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Report

Box Hill North Local Water Centre

RPS Australia & Asia Pacific

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1 INTRODUCTION

This report has been prepared by Pacific Environment for RPS Australia Asia Pacific (RPS) for the Box Hill North Residential Precinct. Flow Systems Operations trading as Box Hill North Water, a wholly-owned subsidiary of Flow Systems, is being considered by the developer as the private water utility for the Box Hill North development. Box Hill North Water will construct, operate and maintain a water recycling facility known as the Local Water Centre (LWC) and will provide all properties within the development with drinking water, sewerage and recycled non-potable water.

The study seeks to determine the odour concentrations at nearby sensitive receptors using atmospheric dispersion modelling. Odour sampling data for the Membrane, Aerobic and Anoxic chambers was collected at an existing Flow Systems water recycling facility located at Pitt Town. These data are used as inputs into the Box Hill North plant model. The flow balance tank (FBT) odour control unit (OCU) proposed for Box Hill North is different to that operating at Pitt Town and as such, the measurements at the Pitt Town FBT OCU have not been used for Box Hill North.

Modelling has been completed using the US-EPA regulatory AERMOD model, approved for use in NSW.

The report comprises the following components:

- A description of the project,
- A discussion of air quality issues with respect to odour,
- A review of the dispersion meteorology in the area, and
- An assessment of potential odour impacts for four operational scenarios.

2 PROJECT DESCRIPTION

The project site (shown on **Figure 2.1**), is part of a proposed residential sub-division located on the urban fringe of The Hills Shire Council, approximately 48 km northwest of Sydney central business district (CBD).

Provision of infrastructure, namely the LWC, will allow subdivision of lands within an area being developed as Box Hill North. The land is undergoing rezoning for residential development.

The intended LWC will utilise sewage from the future residential area to produce high quality recycled water. The sewage will be treated at the LWC through a multi-stage process of screening, anaerobic and aerobic processing, chemical treatment, membrane filtration, ultraviolet disinfection and chlorination. The recycled water will be plumbed into houses for non-potable uses such as toilet flushing, washing machines, irrigation and car washing, thus reducing potable water demand. The LWC is intended to operate 24 hours, 7 days per week, housed in a low-scale, single level building within an open space setting.

The intended hydraulic capacity of the LWC is approximately 3,000 kilolitres (kL) per day, servicing approximately 5,000 dwellings or equivalent, although it has been designed to achieve this benchmark over time in line with uptake in the residential area surrounding the development.

For the first lots in the precinct, interim sewage servicing tanks (ISSTs) will receive raw sewage to be collected by tankers at regular intervals. An interim odour control unit associated with these tanks will operate during this initial period.

An indicative site layout plan is shown in **Figure 2.2**. The potential sources of odour are from the screens (enclosed) used to remove inorganic material prior to treatment of the liquid flow, as well as emissions from the individual odour scrubbers attached to both the FBTs and ISSTs vented via a stack. These sources and the measured data used for this assessment are discussed in **Section 5**.

