TECHNICAL REPORT NO 4

AIR QUALITY ASSESSMENT

PAE HOLMES

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PROPOSED INTEGRATED RECYCLING PARK AT CAMELLIA, NSW

National Environmental Consulting Services

Job No: 3812

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A PEL Company

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

This report has been prepared by PAEHolmes for National Environmental Consulting Services (NECS), on behalf of REMONDIS Pty Ltd (REMONDIS), who are seeking approval for the construction and operation of an Integrated Recycling Park (IRP) located at Camellia in the Western Suburbs of Sydney. The purpose of this report is to assess the air quality impacts, namely odour and dust, which may be associated with activities occurring at the proposed IRP. The location of the proposed site is shown in **Figure 1.1**.

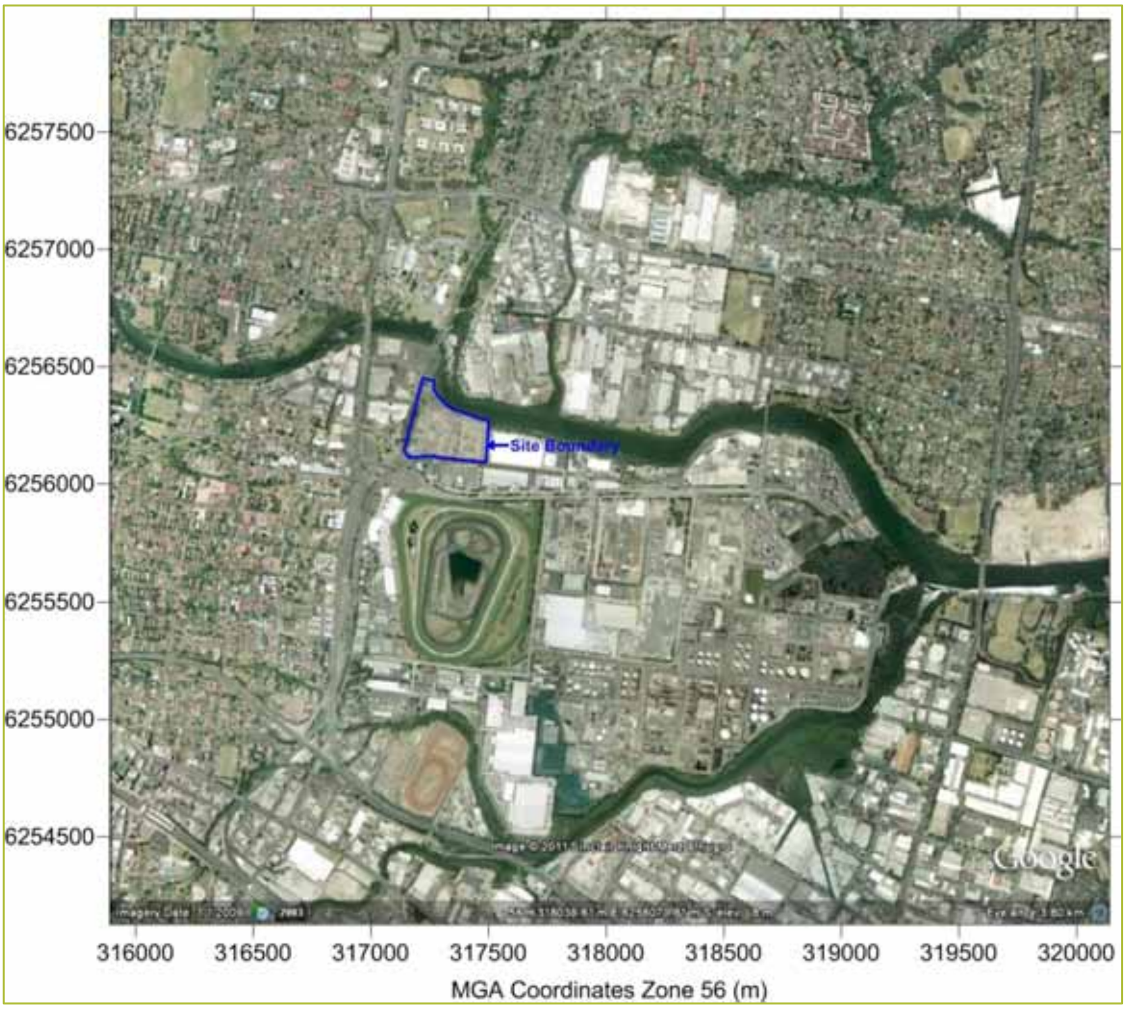


Figure 1.1: Aerial view of the proposed site for IRP, Camellia NSW

The report comprises the following components.

- Description of the project;
- A discussion of air quality issues with respect to odour and dust;
- A review of the dispersion meteorology in the area;
- An assessment of odour and dust emissions; and
- A greenhouse gas assessment.

The modelling has been carried out in accordance with the NSW Department of Environment, Climate Change and Water (DECCW) "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (**NSW DEC, 2005**).

2 PROJECT DESCRIPTION

The proposed facility is located at Camellia, approximately 18 km to the west of Sydney CBD and adjacent to the Parramatta River and Rosehill Racecourse. **Figure 1.1** shows a map of the study area. Land use in the area is predominantly residential to the west and north of the site. Located to the south of the site is the Rosehill Racecourse. The area at east and northeast is industrial and may contain other potential sources of air emissions. **Figure 2.1** shows the proposed site layout.

The proposed development involves the construction and operation of an Integrated Recycling Plant (IRP) that comprises two Alternative Waste Treatment (AWT) plants for:

- Commercial & Industrial (C&I) Resource Recovery Facility (CIRRF); and
- Source Separated Organic Resource Recovery Facility (SSORRF).

Both plants are designed to maximise recovery of resources for market and minimise disposal to landfill.

2.1 Commercial & Industrial Resource Recovery Facility (CIRRF)

The CIRRF facility will be open for waste delivery 24 hours per day, 7 days per week all year. Landfills around Sydney have limited operation hours during both weekdays and weekends. The purpose of the CIRRF is to cater for the operational needs and requirements of REMONDIS. A key requirement is that all waste received is processed immediately on the day of receival with no unprocessed stockpiles of waste left overnight under normal operation. This forms part of the vector management and odour plans for this plant.

REMONDIS currently plans a two-shift operation per day with each shift being of 8 hours duration. Operating hours per shift and number of shifts per day need to accommodate the quantities of waste delivered at the facility and may change accordingly over the life of the project. **Table 2.1** presents the proposed operating parameters based on the current plan.

The nominal processing capacity of C&I waste is 100,000 tonnes per annum (tpa). REMONDIS estimates that approximately 70,000 tpa of these quantities are mixed loads with the remaining 30,000 tpa being dry waste loads with a high content of recyclable material. Dry and mixed/wet streams are kept separate.

On a daily basis, the collection trucks carry an estimated 80 tonnes of dry waste and 190 tonnes of mixed and wet waste collected from small businesses throughout the CBD and the Parramatta area to the CIRRF facility for waste processing.

Table 2.1:Design parameters for CIRRF

Parameter	Dry Waste	Mixed/Wet Waste	Unit
Material Handling			
Annual throughput	30,000	70,000	tpa
Average bulk density	0.2	0.4	t/m³
Annual volumes	150,000	175,000	m³pa
Delivery			
Delivery hours	24	24	Hours/day
Delivery days	7	7	Days/week
Average quantities	82	192	t/day
Average volumes	411	479	m³/day
Mechanical Processing			
Operating shift	8	8	Hours/shift
Shifts/day	2	2	
Average tonnes/hour	5	12	
Average volumes/ hour	26	30	m³/hour

2.1.1 Wastes Sources and Composition

The composition of C&I waste varies significantly depending on the collection area, type of business or industry and service. The source material for the CIRRF will be collected from small business outlets throughout the Sydney CBD and Parramatta area.

The DECCW carried out a field survey in 2008 to determine the content of C&I waste streams. This survey included visual assessment of C&I mixed and single material loads delivered to six landfills and six transfer stations and weight based sorting of garbage bags from eight selected industry sectors. **Table 2.2** presents the composition estimate for the CIRRF.

Table 2.2: Mixed C&I Waste Composition Estimate

Type	Percentage
Food/Vegetation	20%
Paper/Cardboard	17%
Wood	17%
Plastic	17%
Textile	5%
Metals	2%
Construction/Demolition	10%
other	12%
Total	**100%**

2.2 Source Separated Organic Resource Recovery Facility (SSORRF)

In line with the Recycling Park opening hours, the SSORRF facility will be able to accept waste delivery 24 hours per day, 7 days per week all year. A key requirement is that all waste received is processed immediately with no unprocessed stockpiles of waste.

REMONDIS currently plans for a one-shift operation per day with each shift being of 8 hour duration. Operating hours per shift and number of shifts per day need to accommodate the quantities of waste delivered at the facility and may change accordingly over the life of the project.

The nominal processing capacity of SSORRF is 50,000 tonnes per annum. An average bulk density of close to 0.50 t/m^3 has been estimated for the annual average organic waste delivered to this plant. The key design data are summarised in **Table 2.3**:

Table 2.3:Design data for SSORRF

Parameter	Green/Food Waste	Unit
Material Handling		
Annual throughput	50,000	tpa
Average bulk density	0.5	t/m³
Annual volumes	100,000	m³pa
Delivery		
Delivery hours	24	Hours/day
Delivery days	7	Days/week
Average quantities	192	t/day
Average volumes	479	m³/day
Mechanical Processing		
Operating shift	8	Hours/shift
Shifts/day	1	
Average tonnes/hour	17	t/hr
Average volumes/ hour	34	m³/hour

2.2.1 Source Separated Organic Material Composition

The source of waste for the SSORRF will be derived from source separated domestic kerbside collection schemes for groups of councils within the metropolitan area such as the Inner City group comprising Ashfield, Auburn, Burwood, Canada Bay, Leichhardt and Strathfield Councils. **Table 2.2** presents the composition estimate for the SSORRF.

Table 2.4: Composition estimate for the SSORRF

Input	Quantities	Moisture	Solids		Organic (Degradable)		Density/Tip	Quantities
	tpa	%	tpa	tpa	%	tpa	t/m³	m³pa
Green waste	30,000	45	13,500	16,500	70	11,550	0.4	75,000
Food waste	20,000	70	14,000	6,000	80	4,800	0.7	28,751
Other organics	0	50	0	0	60	0	0.4	0
Wood waste	0	30	0	0	30	0	0.3	0
Total	**50,000**	**55**	**27,500**	**22,500**	**73**	**16,350**	**0.48**	**103,571**

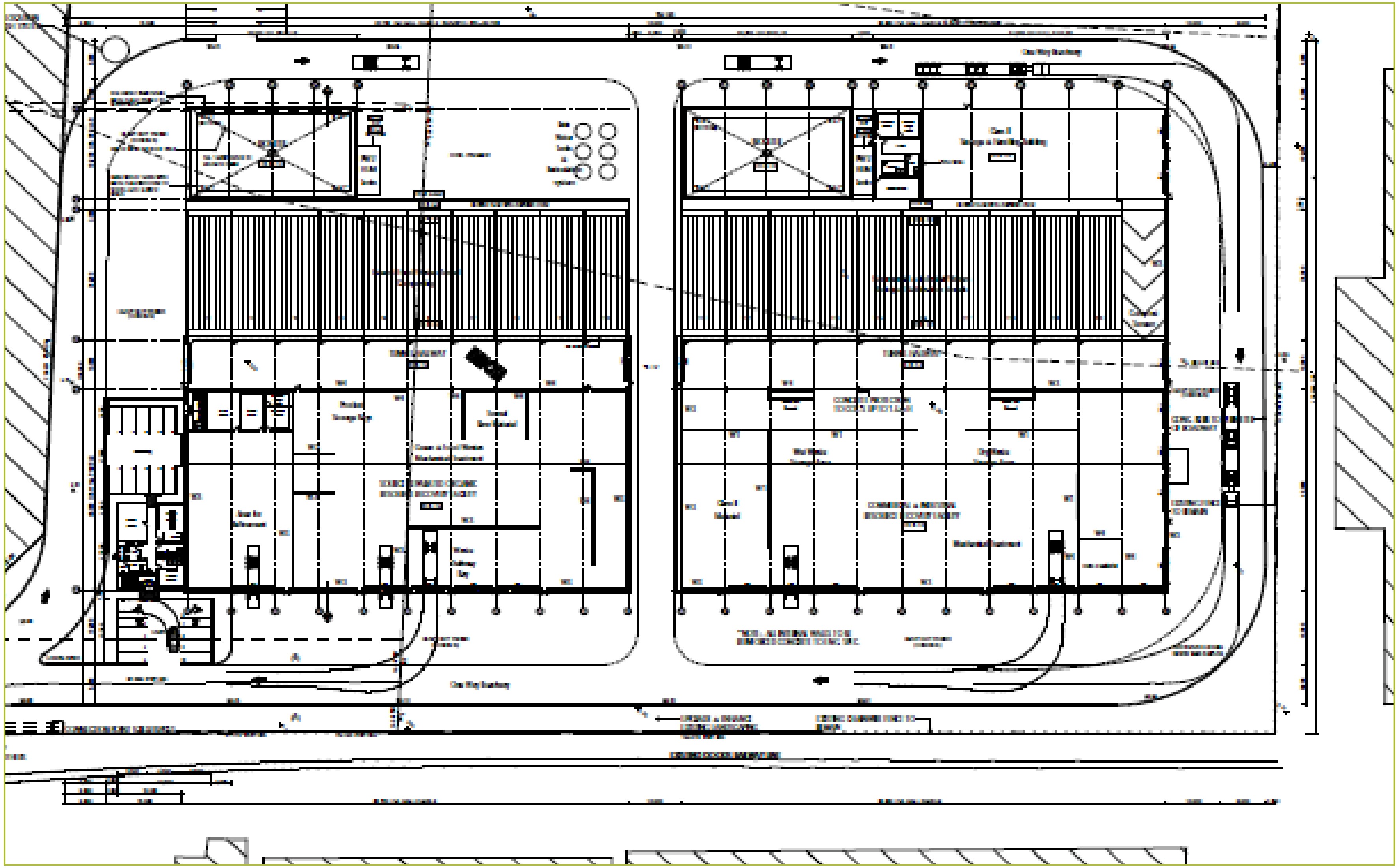


Figure 2.1: Site layout

3 DUST AND ODOUR MANAGEMENT

3.1 Odorous Air Management

The facility consists of three warehouse type buildings; namely CIRRF, SSORRF and a Storage & Handling Building. The tunnel hallway and the Storage & Handling's Building will cover a total area of approximately 6,450 m² with a building height ranging between 7 m and 10m.

