, at an elevation of 7 metres. The Earlwood site is situated within the Department of Environment and Conservation (DEC)'s East Sydney region and monitors the parameters (Government NSW, 2012):

- Nitrogen dioxide (NO2)
- Ozone
- PM10
- PM2.5
- NEPH

Earlwood does not currently monitor Carbon monoxide (CO), hence a second monitoring site further northeast at Rozelle was used for CO as this is the next closest monitoring location to the HPH project. The Rozelle air quality monitoring site was commissioned in 1978 and is located in the grounds of Rozelle Hospital, off Balmain Road, Rozelle. It is situated in a residential area in the Parramatta River valley and is at an elevation of 22 metres and lies within the DEC's East Sydney region (Government NSW, 2012).

NOTE: The Rozelle site does not currently comply with Australian Standard AS/NZS 3580.1.1:2007 - Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment as the clear sky angle is < 120º due to trees within 20 metres to the west of the monitoring site (Government NSW, 2012).

Earlwood does not monitor Sulphur dioxide (SO_2) either, so two alternative monitoring sites either side of the Hurstville hospital were chosen as representative of the HPH. The first site is located inland to the northwest at Chullora and the second is located east toward the coast at Randwick. Data from these sites for the period 01 January 2005 to 12 June 2012 were assessed in order to describe background SO_2 levels for the project.

Air quality monitoring as part of the National Environmental Protection (Ambient Air Quality) Measure (NEPM (Air)) monitoring program has been carried out by the NSW Government (OEH & EPA) at a number of sites throughout the Sydney region. A brief overview of the Sydney regional air quality monitoring program has been included within each pollutant summary section outlined in Section 0 below. The Sydney monitoring program has been divided into the following subregions of which only the Sydney East region is relevant to this project:

- Sydney North West;
- Sydney South West; and
- Sydney East.

The NEPM (Air) provides national environment protection standards and goals for six pollutants outlined in Schedule 1 – *Pollutants* of the NEPM (Air) and defines maximum concentrations and goals for these pollutants in column 4 and 5 of tables 1 and 2 in Schedule 2-*Standards and Goal.* The NEPM (Air) requires monitoring of these pollutants to determine '*whether the standards of this measure are being met'* or to determine '*the extent of the difference between the measured concentration of the pollutants in the air and the standards'*.

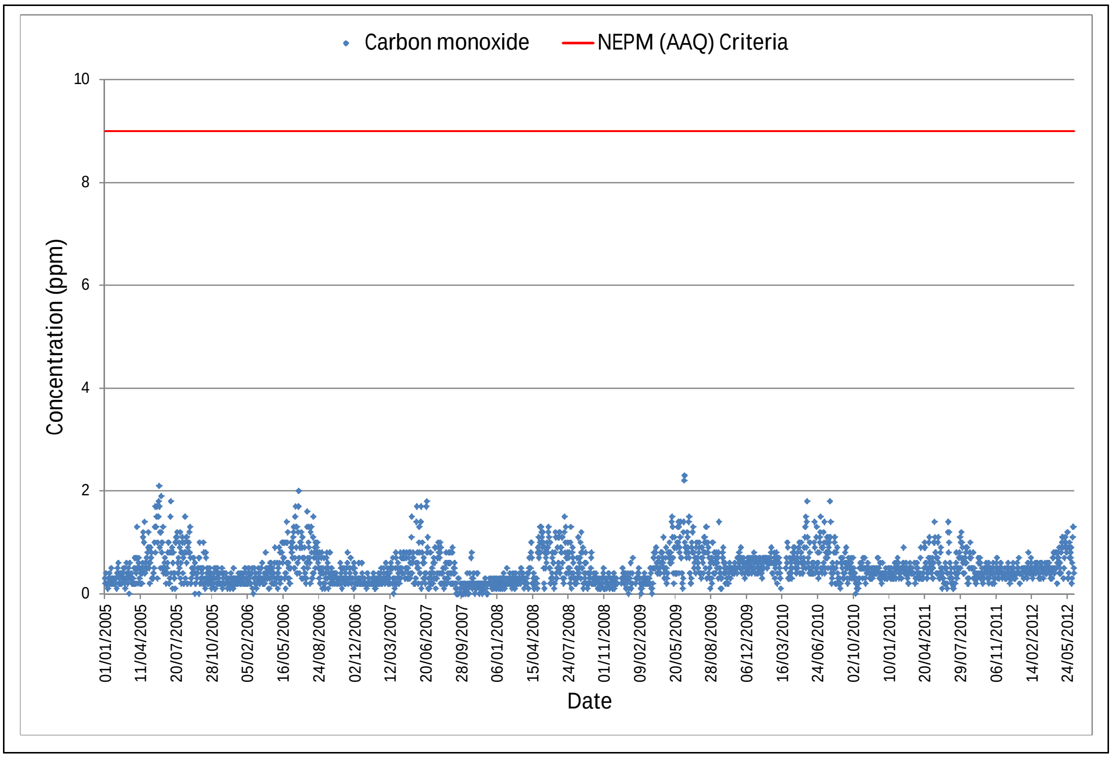
3.3.2 Current Ambient Air Quality

The sections that follow summarise the monitoring that has been carried out in and around the Hurstville Hospital area, Sydney NSW.

Carbon monoxide (CO)

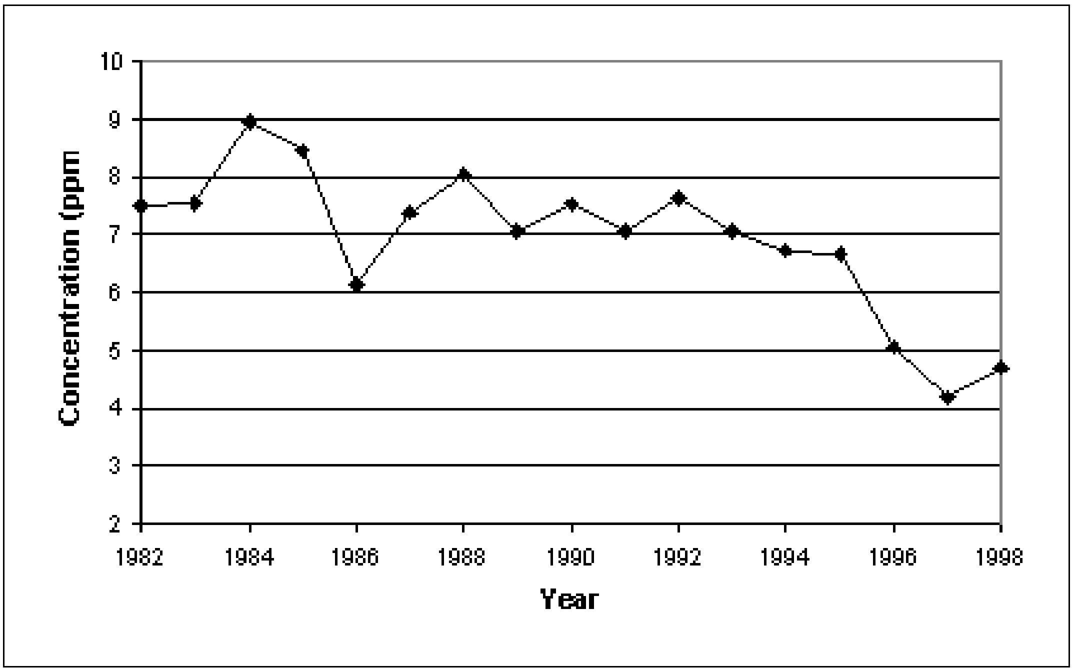
The closest Carbon monoxide (CO) monitoring site to the Hurstville hospital is located north east at Rozelle. Data from this site for the period 01 January 2005 to 12 June 2012 was assessed in order to describe back ground levels for the project. The *National Environment Protection (Ambient Air Quality) Measure* goal and the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales impact assessment criteria* for Carbon monoxide are based on an 8 hour rolling average and aims to achieve a maximum monitored ambient value of 9.0 ppm (10 mg/m^3) with only one exceedance day per year (Commonwealth Government of Australia, 2003), (Government NSW, 2005). The maximum rolling 8-hour average is calculated between 01.00 am and 12.00 midnight, values for the last seven and a half years are displayed in Figure 14 below and demonstrate levels well below the criteria values. The maximum 8 hour rolling average CO concentration at Rozelle during the 7.5 year monitoring period was 2.3 ppm with a mean value of 0.5 ppm. An adopted background value of 2.3 ppm (100th percentile) has been chosen as this is the most conservative.

Figure 14 Maximum Rolling 8-hour average of Carbon monoxide from 01 January 2005 – 12 June 2012



Long term CO monitoring at the peak station in the Sydney CBD on the corner of George and Market Streets is specifically located as a peak site for the impact of emissions from motor vehicles and provides an upper bound to concentrations in the Sydney air shed (Government NSW, 2012). The George and Market Street site has shown CO to be steadily reducing as motor vehicle control technology improves, see Figure 15 (Government NSW, 2012).