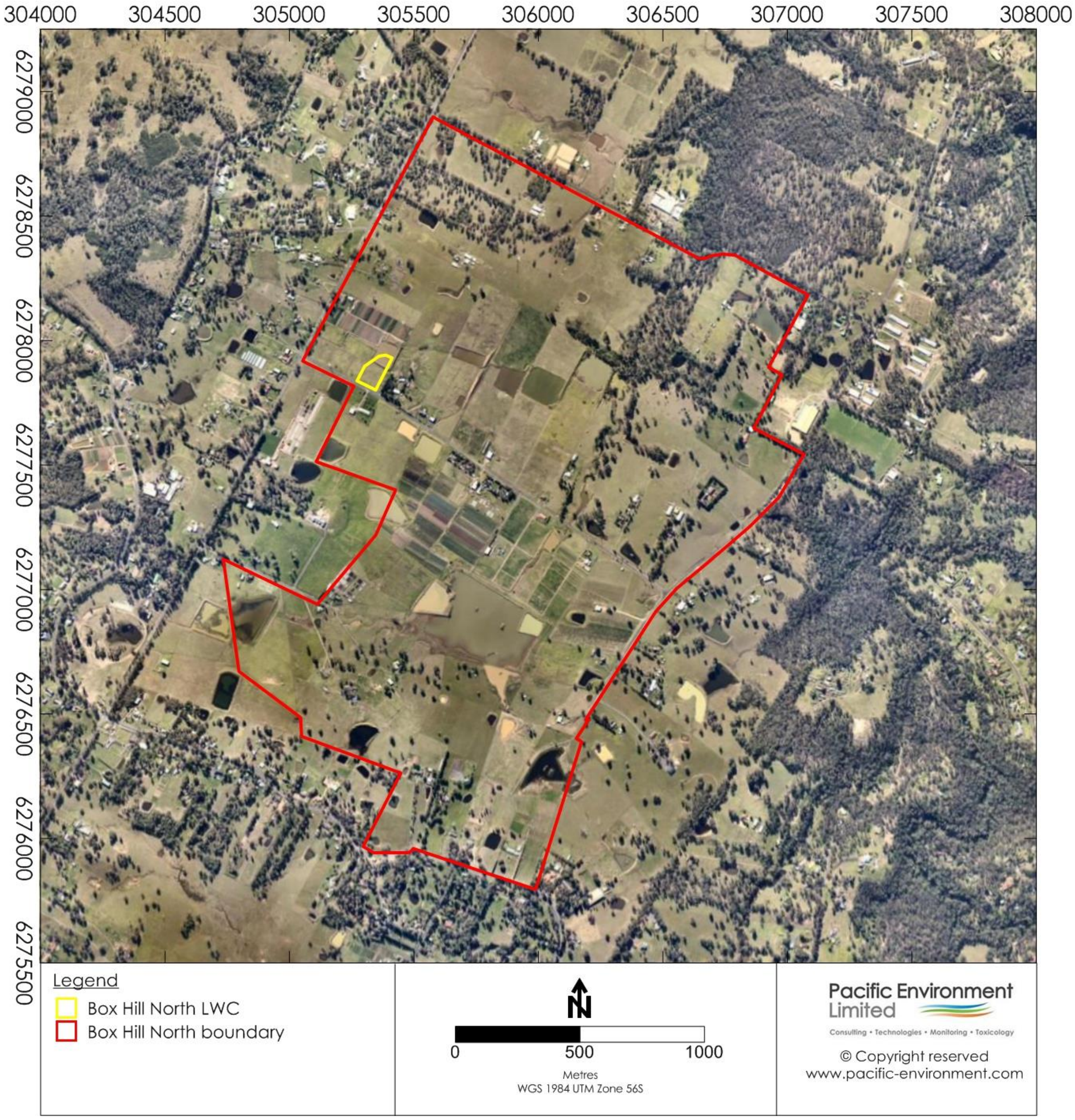


Figure 2.1: Proposed project site location

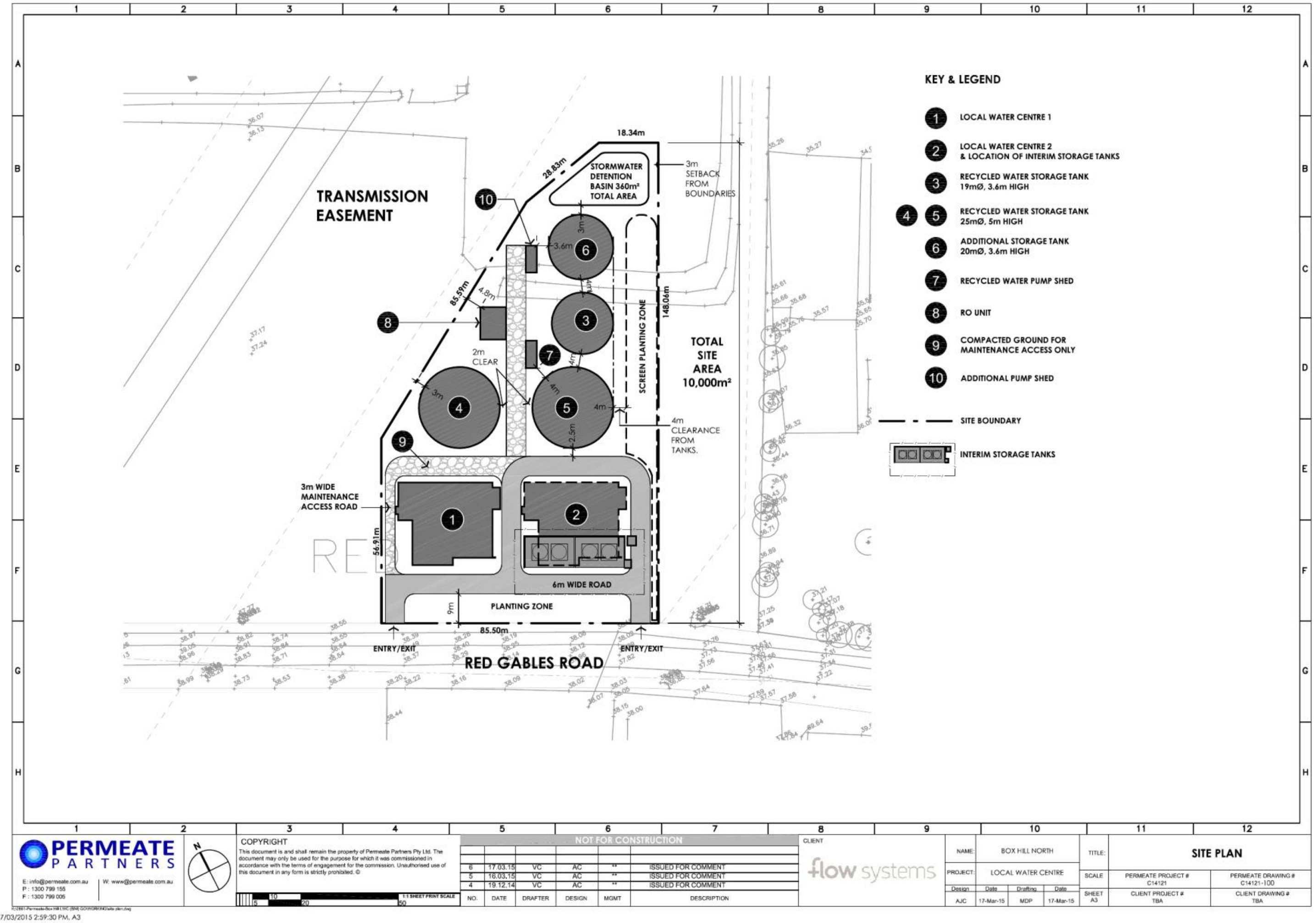


Figure 2.2: Indicative Plant Layout

3 DISCUSSION OF AIR QUALITY ISSUES

3.1 Odour Performance Criteria

3.1.1 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 NSW Environment Protection Authority (NSW EPA) 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 so-called **FIDOL** factors):

- the **F**requency of the exposure
- the **I**ntensity of the odour
- the **D**uration of the odour episodes
- the **O**ffensiveness of the odour
- the **L**ocation of the source

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 FIDOL 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.