The main objectives of the air management system within the main building complex are to:

- Retain odorous air inside the buildings;
- Remove odorous air from the various building areas to the tunnel composting plant;
- Provide heated/cooled fresh air and extraction to the sorting cabins;
- Provide heated fresh air and extraction to the amenities areas; and
- Provide heat pump air conditioning and fresh air to the office areas and the control rooms.

Collection hoods (extraction grills) will be mounted over the high emission areas within the building such as material unloading, storage, handling areas. The air extraction rate in the various parts of the building will be controlled (ramped up/down) by means of various dampers extraction grills. For example, higher extraction rates will be applied in the reception area during waste delivery and pick-up, tunnel loading and unloading.

One fan in each building complex will extract odorous air and deliver the air along the duct pathways to a duct manifold at the rear of the tunnel composting plant. The manifold connects to all fresh air dampers of the tunnel air ventilation system (dampers by others), which controls the air supply into the composting process.

The system will maintain a slight negative pressure inside the respective building areas. Any balance of the odorous air from the buildings is automatically drawn from the biofilter fan and ducted into the biofilter facility.

All frequently trafficked doors (truck delivery and pickup) will be equipped with fast speed roller doors, programmed to only open during delivery times, maintaining negative pressure and containing emissions within the building for the majority of the time.

If required, an option to retrofit the system with additional air curtains mounted above each fast speed roller door entrance can be installed and operated in case of temporary roller door failure or during truck delivery to retain odorous air inside the building.

The fresh air demand for each tunnel will be automatically restricted to a minimum through the recycling of odorous air back into the tunnel. Exchange of exhaust air between the tunnels is controlled through a one-way valve in the discharge duct.

The total building ventilation system air volumes will not exceed 60,000 m³/hour at any time.

3.2 Dust Management

3.2.1 Construction

Activities during the construction stage for the proposed development at Camellia have the potential to temporarily generate dust. The proposed development works involves the construction of two large industrial buildings, including excavation of services trenches to the proposed buildings, filling of the land underneath the proposed buildings and construction of concrete access roads and carpark surrounding the proposed buildings.

Potential dust generating activities have been identified during Stage 1 and Stage 2 of the construction phase. Stage 3 involves the actual construction of the facility. Earth movement activities at this stage will be minimal and there will be minimal dust emission at this stage.

Stage 1 involves excavation and trenching activities below the capping layer required for the provision of utility services and extension of the stormwater system. The excavation for services will be generally 1 m to 3.7 m below existing ground levels within the site and will be excavated through the site to extend the services from the boundary at Grand Avenue to the perimeter of the proposed building/lease area. Excavation of any contaminated soil will be carried out as recommended by the Site Management Plan with all excess material being taken off site to a pre-determined tip site. Appropriate handling of the contaminated soil will be carried out as outlined in the Safe Work Method Statement (SWMS). The work will be supervised by a licensed asbestos removal (AS1) contractor and a suitably qualified occupational hygienist will be engaged to prepare an air monitoring program for the excavation, storage and offsite removal of fill material containing asbestos.

As the site contains asbestos material below the capping layer, appropriate management practices will be in place to ensure no off-site impacts from this material will occur. These include extensive use of watering during the trenching activity and disturbance of the material removed; controlled stockpiling and ensuring dust emissions are minimal.

The work area will be limited to the line of trenching for the stormwater pipes and the incoming services with approximately 550 m of trenching to be excavated which will yield approximately 1200 m^3 of spoil. This spoil will be disposed of to an approved landfill site. Excavated concrete and roadbase will be stripped off the surface and set aside for recycling. The contaminated soil will be set aside in controlled stockpiles and tested for classification for disposal. Any surplus soil will be disposed off site to a licensed landfill.

The construction period is expected to last 6 weeks to 8 weeks with approximately 80 truck and dogs of contaminated soil to be removed from site over a 20 day period. Once the spoil is removed there will only be deliveries to site. It is proposed that the works will generally be carried out in the following phases:

- Phase 1: Erect barrier fencing around the work area, construct sediment traps where required, delineate the construction access route and install sediment and erosion control measures;
- Phase 2: Carry out trench excavation for the stormwater line below the cap;
- Phase 3: Carry out trench excavation for the remaining service lines below the cap;
- Phase 4: Carry out trench excavation for the remaining service lines above the cap or in non-contaminated areas.

Stage 2 involves the construction of the platform above the capping layer. The platform is designed to avoid the penetration of the capping layer for the construction of the main buildings and structures. The dust generating activities have been identified as vehicle movements on-site, emplacing clean fill material and handling of the clean fill material. The time frame for this activity has been estimated to take approximately two to three months.

The majority of dust generating activities has been identified during stages 1 and 2 when the majority of earth movement activities occur. Activities during Stage 3 construction of buildings and structures for the facility would have a low propensity to generate dust. As there are no bulk earthworks in this stage, the major dust generating activity will be truck movement.

Dust emissions due to the construction activities have been estimated and presented in **Table 3.1**. Details of the dust emission estimation techniques are presented in **Appendix A**. The total amount of dust generated from the construction of this facility is predicted to be minor (< 2 tonnes) and short lived. Significant off-site impacts are not expected from construction activities at this scale and have not been considered further in this assessment.

Notwithstanding this, to ensure dust generation is controlled, the site will implement dust mitigation measures which will be utilised to help reduce any off-site impacts from any construction activities.

Mitigation measures to control dust include:

- Watering of any exposed materials and heavily trafficked areas;
- Covering stockpiles of clean fill during platform construction;
- Limit vehicle speeds; and
- Rehabilitate completed sections of the site.

Table 3.1: Dust Emission Inventory

ACTIVITY	TSP emission (kg)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units
Construction (Time period - 6 to 8 weeks)									
Trenching	0.2	1,632	tonnes	1.37E-04	kg/t	1.10	average (ws/2.2)^1.3	10	moisture content - %
Loading material	0.2	1,632	tonnes	1.37E-04	kg/t	1.10	average (ws/2.2)^1.3	10	moisture content - %
Hauling material – Deliveries	12.8	131	trips	0.2	kg/VKT	0.40	km/return trip		
Hauling material offsite	6.4	80	trucks	0.2	kg/VKT	0.40	km/return trip		
Building Platform (Time period – 2 to 3 months)									
Hauling material	192	2,400	trips	0.2	kg/VKT	0.40	km/return trip		
Emplacing material	13.7	100,000	tonnes	1.37E-04	kg/t	1.10	average (ws/2.2)^1.3	10	moisture content - %
Spreading / Compacting (bulldozer)	838.3	480	hours	1.75E+00	kg/hour	6	moisture content - %	5	silt content
Wind Erosion	2.0	5	ha	4.00E-01	kg/ha/hour	2160	hours		
Construction of Facility Buildings (Time period – 9 to 12 months)									
Hauling material	416	5,200	trips	0.2	kg/VKT	0.40	km/return trip		
TOTAL (Construction)	**1,480**								

3.2.2 Operational

Dust emissions from activities taking place when the facility is at full operating capacity will be minor. All trafficked areas are sealed and dust generating activities such as sorting, loading and unloading will take place under enclosed condition (within the building). The potential of generating off-site dust impacts due to the operational activities are minimal and have not been considered further in this assessment.

4 DISCUSSION OF AIR QUALITY ISSUES

4.1 Measuring odour concentration

There are no instrument-based methods that can measure an odour response in the same way as the human nose. Therefore "dynamic olfactometry" is typically used as the basis of odour management by regulatory authorities.

Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air to a panel of people with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. The correlations between the known dilution ratios and the panellists' responses are then used to calculate the number of dilutions of the original sample required to achieve the odour detection threshold. The units for odour measurement using dynamic olfactometry are "odour units" (ou) which are dimensionless and are effectively "dilutions to threshold".

Olfactometry can involve a "forced choice" end point where panellists identify from multiple sniffing ports the one where odour is detected, regardless of whether they are sure they can detect odour. There is also a "yes/no" or "free choice" endpoint where panellists are required to say whether or not they can detect odour from one sniffing port. Forced choice olfactometry generally detects lower odour levels than yes/no olfactometry and is the preferred method for use in Australia.

In both cases, odorous air is presented to the panellists in increasing concentrations. For the forced-choice method, where there are multiple ports for each panellist, the concentration is increased until all panellists consistently distinguish the port with the sample from the blanks. For a yes/no olfactometer (which has only one sniffing port) one method used is to increase the concentration of odour in the sample until all panellists respond. The sample is then shut off and once all panellists cease to respond, the sample is introduced again at random dilutions and the panellists are asked whether they can detect the odour.

During the 1990s significant research was undertaken in Europe to refine the olfactometry method. This led to considerable improvements in panellist management and standardisation and, importantly, clear criteria for repeatability and reproducibility of results.

The draft Committé Européen de Normalisation (CEN) odour measurement standard (**CEN, 1996)** is a performance based standard with strict criteria for repeatability and reproducibility. The Australian standard (introduced in September 2001) (**Standards Australia, 2001**) is based upon the CEN standard.

As with all sensory methods of identification there is variability between individuals. Consequently the results of odour measurements depend on the way in which the panel is selected and the way in which the panel responses are interpreted.

4.2 Odour performance criteria

4.2.1 Introduction

The determination of air quality goals for odour and their use in the assessment of odour impacts is recognised as a difficult topic in air pollution science. The topic has received considerable attention in recent years and the procedures for assessing odour impacts using dispersion models have been refined considerably. There is still considerable debate in the scientific community about appropriate odour goals as determined by dispersion modelling.

The DECCW has developed odour goals and the way in which they should be applied with dispersion models to assess the likelihood of nuisance impact arising from the emission of odour.

There are two factors that need to be considered:

1. what "level of exposure" to odour is considered acceptable to meet current community standards in NSW and

2. how can dispersion models be used to determine if a source of odour meets the goals which are based on this acceptable level of exposure

The term "level of exposure" has been used to reflect the fact that odour impacts are determined by several factors the most important of which are:

- the **F**requency of the exposure
- the **I**ntensity of the odour
- the **D**uration of the odour episodes and
- the **O**ffensiveness of the odour (the so-called FIDO factor)

In determining the offensiveness of an odour it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

In summary, whether or not an individual considers an odour to be a nuisance will depend on the FIDO factors outlined above and although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable. Odour goals need to take account of these factors.

4.2.1.1 Complex mixtures of odorous air pollutants

The DECCW Approved Methods include ground-level concentration (glc) criterion for complex mixtures of odorous air pollutants. They have been refined by the DECCW to take account of population density in the area. **Table 4.1** lists the odour glc criterion to be exceeded not more than 1% of the time, for different population densities.

The difference between odour goals is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The residential areas to the west of the site are considered as urban. Therefore, as shown in **Table 4.1,** the relevant impact assessment criterion is 2 ou **(NSW DEC, 2005)**. For the industrial areas to the east of the site a less stringent criterion, between 4-5 ou, should be applicable as the population is sparser and in some instances only present during part of the day.

Table 4.1: Impact Assessment Criteria for the Assessment of Odorous air pollutants

Population of affected community	Impact Assessment Criteria for Complex Mixtures of Odorous Air Pollutants (OU, nose-response-time average, 99th percentile)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

4.3 Peak-to-mean ratios

It is a common practice to use dispersion models to determine compliance with odour goals. This introduces a complication because Gaussian dispersion models are only able to directly predict concentrations over an averaging period of 3-minutes or greater. The human nose, however, responds to odours over periods of the order of a second or so. During a 3-minute period, odour levels can fluctuate significantly above and below the mean depending on the nature of the source.

To determine more rigorously the ratio between the one-second peak concentrations and three-minute and longer period average concentrations (referred to as the peak-to-mean ratio) that might be predicted by a Gaussian dispersion model, the DECCW commissioned a study by **Katestone Scientific Pty Ltd (1995, 1998)**. This study recommended peak-to-mean ratios for a range of circumstances. The ratio is also dependent on atmospheric stability and the distance from the source. For volume sources or wake affected point sources, as applies in this case, the peak-to-mean ratio is 2.3.

