Preliminary Air Quality Investigation
Hunter Exploration Activity

December, 2006

Sydney Gas Ltd

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NCSI Certified Quality System ISO 9001

2115146A/PR_4959 Iss4

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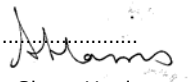

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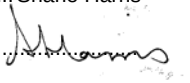

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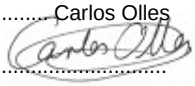

Date: ..... Friday, 15 December 2006

Distribution: .....Sydney Gas (x1 electronic, x3 hard copy) PB (x1 file)

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Executive summary

Parsons Brinckerhoff (PB) has been engaged by Sydney Gas Ltd (Sydney Gas) to undertake a preliminary air quality investigation of the Hunter coal seam methane (CSM) Exploration Area. This pre-works study provides a broad overview of conditions within the regional area and outline of anticipated air quality effects associated with the initial coring activities.

The exploration area covers approximately 120 km^2 surrounding the township of Broke. This area is held by 124 land owners with holdings of varying size.

A two year exploration program is proposed by Sydney Gas to appraise the area and may involve the drilling of five core holes and up to a maximum of 15 exploration test wells. The CSM exploration will be targeting potential seams in the deeper Wittingham Coal Measures.

Any further commercial decisions will be pursuant to the success, or otherwise, of the exploration test wells.

The existing air quality for the CSM exploration area can be characterised as typical of a rural environment.

The locality includes a combination of agricultural, rural and residential land uses. No major pollutant generating activities are located within the immediate study area. Local minor sources of air emissions include a combination of general residential activities as well as local and arterial roads. There is currently limited information in the public domain relating to existing ambient air profiles.

During the exploration works, air emissions would be associated with the short term coring activities only. This is the activity that is the subject of the current Sydney Gas REF. Minor quantities of particulate matter and combustion by-product emissions would be present. Air emissions during the initial coring works would be negligible.

Not withstanding the above, a number of standard management measures and mitigation strategies were recommended for the initial coring exploration works.

During any potential future exploration testing or exploration programs, the major air emission issue will be associated with flaring. Flaring is a high temperature oxidation process used to burn combustible components. During a combustion reaction, several intermediate products are formed, and eventually, the majority are converted to CO_2 and H_20. Some quantities of stable intermediate products (such as NO_X CO, H_2 and C_XH_X – hydrocarbons) can be expected to escape as emissions.

Any flares will be designed and operated by Sydney Gas according to current best practice performance standards and destruction efficiencies. Sydney Gas notes that the flares must be operated so that *no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours occur in accordance with The Protection of the Environment Operations (Clean Air) Regulation 2005.*

The success of the CSM coring activities will determine any decision to drill trial exploration wells at other potential targets in the exploration area. Additional background air quality data and a more refined assessment of air quality issues in those areas would then be recommended.

1. Introduction

Parsons Brinckerhoff (PB) has been engaged by Sydney Gas Ltd (Sydney Gas) to undertake a preliminary air quality investigation of the Hunter coal seam methane (CSM) Exploration Activity. Sydney Gas is investigating the potential seams of the deeper Wittingham Coal Measures for potential economic reserves of coal seam methane gas.

1.1 Background

The exploration area is located within the Hunter Valley between Bulga and Broke, covering an area of approximately 120 km^2.

The Hunter Exploration works include the initial investigation of up to five core holes within the identified exploration area. This activity is the subject of this preliminary air quality assessment.

Following the initial coring works, up to a maximum of 15 exploration test wells may be established. These works may be carried out over a three to six month period, with the possibility of extension up to 24 months. Any further commercial decisions will then be made pursuant to the success, or otherwise, of the exploration test wells.

This report is a preliminary assessment of the regional air quality environs in the exploration area. It uses available information, noting data gaps, to identify any likely future land use conflict issues, as related to air quality emissions pursuant to the Hunter Exploration Activity initial coring works.

Any potential future land use conflicts, which relate to air quality issues, have also been qualitatively determined.

1.2 Scope

The activities for this preliminary air quality assessment involve:

- review of regional meteorological and ambient air quality issues for the exploration area
- identification of existing key air emission sources in the exploration area not associated with the proposed works
- identification of air quality emissions associated with possible future flaring and venting operations
- identification of management issues and mitigation measures for CSM exploration.

1.3 Objectives

The key objectives of this preliminary air quality assessment are to:

- identify and characterise existing ambient air environs in the Hunter Exploration Area
- identify any potential effects to air quality in the proposed Hunter Exploration Area as specifically related to the initial coring activities

At this preliminary stage there may be data gaps; however, this assessment has been made by suitably qualified professionals, who will manage and monitor future investigations and management measures designed to improve the durability of any conclusions.

2. Details of the Hunter Exploration Activity

2.1 Location

The exploration area is located within the Hunter Valley surrounding the township of Broke, and extending north to the township of Bulga. The exploration area lies in the north-western part of the Petroleum Exploration Lease (PEL) 267.

2.2 Proposed development

The exploration area covers approximately 120 km^2 surrounding the township of Broke (Figure 2.1). This area is held by 124 land owners with holdings of varying size.

A two year exploration activity is proposed by Sydney Gas to appraise the exploration area and may involve the drilling of five core holes and 15 trial exploration wells. The CSM exploration will be targeting potential seams in the deeper Wittingham Coal Measures.

Any further commercial decisions will be pursuant to the success, or otherwise, of the exploration test wells.

2.3 Land use

The exploration area is held by 124 land owners with holdings of varying size. The majority of the land holdings are private. Figure 2.2 is the Singleton Rural Residential Development Strategy Constraints Map. The land uses indicated within and adjacent to the Hunter exploration area are:

- rural residential communities (i.e. Broke and Bulga)
- agricultural
- livestock
- viticulture
- military training
- Yengo National Park to the south and southwest
- Pokolbin State Forest Reserve to the east
- Wollemi National Park
- extensive surface and underground coal mining.