3.1.2 Complex Mixture of Odorous Air Pollutants

The Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW (**EPA, 2005**) include ground-level concentration (glc) criterion for complex mixtures of odorous air pollutants. They have been refined by the NSW EPA to take account of population density in the area. **Table 3.1** 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 most stringent of the impact assessment criterion of 2 ou (at the 99th percentile; **EPA, 2005**) has been applied for this assessment.

Table 3.1: Odour Performance Criteria for the Assessment of Odour

Population of affected community	Criteria for complex mixtures of odour (OU)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (>2000) and/or schools and hospitals	2

3.2 Peak-to-mean ratios

It is common practice to use dispersion models to determine compliance with odour goals. This introduces a complication because Gaussian dispersion models 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 3-minute and longer period average concentrations (referred to as the peak-to-mean ratio) that might be predicted by a Gaussian dispersion model, the EPA commissioned a study by **Katestone Scientific Pty Ltd (1995, 1998)**. This study recommended peak-to-mean ratios for a range of variables, such as source type, receptor distance, stability class and stack height (for point sources).

It is important to note that those peak-to-mean factors determined are based on the Pasquill-Gifford stability classes. Since AERMOD replaces the Pasquill-Gifford stability based dispersion with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion, a conservative approach has been taken for area sources and a value of 2.5 has been applied. A value of 2.3 has been applied for wake-affected point and volume sources. A summary of the factors is provided in **Appendix A**.

The Approved Methods take account of this peaking factor and the goals shown in **Table 3.1** are based on nose-response time.

4 LOCAL METEOROLOGY

This section described the dispersion meteorology in the study area. Information on prevailing wind patterns, atmospheric stability and climatic conditions are presented.

4.1 Wind speed and direction

Meteorological data are collected by the Bureau of Meteorology from Richmond RAAF, NSW, approximately 11 km northwest of the site. Wind roses of the data collected from Richmond RAAF are shown in **Figure 4.1**. The wind roses show that on an annual basis winds are predominantly from the southwest and northeast quadrants. Winds from these quadrants are also dominant in autumn with very few winds from the other quadrants. The annual wind speed was 3.3 m/s and the annual percentage of calms, wind speed < 0.5 m/s, was 7.2%.