The DECCW Approved Methods take account of this peaking factor and the goals shown in **Table 4.1** are based on nose-response time.

5 APPROACH TO ASSESSMENT

5.1 Dispersion Modelling Methodology

The air dispersion modelling conducted for this assessment has been based on an advanced modelling system using the models TAPM and CALMET/CALPUFF (see **Figure 5.1**). This system substantially overcomes the basic limitations of the steady-state Gaussian plume models such as AUSPLUME. These limitations are most severe in very light winds, in coastal environments, and where terrain affects atmospheric flow.

The modelling system works as follows:

- TAPM (v. 4.0) is a prognostic meteorological model that generates gridded three-dimensional meteorological data for each hour of the model run period;
- CALMET (v. 6.326), the meteorological pre-processor for the dispersion model CALPUFF, calculates fine resolution three-dimensional meteorological data based upon observed ground and upper level meteorological data, as well as observed or modelled upper air data generated for example by TAPM; and
- CALPUFF (v. 6.263) then calculates the dispersion of plumes within this three-dimensional meteorological field.

5.1.1 TAPM

The Air Pollution Model, or TAPM, is a three dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research. Detailed description of the TAPM model and its performance is provided elsewhere. The Technical Paper by **Hurley (2005)** describes technical details of the model equations, parameterisations, and numerical methods. A summary of some verification studies using TAPM is also given in **Hurley *et al*. (2005)**.

TAPM solves the fundamental fluid dynamics and scalar transport equations to predict meteorology and (optionally) pollutant concentrations. It consists of coupled prognostic meteorological and air pollution concentration components. The model predicts airflow important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses.

Upper air data were generated over the study region using TAPM. The TAPM-generated data and observed surface meteorological data were then entered into the CALMET diagnostic meteorological model, which is discussed below.

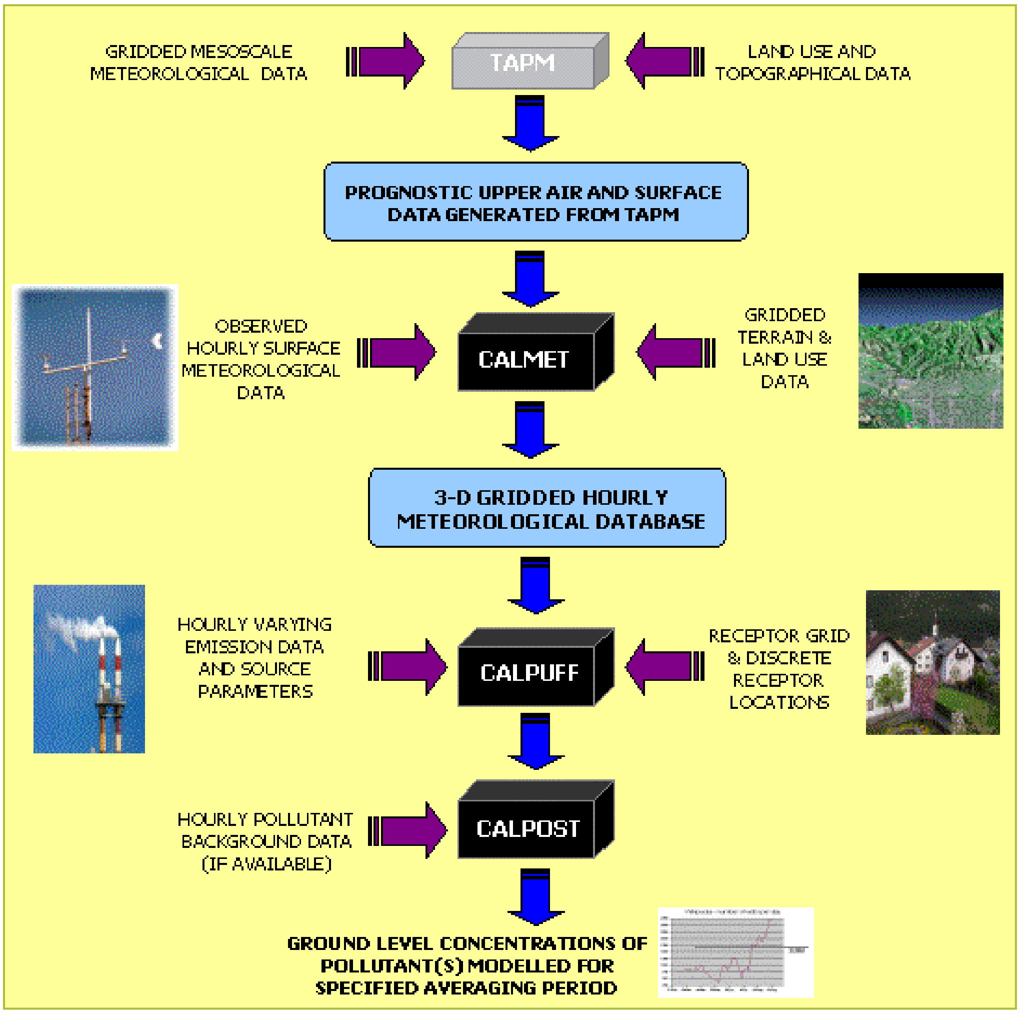


Figure 5.1: Modelling Methodology Used in this Study

5.1.2 CALMET

CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are used in the CALPUFF dispersion model.

The hourly TAPM-generated data and observed data for the period of analysis were used as input to the CALMET pre-processor to create a fine resolution, three-dimensional meteorological field for input into the dispersion model. CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict gridded meteorological fields for the region.

Terrain data has been sourced from the Shuttle Terrain Mission dataset. The spatial resolution of these data is 100 m.

Meteorological information collected at the Sydney Olympic Park Bureau of Meteorology (BOM) station and TAPM-generated surface information were used as input into the CALMET model. Cloud cover data collected at Sydney Airport have been used as input to the model. The data were additionally supplemented with upper air data derived from TAPM simulations.

A summary of the data and parameters used for the meteorological component of this study are shown in **Table 5.1**.

5.1.3 CALPUFF

CALPUFF (**Scire *et al.,* 2000**) is a multi-layer, multi-species, non-steady state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across the puff and takes into account the complex arrangement of emissions from point, area, volume, and line sources.

As with any air dispersion model, CALPUFF requires inputs in three major areas:

- Emission rates and source details;
- Meteorology; and
- Terrain and surface details, as well as specification of specific receptor locations.

CALPUFF is a DECCW approved model, and has been used in many studies in New South Wales, Queensland and other parts of Australia.

Table 5.1: Meteorological Parameters used for CALMET

TAPM (v 4.0)	
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grid points	25 x 25 x 25
Year of analysis	2005
Centre of analysis	Sydney Olympic Park AWS (33°51' S, 151°0.5' E)
CALMET (v. 6.4.0.05)	
Meteorological grid domain	10 km x 10 km
Meteorological grid resolution	0.1 km
Surface meteorological stations	Sydney Olympic Park AWS (Bureau of Meteorology, Station Number 066195) -Wind speed -Wind direction -Temperature -Relative Humidity Sydney Airport AMO (Bureau of Meteorology, Station Number 066037) -Cloud cover -Cloud height TAPM -Wind speed -Wind direction -Temperature -Relative humidity -Pressure
Upper air	Data extracted from TAPM

5.2 Long term Meteorological Data Analysis

No site specific or site representative data are available at the proposed location. The nearest available BOM monitoring station (Olympic Park), with the required meteorological data, is located approximately 5 km southeast of the site.

Figure 5.2 and **Figure 5.3** present the temperature and wind speed analysis for five years (2004 to 2008) for Olympic Park BOM Station. It can be observed from these figures that wind and temperature patterns are relatively similar in every year. Analysis of these data show that meteorological data for the 2005 calendar year correlate best with the long term annual average data. Therefore the 2005 calendar year was selected as the modelling year for this assessment.