Figure 2.1 Petroleum exploration area

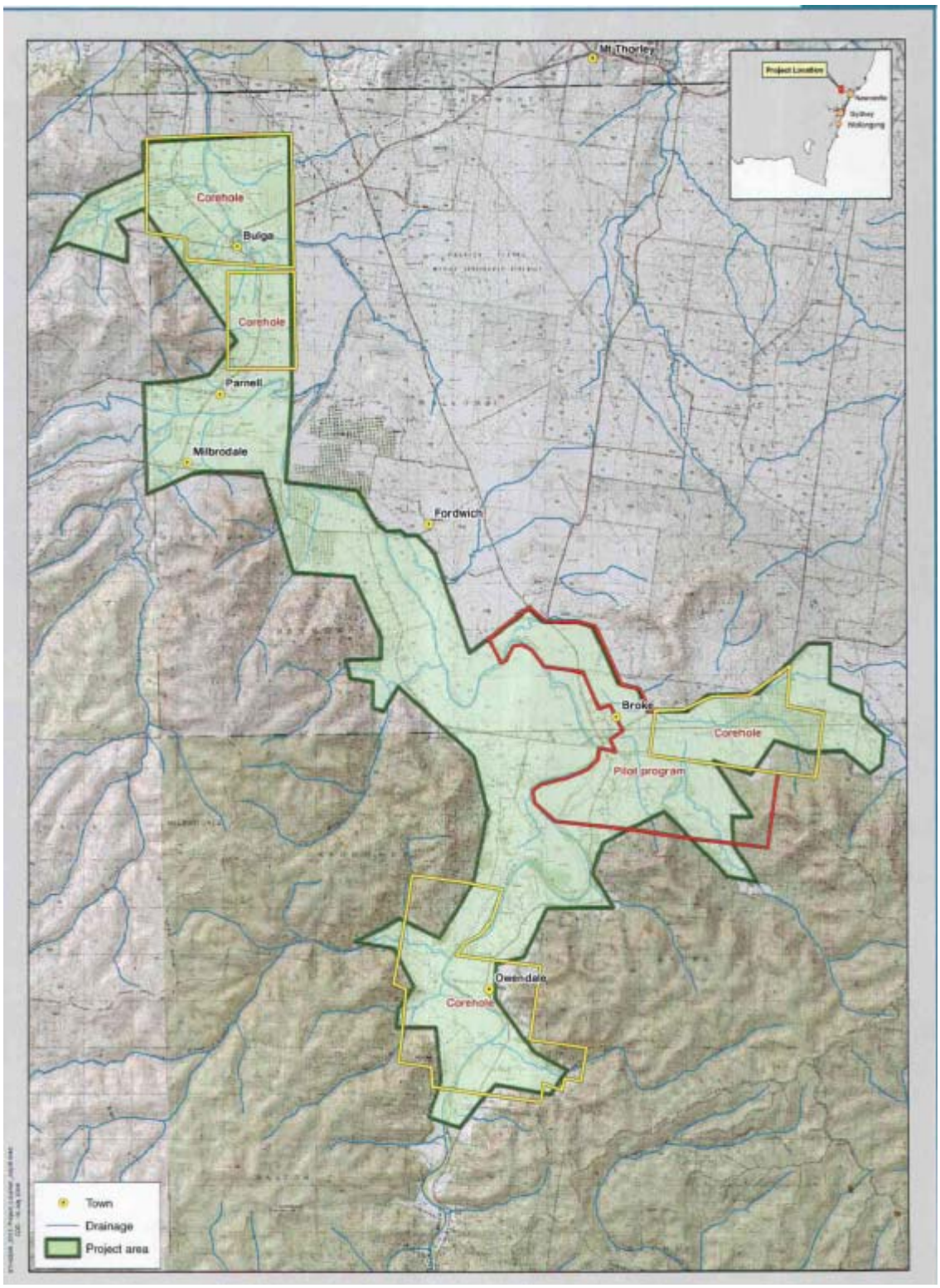
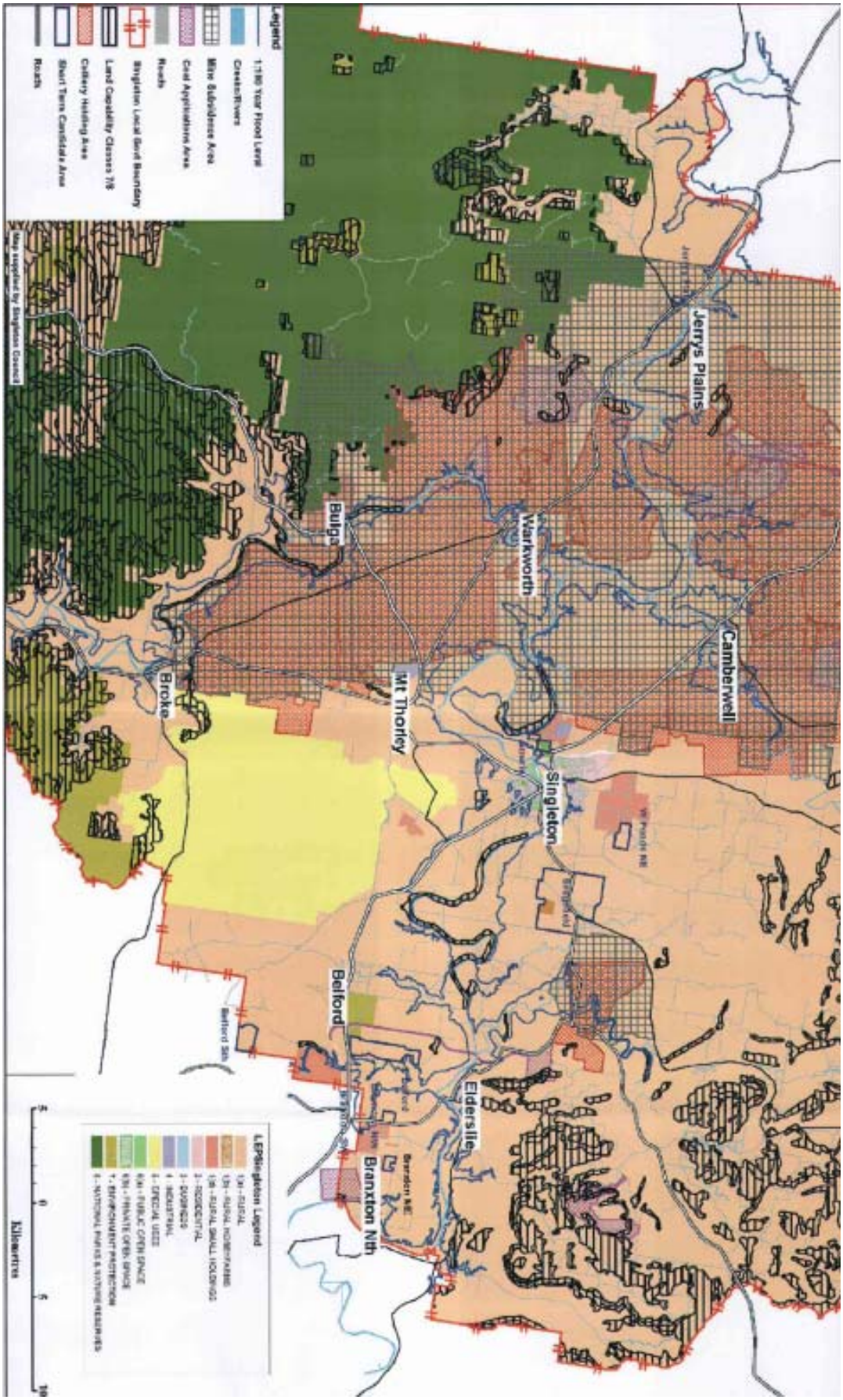