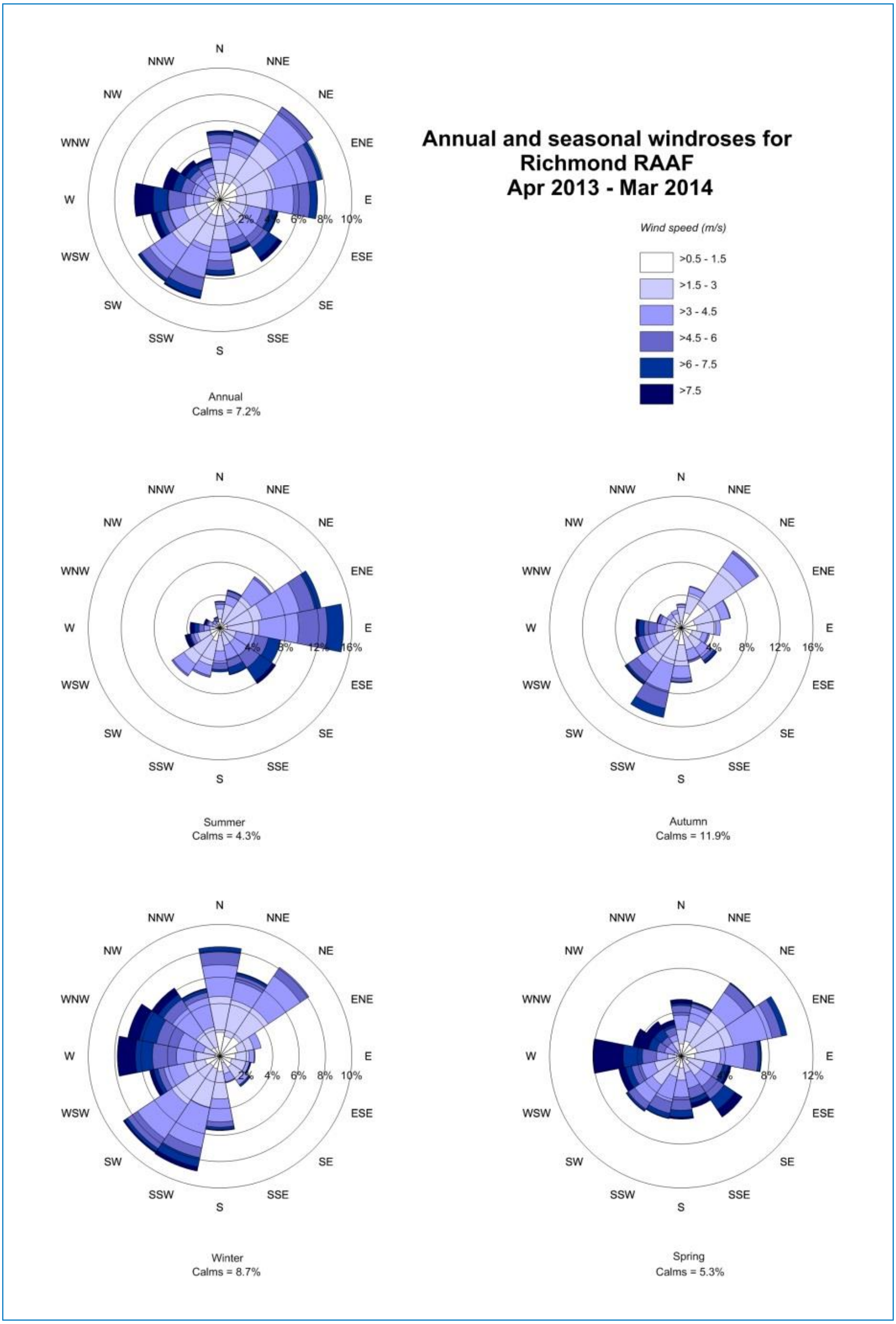


Figure 4.1: Annual and Seasonal wind roses for Richmond RAAF BoM Station

4.2 Local Climatic Conditions

Table 4.1 presents the temperature, humidity and rainfall data for the closest Bureau of Meteorology (BoM) site which is located at Richmond RAAF (Site number 067105), approximately 11 km northwest of the site. Humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures recorded at the Richmond RAAF station are 24.1°C and 11.0 °C, respectively. On average, January is the hottest month, with an average maximum temperature of 30.0°C. July is the coldest month, with average minimum temperature of 3.6°C. The annual average relative humidity reading collected at 9am from the Peats Ridge station is 73% and at 3pm the annual average is 47%. The month with the highest relative humidity on average June with 9am averages of 83% and the months with the lowest relative humidity is September and October with 3pm averages of 39%.

Rainfall data collected at the Richmond RAAF station shows that February is the wettest month, with an average rainfall of 123 mm over an average of 12 rain days. The average annual rainfall is 716 mm with an average of 118 rain days per year.

Table 4.1: Climate Averages for the Richmond RAAF

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	22.1	21.3	19.1	17.0	13.1	10.0	8.9	11.4	15.4	18.3	19.2	20.9	16.4
Humidity	72	78	80	76	82	83	80	69	63	58	68	68	73
3pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	28.5	27.4	25.8	23.0	19.7	17.0	16.5	18.7	21.5	23.5	25.2	27.5	22.9
Humidity	47	52	52	49	53	53	48	39	39	40	46	44	47
Daily Maximum Temperature (°C)													
Mean	30.0	29.0	26.8	23.9	20.7	17.9	17.6	19.8	22.9	25.1	26.7	28.5	24.1
Daily Minimum Temperature (° C)													
Mean	17.6	17.7	15.6	11.5	7.5	5.1	3.6	4.4	8.0	10.9	14.1	15.9	11.0
Rainfall (mm)													
Mean	76	123	76	49	49	48	29	33	47	50	83	60	716
Rain days (Number)													
Mean	11	12	11	10	10	10	8	6	7	9	12	11	118

Source: BOM (2014) Climate averages for Station: 067105; Commenced: 1993 – last record 2014; Latitude: 33.60°S; Longitude: 150.24 °E

5 ODOUR EMISSIONS

To characterise the potential odour impacts of the proposed development, odour sampling was completed at a similar facility in Pitt Town, NSW (**Pacific Environment 2013**, **Pacific Environment 2014**). The purpose of the monitoring was to characterise the odour from the existing facility and use the data to derive odour emission rates (OERs) for use in odour impact assessments for future proposed facilities.

5.1 Monitoring Methodology

Odour samples from each chamber were taken using an isolation flux hood (in accordance with AS/NZS 4323.4:2009 "Area source sampling – Flux chamber technique" and the method described in the US EPA technical report "EPA/60068-86/008"). The IFH was floated on the surface of each chamber and odour-free nitrogen was forced into the hood via odour free Teflon tubing until it has reached equilibrium. The nitrogen flow (5 L/min) purges the flux hood with a residence time of 4 times the chamber volume occurring before sampling begins (24 minutes). The odorous sample is then drawn at a sample rate of approximately 3 L/min over a period of 30 minutes into a single use, odour-free Nalophan sample bag, secured inside a drum kept under vacuum using a pump.

The odour samples were collected on the morning of 20 November 2014 as part of the most recent odour monitoring campaign:

- 1 x sample taken at the MBR Membrane Chamber. The sample was drawn from the surface of the liquid inside the chamber.
- 1 x sample taken at the MBR Aerobic Chamber. The sample was drawn from the surface of the liquid inside the chamber.
- 1 x sample taken at the MBR Anoxic Chamber. The sample was drawn from the surface of the liquid inside the chamber.

Following collection, all odour samples were analysed within 30 hours at a NATA accredited laboratory using dynamic olfactometry [a] (in accordance with AS/NZS 4323.3:2001 "Determination of Odour Concentration by Dynamic Olfactometry" (**AS/NZS, 2001**).

The results of the odour monitoring are presented as odour concentrations measured in odour units (OU) in **Table 5.2**. The laboratory report from the odour monitoring in is presented in **Appendix B**.

[a] There are no instrument-based methods that can measure an odour response in the same way as the human nose and "dynamic olfactometry" is therefore the preferred method for odour analysis. 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".

Table 5.1: Odour Monitoring Results

Sample	Sample Date	Sample Time	Odour Concentration (OU)	Specific Odour Emission Rate ($OU.m^3/s/m^2$)[(b)]
1 – MBR Tank – Membrane Chamber	20/11/2014	13:51	197	0.068
2 – MBR Tank – Aerobic Chamber	20/11/2014	11:37	362	0.119
3 – MBR Tank –Anoxic Chamber	20/11/2014	11:35	431	0.142

5.2 Odour Control Unit

Flow Systems propose to install an odour control system at Box Hill North similar to that installed at their, as yet non-operational, Wyee local water centre. The system includes both biological and activated carbon filtration to remove the majority of the odorous air from the flow balance tanks. The Operating and Maintenance Manual for the proposed Odour Control System (**OCR, 2014**) advises that between 90-98% of odours can be removed via biological treatment (FiltaOdor™), and then a further 99% via the activated carbon filter (FiltaCarb™).