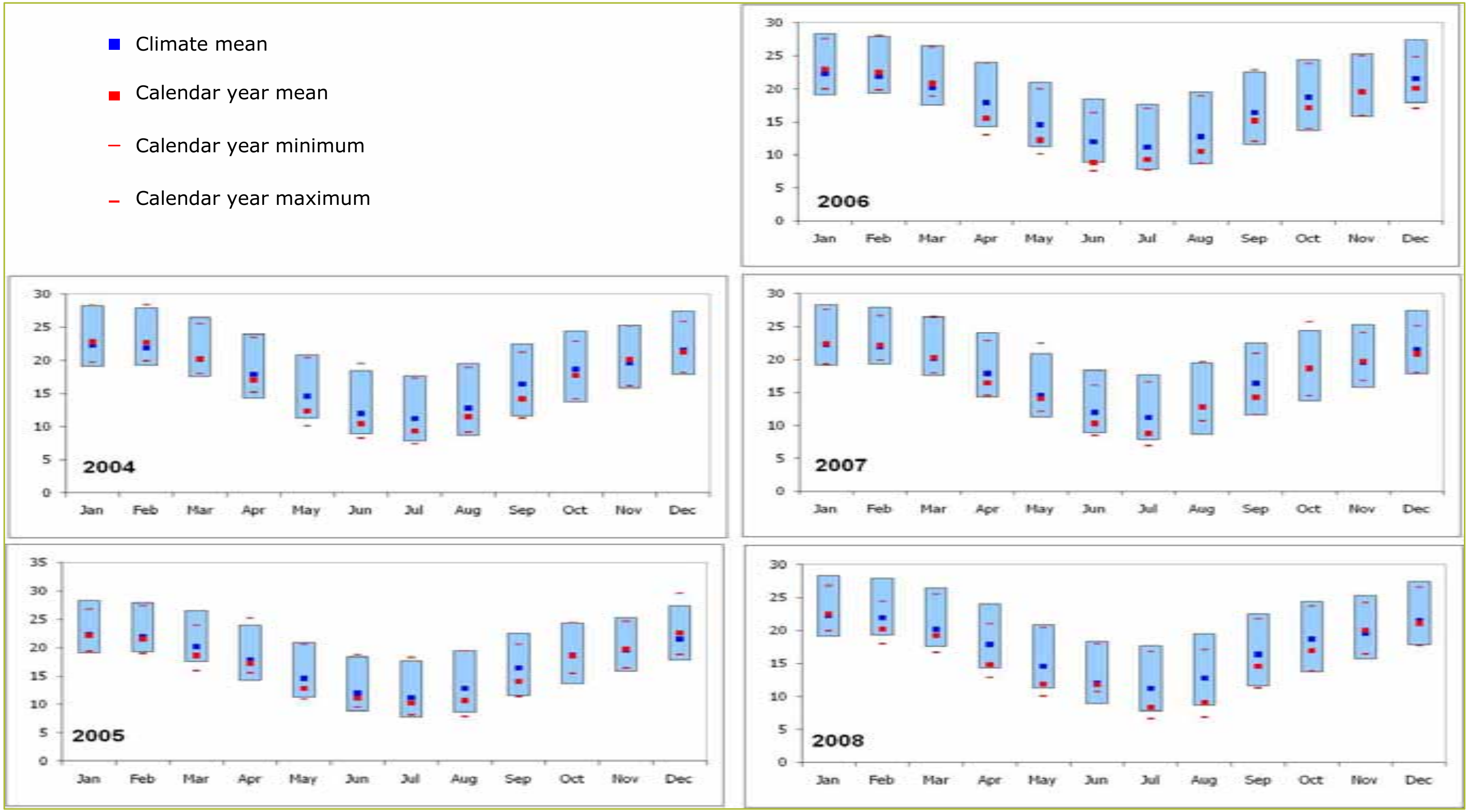


Figure 5.2: Long term temperature analysis

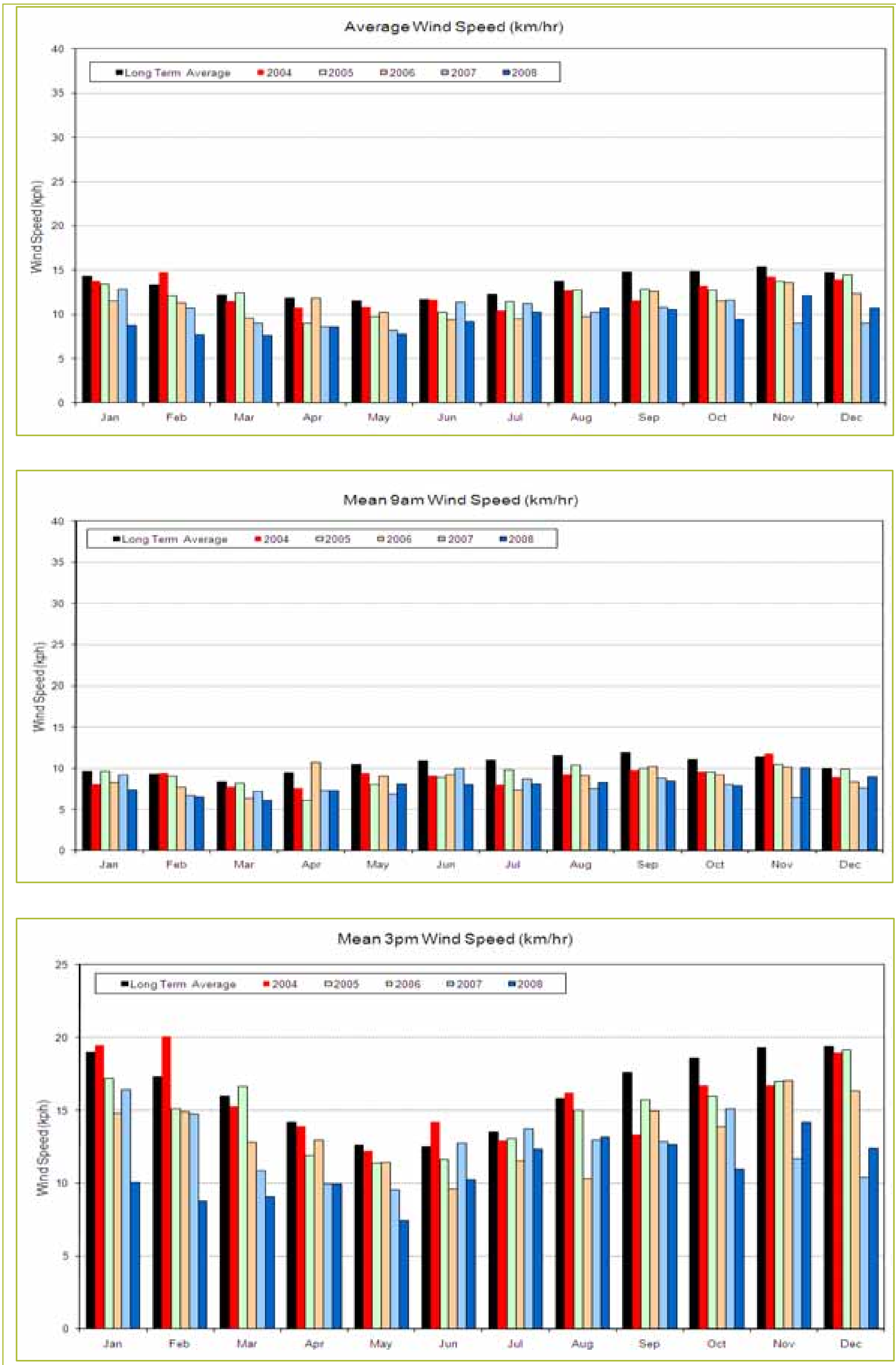
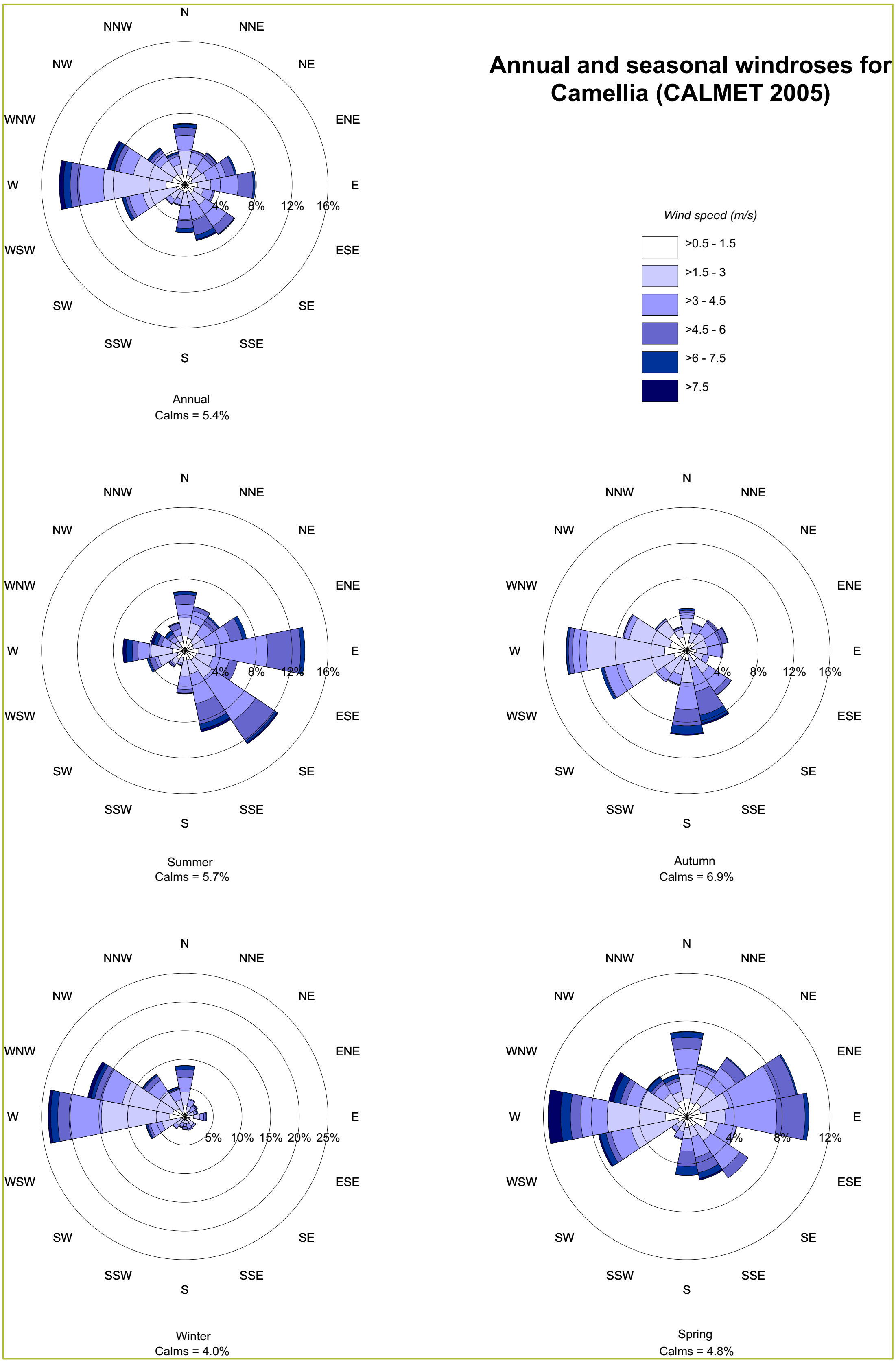


Figure 5.3: Long term windspeed analysis

5.2.1 Wind

Windroses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points – N, NNE, NE, etc. The bar at the top of each windrose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the colour of the bar sections correspond to wind speed categories, the lighter colour representing the lightest winds.

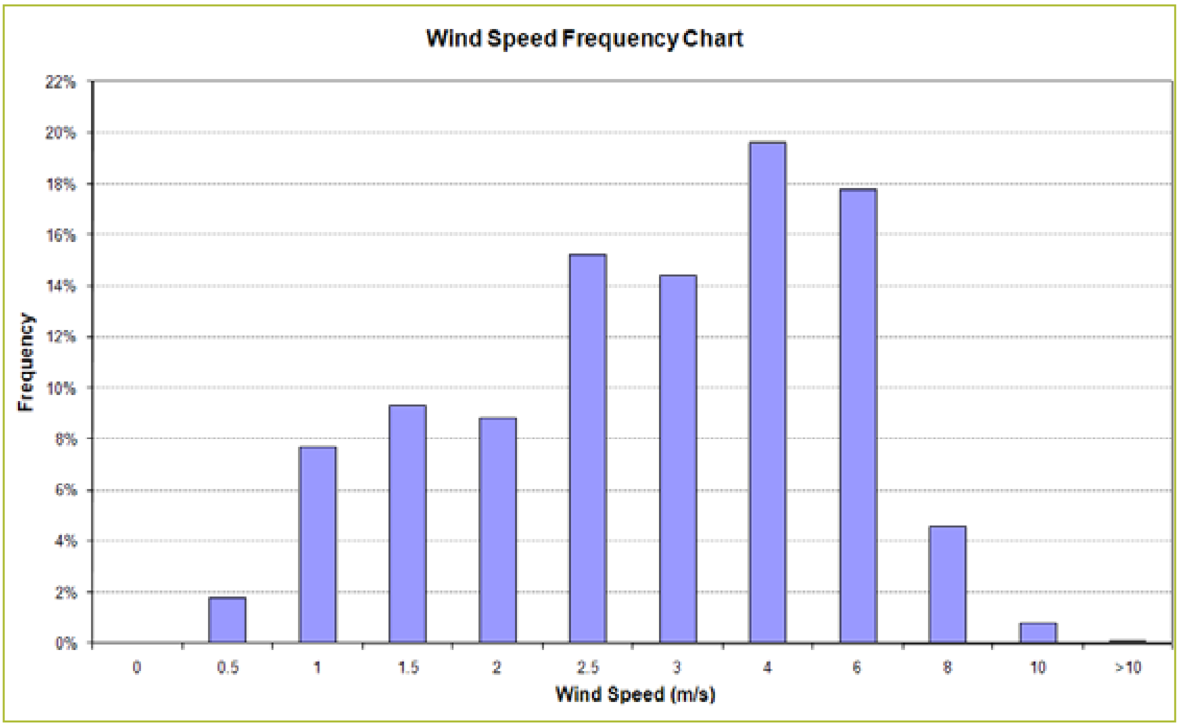
The annual and seasonal windroses based on the CALMET extract are shown in **Figure 5.4**. On an annual basis winds from the west are most predominant with a good proportion of winds from the west-northwest. In autumn, winds blow predominantly from the west with some strong winds from the south and south-southeast. In summer winds from the east and southeast are most significant. Winter winds predominantly occur from the northeast and west-northwest. In spring, the dominant wind directions are from the west, east and east-northeast.



Source: CALMET

Figure 5.4: Annual and seasonal windroses, 2005

The frequency distribution of hourly averaged wind speed values is shown in **Figure 5.5**. Light wind speeds (up to 2 m/s) are relatively infrequent and occur approximately 27.6% of the time. Strong winds (greater than 6 m/s) occur approximately 5.4% of the time.



Source: CALMET

Figure 5.5: Wind Speed Distribution for 2005

5.3 Stability

Atmospheric turbulence is an important factor in plume dispersion. Turbulence acts to increase the cross-sectional area of the plume due to random motions, thus diluting or diffusing a plume. As turbulence increases, the rate of plume dilution or diffusion increases. Weak turbulence limits plume diffusion and is a critical factor in causing high plume concentrations downwind of a source, particularly when combined with very low wind speeds.

Turbulence is related to the vertical temperature gradient, the condition of which determines what is known as stability, or thermal stability. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe atmospheric conditions and thus dispersion.

The most well-known stability classification is the Pasquill-Gifford scheme[a], which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution.

At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early

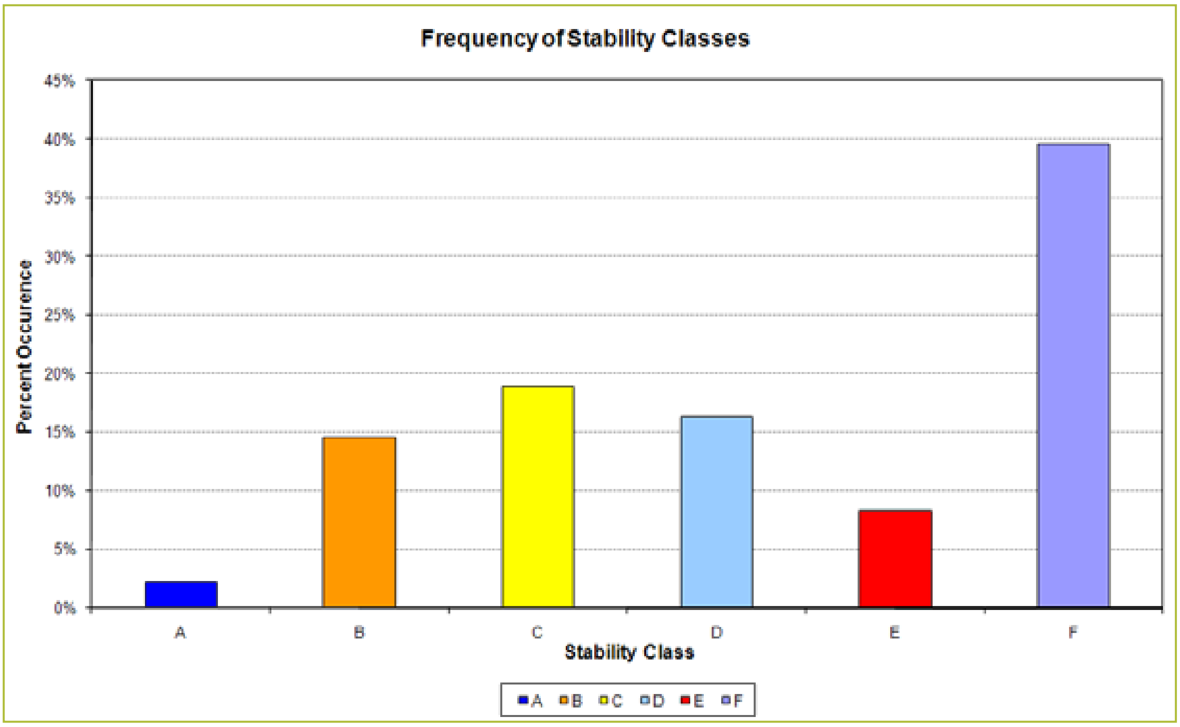
[a] A more accurate turbulence scheme within CALPUFF, based on micrometeorological parameters, was used for modelling.

morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind.

Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

The frequency distribution of estimated stability classes in the meteorological file is presented in **Figure 5.6**. The data show a total of 47.9% of hours with either E or F stability class.