Figure 2.2 Singleton Rural Residential Development Strategy constraints map



3. Existing air quality and dispersion meteorology

3.1 Ambient air quality

The existing air quality for the CSM exploration area can be characterised as typical of a rural environment.

The locality includes a combination of agricultural, rural and residential land uses. No major pollutant generating activities are located within the immediate study area. Local sources of air emissions include a combination of general residential activities as well as local and arterial roads.

A discussion of key existing regional sources that effect air quality follows within Section 3.2.

The emissions of the established mining activities are considered a primary contributor to air pollution for the local area.

Sufficiently detailed background air quality data is not currently available in the public domain for the local area. No background air quality monitoring has been undertaken for this preliminary air quality investigation. Historic monitoring information relating to existing ambient air quality levels was not available for the local air shed at the date of this document.

Acceptable ranges of particulates, dust, hydrocarbons, oxides of nitrogen and sulphur would be expected throughout the project exploration area for the majority of the time due to the relatively undeveloped nature of the surrounds.

3.1.1 Adopted background levels

No historical information was available or site-specific monitoring undertaken. The data supplied by the DEC Air Monitoring Network has been adopted.

Data measured for the Pacific Highway at Beresfield, near Newcastle (2003) was adopted. The monitoring station is located on Lawson Street in Beresfield in a rural residential area. The measured air quality would be influenced by higher traffic flow profiles and increased industrial emissions than expected within the Hunter Exploration Area.

Although the Beresfield monitoring site is not site specific, it is considered an over-conservative estimation of typical (or indicative) ambient air environs for the study area. Air quality within the CSM exploration area would be expected to be lower than the reported Beresfield data. The data presented within this preliminary air quality investigation is considered to be a worse case estimate of baseline conditions.

Monthly averaged data for monitored levels of particulate matter, nitrogen dioxide and sulphur dioxide is provided in Table 3.1.

Table 3.1: Adopted background levels (Beresfield, 2003)

Month	Pollutant								
	PM_{10} [TEOM] ($\mu g/m^3$) 24-hour average			NO_2 ($\mu g/m^3$) 1-hour average			SO_2 ($\mu g/m^3$) 1-hour average		
	Avg.	Max.	days > goal	Avg.	Max.	days > goal	Avg.	Max.	days > goal
January	nd	nd	nd	14.4	55.4	0	2.9	57	0
February	20	39	0	10.3	79.9	0	2.9	119.7[1]	0
March	19	59	1	16.4	51.5	0	2.9	48.5	0
April	16	34	0	20.5	67.7	0	5.7	42.5	0
May	16	30	0	20.5	67.7	0	5.7	199.5[1]	0
June	18	31	0	20.5	67.7	0	5.7	65.6	0
July	17	27	0	22.6	65.6	0	5.7	82.7	0
August	20	35	0	22.6	59.5	0	5.7	65.6	0
September	25	51	1	18.5	82	0	5.7	68.4	0
October	17	88 [1]	1	16.4	69.7	0	5.7	59.5	0
November	17	49	0	16.4	67.7	0	5.7	91.2	0
December	20	34	0	10.3	57.4	0	5.7	57	0
NSW GOAL		30			62			60	
Annual Avg.		**18.6**			**18.5**			**5.7**	
NSW GOAL		50			246			570	
Peak		**88**			**82**			**199.5**	

Notes to *Table 3.1*

Source: NSW DEC Air Quality Monitoring Points

PM_{10} = Particulate matter $\leq$ 10μm in aerodynamic diameter

NO_2 = nitrogen dioxide

SO_2 =sulfur dioxide

$\mu g/m^3$ = micro grams per cubic metre

TEOM – I hour average

nd – no data

1 – cause of peak levels unknown. Expected to be the result of local sources / a-typical conditions

The measured PM_{10} Tapered Element Oscillating Microbalance (TEOM) measurements provide continuous recordings of PM_{10} with 24-averaged measurements reported. The annual average of 18 $\mu g/m^3$ was noted at below the NSW Department of Environment and Conservation (DEC) 30 $\mu g/m^3$ long-term reporting goal. A maximum 24 hour average of 88 $\mu g/m^3$ exceeded the 24-hour goal of 50 $\mu g/m^3$. The TEOM measurements indicate that three days on 2003 exceeded the 24-hour PM_{10} goal. Localised sources or regional bushfire conditions are expected to be the cause of this.