This OCU proposed for Box Hill North is very different to the OCU currently operating at Pitt Town and so the measurements made at the Pitt Town OCU vent stack are not relevant for this study. In March 2013 and November 2014, odour samples were also taken from the head space in the Pitt Town FBT which would represent the odours prior to treatment and ventilation through the OCU stack. These samples were taken using the same flux-hood methodology as described in **Section 5.1** and listed in **Table 5.2**. Assuming that the untreated odour in the Pitt Town FBT will be similar to that at Box Hill North, the minimum biofilter efficiency of 90% control and a further 99% via the activated carbon filter was applied to these values to represent the resulting odour concentrations (shaded) which may be present in the vent stack.

Table 5.2: Odour sampling of the FBT headspace

Sample	Odour Concentration (OU)	90% control after biological filtration (OU)	Further 99% control after activated carbon filtration (OU)
FBT headspace March 2013	77,900	779	78
FBT headspace November 2014	114,000	1,140	114

In 2011, Sydney Water published standard specifications for manufacturers and installers of odour control units (**Sydney Water, 2011**). It is required that reliable and effective odour removal is provided, to a level of the minimum requirements outlined in that document. One such requirement is that the odour concentrations at the exit of the vent stack be no more than 500 OU, which is only slightly higher than the 446 OU level measured at the Pitt Town OCU stack in March 2013, and significantly higher than the values in **Table 5.2**, calculated by applying the combined control efficiencies likely to be achieved using the biological and activated carbon filtration system proposed for Box Hill North. Applying the minimum Sydney Water requirement of 500 OU at the vent stack is therefore conservative and has been used for this modelling study.

[b] Specific odour emission rate (SOER) is calculated from the sweep gas flow rate and area of flux hood. That is: SOER = odour concentration (ou) x sweep gas flow rate (Nm^3/s) x area (m^2). The SOER is only used when the source is represented as an area source. For the point source (FBT OCU vent), the measured odour concentration is multiplied by the volumetric flow rate to determine an estimated emission rate.

6 APPROACH TO ASSESSMENT

The overall approach to the assessment follows the Approved Methods using the Level 2 assessment methodology. The Approved Methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the project. The approach taken in this assessment follows as closely as possible the approaches suggested by the guidelines.

6.1 Dispersion model

The air dispersion modelling conducted for this assessment is based on an advanced modelling system using the AERMET/AERMOD model. AERMOD was chosen as the most suitable model due to the source types, location of nearest receptors and nature of local topography. AERMOD is the US-EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it incorporates more recent, and potentially more accurate, algorithms to represent both meteorological interactions and air quality dispersion. AUSPLUME, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications is based on ISC, which has now been replaced by AERMOD.

A significant feature of AERMOD is the Pasquill-Gifford stability based dispersion is replaced with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion.

The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data. Terrain data were sourced from NASA's Shuttle Radar Topography Mission (SRTM) Data (3 arc-second (~90m) resolution) and processed within AERMAP to create the necessary input files.

AERMET requires surface and upper air meteorological data as inputs. Surface data were sourced from the BoM meteorological station at Richmond RAAF located approximately 11 km northwest of the project. Cloud cover data are required for AERMET and these were sourced from the Richmond RAAF station.

Appropriate values for three surface characteristics are required for AERMET as follows:

- Surface roughness, which is the height at which the mean horizontal wind speed approaches zero, based on a logarithmic profile.
- Albedo, which is an indicator of reflectivity of the surface.
- Bowen ratio, which is an indicator of surface moisture.

Values of surface roughness, bowen ratio and albedo were determined based on a review of aerial photography for a radius of 3 km centred on the Project site. Default values for cultivated land were chosen for a single sector sectors to represent the land use type in the surrounding area.

Building wake effects were included in the modelling simulations to represent the plant building on-site at a height of 3.5 m. The OCU stack was represented as a point source at 6.4 m above ground level.

6.1.1 Atmospheric Stability

An important aspect of pollutant dispersion is the level of turbulence in the lowest 1 km or so of the atmosphere, known as the planetary boundary layer (PBL). Turbulence controls how effectively a plume is diffused into the surrounding air and hence diluted. It acts by increasing the cross-sectional area of the plume due to random motions. With stronger turbulence, the rate of plume diffusion increases. Weak turbulence limits diffusion and contributes to high plume concentrations downwind of a source.

Turbulence is generated by both thermal and mechanical effects to varying degrees. Thermally driven turbulence occurs when the surface is being heated, in turn transferring heat to the air above by convection. Mechanical turbulence is caused by the frictional effects of wind moving over the earth's surface, and depends on the roughness of the surface as well as the flow characteristics.

Turbulence in the boundary layer is influenced by the vertical temperature gradient, which is one of several indicators of stability. Plume models use indicators of atmospheric stability in conjunction with other meteorological data to estimate the dispersion conditions in the atmosphere.

Stability can be described across a spectrum ranging from highly unstable through neutral to highly stable. A highly unstable boundary layer is characterised by strong surface heating and relatively light winds, leading to intense convective turbulence and enhanced plume diffusion. At the other extreme, very stable conditions are often associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind. Neutral conditions are linked to windy and/or cloudy weather, and short periods around sunset and sunrise, when surface rates of heating or cooling are very low.