Source: CALMET

Figure 5.6: Frequency Distribution of Estimated Stability Classes

5.4 Local Climate

This section describes the general climate in the study area to give a more complete picture of the local meteorology.

Table 5.2 presents the temperature, humidity and rainfall data for the nearby Bureau of Meteorology site located at Sydney Olympic Park, approximately 4.5 km south of the site. Also presented are monthly averages of maximum and minimum temperatures, 9am and 3pm temperatures and humidity. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures experienced are 23.6°C and 13.9°C. July is the coldest month, with an average minimum temperature of 7.8°C. January is the hottest month, with an average maximum temperature of 28.3°C.

Rainfall data show that February is on average the wettest month, with a mean rainfall reading of 116.4 mm, over 10.1 rain days. July is the driest month with an average rainfall of 56.4 mm, over an average of 8.7 rain days. The average annual rainfall is 876.7 mm and the average number of rain days annually is 115.9.

Table 5.2:Temperature, Humidity and Rainfall Data for Sydney Olympic Park

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Daily Maximum Temperature (°C)													
Mean	28.3	27.9	26.6	24	20.9	18.3	17.7	19.5	22.5	24.4	25.3	27.4	23.6
Daily Minimum Temperature (°C)													
Mean	19.2	19.4	17.7	14.3	11.3	8.9	7.8	8.7	11.6	13.7	15.8	17.9	13.9
9 am Mean Temperatures (°C) and Relative Humidity (%)													
Mean	22.3	21.9	20.3	18	14.6	12	11.2	12.8	16.4	18.7	19.6	21.5	17.4
Humidity	67	72	72	68	70	71	68	61	57	56	64	64	66
3 pm Mean Temperatures (°C) and Relative Humidity (%)													
Mean	26.3	26.1	24.9	22.4	19.5	17.3	16.6	18.2	20.7	22.1	23.2	25.3	21.9
Humidity	53	55	53	51	51	52	47	42	43	45	51	50	49
Rainfall (mm)													
Mean	87.2	116.4	62.2	84.7	88.2	75.8	56.4	60.8	51.5	63.5	72.9	56.1	876.7
Rain days (Number)													
Mean	10.7	10.1	11	9.1	10.7	10.1	8.7	7.6	8.3	8.7	11.8	9.1	115.9

Station Number 066195, Latitude: -33.85 South, Longitude: 151.06 East, Elevation: 25 m

Source: **Bureau of Meteorology, 2010**

5.5 Emission Estimation

With the proposed air management system, the main buildings will maintain a slight negative pressure and high speed roller doors will operate in truck delivery and pickup areas to retain the odorous air inside the buildings. Therefore the main source of odour from the proposed operation will be the two biofilters located at the rear of the proposed building. The size of each biofilter would cover an area of approximately 576 m² (32 m × 18 m).

Specifications for the biofilters have been provided by the biofilter manufacturer. It is noted that the exhaust volume of each biofilter will not exceed 50,000 m^3/hour and the biofilter surface emission will not exceed 125 ou. It is also noted that, operating data from a similar biofilter facility operation at Port Macquarie, operated by REMONDIS, showed that the exhaust volume of each biofilter will be around 35,000 m^3/hour at any one time with a slight fluctuation of around 10% between night and day times. However as a conservative approach, the design flow rate of 50,000 m^3/hour has been used in this assessment.

5.5.1 Biofilter Performance

REMONDIS has consulted with the manufacturer of the biofilters and has made an investigation to justify whether the biofilter odour performance criterion of 125 ou is achievable.

The biofilters for the Camellia plant have been significantly improved on the original biofilter design in Port Macquarie which was designed 10 years ago. Significant improvements are as follows:

- Humidifier pump and water curtain to ensure fully saturated air and a more consistent exhaust air temperature into the biofilter;
- Biofilter back pressure monitoring, biofilter air temperature monitoring and control ; and
- Air inlet relative humidity monitoring and control.

Therefore measured biofilter data from Port Macquarie site are not appropriate for assessing the biofiter performance proposed for Camellia site.

The manufacturer (AP Business and Consultancy) of the proposed biofilter for Camellia site has provided the performance guarantee to REMONDIS Australia that the proposed biofilter will have an average odour concentration of 125 ou (see **Appendix B**). To support this performance guarantee, AP Business and Consultancy has also provided to REMONDIS Australia a biofilter performance test report for one of their installations at Spring Farm, Jacks Gully, conducted by a NATA accredited consultant in July 2008 (See **Appendix C**). The report shows an average concentration of 106 ou was achieved at Spring Farm, Jacks Gully. It is noted that odorous air from each biofilter will be released via a stack at the proposed site and therefore use of an average odour concentration is appropriate for application in the odour assessment.

Furthermore it is understood that in response to the OEH concerns, REMONDIS Australia will also commit to perform a Biofilter performance test once the plant is installed and operating at full capacity to validate the biofilter performance assumption made in this assessment.

5.6 Modelling Scenarios and Source Parameters

Modelling of the initial biofilter design and estimated maximum emission rate predicted exceedences of DECCW criteria at nearby sensitive receptor locations (Camellia Railway Station and carpark of ALDI). Therefore several iterative model runs were conducted to investigate other practical control options to achieve compliance with DECCW criteria at nearest sensitive receptors without changing the biofilter design. However model predictions show that compliance with DECCW criteria could not be met using the initial biofilter design and an alternative design is necessary to comply with DECCW criteria. Details of these iterative model runs have not been included in this report but can be made available upon request.

Based on the outcomes of the iterative modelling analysis, the biofilter design has been modified to a fully enclosed pitch roofed system with a vertical discharge stack to enhance dispersion of odour. The modified design (fully enclosed biofilter) was used in the modelling for this assessment. A fan provides the initial momentum flux for the odorous air from the stack. **Figure 5.7** presents a schematic diagram of the full enclosed biofilter design.

Stack parameters for each biofilter in the revised design have been presented in **Table 5.3**.

Table 5.3: Stack Parameters

Stack Parameter	Data
Location	Biofilter 1: 317394mE, 6256231mN Biofilter 2: 317304mE, 6256240mN
Stack Height	9m
Stack Diameter	1.5m
Exit Velocity	9 m/s
Exit Temperature	35ºC
Building Downwash	Prime

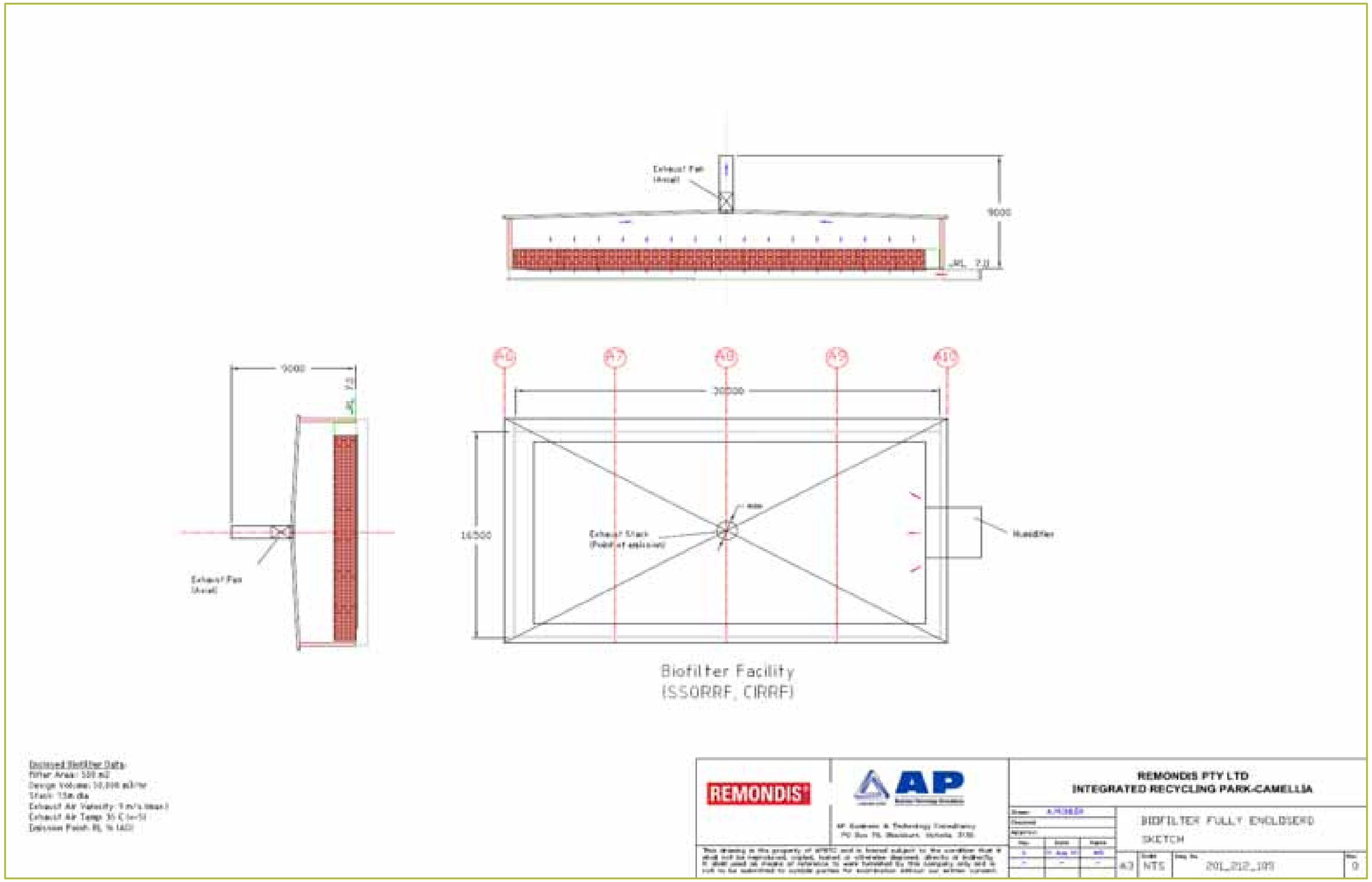


Figure 5.7: Fully Enclosed Biofilter System

It is noted that there is potential for other sources of fugitive odours to be generated on-site. These odours would generally occur from the receival of waste to the facility. Odour management principles considered in the design of the facility will minimise the potential for these fugitive emissions to be generated.

Management practices and the facility design features include:

- No outdoor handling of materials;
- Traffic management procedure will include co-ordination of the delivery schedule to avoid a queue of the incoming or outgoing trucks outside the shed for an extended period of time;
- Spill management procedure will include immediate cleanup of any spill/leakage from the incoming and outgoing trucks, identify the cause and take appropriate action to prevent any future spill/leakage incidents;
- Maintain an odour complaint logbook. Once any complain is made, the site manager will immediately investigate any unusual odour sources (including spill or leakage in the traffic areas) within the site boundary and take appropriate action to eliminate any unusual odour sources;
- Real-time processing of odourous feedstock material and raw materials will not be stockpiled for more than a day under normal operating conditions;
- Air management system will include ventilation hoods over emission sources;
- Odorous air will be recycled as far as possible through the tunnel composting system to minimise air volume into the deodorisation;
- Stockpiles will be managed to facilitate natural ventilation to prevent anaerobic zones;
- Air management system will ensure building is under slight negative pressure; and
- Additional air curtains mounted above each fast speed roller door entrance will be installed (if required).

5.7 Surrounding Sensitive Receptors

The proposed site is surrounded by several sensitive receptors including public places (Camellia Railway Station, Rosehill Racecourse), an ALDI supermarket and a childcare centre. Most of these receptors are adjacent to the site boundary. The locations of these receptors are presented in **Table 5.4** and **Figure 5.8**.