A maximum NO_2 level of 85 $\mu g/m^3$ was measured during 2003 for the Beresfield monitoring station. The National Environment Protection Measure (NEPM) 1 hour maximum goal of 246 $\mu g/m^3$ was achieved. The annual average of 18.5 $\mu g/m^3$ readily achieved the goal of 62 $\mu g/m^3$.

A maximum SO_2 level of 199.5 $\mu g/m^3$ was measured during 2003 for the Beresfield monitoring station. A NEPM 1 hour maximum goal of 570 $\mu g/m^3$ was achieved. The annual average of 5.7 $\mu g/m^3$ readily achieved the goal of 60 $\mu g/m^3$.

No indicative annual average background Total Suspended Particulate (TSP) data for the CSM exploration area is available. Similarly, records relating to dust deposition monitoring in vicinity of the proposed works were not available at the date of this document. Pursuant to PB's experience of dust deposition levels in similar receiving environments, it is anticipated that existing ambient levels would be less than two grams per square metre per month.

3.2 Regional sources

A search of the National Pollution Inventory database (NPI) 2004 – 2005 indicated 17 facilities reporting emissions to the Singleton airshed. Reporting was carried out for a total of 48 substances from 44 industrial sources.

Industrial sources included bulk petroleum storage facility, coal mining handling and processing, wine fermentation and storage; electricity generation from black coal, open cut coal mining, domestic sewage by aeration, settling, decanting and disinfection (by sunlight) processes.

Diffuse data was selected for 32 diffuse sources, such as traffic and agricultural sources, and reported for air emissions.

Key sources of air emissions for the regional air shed include motor vehicles, coal mining and power generation.

3.3 Existing meteorology

Air quality effects are influenced by both regional meteorological conditions, primarily in the form of gradient wind flow regimes, and by local conditions, generally driven by topographical features in the form of drainage flows. Topography, wind speed and wind direction all affect the potential dispersion and transport of plumes. An effort to define both the regional and local dispersion meteorology within the exploration area has been made.

Regional surface wind profiles have been obtained from the observations compiled for Williamtown (Bureau of Meteorology, station #61078). Williamtown is approximately 70 km east of the CSM exploration area. This location is also coastal compared to the inland Hunter area. Seasonal and annual wind rose plots have been provided in Appendix A.

Review of the wind rose data indicates that wind directions are generally unidirectional, with profiles variable throughout each season. Williamtown experiences winds predominately from the southern, north-east and west north-western quadrants on an annual basis. In summer, the winds are predominately from the south-east and north-east. Southerlies predominate in autumn. West north-westerlies are frequent in the winter and spring experiences winds predominately from the north-east.

Annual and seasonal wind rose data for Camberwell (2001) have also been assessed. Camberwell is located approximately 20 kilometers to the north of the CSM exploration area. The wind roses exhibit primarily north / south flow patterns. Southerlies dominate in summer, with wind shifting through to a northerly, north westerly direction in autumn. The north westerly gradients are maintained during winter and spring.

Experience has shown that the majority of the Hunter Valley wind flow regimes occur along a north west through south east alignment. This varies slightly to the data presented for Camberwell (2001).

It is recommended that any datasets referenced within this report are verified with patterns measured throughout other locations in the Hunter Region.

3.4 Topography

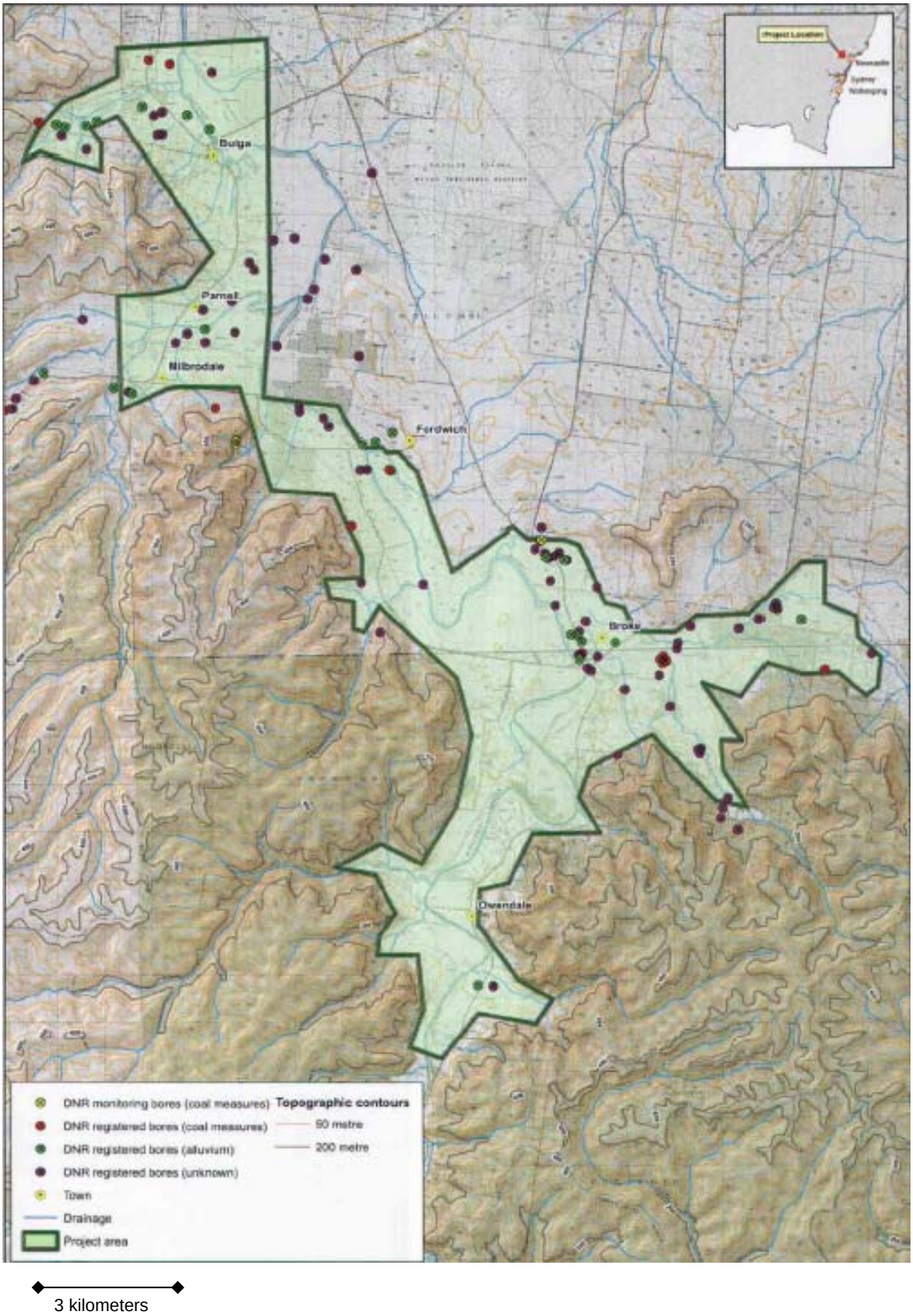
When assessing air quality emissions from a ground level source of air pollutants, it is also important to consider local drainage flows. The movement of cold air down a slope (generally under stable atmospheric conditions) is referred to as katabatic drift and can result in plume entrapment, poor dispersion of air borne pollutants, and the potential to cause greater off-site effects. Katabatic drift would follow the topography of the site.