Figure 15 Annual 90th percentile concentration of 8-hour CO, Sydney CBD



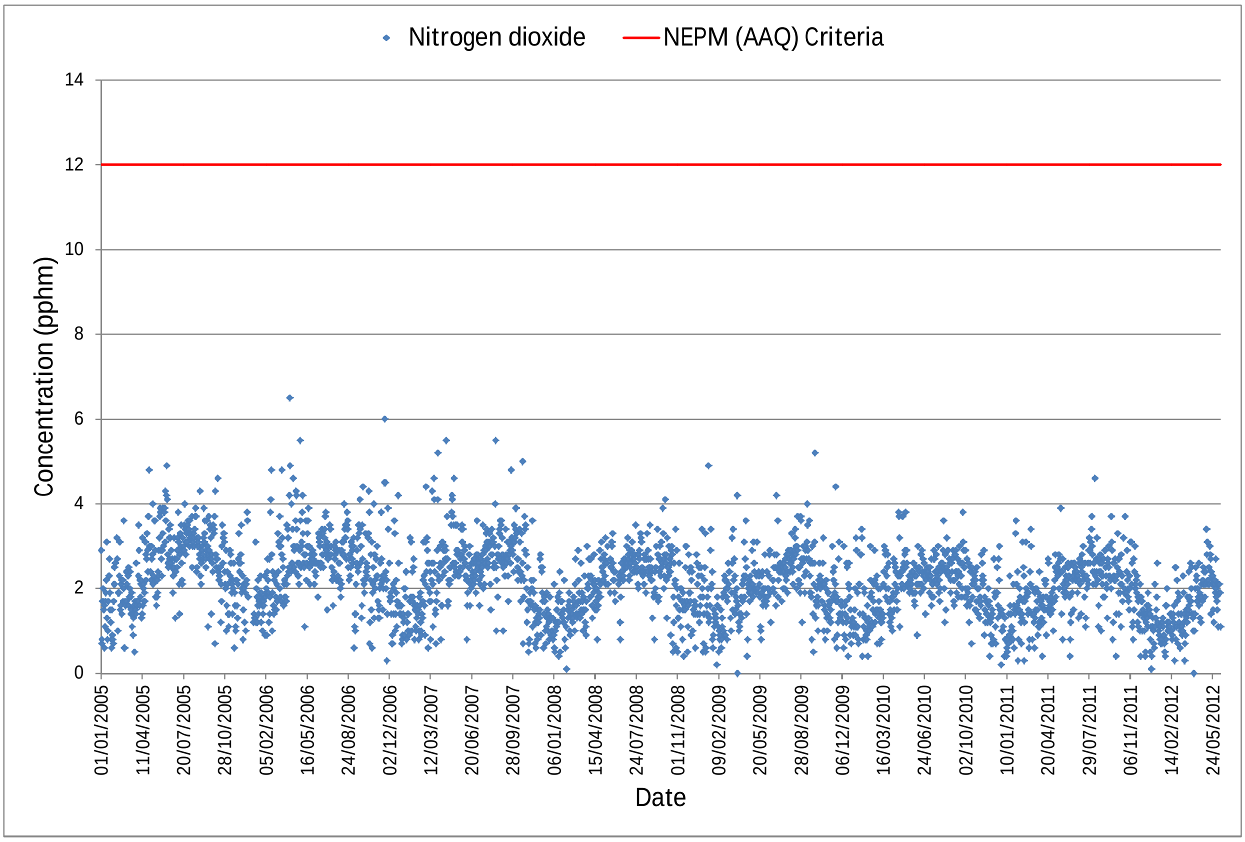
Source: http://www.environment.nsw.gov.au/air/nepm/301sydney.htm

Nitrogen dioxide (NO_2)

The closest Nitrogen dioxide (NO_2) monitoring site to the Hurstville hospital is located north east at Earlwood. Data from this site for the period 01 January 2005 to 12 June 2012 was assessed in order to describe back ground levels for the project. The NEPM (Air) aims to achieve a 1 hour average NO_2 of 0.12 ppm (12 pphm) with only one exceedance day per year and an annual average of 0.03 ppm with no exceedances.

The maximum 1 hour average NO_2 concentration at Earlwood during the 7.5 year monitoring period was 6.5 pphm with a mean value of 2.1 pphm. An adopted background value of 6.5 pphm has been chosen as this is the most conservative. The maximum 1-hour average values for the last seven and a half years are displayed in Figure 16 below and demonstrate levels well below the NEPM (Air) goal.

Figure 16 Maximum 1-hour average of Nitrogen dioxide from 01 January 2005 – 12 June 2012



Elevated concentrations of nitrogen dioxide tend to occur in or close to heavily urbanised areas throughout the year in Sydney from both direct emission and production by secondary processes. During the autumn and winter periods, elevated concentrations tend to occur later in the day under more stable atmospheric conditions when air dispersion is limited and are often associated with elevated concentrations of particulate matter. During the summer period elevated concentrations can occur due to photochemical smog reactions and are often associated with morning and afternoon peak hours (Government NSW, 2012).

Historically, for the period 1996-98 there were a total of 24 days when nitrogen dioxide concentrations were greater than 8 pphm, 12 occurring during the summer/spring and 12 during the autumn/winter months (Government NSW, 2012).

Table 5 Sydney nitrogen dioxide concentrations for period 1996-98

Station	Subregion	1-hour concentrations (ppm)			Season of maximum
		Maximum	99th percentile	90th percentile	
Earlwood	East	0.09	0.04	0.03	Autumn
Lidcombe	East	0.13	0.04	0.03	Summer
Lindfield	East	0.07	0.04	0.02	Winter
Randwick	East	0.09	0.04	0.03	Summer
Rozelle	East	0.08	0.05	0.03	Autumn
Woolooware	East	0.09	0.04	0.02	Autumn

Source: http://www.environment.nsw.gov.au/air/nepm/301sydney.htm

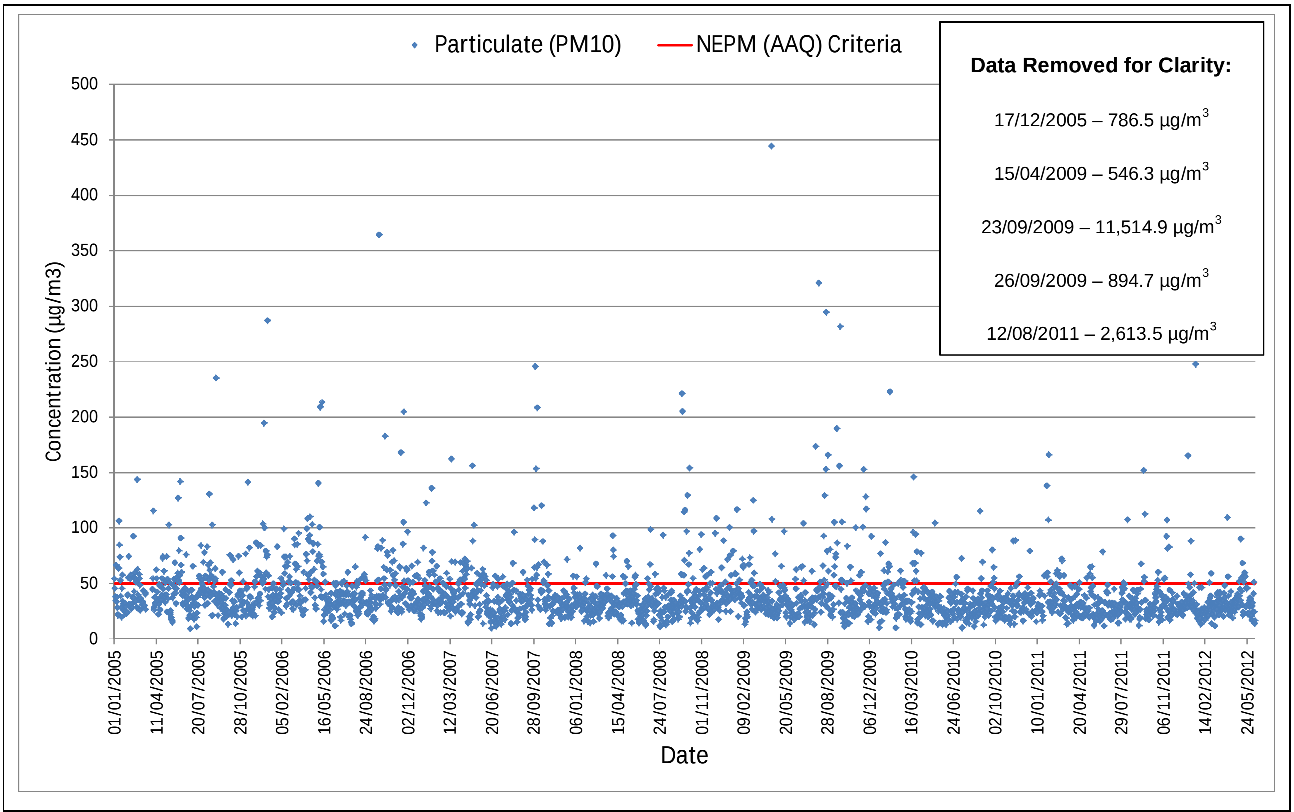
Particulate as PM_{10}

Particulate as PM_{10} monitoring at Earlwood for the period 01 January 2005 to 12 June 2012 was assessed in order to describe back ground levels for the project. The NEPM (Air) aims to achieve a 24 hour average PM_{10} of 50 µg/m^3 with a maximum of 5 exceedance days per year. The NSW Approved Methods outlines an annual impact assessment criterion of 30 µg/m^3 (Government NSW, 2005).