Table 5.4: Location of surrounding sensitive receptors

ID	Easting (m)	Northing (m)	Description
1	317222.9	6256091	ALDI Superstore and childcare centre
2	317244.1	6256109	Carpark
3	317139.8	6256159	Camellia Railway Station
4	317339.4	6255914	Rosehill Racecourse
5	317053.5	6256147	Residence to west
6	316727.8	6256301	Residence to west
7	316898.4	6256758	Residence to northwest
8	317305.6	6256697	Residence to north
9	318708.9	6256582	Residence to northeast
10	319308.7	6255888	Residence to east

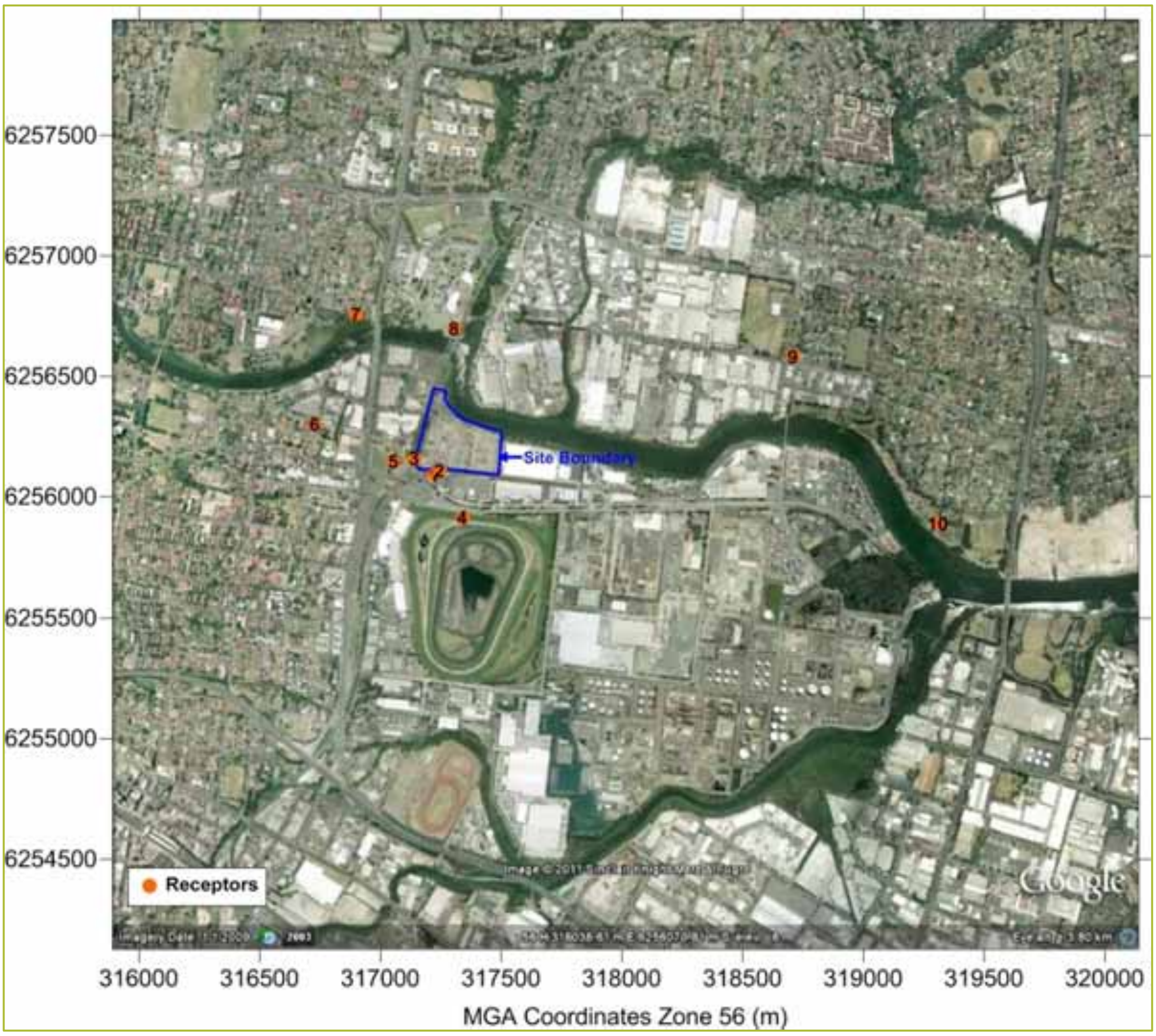
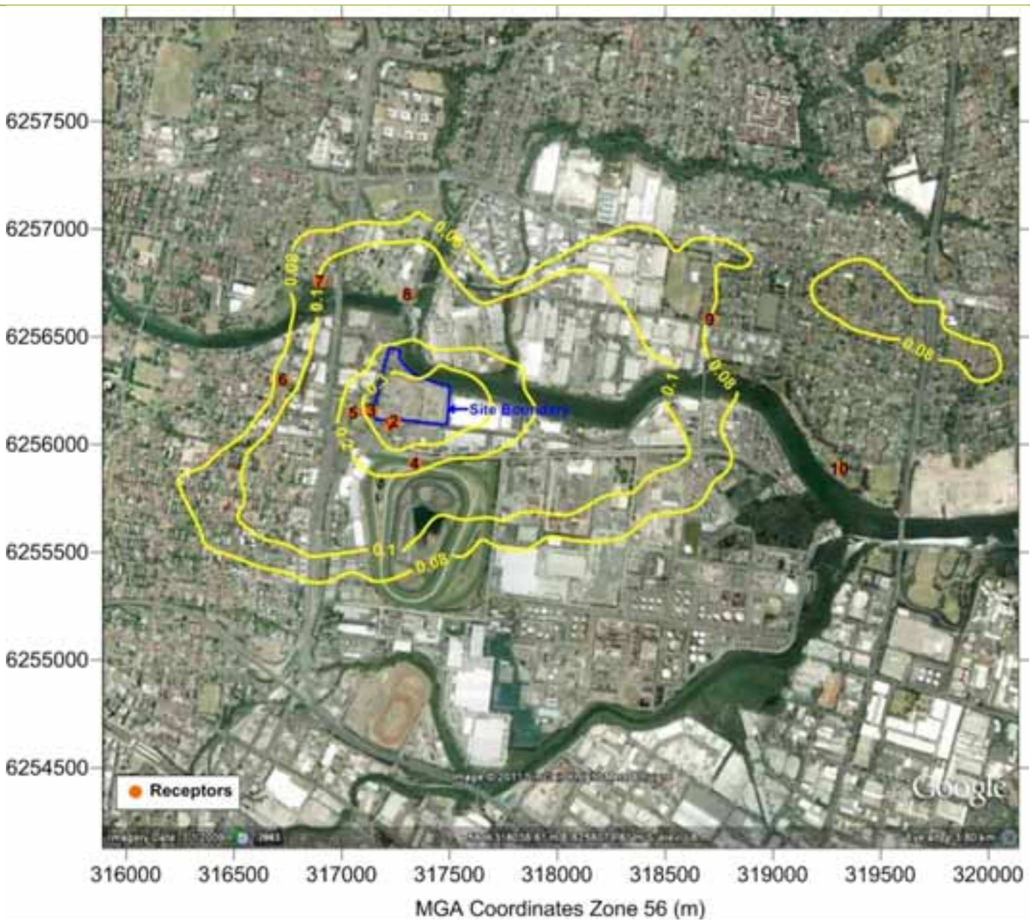


Figure 5.8: Location of sensitive receptors

6 MODELLING RESULTS

6.1 Assessment of Potential Odour Impacts

Predicted odour concentrations due to the proposed facility with the full enclosed biofilter design have been presented in **Figure 6.1**. It can be observed from this figure that predicted ground level odour levels at surrounding receptors comply with the DECCW odour criteria of 2 ou. The maximum predicted off-site odour concentration is less than 0.6 OU, which is less than the minimum theoretical level at which odour can be detected.



Species: Odour	**Location:** Camellia, NSW	**Scenario:**	**Percentile:** 99th	**Averaging Time:** Nose response
Model Used: CALPUFF v6.4	**Units:** ou	**Guideline:** DECCW = 2 ou	**Met Data:** 2005 CALMET-Generated	**Plot:** P Henschke

Figure 6.1: 99th percentile nose response ground level odour concentrations

7 GREENHOUSE GAS ASSESSMENT

7.1 International Framework

7.1.1 Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP), to provide independent scientific advice on climate change. The panel was asked to prepare, based on available scientific information, a report on all aspects relevant to climate change and its impacts and to formulate realistic response strategies. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC).

Since the UNFCCC has entered into force, the IPCC remains the pivotal source for its scientific, technical and socio-economic information.

The stated aims of the IPCC are to assess scientific information relevant to:

- Human-induced climate change;
- The impacts of human-induced climate change; and
- Options for adaptation and mitigation.

The fourth IPCC assessment report was released in 2007 (**IPCC, 2007**). IPCC reports are widely cited in climate change debates and policies, and are generally regarded as authoritative.

7.1.2 United Nations Framework Convention on Climate Change (UNFCCC)

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource, the stability of which can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 183 countries (Parties) having ratified the contained treaty, the Kyoto Protocol – see **Section 7.1.2.1**. Australia ratified the Kyoto Protocol in December 2007.

Under the UNFCCC, governments:

- Gather and share information on greenhouse gas emissions, national policies and best practices;
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and
- Cooperate in preparing for adaptation to the impacts of climate change.

7.1.2.1 Kyoto Protocol

The Kyoto Protocol entered into force on 16 February 2005.

The Kyoto Protocol builds upon the UNFCC by committing Annex I Parties to individual, legally-binding targets to limit or reduce their GHG emissions for the following gases:

- Carbon dioxide (CO_2);

- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulfur hexafluoride (SF_6)

The emission reduction targets are calculated based on a Party's domestic emission greenhouse inventories (which include the sectors land use change and forestry clearing, transportation, stationary energy, etc). Domestic inventories require approval by the Kyoto Enforcement Branch. The Kyoto Protocol requires developed countries to meet national targets for greenhouse gas emissions over a five year period between 2008 and 2012.

To achieve their targets, Annex I Parties must put in place *domestic policies and measures.* The Kyoto Protocol provides an indicative list of policies and measures that might help mitigate climate change and promote sustainable development.

Under the Kyoto Protocol, developed countries can use a number of flexible mechanisms to assist in meeting their targets. These are trading-based market mechanisms which include:

- Joint Implementation (JI) – where developed countries invest in GHG emission reduction projects in other developed countries; and
- Clean Development Mechanism (CDM) – where developed countries invest in GHG emission reduction projects in developing countries.

Annex I countries that fail to meet their emissions reduction targets during the 2008-2012 period may be liable for a 30 percent penalty, to be made up in the post 2012 commitment period.

7.2 Australian Context

7.2.1 Australia and the Kyoto Protocol

The Kyoto Protocol is an international agreement under the United Nations Framework on Climate Change (UNFCC) that was agreed in 1997. As of October 2009 it has been ratified by 187 countries. Australia ratified the protocol in December 2007.

The aim of the Protocol is to reduce global greenhouse gas emissions by requiring developed countries to meet national targets for greenhouse gas emissions over the five year period from 2008 to 2012. Australia's annual target is 108% of the 1990 emissions.

Countries are required to take on a range of monitoring and reporting commitments, which are designed to ensure they remain on track to meet their obligations and to measure the overall success of the Protocol. Australia is in the process of developing a Carbon Pollution Reduction Scheme to ensure compliance with its Kyoto targets and successive international agreements to constrain greenhouse emissions.

7.2.1.1 National Greenhouse and Energy Reporting Act

The *National Greenhouse and Energy Reporting (NGER) Act 2007* was passed in September 2007. The NGER Act establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production. The NGER scheme consolidates existing greenhouse reporting schemes.

The NGER Act is underpinned by a number of legislative instruments that provide greater detail about obligations, which in conjunction with the NGER Act, form the National Greenhouse and Energy Reporting System, as follows:

- The National Greenhouse and Energy Reporting Regulations 2008; and
- The National Greenhouse and Energy Reporting (Measurement) Determination 2008.

NGER is seen as an important first step in the establishment of a domestic emissions trading scheme. This intention is explicitly stated in the objectives for the NGER scheme, as follows:

- Establish a baseline of emissions for participants in a future Australian emissions trading scheme;
- Inform the Australian public;
- Meet international reporting obligations and
- Assist policy formulation of all Australian governments while avoiding duplication of similar reporting requirements.

Companies must register and report if they emit greenhouse emissions or produce/consume energy at or above the following trigger thresholds:

- If they own facilities that emit greater than 25kt greenhouse emissions (expressed as CO_2-e) or produce/ consume greater than 100 TJ of energy and
- If the corporate group emits greater than 125kt of greenhouse emissions (expressed as CO_2-e) or produce/ consume greater than 500TJ of energy.

A project is required to report to the NGER system if it will emit greater than 25kt of greenhouse emissions. As such, this Project would not be subject to the reporting under the system (see **Section 7.5**).

7.2.1.2 Carbon Pollution Reduction Scheme

A green paper detailing Australia's plans to implement a domestic emissions trading scheme was released on the 16 July 2008 (**DCC, 2008a**). A subsequent white paper was released in December 2008 (**DCC, 2008b**) with the intent that a Carbon Pollution Reduction Scheme (CPRS) would commence in July 2010. Due to the global financial crisis, the start date has been deferred to July 2011. Legislation was introduced to Parliament in May 2009, and again in November 2009 but was voted down in the Senate.

The CPRS is 'cap and trade' emissions trading mechanism scheme whereby emitters of greenhouse gases greater than 25,000t carbon dioxide-equivalent (CO_2-e) are required to purchase a permit for every tonne of greenhouse gas that they emit. As such, the Project would not be subject to the scheme (see **Section 7.5**).

7.3 Greenhouse Gas Inventories

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

From the point of view of the proposed development, CO_2, CH_4 and N_2O would be the most significant gases for the project which would be formed and released during the combustion of diesel fuel. They would be liberated when fuels are burnt in diesel powered equipment and in the generation of the electrical energy that will be used at the site.

Other direct emissions of CH_4 and N_2O will occur from the composting of the product at the facility.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The estimated emissions are referred to in terms of CO_2-equivalent (CO_2-e) emission by applying the relevant global warming potential.