The topography of the area consists of gullies and elevated ridgelines as shown in Figure 3.1. Elevations range from up to 500 mAHD at the top of the ridgelines (approximately 1.5 km south of Broke) to 60 mAHD in the valley.

Although general air flow patterns can be determined with confidence, it is difficult to accurately predict the influence of local drainage flows without detailed site-specific meteorological information. Topographic information available for the site of the proposal indicates that a localised catchment is formed within the site towards Wollombi Brook and the smaller tributary gullies.

No further assessment of topographical influences in relation to the transport of air emissions has been made as part of this preliminary air quality investigation.

Figure 3.1 CSM exploration area topographical setting



4. Key potential air emission sources

The major air emission sources associated with the exploration and development of the CSM exploration area include:

- short term coring activities, including preparation of access road to well sites
- exploration testing of selected wells

The majority of site disturbance takes place during the exploration/assessment stage of the exploration activity. This is in direct contrast to the more traditional forms of resource developments.

As part of the well preparation activities, site works generally involve the removal of topsoil and subsoil (access road construction). The well area is then prepared as required (levelled). Drilling of the well is then completed.

If successful, the exploration test well is put into test mode. Flaring then occurs. The access roads are maintained to the site with access required on an 'as-needs' basis.

4.1 Coring activities

Potential dust emission sources that relate to the initial coring activities associated with the Hunter Exploration Activity are detailed below.

The primary air emissions associated with the coring works occur during the initial site establishment works only. It is the preparation of the road and the movement of heavy construction vehicles which are considered to have the greatest potential for air emission release (particulate matter) at this time.

4.1.1 Drilling activities

No published data is currently available for the emission of material as associated with sub surface soil drilling activities.

4.1.2 Fugitive dust sources

Significant atmospheric dust arises from the mechanical disturbance of granular material exposed to the air. Dust generated from these open sources is termed 'fugitive' because it is not discharged to the atmosphere in a confined low flow stream. Common sources of fugitive dust include unpaved roads and exposed areas of soil.

Dust generation from 'fugitive sources' is caused by two basic physical phenomena:

- pulverisation and abrasion of surface materials by application of mechanical force through implements (wheels, blades) – this is fundamental to the release of dust from roadways, for example, the driving of motor vehicles
- entrainment of dust particles by the action of turbulent air currents, such as wind erosion of an exposed surface.

The effect of a fugitive dust source on air pollution primarily depends on the quantity and drift potential of the dust particles released into the atmosphere.

The potential drift distance of particles is governed by the initial release height of the particle, the terminal settling velocity of the particle, the reflection co-efficient of the particle, the specific gravity of the particle and the degree of atmospheric turbulence.

4.1.3 Unpaved roads

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Emissions depend on source parameters that characterise the condition of a particular road and the associated vehicle traffic.

When a vehicle travels on an unpaved road, the force of the wheels on the road surface causes pulverisation of surface material. Particles are lifted and dropped from the rolling wheels, together with the road surface being exposed to strong air currents. The turbulent wake behind a vehicle also continues to act on the road surface after the vehicle has passed.

Historically, particulate matter emissions that are associated with the hi-volume movement of heavy vehicles along unpaved roadways have been found to be a significant dust release source.

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 μm in diameter) in the road surface materials.

4.1.4 Well construction vehicular air emissions

Fossil fuel is the major source of the world's energy and has been stated as being the primary contributor to human generated greenhouse gas emissions. The operation of on-site machinery will generate carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NO_X), sulphides (SO_X) and trace amounts of non-combustible hydrocarbons (C_XH_X).

Contractors need to ensure that all diesel powered equipment does not release smoke in contravention of the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2006*.

Air emission as caused by the internal combustion (and exhausting to atmosphere) of mobile plant (including drilling equipment) was not considered in detail as part of this study due to the inherently short-term nature of the exploration activity.

4.2 Exploration activity air emissions

Following the outcomes of the initial coring works, Sydney Gas may decide to move into exploration evaluation phase. If this occurs, flaring would be the key air emission source associated with the exploration activities. A brief outline only has been presented below.