The stability of the atmosphere plays a large role in determining the dispersion of a plume and it is important to have it correctly represented in dispersion models. Current air quality dispersion models (such as AERMOD and CALPUFF) use the Monin-Obukhov Similarity Theory (MOST) to characterise turbulence and other processes in the PBL. One of the measures of the PBL is the Monin-Obukhov length (L), which approximates the height at which turbulence is generated equally by thermal and mechanical effects (**Seinfeld and Pandis 2006**). It is a measure of the relative importance of mechanical and thermal forcing on atmospheric turbulence. Because values of L diverge to + and - infinity as stability approaches neutral from the stable and unstable sides, respectively, it is often more convenient to use the inverse of L (i.e., 1/L) when describing stability.

Figure 6.1 shows the hourly averaged 1/L for the site computed from all data in the AERMET surface file. Based on **Table 6.1** this plot indicates that the PBL is stable overnight and becomes unstable as radiation from the sun heats the surface layer of the atmosphere and drives convection. The changes from positive to negative occur at the shifts between day and night. This indicates that the diurnal patterns of stability are realistic.

Table 6.1: Inverse of the Monin-Obukhov length L with respect to atmospheric stability

1/L	Atmospheric Stability
Negative	Unstable
Zero	Neutral
Positive	Stable

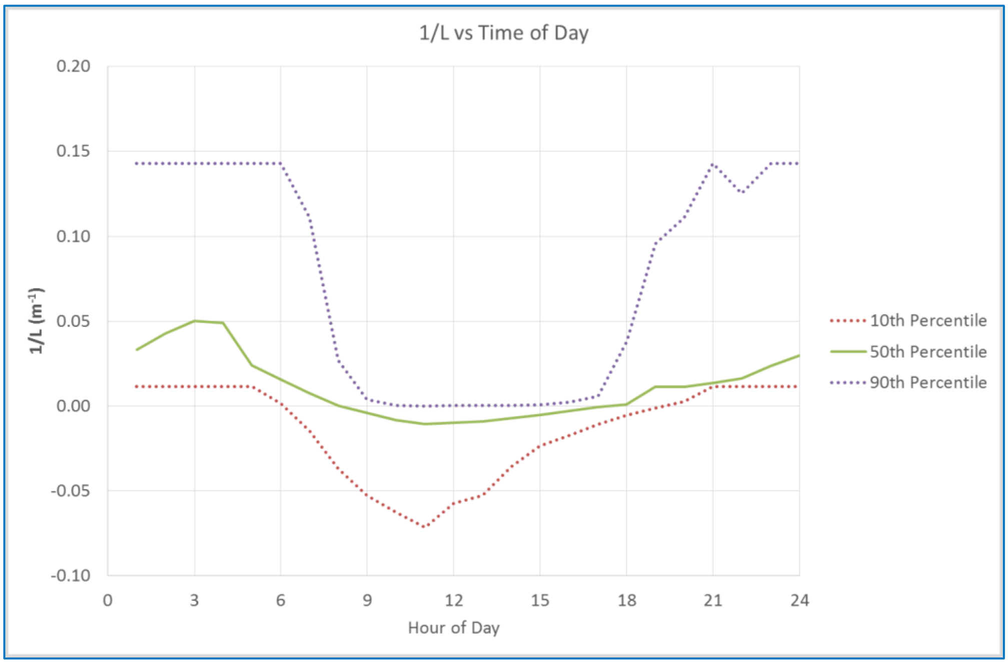


Figure 6.1: Annual statistics of 1/L by hour of the day

Figure 6.2 shows the variations in stability over the year by hour of the day, with reference to the widely known Pasquill-Gifford classes of stability. The relationship between L and stability classes is based on values derived by **Golder (1972)** set out in **EPA 2005**. Note that the reference to stability categories here is only for convenience in describing stability. The model uses calculated values of L across a continuum.

Figure 6.2 shows that neutral and very stable conditions occur for about 50% of the time, which is typical for inland locations that regularly experience temperature inversions at night. Atmospheric instability increases during the day and reaches a peak around noon as solar-driven convective energy peaks. A stable atmosphere is prevalent during the night. These profiles indicate that pollutant dispersion is most effective during the daytime and least effective at night.