The maximum 24 hour average PM_{10} concentration at Earlwood during the 7.5 year monitoring period was 11,514.9 µg/m^3 with an overall mean value of 46.4 µg/m^3. The extreme high values noted in the data are either instrument error or related to forest burn off events. Up to five exceedances are allowed in any one year so if the top five values for each year are excluded from the data set the overall average value decreases to 38.3 µg/m^3. The rolling 24 hour average for PM_{10} at Earlwood from the NSW Environment and Heritage website for 06 September 2012 for 3-4 pm was 34.4 µg/m^3 (http://www.environment.nsw.gov.au/AQMS/hourlydata.htm).

The Maximum 24-hour average values for the last seven and a half years are displayed in Figure 17 below and demonstrate levels above the NEPM goal. Background values range from the extreme case of 11,514.9 µg/m^3 down to 9.3 to µg/m^3 with a 70th percentile value of 42 µg/m^3 and a geometric mean of 46.4 µg/m^3. Values exceed the NEPM goal at the 80.7th percentile value (50.1 µg/m^3).

Figure 17 Maximum 24-hour average of Particulate PM_{10} from 01 January 2005 – 12 June 2012



Historical measurements between 1996 and 1998 throughout the Sydney region were made using a tapered element oscillating microbalance TEOM analyser and are shown in Table 6 below. All stations (except Lidcombe) had exceedances of the NEPM standard concentration, however none experienced more than the five allowable exceedances in any one year. Exceedances were mostly associated with summer wildfires such as those which occurred during the summer of 1997/98 (Government NSW, 2012).

Occasionally incidences of elevated dust can also result in increased concentrations of PM_{10}. These events tend to be driven by synoptic-scale rather than mesoscale winds and are hence widespread in nature (Government NSW, 2012).

More moderate concentrations of particulate may occur during the cooler autumn and winter months, with the highest concentrations observed during the early evening and early morning, associated with high-pressure weather systems, light winds, and stable conditions. These conditions are conducive to clear cold nights and the development of inversions and drainage flows which can result in the trapping of pollutants close to the surface (Government NSW, 2012). Increased particle concentrations at this time of the year are generally related to emissions from morning and evening peak traffic hours and domestic wood heating.

Table 6 Sydney PM_{10} concentrations for period 1996-98 (by TEOM)

Station	Subregion	24-hour concentrations (µg/m^3)		
		maximum (1996-1998)	2nd highest (1996-1998)	maximum 6th highest in any calender year
Randwick	East	86	68	37
Woolooware	East	82	63	35
Lindfield	East	84	48	36
Earlwood	East	52	49	39
Lidcombe	East	50	46	38

Source: http://www.environment.nsw.gov.au/air/nepm/301sydney.htm

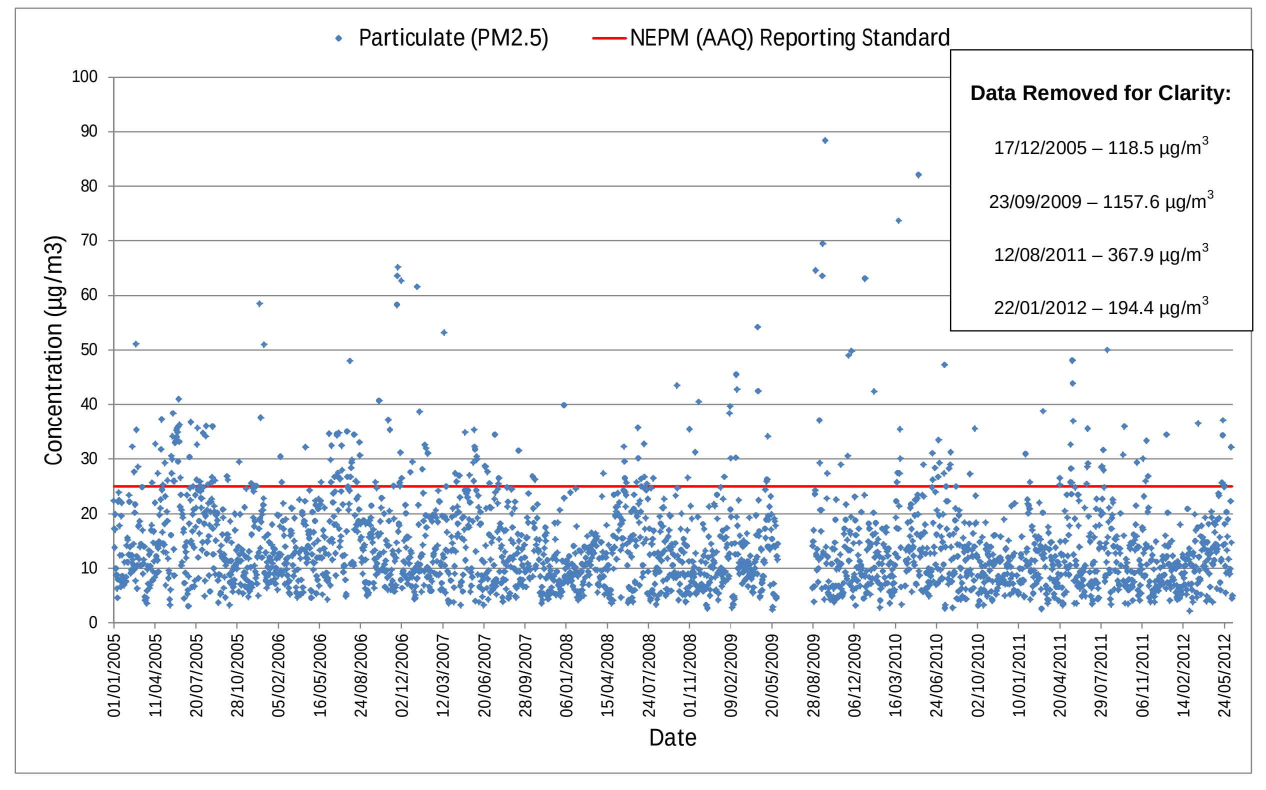
Particulate as $PM_{2.5}$

Particulate as $PM_{2.5}$ monitoring at Earlwood for the period 01 January 2005 to 12 June 2012 was assessed in order to describe back ground levels for the project. The NEPM (Air) outlines a 24 hour average $PM_{2.5}$ advisory reporting standard of 25 µg/m^3 and an annual average advisory reporting standard of 8 µg/m^3. These advisory reporting standards are not a criteria value and are simply in place to allow for a review of the $PM_{2.5}$ air quality guidelines in the future (Commonwealth Government of Australia, 2003).

The maximum 24 hour average $PM_{2.5}$ concentration at Earlwood during the 7.5 year monitoring period was 1,157.6 µg/m^3 with an overall mean value of 14.6 µg/m^3. The extreme high values noted in the data are either instrument error or related to forest burn off events. The rolling 24 hour average for $PM_{2.5}$ at Earlwood from the NSW Environment and Heritage website for 06 September 2012 for 3-4 pm was 6.5 µg/m^3 http://www.environment.nsw.gov.au/AQMS/hourlydata.htm.

The Maximum 24-hour average values for the last seven and a half years are displayed in Figure 18 below and demonstrate levels above the reporting standard. Background values range from the extreme case of 1,157.6 µg/m^3 down to 2.2 to µg/m^3 with a 70th percentile value of 16 µg/m^3 and a geometric mean of 14.6 µg/m^3. Values exceed the NEPM reporting standard at the 91st percentile value (25.1 µg/m^3).

Figure 18 Maximum 24-hour average of Particulate $PM_{2.5}$ from 01 January 2005 – 12 June 2012



Sulphur dioxide (SO_2)

The closest Sulphur dioxide (SO_2) monitoring site to the Hurstville hospital is located inland to the northwest at Chullora or east toward the coast at Randwick. Data from these sites for the period 01 January 2005 to 12 June 2012 were assessed in order to describe back ground levels for the project.