Flaring is a high temperature oxidation process generally used to burn combustible components, mostly hydrocarbons, from industrial processes.

During a combustion reaction, several intermediate products are formed, and eventually, the majority are converted to CO_2 and H_20. Some quantities of stable intermediate products (such as NO_X CO, H_2 and C_XH_X – hydrocarbons) can be expected to escape as emissions.

Typical flare systems comprise the following components:

- gas collection header and piping for collection gases
- a knockout drum (disentrainment drum) to remove and store condensables and entrained liquids
- a proprietary seal, water seal or purge gas supply to prevent flash-back
- a burner unit and flare stack
- gas pilots and an ignitor
- a provision for external momentum force (steam injection or forced air) for smokeless flaring.

Complete combustion requires sufficient combustion air and proper mixing of air and waste gas. Smoking is not expected to be an issue that results from combustion, based on the clean gas components (which will be methane).

A flare associated with the CSM exploration phase will be used to dispose of low-volume emissions.

5. General comment on air quality issues

A statement of air quality effects cannot be made at the writing of this document. Information provided by Sydney Gas indicates that the exact coring and exploration test well locations are in the process of determination at this juncture. Well locations will vary and the exact seams and gas contents will not be revealed accurately until Sydney Gas has completed its initial investigations.

Not withstanding the above, a general comment on potential air quality issues has been provided based on the experience of PB.

A summary of anticipated air quality issues is outlined in Table 5.1.

Table 5.1: Summary of anticipated air quality issues from exploration activities

Pollutant	Initial Coring (relevant to current Sydney Gas REF)	Exploration testing
Carbon monoxide	Negligible	Minor
Nitrogen oxides	Negligible	Minor
VOC's	Negligible	Minor
Particulate matter	Negligible	Minor
Methane / Greenhouse gases	Negligible	Unqualified - TBC

Notes to Table 5.1

TBC – to be considered further

No adverse effects are to be associated with the initial coring activities.

During exploration testing, emissions would be very minimal. Adverse air quality effects are not expected to be an issue during any exploration activity works carried out.

5.1 Recommended management measures and mitigation strategies

Further to standard practices implemented by Sydney Gas during construction works, there are no specific management measures or mitigation strategies that need to be considered by Sydney Gas for the CSM exploration activity.

Sydney Gas will implement the following:

- all due care will be taken to minimise particulate matter emissions during the initial clearing and site establishment works
- as far as practicable, and where required, all exposed bare earth will be stabilised.
- ensure all construction vehicles using public roads are maintained so that any loss of load is prevented
- dust emission will be visually assessed to determine the need for any dust generating activities to cease
- ensure all plant and equipment used in connection with the exploration activity are operated in a proper and efficient manner
- all vehicles and machinery are to be properly serviced and maintained to ensure that they do not cause undue air pollution.

Any flares will be designed and operated by Sydney Gas according to current best practice performance standards and destruction efficiencies.

Sydney Gas notes that the flares must be operated so that *no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours occur* in accordance with *The Protection of the Environment Operations (Clean Air) Regulation 2005*.

6. Concluding remarks

A review of air quality issues was conducted for the proposed Hunter Exploration Activity.

The works included a review of existing conditions and a qualitative assessment of anticipated air quality issues. No targeted calculations or background ambient air measurements were carried out.

The major works associated with the exploration of the CSM exploration area include: short term coring activities, including preparation of access road to well sites, exploration testing of selected wells.

The initial coring activities, that are the focus of the current Sydney Gas REF, will be present for a maximum of four weeks only at each of the five sites. Negligible effects on air quality would be associated with these works.

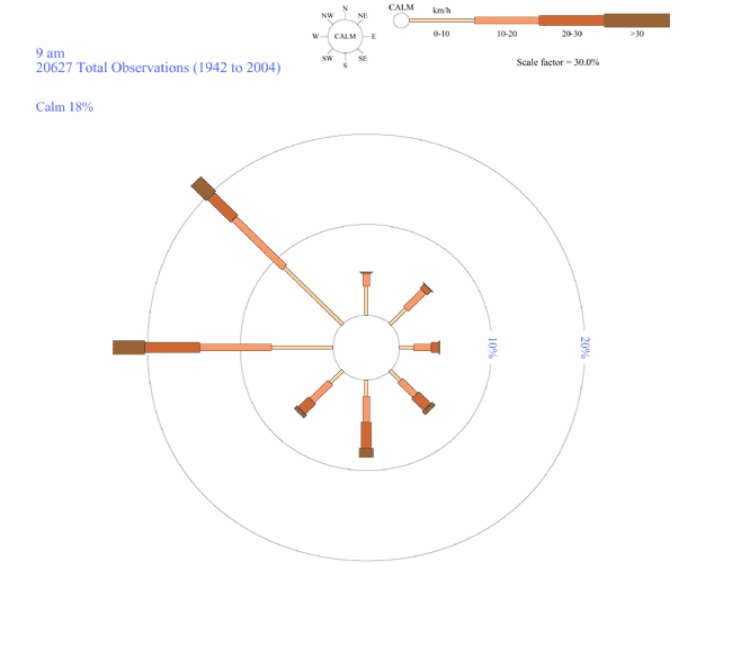
During exploration testing, emissions would be minimal. Adverse air quality effects are not expected to be an issue during any exploration testing works carried out.

The success of the CSM coring activities will determine any decision to drill trial exploration wells at other potential targets in the exploration area. Additional background air quality data and a more refined assessment of air quality issues in those areas would then be recommended.