7.4 Greenhouse Emission Calculation Methodology

7.4.1 Introduction

The following formula (**DCC, 2009a**) was used to estimate the greenhouse gas emissions from fuel usage:

$$GHG\ Emissions\ (tCO_2 - e) = \frac{Q \times EC \times EF}{1000}$$ Equation 1

Where:

Q = quantity of fuel in tonnes or thousands of litres

EC = energy content of the fuel in GJ/tonne or GJ/kL

EF = relevant emission factor in kg CO_2-e/GJ

To calculate emissions from electricity usage, the following equation was used:

$$GHG\ Emissions\ (tCO_2 - e) = Q \times \frac{EF}{1000}$$ Equation 2

Where:

Q = electricity consumed in GJ

EF = relevant emission factor in kg CO_2-e/GJ

To calculate emissions from the biological treatment of solid waste, the following equations were used:

$$CH_4 Emissions = \sum i\,(Q_i \times EF_i) - R$$ Equation 3

Where:

CH_4 = total CH_4 emissions in inventory year, tonnes of CO_2-e

Q_i = mass of wet organic waste treated by biological treatment type i, tonnes

EF = emission factor for treatment i, tonnes CO_2-e/tonne of wet waste treated and equal to:

- For composting: 0.08

- For anaerobic digestion: 0.02

R = total amount of CH_4 recovered in inventory year, tonnes CO_2-e

CH_4 emissions are converted to CO_2-e emissions by multiplying by a factor of 21.

$$N_2O\ Emissions = \sum i\,(Q_i \times EF_i)$$ Equation 4

Where:

N_2O = total N_2O emissions in inventory year, tonnes of CO_2-e

Q_i = mass of wet organic waste treated by biological treatment type i, tonnes

EF = emission factor for treatment i, tonnes of CO_2-e/tonnes of wet waste treated and equal to:

- For composting: 0.09
- For anaerobic digestion: 0.0

7.4.2 Emission Factors

Data provided in the National Greenhouse Accounts (NGA) Factors, published by the Department of Climate Change (**DCC, 2009a**) were used. DCC defines three 'scopes' (or emission categories):

- Scope 1 covers direct emissions from sources within the project boundary such as fuel combustion and manufacturing processes;
- Scope 2 covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation; and
- Scope 3 includes all other indirect emissions that are a consequence of the organisations activities but are not from sources owned or controlled by the organisations, for example, production of diesel fuel, off-site transport of the product, or staff travel etc.

For the purposes of this assessment, a full fuel cycle emission factor (that is the sum of scope 1, scope 2 and 3 emission factors, where applicable) has been used.

Table 7.1 provides a summary of the emission factors used.

Table 7.1: Summary of emission factors for greenhouse gas assessment

Type of Fuels and Electricity	Emission factor		Scope	Source
Diesel - Stationary	69.5	kg CO_2-e/GJ	1	Table 3 (**DCC, 2009a**)
	5.3	kg CO_2-e/GJ	3	Table 3 (**DCC, 2009a**)
Diesel - Transport	69.9	kg CO_2-e/GJ	3	Table 4 (**DCC, 2009a**)
Electricity	0.89	kg CO_2-e/kWh	2	Table 39 (**DCC, 2009a**)
	0.18	kg CO_2-e/kWh	3	Table 3 (**DCC, 2009a**)

7.4.3 Fuel and Electricity Usage

Based on information provided by the Proponent, **Table 7.2** presents a summary of annual diesel fuel and electricity usage. Hours of operation for the Project are assumed to be 24 hours per day and 7 days per week all year.

Table 7.2: Summary of on-site diesel and electricity usage

Diesel usage per year (Kl)	Electricity usage per year (kWh)
315	1,500,000

Source: REMONDIS

The energy content of diesel was taken to be 38.6GJ/kL (**DCC, 2009a**).

7.4.4 Composting

Greenhouse gas emissions generated from the composting of waste materials have not been included in this assessment. If not used in the composting process, these waste materials would undergo natural decomposition and release equivalent greenhouse gas emissions. Well managed composting facilities replace the anaerobic conditions of landfilling with aerobic decomposition, and can reduce greenhouse gas emissions. Therefore the composting process undertaken at this facility is not expected to contribute any additional greenhouse gas emissions as the waste would otherwise be landfilled.

For information purposes we have calculated the equivalent greenhouse gas emissions using Equations 3 and 4 as shown in **Section 7.4**. The amount of organic waste sent to the composting facility per year is summarised in **Table 7.3**.

Table 7.3: Summary of organic waste composted

Annual mass of wet organic waste	Amount (tonnes/year)
CIRRF facility (food and paper waste)	37,000
SSORRF facility	50,000

Source: REMONDIS

7.4.5 Other Scope 3 Emissions

Activities occurring at the facility require inputs and outputs of materials delivered to the site. These inputs and outputs have been considered as part of the Scope 3 emissions generated for the site.

Materials delivered to the site will be sourced from various locations within the Sydney metropolitan area. As it is difficult to accurately determine the travel distances of the trucks, we have conservatively assumed an average return travel distance of 50 km when calculating the emissions generated. Truck numbers visiting the site have been provided by the proponent, they estimate 92 trucks per day. The average fuel consumption of articulated trucks was taken as 54.6 litres per 100 km (**ABS, 2007**). The annual fuel usage to transport product is calculated to be 916,734 L/year.

7.5 Greenhouse Gas Emissions Results

Based on the fuel and electricity usage and amount of organic waste composted presented in **Section 7.4.4,** the annual CO_2-e emissions for the site are summarised in **Table 7.4**.

Table 7.4: Summary of estimated CO_2-e emissions (t CO_2-e/y)

	Scope 1	Scope 2	Scope 3	TOTAL (t CO2-e)
Diesel - Stationary	845	-	64	909
Electricity	-	1,335	270	1,605
Diesel – Transport	-	-	2,473	2,473
Composting	15,635*	-	-	-
Total	**845**	**1,335**	**2,808**	**4,987**

Note: some figures not exact due to rounding

*Based on the discussion presented in Section 7.4.4, emissions from the composting process were not considered in calculating total emissions.

On an annual basis it has been estimated that the facility would release approximately 0.002 Mt/y of additional CO_2-e (Scope 1 (excluding composting) and 2 emissions). The annual greenhouse emissions in NSW for 2008 were 164.7 Mt CO_2-e (**DCC, 2010**). Therefore the facility represents approximately 0.001% of the total NSW greenhouse emissions.

Australia's total greenhouse gas emissions were estimated at 581.9 Mt CO_2-e (**DCC, 2010**). Comparing the annual emissions for the proposed facility, the predicted increase is approximately 0.0003% of the total Australian emissions in 2008.

8 CONCLUSIONS

This report has assessed the air quality and odour impacts of the Project. Dispersion modelling has been used to predict off-site odour levels due to the activities of the Project. The dispersion modelling took account of meteorological conditions and terrain information and used odour emission estimates to predict the odour impacts at surrounding sensitive receptors.

Iterative dispersion modelling (discussed in **Section 5.6**) was conducted to find the optimise design parameters for biofilters. Based on the iterative dispersion modelling results, each biofilter was redesigned to comply with DECCW odour criterion at surrounding sensitive receptor locations. Results from the dispersion modelling (discussed in **Section 6**) show that odour levels at nearby residences comply with the DECCW's odour criterion and the predicted maximum offsite odour levels will be less than 0.6 OU.

Appropriate mitigation measures and management practices (discussed in **Section 5.6)** will be applied to minimise fugitive odour emissions.

Based on the modelling results, it can be concluded that with the full enclosed biofilter design (presented in **Figure 5.7**) the proposed project will comply with DECCW odour criterion at all locations.

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APPENDIX A

Estimation of Emissions

A.1 DUST EMISSIONS

The dust emission inventories have been formulated from the operational description provided by the Proponent. Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

Loading, unloading and transferring material

The dust emission from this activity will depend on wind speed according to the **US EPA (1985)** emission factor equation. This means that the emissions will vary with wind speed. The actual emission is given by Equation 1.

Equation 1

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \quad kg/t$$

where,

E_{TSP} = *TSP emissions*

$k = 0.74$

U = *wind speed (m/s)*

M = *moisture content (%)*

[where $0.25 \leq M \leq 4.8$*]*

Vehicle movements on sealed road surfaces

The emission factor used for vehicles movements on the sealed surfaces of the site was 0.2 kg per vehicle kilometre travelled (kg/VKT). No reductions in emissions from the use of water sprays have been considered.

Spreading / Compacting

The emission factor used for the activity of spreading and compacting the clean fill material during the platform construction is given by Equation 2.

Equation 2

$$E_{TSP} = \frac{2.6 \times S^{1.2}}{M^{1.3}} \quad kg/hr$$

where,

E_{TSP} = TSP emissions

S = silt content (%)

M = moisture content (%)

Wind erosion from exposed areas and stockpiles

The emissions factor for wind erosion dust is 0.4 kg/ha/hour (**SPCC, 1983**). The emissions will also depend on the state of cleanliness of the area.

A.2 BIOFILTER ODOUR EMISSIONS

Odour emissions are estimated based on the biofilter manufacturer's performance guarantee. The maximum exhaust volume discharge with the maximum odour concentration has been used to calculate the emission rate used in the modelling.

Odour concentration = 125 OU

Air flow rate (m^3/s) = 13.9 m^3/s

Odour emission rate for each biofilter = Odour concentration × Air flow rate (m^3/s)
= (125 × 13.9)
= 1737.5 OU.m^3/s

APPENDIX B

Biofilter Performance Guarantee

PO BOX 79
BLACKBURN VIC 3130
AUSTRALIA

REMONDIS Australia Pty Ltd
Mohan Selvaraj
P.O. Box 885
Mascot NSW 1460

From Andreas Pichler

Phone: +61 3 9802 5013
Fax: +61 3 9802 9500
E-Mail: andreas.pichler@apbtech.com.au

Date: 14 April, 2011

Dear Sir,

Re: Camellia Project, Biofilter Performance

We herewith confirm that our performance guarantee to RE MONDIS Australia for the biofilter system as proposed for the Integrated Recycling Park at Grand Avenue at Camellia will include an average odour concentration of 125 odour units.

The proposed system relies on our proven technology which is in operation in various similar applications across Australia and New Zealand.

For your confidential information, we have attached a biofilter performance test report for one of our installations at Spring Farm, Jacks Gully, conducted by a NATA accredited consultant in July 2008. The plant is operated by SITA (former WSN Environmental Services).

Table 4-1 (page 6) summarises the test results including a measured average odour concentration of 106 odour units at 100% flow across the entire biofilter area.

Yours sincerely,
AP Business & Technology Consultancy

Andreas Pichler

Enclosed: Biofilter performance test report

APPENDIX C

Biofilter Performance Test Report

Stephenson

Environmental Management Australia

BIOFILTER PERFORMANCE TEST - ODOUR ASSESSMENT

WSN ENVIRONMENTAL SOLUTIONS

SPRING FARM, NSW

PROJECT NO.:	4107/S14172A/08/B
DATE OF SURVEY:	JULY 2008
DATE OF ISSUE:	25 AUGUST 2008

P W STEPHENSON

M BRECKO

D HELM

Table of Contents

Table of Tables

Table of Figures – Appendices

1 Introduction

Stephenson Environmental Management Australia (SEMA) was commissioned by WSN Environmental Solutions to undertake an odour emission survey of their Biofilter at their Jacks Gully Waste & Recycling Centre in Spring Farm, New South Wales (NSW).

The facility is licensed under Environment Protection Licence (EPL) number (No.) 12588. The Biofilter has no EPL limit however is required to operate in accordance with Section 129 of the Protection of the Environment Operations Act 1997 as defined in Section L7 of the EPL.

The objectives of the emission testing were:

- To conduct a Performance Test of the Biofilter by determining the odour concentration using an equilibrium hood at 100% flow (50,000 cubic metres per hour).
- Calculate the mass odour emission rates
- Determine compliance with biofilter design performance criteria of 70 odour units per cubic metre per second (ou. m^3/s).

Table 1-1 summarises the scope of work conducted during the odour assessment.

Table 1-1 Odour & Flow Survey – Scope of Work

Parameter	Biofilter Outlet	Test Method
Temperature (wet and dry)	✓	NSW DECC TM-2
Odour concentration	9 single samples	OM-8/OM-7/AS4323.3

Note: odour sampling is to occur in the middle of each evenly distributed section.

The monitoring was undertaken on the 1 July 2008.

2 PRODUCTION CONDITIONS

WSN Environmental Solutions personnel considered the plant was operating under typical conditions on the day of testing. WSN Environmental Solutions hold all relevant production records should they be required for review.

3 Emission Test Results

3.1 Introduction

SEMA completed all the sampling work for the monitoring. SEMA is NATA accredited to perform all the sampling of these parameters in accordance with ISO 17025-2005 – General Requirements for the competence of testing and calibration laboratories. SEMA is NATA accredited for the parameters, SEMA's accreditation No. is 15043.

Odour Research Laboratories Australia (ORLA), a subsidiary of Peter W Stephenson and Associates Pty Ltd, completed the odour analysis, ORLA is NATA accredited to ISO17025 for this analysis, ORLA's accreditation No. is 15043.

The results of the biofilter odour survey are described in detail in Sections 3.2.

Refer to Appendix A for the Certificates of Analysis. The sampling location is shown graphically in Appendix B.

3.2 Odour

3.2.1 Sampling

As outlined in Section 1, SEMA used an Equilibrium Flux Hood to take nine odour samples at 100% flow through the biofilter, that is, 50,000 cubic metres per hour (m^3/hr) (nominal).

The Biofilter was divided into nine equal sections and the centre of each section was tested. Refer to Appendix B for sampling locations. The surface area of the biofilter is of the order of 430 square metres (m^2).

Sample A1 to A3 along the back of the Biofilter were conducted during a period that a shadow was cast over the Biofilter from the neighbouring shed. It was observed that this section of the Biofilter would not be exposed to sunlight during the winter months. Samples B1 to B3 through the centre of the Biofilter were also conducted in this shadow however later on in the day this shadow slowly exposed the Biofilter to sunlight. Samples C1 to C3 along the front of the Biofilter were conducted in direct sunlight.