The *NEPM (Air)* standards for Sulphur dioxide are (Commonwealth Government of Australia, 2003):

- 1 hour = 0.20 ppm (20 pphm) (1x allowable exceedance day per year)
- 1 day = 0.08 ppm (8 pphm) (1x allowable exceedance day per year)
- 1 year = 0.02 ppm (2 pphm) (No exceedances)

Sulphur dioxide levels at both Chullora and Randwick over the last seven and a half years are displayed in below and demonstrate levels well below the criteria values. Background values range from 4.3 pphm to 0 to pphm with a 70th percentile value of 0.6 pphm at Randwick and 0.3 pphm at Chullora. The geometric mean ranged from 0.3 to 0.5 pphm at Chullora and Randwick respectively. The 100 percentile value never exceeds the NEPM goal of 20 pphm during the period 01 January 2005 to 12 June 2012.

Recent 1-hour averages for SO2 at Chullora and Randwick from the NSW Environment and Heritage website for 06 September 2012 for 3-4 pm were both less than 1 pphm http://www.environment.nsw.gov.au/AQMS/hourlydata.htm. An adopted background value of 4.3 pphm (100th percentile from Randwick) has been chosen as this is the most conservative.

Figure 19 and Figure 20 below and demonstrate levels well below the criteria values. Background values range from 4.3 pphm to 0 to pphm with a 70th percentile value of 0.6 pphm at Randwick and 0.3 pphm at

Chullora. The geometric mean ranged from 0.3 to 0.5 pphm at Chullora and Randwick respectively. The 100 percentile value never exceeds the NEPM goal of 20 pphm during the period 01 January 2005 to 12 June 2012.

Recent 1-hour averages for SO_2 at Chullora and Randwick from the NSW Environment and Heritage website for 06 September 2012 for 3-4 pm were both less than 1 pphm http://www.environment.nsw.gov.au/AQMS/hourlydata.htm. An adopted background value of 4.3 pphm (100th percentile from Randwick) has been chosen as this is the most conservative.

Figure 19 Maximum 1-hour average of Sulphur dioxide (SO_2) from 01 January 2005 – 12 June 2012 at Chullora Monitoring Station

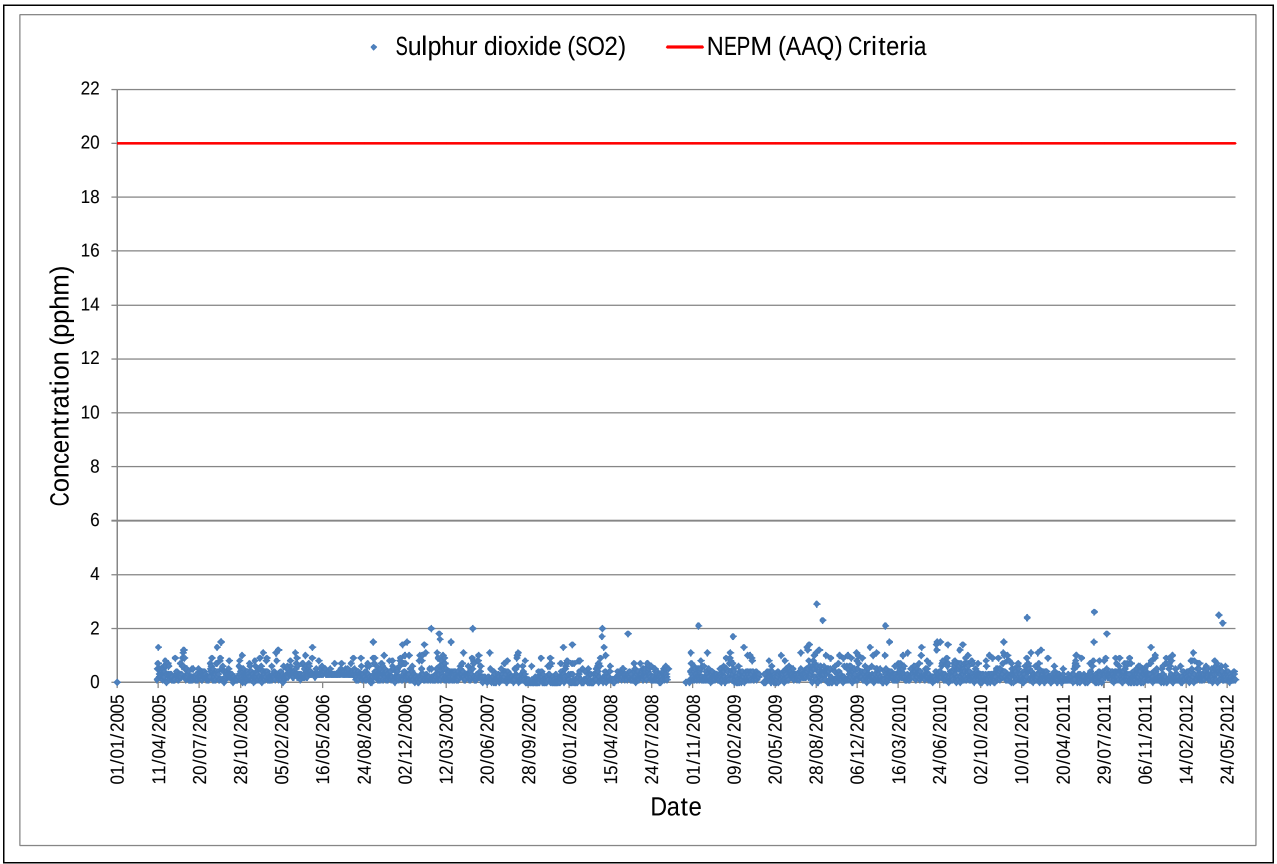
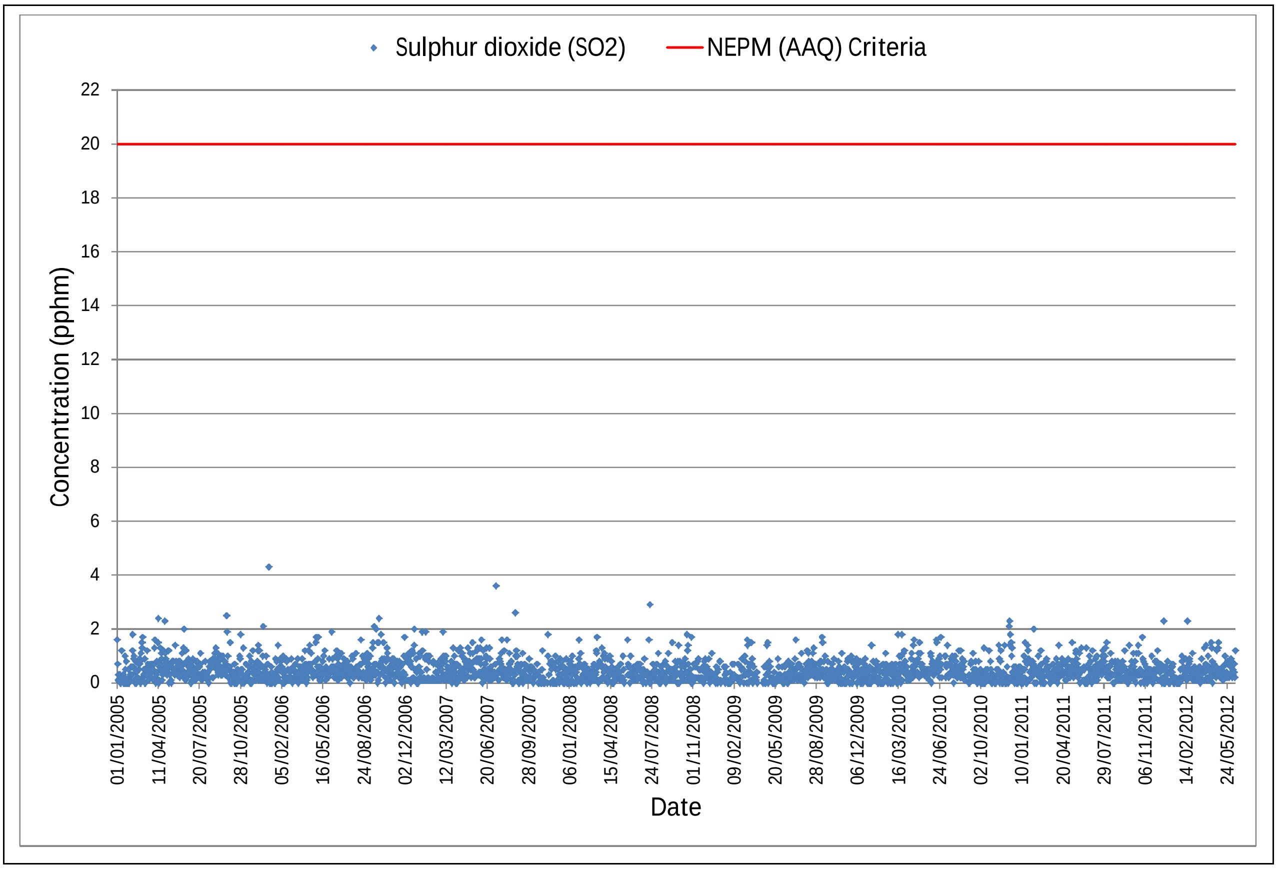


Figure 20 Maximum 1-hour average of Sulphur dioxide (SO2) from 01 January 2005 – 12 June 2012 at Randwick Monitoring Station



To date, monitoring has shown low concentrations of Sulphur dioxide (SO_2) throughout the Sydney region. There are only a small number of industrial premises emitting significant quantities of Sulphur dioxide in the region with the remainder of emissions originating from motor vehicles. The largest of the industrial sources comes from two oil refineries which are located in the metropolitan area, however, measurements have confirmed that concentrations are low and do not approach the NEPM criteria (below 65% of the NEPM) (Government NSW, 2012). Table 7 below, shows Sydney Sulphur dioxide concentrations for the period 1996-98 (Government NSW, 2012).