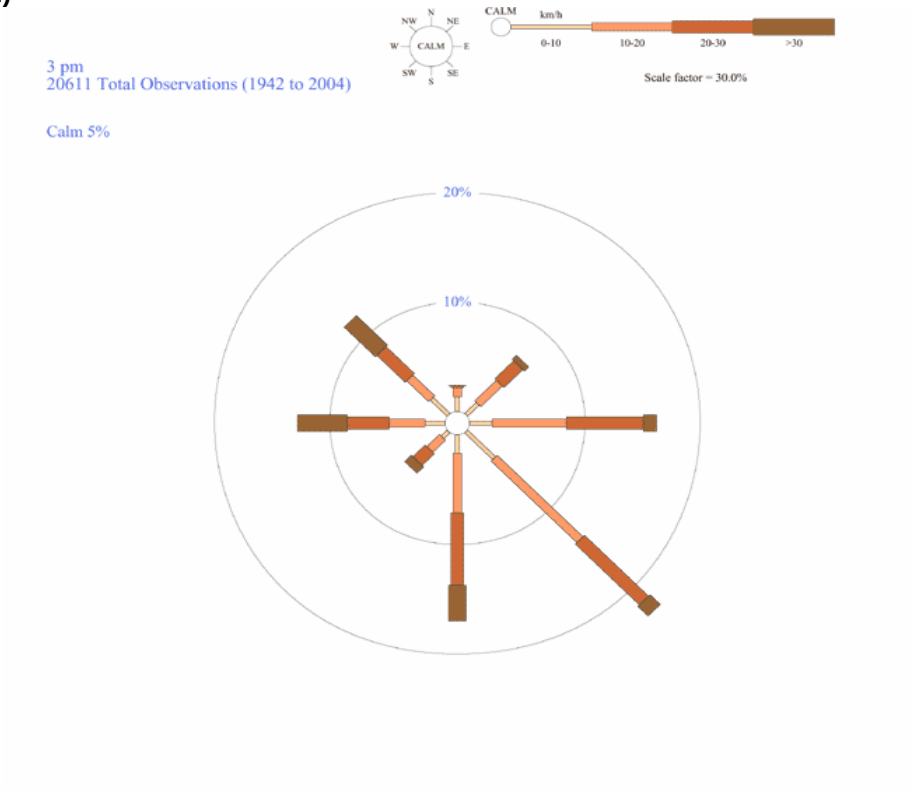
Appendix A

Wind Rose Data (Williamstown & Camberwell)

Mean 9am and 3 pm Wind Speeds (Williamtown)
Annual (9 am)
Location: Williamtown **Site Number:** 61078
Lattitude: -32.80 **Longitude:** 151.83 **Elevation:** 9 metres (above sea level)

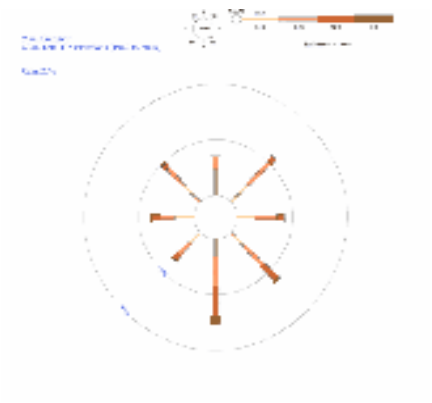


Annual (3 pm)

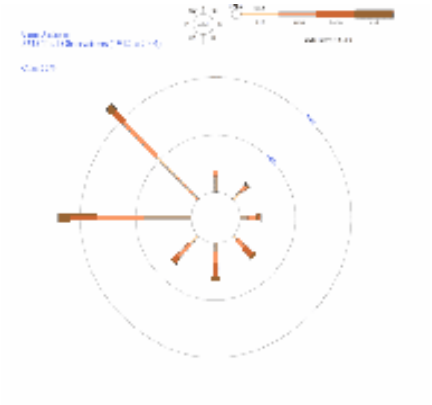


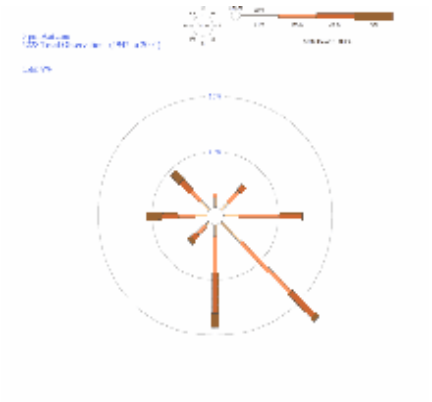
Source: Bureau of Meteorology

Mean 9am and 3 pm Wind Speeds (Williamtown)
Summer
Location: Williamtown **Site Number:** 61078
Lattitude: -32.80 **Longitude:** 151.83 **Elevation:** 9 metres (above sea level)