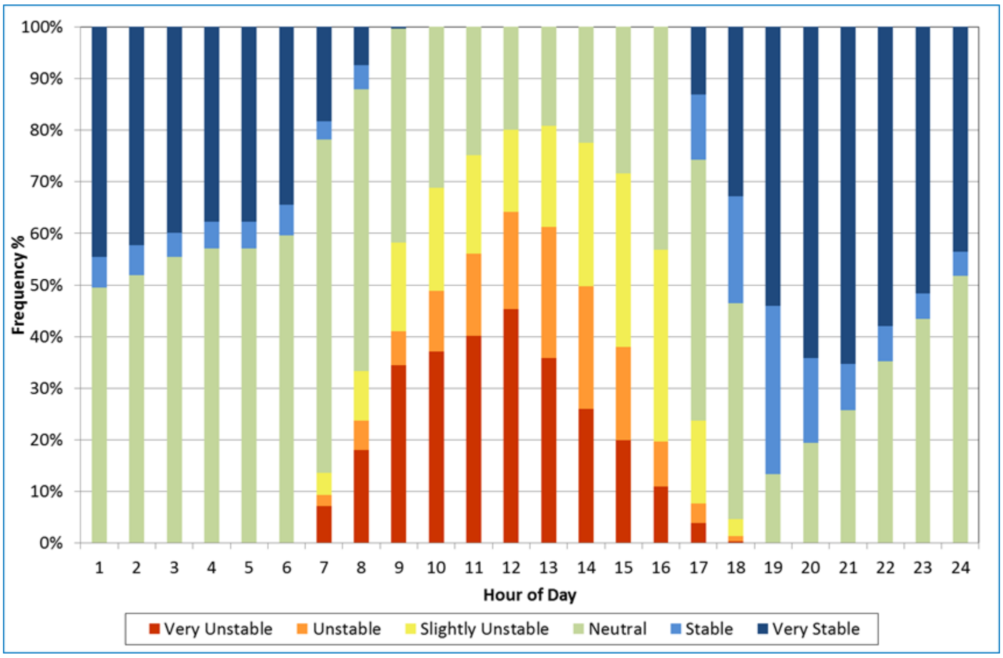


Figure 6.2: Annual distribution of stability type by hour of the day

6.2 Odour emission rates

Odour emission rates (OER) and other input parameters are shown in **Table 6.2** and **Table 6.3** for point and area sources, respectively. The OERs from the measured data and the OERs used in the modelling are both presented. The modelled OERs include a peak-to-mean of 2.3 for point sources, and a value of 2.5 for area sources, as described in **Section 3.2**.

Table 6.2: Modelling parameters used for point source (FBT OCU stack)

Model Parameter	Value
Stack location FBT OCU Vents	305,310 m, 6,277,835 m 305,349 m, 6,277,818 m
Release height	6.4 m
Temperature	27.75 °C
Stack diameter	0.3 m
Exit velocity	11.8 m/s
Flow rate	0.83 m^3/s
In-stack odour concentration	500 OU
Odour emission rate (OER)	416 $OU.m^3/s$
Peak to mean factor	2.3
OER incorporating peak to mean	958 $OU.m^3/s$

Table 6.3: Modelling parameters used for area sources

Source Name	Odour Concentration (OU)	SOER ($OU.m^3/s/m^2$)	Peak to mean factor	SOER used for modelling ($OU.m^3/s/m^2$)
Pre-anoxic Tank A	431	0.142	2.5	0.35
Pre-anoxic Tank B	431	0.142	2.5	0.35
Post-anoxic Tank A	431	0.142	2.5	0.35
Post-anoxic Tank B	431	0.142	2.5	0.35
Membrane Tank A	197	0.068	2.5	0.17
Membrane Tank B	197	0.068	2.5	0.17
Bioreactor A	362	0.119	2.5	0.30
Bioreactor B	362	0.119	2.5	0.30

For the purposes of presenting the results, all predicted odour levels at each receptor have been retained by the model and a contour plot has been prepared showing the distribution of the 99th percentile 1-hour levels at ground-level. The 99th percentile levels are plotted as the impact assessment criteria are set to ensure that the predicted odour level is not exceeded more than 1 percent of the year. Predicted odour levels are shown in **Section 7**.

7 ASSESSMENT OF IMPACTS

The odour impact at the site was assessed for two scenarios as follows:

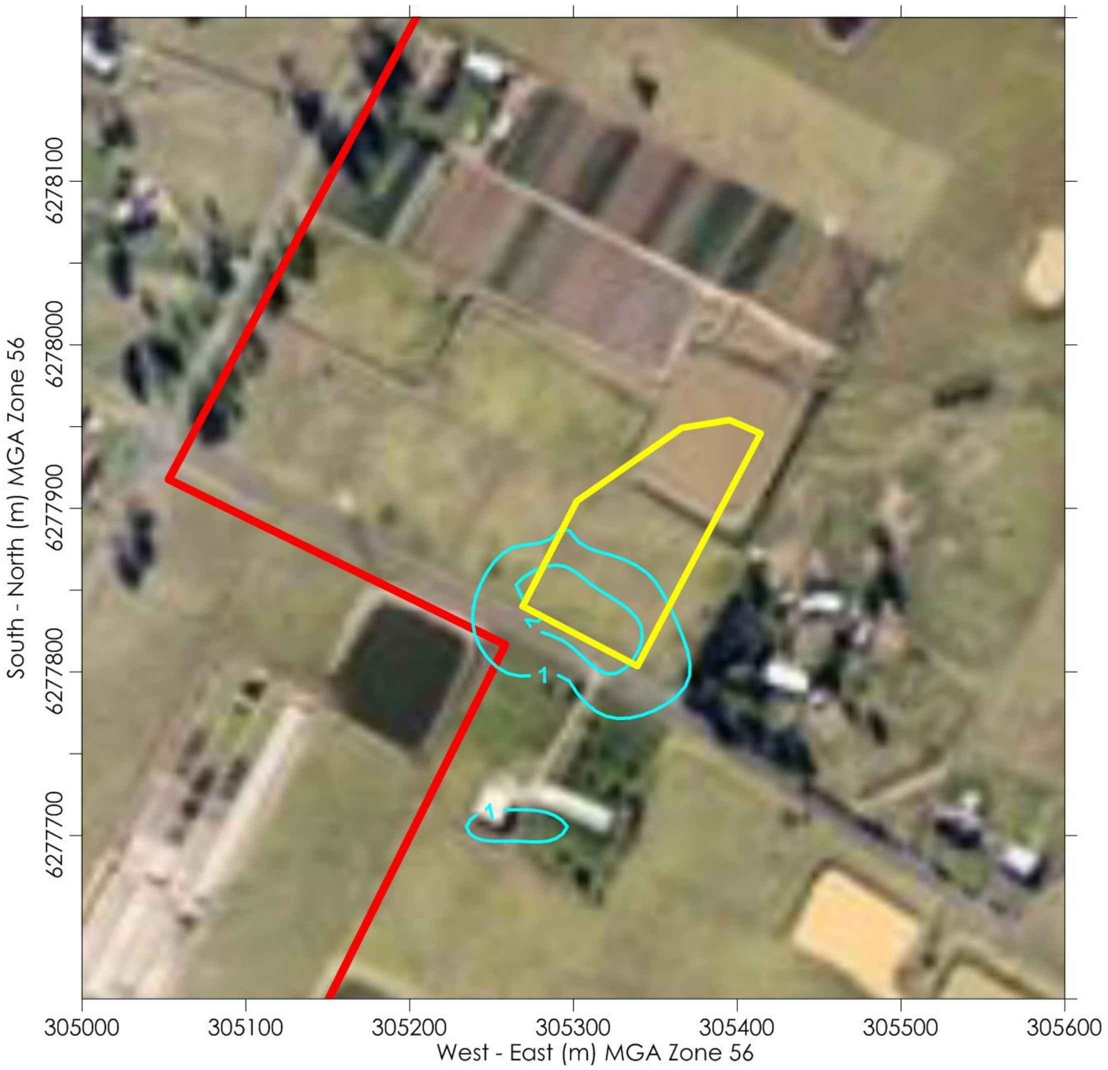
- Only ISST operational
- Two fully operational plants and ISST decommissioned