Table 7 Sydney Sulphur dioxide concentrations for period 1996-98

STATION(1)	Average of monthly maximums	1-hour concentrations (ppm)		Months of valid data over three-year period (2)
		maximum	2nd highest	
Randwick	0.02	0.04	0.03	32
Lindfield	0.02	0.04	0.03	28
Woolooware	0.01	0.03	0.03	34

Source: http://www.environment.nsw.gov.au/air/nepm/301sydney.htm

Lead (Pb)

Lead is not expected to be emitted during either the construction or operation of the HPH and will not be a consideration in this assessment.

Historically however, Lead monitoring on the corner of George and Market Street has consistently recorded concentrations higher than any others areas in Sydney (Government NSW, 2012). Following the introduction of unleaded petrol, substantial progress has been made in reducing concentrations of lead in the air to the point where the George and Market Street site now measure lead concentrations less than 40% of the NEPM standard of 0.33 (µg/m^3) (Government NSW, 2012). The George and Market Street location is considered an upper bound site for the monitoring of lead.

Table 8 Lead in the Sydney region, annual averages for the period 1990-98

STATION	Annual average lead concentrations (µg/m^3)								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sydney CBD	0.69	0.75	0.64	0.47	0.33	0.25	0.24	0.23	0.18
Earlwood	0.35	0.68	0.57	0.34	0.43	0.19	0.06	0.14	0.09
Rozelle	0.18	0.36	0.33	0.27	0.20	0.09	0.05	0.07	0.05

Source: http://www.environment.nsw.gov.au/air/nepm/301sydney.htm

Ozone (O_3)

The NEPM (Air) outlines two averaging periods with associated standards for Ozone (O_3) (Commonwealth Government of Australia, 2003):

- 1 hour = 0.10 ppm (10 pphm) (1x allowable exceedance day per year)
- 4 hour = 0.08 ppm (8 pphm) (1x allowable exceedance day per year)

Ozone monitoring at Earlwood for the period 01 January 2005 to 12 June 2012 describes back ground values ranging from 13.8 pphm down to 0 to pphm with a 70th percentile value of 3.1 pphm and a geometric mean of 2.9 pphm. Values exceed the NEPM goal at the 99.9th percentile value.

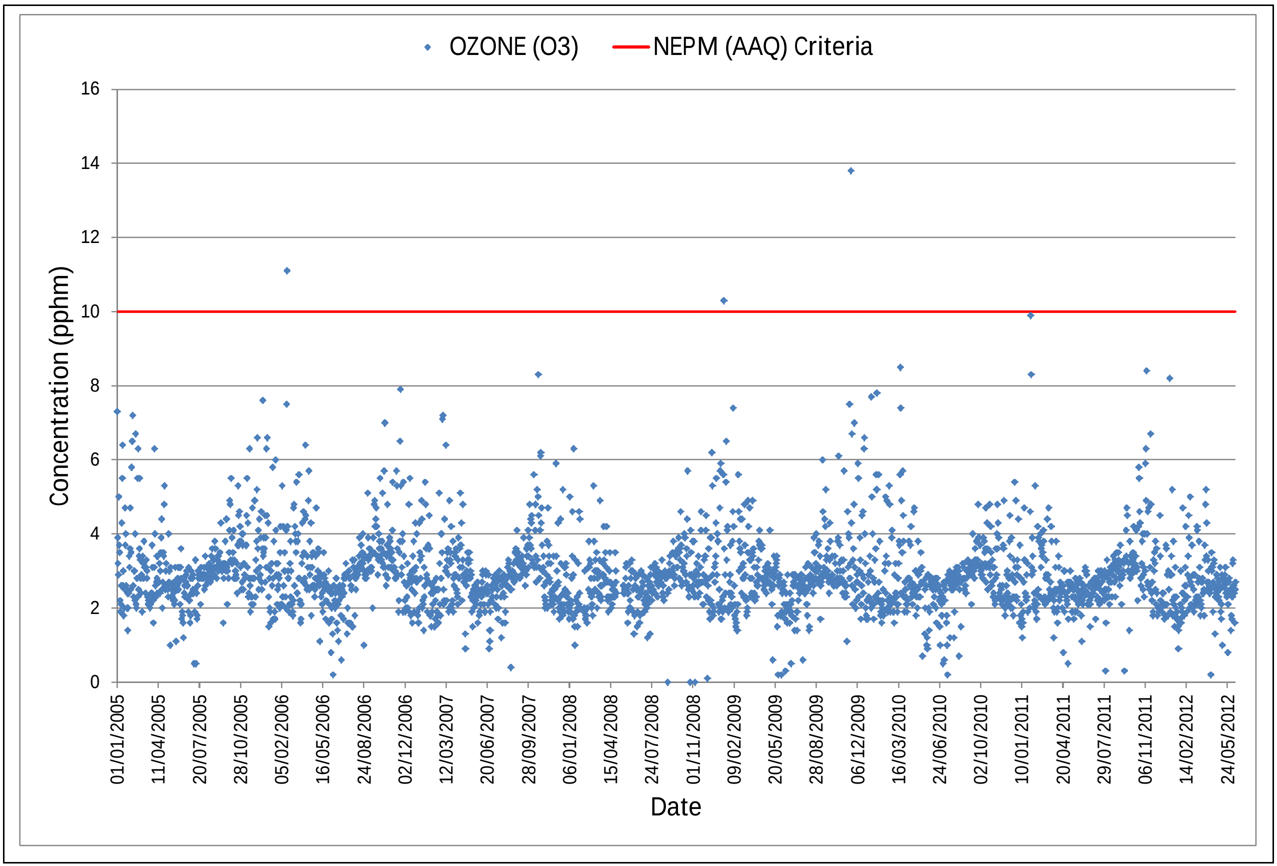
The maximum 1-hour average values for the last seven and a half years are displayed in below and demonstrate good general compliance with the NEPM (Air) goal.

Ozone (O3) is not expected to be emitted during either the construction or operation of the HPH and will not be considered further in this assessment.

Figure 21 below and demonstrate good general compliance with the NEPM (Air) goal.

Ozone (O_3) is not expected to be emitted during either the construction or operation of the HPH and will not be considered further in this assessment.

Figure 21 Maximum 1-hour average of Ozone (O_3) from 01 January 2005 – 12 June 2012