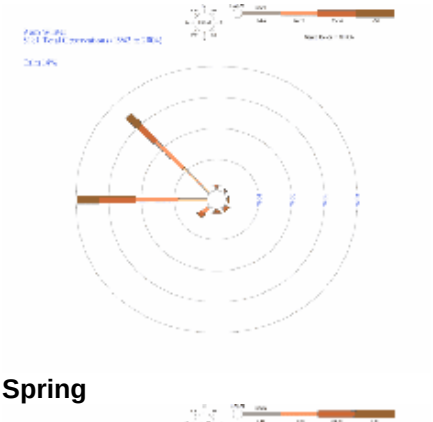


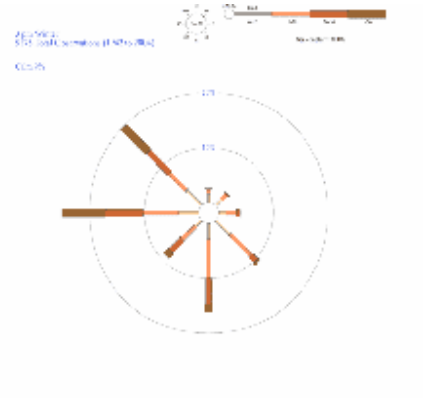
Autumn



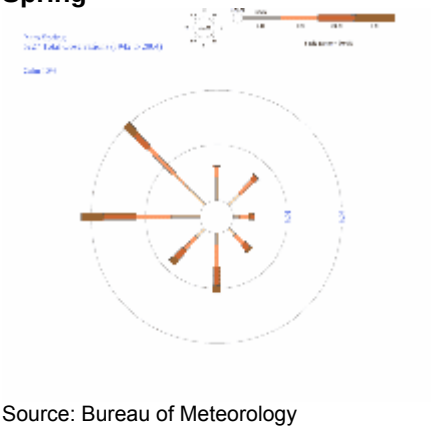


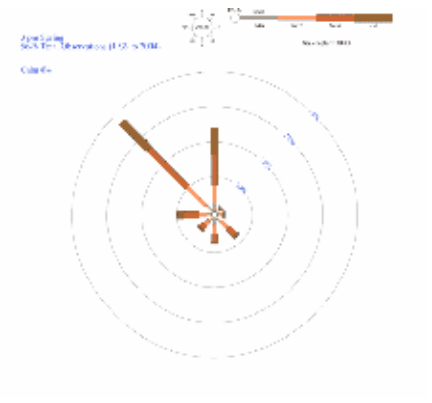
Winter





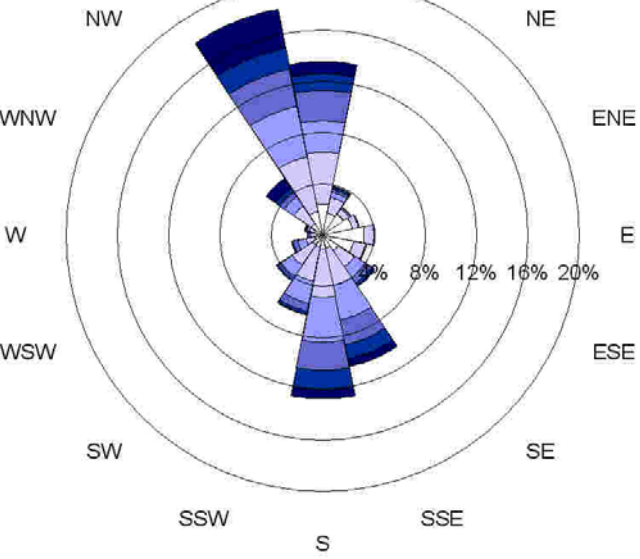
Spring



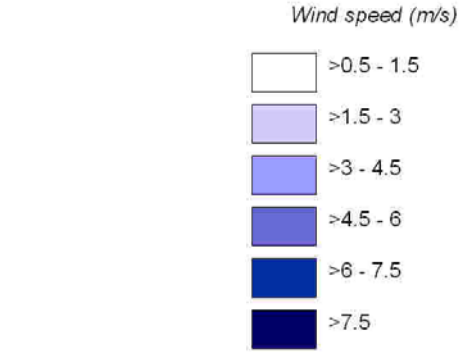


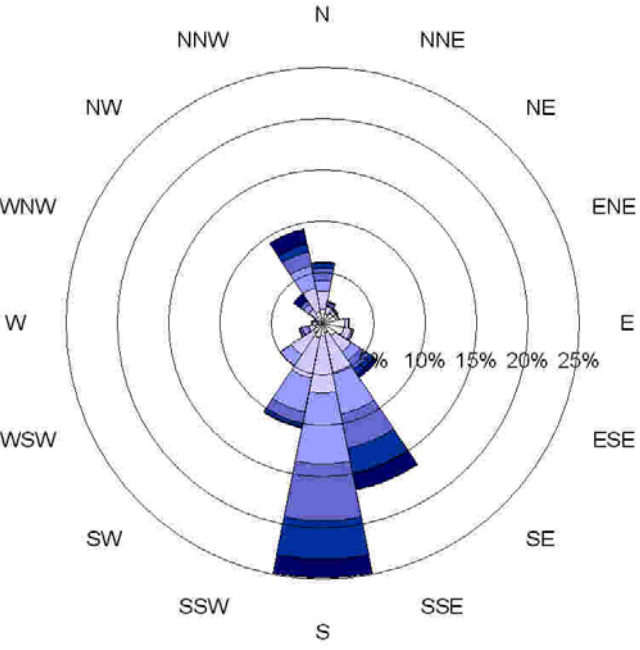
Source: Bureau of Meteorology

Annual and seasonal windroses for Camberwell (2001)

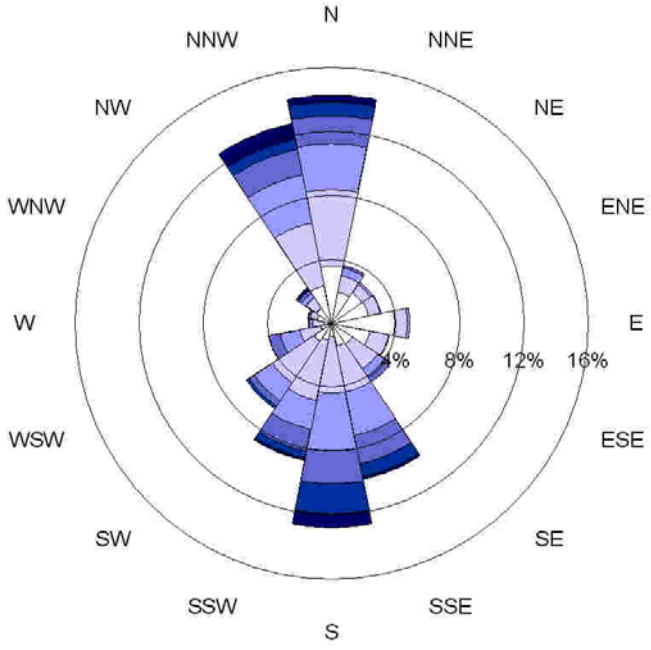


Annual
Calms = 2.1%





Summer
Calms = 2.3%



Autumn
Calms = 2.8%