The predicted odour concentrations for the ISST only are shown in **Figure 7.1** and for the two fully operational plants combined, in **Figure 7.2**. Peak-to-mean factors have been applied in the modelling and are included in the predictions. It is also noted that the OCU vent stack emissions are likely to be conservative, for the reasons outlined in **Section 5.2** and therefore ground level odour concentrations may be lower than those predicted.

It can be seen from both plots that 2 OU (99^{th} percentile) is not predicted to be exceeded at any of the nearest sensitive receptors and is considered to comply with the NSW EPA odour assessment criterion.

Species: Odour	Location: Box Hill North	Scenario: ISST Only	Percentile: 99%	Averaging Time: 1-hour
Model Used: AERMOD v8.2	Units: Odour Units (OU)	Criterion: 2 OU	Met Data: 2013 – 2014	Plot: J. Firth

Figure 7.1: Predicted 99th percentile odour concentration (OU) for Interim FBT operations



Species: Odour	Location: Box Hill North	Scenario: Fully Operational	Percentile: 99%	Averaging Time: 1-hour
Model Used: AERMOD v8.2	Units: Odour Units (OU)	Criterion: 2 OU	Met Data: 2013 – 2014	Plot: J. Firth

Figure 7.2: Predicted 99th percentile odour concentration (OU) for the fully operational plant

8 CONCLUSIONS

This study assessed the air quality impacts of the proposed Local Water Centre at Box Hill North. The odour assessment was based on odour emission rates derived both from measurements at a similar facility, Sydney Water standards for odour control units and technical specifications for the odour control units proposed to be used. This information was combined with local meteorological data and computer-based dispersion modelling to predict the ground level odour concentrations in the vicinity of the plant.

Results from the dispersion modelling indicated that predicted odour concentrations from the proposed facility would comply with the most stringent assessment criterion of 2 OU (99^{th} percentile) at all sensitive receivers outside the plant boundary.

The predicted odour concentrations are at or below 1 OU, the theoretical level at which odour becomes detectable but not necessarily distinguishable, at all receivers.

9 REFERENCES

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Appendix A PEAK TO MEAN RATIOS

Table A.1: Factors for Estimating Peak Concentration

Source Type	Pasquill-Gifford stability class	Near field P/M60*	Far field P/M60
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A – F	6	6
Surface point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A – F	2.3	2.3
Volume	A – F	2.3	2.3

*Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

Appendix B ODOUR MEASUREMENTS FROM PITT TOWN

Measurements taken at the open sources and FBT headspace taken in November 2014

Odour Sample Measurement Results
Panel Roster Number: SYD20141121_101

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
Sample #1 – Anoxic	SC14715	20/11/2014 1135hrs	21/11/2014 1031hrs	4	8	-	-	431	431	-
Sample #2 – Aerobic	SC14716	20/11/2014 1137hrs	21/11/2014 1103hrs	4	8	-	-	362	362	-
Sample #3 – Membrane	SC14717	20/11/2014 1351hrs	21/11/2014 1134hrs	4	8	-	-	197	197	-
Sample #6 – FBT Headspace	SC14720	20/11/2014 1340hrs	21/11/2014 1341hrs	4	8	-	-	77,900	77,900	-

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:
1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

Measurements at the FBT headspace and OCU stack taken in March 2013

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Odour Character
Sample #1 – Membrane Chamber	SC13176	18/03/2013 1405hrs	19/03/2013 1031hrs	34	34	Musty
Sample #2 – Aerobic Chamber	SC13177	18/03/2013 1444hrs	19/03/2013 1059hrs	42	42	Musty
Sample #3 – Anoxic Chamber	SC13178	18/03/2013 1544hrs	19/03/2013 1127hrs	52	52	Musty, Rubbery, Garlic
Sample #4 – FBT OCU Vent	SC13179	18/03/2013 1615hrs	19/03/2013 1201hrs	446	446	H^2S, Rotten Egg, Cabbage
Sample #5 – FBT Headspace	SC13180	18/03/2013 1645hrs	19/03/2013 1227hrs	114,000	114,000	H2S, Rotten Egg

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1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.