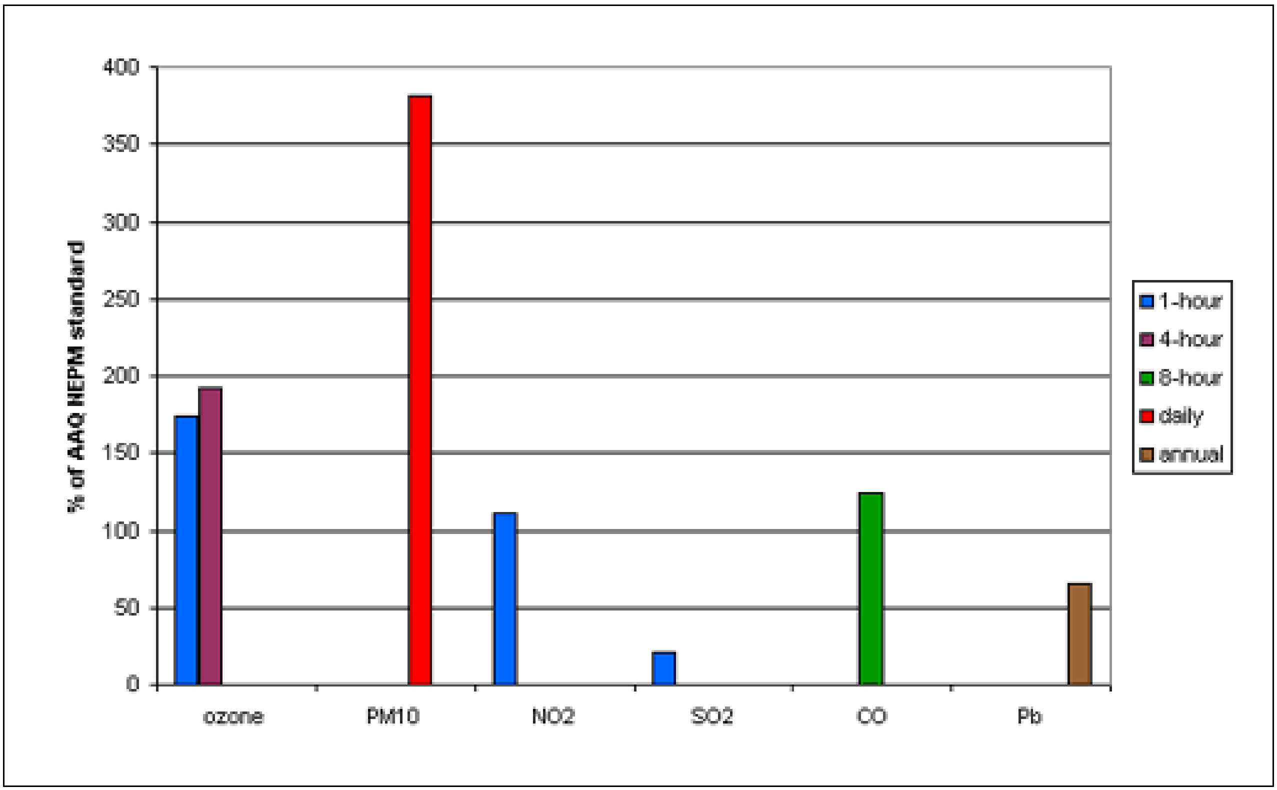


Overall Air Quality – Sydney Region

Current monitoring within the Sydney region has demonstrated exceedances of the NEPM standard concentrations for one-hour ozone, four-hour ozone, daily PM_{10}, eight-hour Carbon monoxide, and sometimes one-hour Nitrogen dioxide (Government NSW, 2012).

Concentrations of Sulphur dioxide and Lead have been demonstrated to be low (Government NSW, 2012).

Figure 22 Maximum concentrations as percentages of NEPM (Air) standards, Sydney Region 1994-98



Source: http://www.environment.nsw.gov.au/air/nepm/301sydney.htm

Elevated concentrations of PM_{10} are associated with hazard reduction burning or wildfire and have been recorded in all three sub-regions (Government NSW, 2012), being:

- Sydney North West;
- Sydney South West; and
- Sydney East.

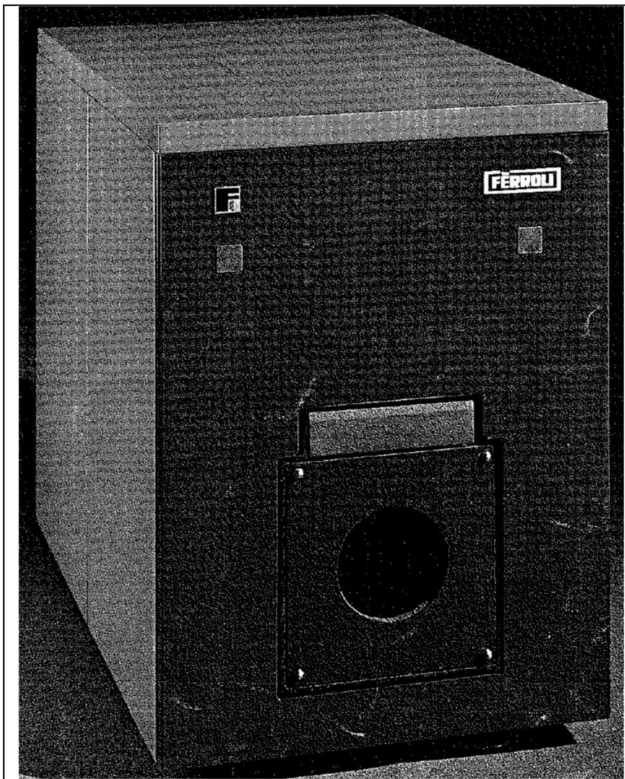
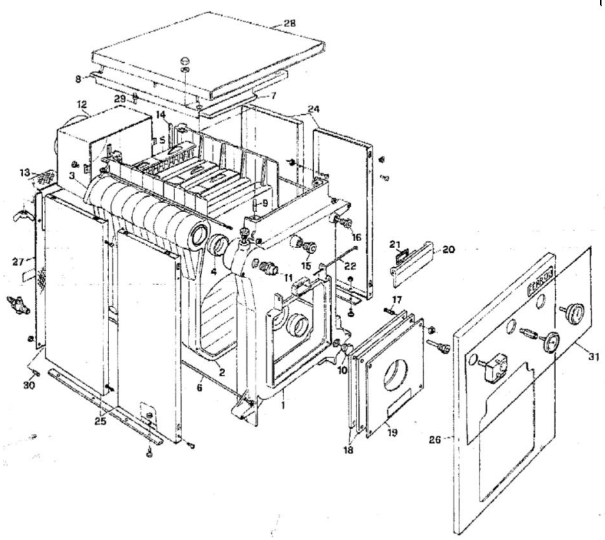
Exceedances of the Carbon monoxide goal are only recorded by the peak station in the central business district. Elevated concentrations of Nitrogen dioxide occur in both the warmer and cooler months. They tend to be local and are more likely in the east of the basin. Concentrations of ozone greater than the AAQ NEPM standard have been recorded at all stations in the region, occurring for a variety of meteorological conditions (Government NSW, 2012).

3.4 Existing Hospital Emissions

The Hurstville Private Hospital maintains and operates a Ferroli dual-fuel boiler with associated steam generator onsite. The boiler is located in the Plant Room and was installed in 1984, it has the following specifications, refer to Figure 23:

- Cast iron 7 section boiler;
- Oil/gas fired;
- Output 140 kW;
- Output 480,000 Btu/h; and
- 62.5 Litre indirect hot water service at up to 72.5 psi.

Figure 23 Ferroli Oil/Gas Fired Boiler - NLR120 140 kW

	
Boiler Casing	Expanded View

Based on the boiler model, size and fuel types described above, emissions from this boiler have been estimated using emission factors and fuel consumption guidelines from:

- USEPA AP42 - Appendix A - Miscellaneous Data and Conversion Factors, (USEPA - United States Environmental Protection Agency, 1985);
- Council of Industrial Boiler Owners (CIBO) - Energy Efficiency & Industrial Boiler Efficiency - An Industrial Perspective, (CIBO - Council of Industrial Boiler Owners); and
- National Pollutant Inventory (NPI) - Emission Estimation Technique Manual for Combustion in Boilers, Table 21 and Table 28, (Commonwealth Government of Australia, September 2010).

Emissions could potentially contain the pollutants and approximate annual emission rates outlined in Table 9. Annual emission rates are based on continuous operation of the boiler at a 75% fuel to heat output efficiency (CIBO - Council of Industrial Boiler Owners).

Table 9 Fuel Type and Estimated Emission Rate for Oil and Gas Fired Boilers at 480,000Btu/hr

Substance	Fuel Type and Estimated Emission Rate	
	Oil	Gas
	Estimated Annual Emission Rate (Kg/yr)	Estimated Annual Emission Rate (Kg/yr)
Carbon monoxide	78	182
Oxides of Nitrogen	312	-
Uncontrolled	-	215
LNB	-	108
Flue Gas Recirculation + LNB	-	69
Particulate matter ≤10.0 µm	16	16
Particulate matter ≤2.5 µm	3	16
Polycyclic aromatic hydrocarbons (B[a]Peq)	0.0258	0.0014
Sulphur dioxide	2	2
Total volatile organic compounds (Total VOC)	3	12
Arsenic and compounds	0.0089	0.0004
Beryllium and compounds	0.0066	2.59E-06
Cadmium and compounds	0.0066	0.0024

Substance	Fuel Type and Estimated Emission Rate	
	Oil	Gas
	Estimated Annual Emission Rate (Kg/yr)	Estimated Annual Emission Rate (Kg/yr)
Chromium (III) compounds	0.0066	0.0030
Copper and compounds	0.0133	0.0018
Lead and compounds	0.0199	0.0011
Mercury and compounds	0.0066	0.0006
Nickel and compounds	0.0066	0.0045
Polychlorinated dioxins and furans (TEQ)	5.15E-08	1.07E-08
Cobalt and compounds (Category 1 Substance)	-	0.0002
Manganese and compounds (Category 1 Substance)	0.0133	0.0008
Selenium and compounds (Category 1 Substance)	0.0335	5.10E-05
Zinc and compounds (Category 1 Substance)	0.0066	0.0621
Note: Emission rates based on continuous operation (24/7 365 days) for a 480,000 Btu/hr boiler.		

Further information would be required from Continuum Healthcare Group Pty Limited in order to make a more accurate assessment of the existing hospital emissions. However, it is expected that emissions from the hospital boiler/steam generator would be no more than minor in nature.

3.5 Assumptions

The following assumptions have been made during the course of this Air Quality study:

- BoM data used in meteorological analysis is accurate;
- The stability class data synthesised from 1997 data at Sydney Airport are representative of the general area of the Project site;
- Ambient air quality data from Earlwood monitoring station is representative of the Project area;
- Site emission data provided by the client is accurate and up-to-date; and
- Annual estimated boiler emission rates based on client data and National Pollutant Inventory emission factors for boilers ≤30 MW portray a good estimation of boiler emissions from the site.