At the time of testing the meteorological conditions observed were calm to very light winds and clear sky.

3.2.2 ODOUR CONCENTRATIONS AND EMISSION RESULTS

The odour concentrations for the nine locations sampled are summarised in Table 3-1. The odour concentrations ranged from 32 to 203 odour units (ou).

The MOER for all samples were determined to establish compliance with the Biofilter design criteria of 70 ou.m^3/s.

The MOER can be calculated using the following formula:

MOER = Odour Concentration (ou) x Equilibrium Hood Velocity (m/s) x total area of the Biofilter (m^2)

Equilibrium Hood Velocity	= velocity of air supply to Equilibrium Hood in metres per second
Total Surface Area	= Cross Sectional Area of the Biofilter in square metres (m^2).
Odour Concentration	= As per Table 3-1

The Mass Odour Emission Rates for the samples have been calculated and the results are shown in Table 3-1. The Biofilter measures 19 metres x 23 metres.

Table 3-2 summarises the Biofilter discharge gas temperature at each sampling location.

TABLE 3-1 ODOUR EMISSIONS RESULTS – BIOFILTER @ 100% FLOW

Sample Description	Odour Concentration (ou)	Calculated MOER (ou m^3/s) wet (Equilibrium Flux Hood)	Section of Biofilter
Equilibrium Flux Hood - 100% Flow			
Biofilter A1	32	9.05	Back
Biofilter A2	38	10.74	Back
Biofilter A3	32	9.05	Back
Biofilter B1	203	57.39	Middle
Biofilter B2	144	40.71	Middle
Biofilter B3	172	48.62	Middle
Biofilter C1	109	30.81	Front
Biofilter C2	140	39.58	Front
Biofilter C3	85	24.03	Front
Average	**106**	**28.19**	

Key:

ou	=	odour units
ou.m^3/s	=	odour units per cubic metre per second wet
MOER	=	Mass Odour Emission Rate

Table 3-2 Biofilter Discharge Gas Temperature Results

Sample Description	Temperature (Dry) (°C)	Temperature (Wet) (°C)
Biofilter A1	26.5 - 26.8	26.2
Biofilter A2	25.0 – 25.1	--
Biofilter A3	22.1	--
Biofilter B1	25.5 – 26.9	26.2
Biofilter B2	26.5 – 26.8	25.6
Biofilter B3	26.1	25.8
Biofilter C1	27.6	--
Biofilter C2	26.8	26.3
Biofilter C3	23.9	22.8

Key:

-- = Not measured

°C = degrees Celsius

4 Conclusions

SEMA completed the Biofilter odour assessment in accordance with the scope of work as defined by WSN Environmental Solutions. The site work was performed on the 1 July 2008.

From the data presented and test work conducted during normal production conditions, Table 4-1 summarises the assessment data. All locations tested complied with the Biofilter design criteria of 70 ou.m³/s.

Table 4-1 Odour Emissions Results – Biofilter – 100% Flow (50,000 m³/hr)

Sample Description	Odour Concentration (ou)	Calculated MOER (ou m³/s) wet (Equilibrium Flux Hood)	Section of Biofilter
Equilibrium Flux Hood - 100% Flow			
Biofilter A1	32	9.05	Back
Biofilter A2	38	10.74	Back
Biofilter A3	32	9.05	Back
Biofilter B1	203	57.39	Middle
Biofilter B2	144	40.71	Middle
Biofilter B3	172	48.62	Middle
Biofilter C1	109	30.81	Front
Biofilter C2	140	39.58	Front
Biofilter C3	85	24.03	Front
Average	**106**	**28.19**	

Key:

ou	=	odour units
ou.m³/s	=	odour units per cubic metre per second wet
m³/hr	=	cubic metres per hour
MOER	=	Mass Odour Emission Rate

5 TEST METHODS

5.1 ODOUR MEASUREMENT/DYNAMIC OLFACTOMETRY

(AS 4323.3 and OM-7 and OM-8)

Samples were collected in 30L Nalophane sampling bags which are enclosed in airtight plastic containers. Surface samples were collected utilising an equilibrium flux hood.

Odorous gas for analysis was drawn through a Teflon (PTFE) sample probe. The gas then passes through a Teflon (PTFE) tube connected to the Nalophane sampling bag. The sampling pump is connected to the airtight plastic container to provide a sample gas flow-rate of approximately 0.5 – 1.5 litres per minute. After the required volume has been sampled, the pump is stopped and the bag sealed with a stainless steel valve. Two samples were collected from each site.

Using a triangular forced choice olfactometer, the Nalophane bag of odour sample was dynamically diluted to various concentrations with dry odour free air.

The diluted sample was then presented to a panel of screened panellists as one of these airflows. The panellists then recorded if they could detect any odour and from which flow. The other two flows were discharging odour free air.

The odour is always presented to the panellists in ascending concentration; that is, from lower to higher concentration. The panellists are required at each dilution level to give a response as to what they are smelling from the flows (forced choice methodology). The response options for the panellists are:

'Guess'	Unable to determine which air flow contains the diluted odours
'Inkle'	Thinks that one of the flows may be different from the other two flows
'Detect' or 'Certain'	Is confident that one of the airflows smells different from the other two flows. Not necessarily able to say what the smell is.
'Recognise'	Thinks that one of the flows may be different from the other two flows and is able to: ▪ Assign a 'hedonic tone' (pleasantness scale number) to the odour ranging from –10 to 10 and/or ▪ Able to assign a character to the colour, as in 'it smells like …' *Note: that the Recognise level concentration and Hedonic Tone and Odour descriptors are obtained with the diluted odour, panellists are not exposed to the full strength odour.*

The percentage panel response and dilution levels used were then entered into a computer programme to determine the 50% panel response. This dilution level corresponds to the odour concentration of the sample.

Sampling and dilution lines are constructed from teflon, stainless or glass to prevent contamination of the sample.

The sampling and the dilution procedures used were in accordance with DECC NSW Method OM-7 and OM-8, which are based on Standards Association of Australia, AS4323.3.

5.1.1 Odour Panel Selection

Odour panellists must meet certain criteria to qualify as and remain panellists. Their average sensitivity to n-Butanol must be between 20 and 80 parts per billion (ppb) and their variability in response to n-Butanol must be within a certain range.

Panellists are tested against n-Butanol before every panel session to ensure they are in compliance.

Panellists should not suffer from respiratory complaints, nor should they eat or smoke or drink anything but water during the half hour preceding or during the test period and their person and clothing should be odour free and have not been exposed to an odorous environment before testing.

5.1.2 Odour Terminology

The odour level is expressed in odour units and for mixed odours is analogous to concentration expressed in parts per billion. The odour detection level is defined as the ratio of *the volume that a sample of odorous gas would occupy when diluted to the threshold of detection of that odour to the volume of the sample*. In simpler terms, the ratio indicated the number of dilutions necessary to reduce the odour to its threshold of detection or odour detection threshold. This ratio is expressed in odour units or number of dilutions to detection threshold. For example, a value of 2,000 odour units would mean the volume of the initial sample of odorous gas would need to be diluted 2,000 times before the odour would just be detectable to the average human nose, that is, at the odour detection threshold.

Appendix A – Certificates of Analysis

Odour Research Laboratories Australia

A Division of Peter W. Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

Newington Business Park
Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
E-Mail: mbrecko@orla.com.au

Olfactometry Test Report

The measurement was commissioned by SEMA on behalf of:

Client	Organisation:	WSN Environmental Solutions
	Address:	Jacks Gully Waste & Recycling Centre 275 Richardson Road, Spring Farm NSW 2570
	Contact:	Isaac Tsui
	Sampling Site:	Biofilter
	Telephone:	02 4658 0976
	Facsimile:	02 9934 7185
	Email:	isaac.tsui@wsn.com.au
Project	ORLA Report Number:	4107/ORLA/01
	Project Manager:	Peter Stephenson
	Testing operator:	Michael Brecko
	ORLA Sample number(s):	1722, 1723, 1724, 1725, 1726, 1727, 1728, 1729, 1730
	SEMA Sample number(s):	715399, 715400, 715401, 715402, 715403, 715404, 715405, 715406, 715407
Order	Analysis Requested:	Odour Analysis
	Order requested by:	SEMA on behalf of WSN Environmental Solutions
	Date of order:	1 July 2008
	Order number:	2033
	Telephone:	02 9737 9991
	Signed by:	Michael Brecko
	Order accepted by:	Michael Brecko

Investigated Item	Odour concentration in odour units 'ou' determined by Sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Analysis Method	The samples were analysed in accordance with AS/NZS4323.3:2001.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for n-butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Instrument Used	The Olfactometer used during this testing session was: AC'SCENT International Olfactometer
Measuring Range	The measuring range of the AC'SCENT International olfactometer is $2^4 \leq \chi \leq 2^{16}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between ± 3°C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.05$ in accordance with the Australian Standard AS/NZS4323.3:2001. AC'SCENT International Olfactometer: $r = 0.0106$ (March 2008) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.20$ in accordance with the Australian Standard AS/NZS4323.3:2001. AC'SCENT International Olfactometer: $A = 0.069$ (March 2008) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the AC'SCENT International Olfactometer has been determined to be 15 ou
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

10 July 2008

Michael Brecko
Laboratory Manager

Odour Research Laboratories Australia

Odour Olfactometry Results – 4107/ORLA/01

Sample Location	Sample ID No.	Sampling Date & Time	ORLA Sample No.	Analysis Date & Time (Completed)	Panel Size	Valid ITEs	Sample Pre-Dilution	Sample Odour Concentration (ou) [1]	Sample Odour Concentration (ou) [2]	Odour Character & Hedonic Tone ^ +
Sample ID: Biofilter 1A	715399	1/7/08 1117	1722	2/7/08 1018	4	8	Nil	32	32	Manure, mould, dirt, dusty, freshly cut plants, burnt (-2.5)^
Sample ID: Biofilter 1B	715400	1/7/08 1147	1723	2/7/08 1051	4	8	Nil	38	38	Dusty, soil, cut plants, burning garbage (-2)^
Sample ID: Biofilter 1C	715401	1/7/08 1218	1724	2/7/08 1107	4	8	Nil	32	32	Dusty, soil, to weak to descibe (-0.5)^
Sample ID: Biofilter 2A	715402	1/7/08 1117	1725	2/7/08 1122	4	8	Nil	203	203	Soil, manure, dirt, vomit, sweet cocoa (-2)^
Sample ID: Biofilter 2B	715403	1/7/08 1147	1726	2/7/08 1137	4	8	Nil	144	144	Mould, soil, sweet cocoa, rubbish (-1.5)^
Sample ID: Biofilter 2C	715404	1/7/08 1218	1727	2/7/08 1151	4	8	Nil	172	172	Burnt, smokey, cocoa, mould (-1.5)^
Sample ID: Biofilter 3A	715405	1/7/08 1252	1728	2/7/08 1205	4	8	Nil	109	109	Burnt garbage, smokey, cut plants, dirt (-2.5)^

Odour Research Laboratories Australia

Odour Olfactometry Results – 4107/ORLA/01

Sample Location	Sample ID No.	Sampling Date & Time	ORLA Sample No.	Analysis Date & Time (Completed)	Panel Size	Valid ITEs	Sample Pre-Dilution	Sample Odour Concentration (ou) [1]	Sample Odour Concentration (ou) [2]	Odour Character & Hedonic Tone [^] [+]
Sample ID: Biofilter 3B	715406	1/7/08 1252	1729	2/7/08 1221	4	8	Nil	140	140	Burnt sewerage, smoke, cut plants, off cheese, manure, mould, dirt (-3.3)[^]
Sample ID: Biofilter 3C	715407	1/7/08 1355	1730	2/7/08 1236	4	8	Nil	85	85	Burnt, cocoa, soil, musty (-2.3)[^]

Odour Panel Calibration Results - 4107/ORLA/01

Reference Odorant	ORLA Sample No.	Concentration of Reference Gas (ppm)	Reference Gas Measured Concentration (ou)	Panel Average Measured Concentration (ppb) [3]	Does this panel calibration measurement comply with AS/NZS4323.3:P2001 (Yes/No) [4]
n-butanol	1719	52.3	1,103	47.4	Yes

Comments: All samples were collected by Stephenson Environmental Management Australia and analyses by Odour Research Laboratories Australia at their Sydney Laboratory.

Notes from Odour Olfactometry Results:

1 Sample Odour Concentration: as received in the bag

2 Sample Odour Concentration: allowing for pre-dilution

3 Panel Average Measured Concentration: indicates the sensitivity of the panel for the session completed

4 Target Range for reference gas n-butanol is $20 \leq \chi \leq 80$ ppb and compliance with AS/NZ4323.3:2001 is based on the individuals rolling average and not on the panel average measured concentration. Panellist Rolling Average: PR = 78.6, RA = 20.5, SS = 60.3, AC = 74.7, CB = 54.1, AS = 52.5

^ denotes the Average Hedonic Tone: describes the pleasantness of the odour being presented where (+5) represents Very Pleasant, (0) represents Neutral and (-5) represents Very Unpleasant and has been derived from the panellist responses at the recognition threshold.

+ This value is not part of our NATA Scope of Accreditation and AS4323.3

APPENDIX B – SAMPLING LOCATION

Figure B - 1 Biofilter Sample Locations