3.6 Existing Conditions Summary

The Hurstville Private Hospital area can be classified as having a climate of ‘temperate’ with ‘no dry season (warm summer)’. Extreme values in temperature occur for a small proportion of the time, with hot days and frost days both more frequent inland away from the coast.

The wettest months occur during the transition between summer and autumn with greater rainfall expected at the eastern end of the study area toward the coast.

Annual average wind direction is evenly spread throughout the compass sectors with a slight dominance from the southern and western sectors. The Project area experiences seasonal variations to the wind climate, with a shift to the west during the winter months. Winds are lightest during late autumn and winter, so that predicted impacts from ground and near ground sources are likely to be greater in these seasons.

Sydney Airport’s atmospheric stability class is site-representative for the project area and is predominately ‘neutral’ for greater than one half of all hours and ‘stable’ for about twenty percent of the time. It is intended that construction will be carried out during the daytime and therefore mostly neutral stability conditions.

Existing Ambient Air Quality is low in Sulphur dioxide (SO_2) and Lead (Pb) and is exceeding of the NEPM goals for ozone (irrelevant for this assessment), PM_{10}, Carbon monoxide (CBD only), and Nitrogen dioxide.

The annual emission rates described in Table 9 are based on a continuous boiler operation, 24 hours a day 365 days a year, and can therefore be considered a worst case scenario with regards to exhaust emissions and do not take into account boiler loading, maintenance, and other non-operational periods.

4. Adopted Background Concentrations

Background pollutant concentration levels are used in the modelling of air quality impacts, if required, these levels need to be considered so that the addition of any project-generated emissions does not exceed the policy criteria. Table 10 gives the background levels derived from the EPA monitoring sites at Earlwood, Rozelle, Randwick and Chullora.

Table 10 Adopted background air pollutant levels for Hurstville Development Application

Substance	Averaging Time	Units	Adopted Background Values
Carbon monoxide (CO)	8 hour	ppm	2.3
Oxides of Nitrogen	-	-	-
Uncontrolled	1 hour	µg	0.0
LNB	1 hour	µg	0.0
Flue Gas Recirculation + LNB	1 hour	µg	0.0
Nitrogen dioxide (NO_2)	1 hour	ppm	0.065
Sulphur dioxide	1 Year	ppm	0.043
Polycyclic aromatic hydrocarbons (PAH)	1 hour	µg	0.0
Particulate matter (PM_{10})	24 hour	$\mu g/m^3$	N/A
Particulate matter ($PM_{2.5}$)	24 hour	$\mu g/m^3$	N/A

Where there is no listed background level this indicates that background levels are already above the NEPM (air goals) and in this instance emissions should be controlled using best available technology. Background levels of any other compounds, especially those involved in combustion processes, are assumed to be low enough to be negligible and they can have a background value of zero.

5. Risk Assessment

5.1 Method

The following impact assessment methodology was used to determine the air quality impact pathways and risk ratings for the Project:

1. Determine the impact pathway (how the Project impacts on a given air quality issue).
2. Describe the consequences of the impact pathway.
3. Determine the maximum credible 'consequence level' associated with the impact. Table 11 provides guidance criteria for assigning the level of consequence. The method for defining these criteria is described in Section 5.2.
4. Determine the likelihood of the consequence occurring to the level assigned in step 3. Likelihood descriptors are provided in Table 12 below.
5. Using the Consequence Level and Likelihood Level in the Risk Matrix in Table 13 to determine the risk rating.

Table 11 Consequence table for air quality impacts

Insignificant	Minor	Moderate	Major	Catastrophic
Applicable air quality standards met at all sensitive receptors (e.g. dwellings), at all times.	Isolated temporary exceedance of air quality standards at a sensitive receptor.	Minor temporary exceedance of applicable air quality standards in a local area.	Exceedance of applicable air quality standards in a number of local areas.	Widespread exceedance of applicable air quality standards

Table 12 Likelihood Guide

Descriptor	Explanation
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances
Possible	The event could occur
Unlikely	The event could occur but not expected
Rare	The event may occur only in exceptional circumstances

Table 13 Risk Matrix

Likelihood	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

5.2 Consequence Criteria

Consequence criteria range on a scale of magnitude from “insignificant” to “catastrophic”. Magnitude was considered a function of the size of the impact; the spatial area affected and expected recovery time of the environmental system. Consequence criteria descriptions indicating a minimal impact over a local area, and with a recovery time potential within the range of normal variability were considered to be at the insignificant end of the scale. Conversely, catastrophic consequence criteria describe scenarios involving a very high magnitude event, affecting a State-wide area, or requiring over a decade to reach functional recovery.

Consequence criteria for air quality were selected for each level of magnitude based on whether an exceedance of an applicable standard (outlined in section 1.3) would occur at a sensitive receiver such as a residential dwelling, school or hospital and if an exceedance occurred what the spatial spread of that exceedance would be. Generally, a more localised exceedance would incur a lower penalty (magnitude) than an exceedance over a larger region.

Results of the risk assessment are described in Section 5.4 and Table 14.

5.3 Impact Pathways

This section identifies and describes air quality cause and effect pathways associated with the construction and operation of the Project.

Four pathways were chosen based on potential impacts from the construction stage of the Project, as well as its subsequent operation. Air quality pathways were further separated spatially by sensitive receptor and location. Pathways are summarised as follows:

- Construction emissions impact an individual sensitive receptor;
- Construction emissions impact on a local area (community);
- Construction/operational emissions deposit on residential housing that drain into domestic water supplies (i.e. tank water); and
- Operation of the HPH generates air emissions from boiler operation.

5.4 Risk Assessment

A risk assessment of the potential air quality impacts likely to occur during both construction and operation of the Project was carried out as per the methodology outlined in section 5.1.

As a result of the initial risk assessment, recommended project specific controls where needed have been proposed to reduce risks. These are outlined in the "Controls Recommended to Reduce Risk" column of the risk assessment in Table 14.

Key observations from the risk assessment of the proposed alignment and associated construction impact footprint are:

- Construction is expected to have no more than a minor impact on air quality at individual sensitive receivers;
- Construction is expected to have no more than a minor impact on air quality within a local community;
- Construction/operational emissions are not expected to impact on residential housing; and
- Operation of the HPH boiler is expected to have no more than a minor impact on air quality.

Where the level of risk is considered unacceptable, i.e. a risk rating of medium, high or extreme, these risks can be reduced to acceptable limits through the addition of project specific controls such as communication, air quality monitoring and mitigation strategies. Following the inclusion of recommended controls, the residual risk ratings for air quality are expected to be low or negligible and hence impacts at sensitive receiver locations are expected to be no more than minor.

Table 14 **Air Quality Risk Assessment**

Risk No.	Impact Pathway Description (how the project interacts with assets, values and uses)	Description of consequences	Initial Risk Assessment			Controls Recommended to Reduce Risk	Residual Risk Assessment		
			Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
A1	Construction emissions impact an individual sensitive receptor	Exceedance of National Environment Protection (Ambient Air Quality) Measure within a small localised area affecting a sensitive receptor, Aeolian transport and deposition potentially affecting human health, flora, fauna, visual and social aspects, and water quality.	Minor	Possible	Low	• Implement methods and management systems to maintain air quality during construction consistent with the National Environment Protection (Ambient Air Quality) Measure for particulates. • Apply sprays during concrete cutting or other dust emitting activities; • Applying dust suppression measures on exposed areas as required; • Sweep areas where dust accumulation occurs; • Use continuous air monitoring techniques and alert systems; • Limit vehicle speed; and • Cover material that may create a hazard or nuisance dust s during transport.	Minor	Rare	Negligible
A2	Construction emissions impact a local area (community)	Exceedance of National Environment Protection (Ambient Air Quality) Measure within a local area, Aeolian transport and deposition potentially affecting human health, flora, fauna, visual and social aspects, and water quality.	Moderate	Possible	Medium	As for risk A1	Moderate	Rare	Low

Risk No.	Impact Pathway Description (how the project interacts with assets, values and uses)	Description of consequences	Initial Risk Assessment			Controls Recommended to Reduce Risk	Residual Risk Assessment		
			Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
A3	Construction/operational emissions deposit on residential housing that drain into domestic water supplies (i.e. tank water).	Exceedance of 2004 Australian Drinking Water Guideline (ADWG) for residential rainwater tanks.	Minor	Rare	Negligible	As for Risk A1. This is a negligible risk so no additional controls are required. This is due to in an urban area a reticulated water supply should be used for human consumption (drinking water). Any rain water tanks in the area are most likely to be used for garden use where this project will not materially change the in-tank water quality.	Minor	Rare	Negligible
A4	Operation of the Hurstville Private Hospital generates air emissions from boiler operation.	Exceedance of National Environment Protection (Ambient Air Quality) Measure.	Moderate	Possible	Medium	• Implement a boiler operation management system to maintain air quality during operation consistent with the National Environment Protection (Ambient Air Quality) Measure for pollutants. • Install modern low emission boiler as part of upgrade; • Install opacity meter and/or efficiency meters on boiler to ensure cleanest possible fuel consumption.	Moderate	Rare	Low

6. Impact Assessment

6.1 Construction Air Quality

6.1.1 Background

Construction activities during the HPH redevelopment have the potential to create particulate discharges from various source and activities. Those activities may include:

- Demolition dust from previous onsite buildings and pavement
- Truck and vehicles movements on/off site
- Truck Loading/Unloading
- Digger loading onto trucks
- Digger movements
- Grinder
- Windblown dust from stockpiles
- Windblown dust from surfaces

Amenity values within the Project area that need protecting are concerned with deposited particles of all sizes. These have potential to soil surfaces and other infrastructure. It can also lead to unpleasant living conditions. The so-called Total Suspended Particulates (TSP) can be measured as an in-air concentration but for amenity considerations it is better measured as deposited (insoluble) matter per area per time period (usually a month).

Health effects are more concerned with the finer respirable sized particles. These are generally considered to be particulate matter with an aerodynamic diameter of less than or equal to10 microns (one-millionth of a metre; also referred to as PM_{10}). There will be a background level of these particles in such an urban environment but with an additional contribution from the building works.

Various trigger levels can be used to define levels of concern for amenity (deposited TSP) and health effects (in-air concentration of PM_{10}). Although a large city has an elevated ambient pollutant load, it would be an aim to minimise exposure to airborne contaminants to the following trigger levels or the ambient particulate atmosphere, whichever is the higher:

- Deposited dust less than 4.0 g/m2/month (annualised average); and
- 24-hour PM10 to less than 50 µg/m3.

It is noted that background (ambient) levels already exceed the 24 hour PM_{10} trigger. Therefore, construction dust management should be to accepted best practice standards.

6.1.2 Program Summary

The proposed works are expected to involve site preparation, pavement and building construction activities following the general methodology outlined below:

- Delineate project boundaries with suitable fencing and signage. Install traffic management measures as required;

- Establish a Contractor's site office and compound as required;
- Install environmental management measures, as required;
- Remove vegetation, grubbing of tree stumps and strip topsoil as required;
- Relocate or protect utility services, as and when required;
- Demolish any buildings or partial building areas and pavement as required;
- Excavate cut material to the necessary level, as and where required. Recycle suitable excavated material and incorporate in earthworks where ever possible. Transport and dispose unsuitable cut material;
- Install bored or driven piles for structural elements and complete all footing works, as and when required;
- Construct building levels, structural supports, walls and roofs;
- Install any required plant and equipment;
- For retaining walls, typically once a strip footing (or similar) is in place, place wall units and build up structural fill in layers so as to tie all elements together. Once at the required level install handrails and other protective mechanisms;
- Landscape and re-vegetate the construction site including reinstatement and topping up of topsoil, seeding, planting trees and shrubs, installing weed mat, mulch and the like; and
- Clean-up site and dispose of all surplus waste materials.

6.2 Operational Air Quality

Annual emission rates as described in Table 9 are based on a continuous boiler operation, 24 hours a day 365 days a year. However it is more likely that boiler load will fluctuate with peak periods around morning and evenings times due to increase hot water demand for showers and the like.

With an increase in hospital bed numbers from 54 to 96 it is highly likely the current boiler will require replacing. In which case it is recommended that HPH select a modern, energy efficient and environmentally non-polluting boiler as practical and hence emissions are expected to be no more than minor in nature.

Power generation via the HPH boiler installation is unlikely to become an issue unless there is a regional power failure, in which case emergency power generation would be required.

7. Management and Mitigation Measures

7.1 Construction CEMP

HPH would require the construction contractor(s) to develop and implement a Construction Environmental Management Plan (CEMP) for the Project. Recommended environmental protection measures identified below should be incorporated into the Environmental Management Framework for the Project. HPH would require the construction contractor(s) to incorporate all of these measures into the CEMP.

Environmental protection measures for air quality that would be adopted for this Project are outlined in Table 15. These controls are based on GHD experience as well as 'Best Practice Environmental Management'.

Table 15 Project Specific Dust Management Controls (Proposed)

Management Type	Specific Controls
Prevention	Prompt remedial strategies, such as watering, would need to be implemented in the event of visible dust emissions.
	Reduce dust production on site by scheduling work into stages to minimise land disturbance in the planning and design stage, including scheduling installation of control measures for dust prevention, while having regard for seasonal dryness (July, August and September, see table five).
	Include special operations precautions in the CEMP for when work is being carried out during high wind events.
	Prevent the generation of dust in preference to applying dust suppression measures.
	Maintain dust awareness on site and use a reporting system (staff hierarchy of action).
	Identify dust sources prior to carrying out works in a particular area.
	Keep the areas of land cleared to a minimum, and the period of time areas remain cleared to a minimum.
	Minimise working areas and create designated routes to be used wherever it is necessary for vehicles to traverse the Project area.
	Rehabilitate cleared areas promptly.
	Limit activities during construction that generate dust when wind speeds are greater than 10 m/s.
	Limit vehicle speeds on construction areas where dust may become an issue to 10-25 km/hr and cease using during periods of high winds.
	Ensure that all trucks transporting soil/fine materials are covered and/or wetted down.
	Minimise the number and locations of stockpiles if these are required.

Management Type	Specific Controls
	Construct stockpiles with slope no greater than 2:1 (horizontal to vertical) and ensure that all stock piles are covered and kept below 4 m in height.
	Locate stockpiles in areas that are protected from wind where possible and/or away from sensitive receptors.
	Sweep, vacuum or wash sealed areas where appropriate to minimise dust generation.
	Construct wind fences where appropriate, including shade cloth like material on construction safety fencing.
	Review and adjust (as necessary) the dust management in the CEMP after the first month and six monthly thereafter.
Monitoring	If complaints occur, then the use of an alarmed continuous dust sampling monitor should be considered.
	Monitor wind speeds and check for visible dust by site supervisor.
	Identify all possible dust sources at the beginning of each day and throughout the day.
Mitigation	The primary method for controlling dust generated by construction and maintenance activities would be the application of water and/or an approved suppression agent, via water. This should be included in a construction environmental management plan (CEMP).

7.2 Construction Air Quality Monitoring

The following list describes a few of the various options available for use in monitoring air quality onsite at the Project site. The list is not exhaustive however provides some of the more commonly used systems for data collection.

- Dust deposition gauges
- High-volume sampler
- DustTrackII

There are other types of equipment available but the use of these would only be required after checking with the local regulator.

The first dot point is the best available methodology for amenity determination due to dust fallout. The Australian Standard AS 3580.10.1 '*Methods for sampling and analysis of ambient air – Determination of particulates – Deposited matter – Gravimetric method*' defines how measurements of mass per unit area per month are to be performed. In summary, a glass container with an upward exposed funnel is supported on a sturdy stand for a period of 30 plus or minus 2 days. The insoluble matter is then filtered and weighed to give the mass loading.

The last dot point utilises light for the measurement of continuous dust levels and is a simple way to maintain an alarmed dust monitoring system, if required this can be used as a trigger device within the CEMP.

7.3 Operation

Operational air quality impacts are expected to be limited mainly to the boiler operation. HPH would implement a boiler operation management system to maintain air quality during operation. The management system could include:

- The selection and installation of modern low emission boiler as part of the upgrade;
- Installation of either an opacity meter and/or efficiency meters on the boiler to ensure the cleanest possible boiler operation;
- A goal for emissions of visible smoke to the atmosphere from the boiler plant and equipment of no more than 10 consecutive seconds at any one time and as seldom as practical; and
- Continued maintenance, cleaning and certification as required by the boiler manufacturer.

8. Conclusion

The air quality impact of the Project is influenced from two main emission sources, which are the dust emissions resulting from the construction activities and the boiler emissions resulting from the generation of hot water and for use as a backup generator. A risk assessment of both construction and operation emissions was carried out in order to determine the likelihood and consequence of impact on the local environment and community. All of the identified risks are considered to be negligible or low provided that the identified mitigation measures are implemented.

Construction impacts have the potential to extend beyond the construction area. Construction dust is expected to be greatest during the preparation/demolition stage as opposed to the building stage. However, provided that the methods and management systems designed to maintain air quality during construction are implemented as outlined in the mitigation section, construction impacts are not expected to be any more than minor.

Construction and operational emissions are not expected to affect domestic water supplies. Through management of the smaller particle size fractions (equal and less than PM_{10}), it follows that the nuisance dust would also be managed.

Operational air quality impacts are expected to be no more than minor. However, ambient particulate monitoring shows background particulate levels are often exceeding the NEPM (Air) goals of 50 ug/m^3. It is expected any contribution from the HPH boiler would be managed in order to achieve the best possible environmental outcome practical through the use of best practice techniques and efficient boiler selection.

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