Appendix E

Air Quality Impact Assessment

(Pacific Environment, 2015)

Report

AIR QUALITY IMPACT ASSESSMENT – EUROLEY POULTRY PROJECT

PROTEN HOLDINGS PTY LIMITED

Job ID. 8976 - Euroley

22 April 2015

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1 INTRODUCTION

Pacific Environment Limited was engaged by SLR Consulting Australia Pty Ltd (SLR) on behalf of ProTen Holdings Pty Limited (ProTen) to prepare an odour and dust assessment of a proposed intensive poultry broiler production complex ("Euroley Poultry Production Complex") located near Euroley in south-western New South Wales (NSW).

1.1 Background

ProTen intends to submit a development application seeking consent under Part 4 of the EP&A Act to develop five PPUs where broiler birds will be grown for human consumption.

Each of the proposed PPUs will comprise 16 tunnel-ventilated fully-enclosed climate-controlled poultry sheds, with associated support infrastructure and staff amenities. Each shed will have the capacity to house a maximum of 49,000 broilers at any one time, equating to a PPU population of up to 784,000 broilers. The total maximum population for the complex will be 3,920,000 broilers at any one time.

The subject site is shown in Figure 1-1 as a red polygon. The yellow line is a 5 km radius around the site and the pink square are sensitive receptors as identified by SLR.

The proposed shed locations are shown in Figure 1-2 as yellow rectangles. The PPUs on the west side of the site will exhaust to the west, and the PPUs on the east side of the site will exhaust to the east.

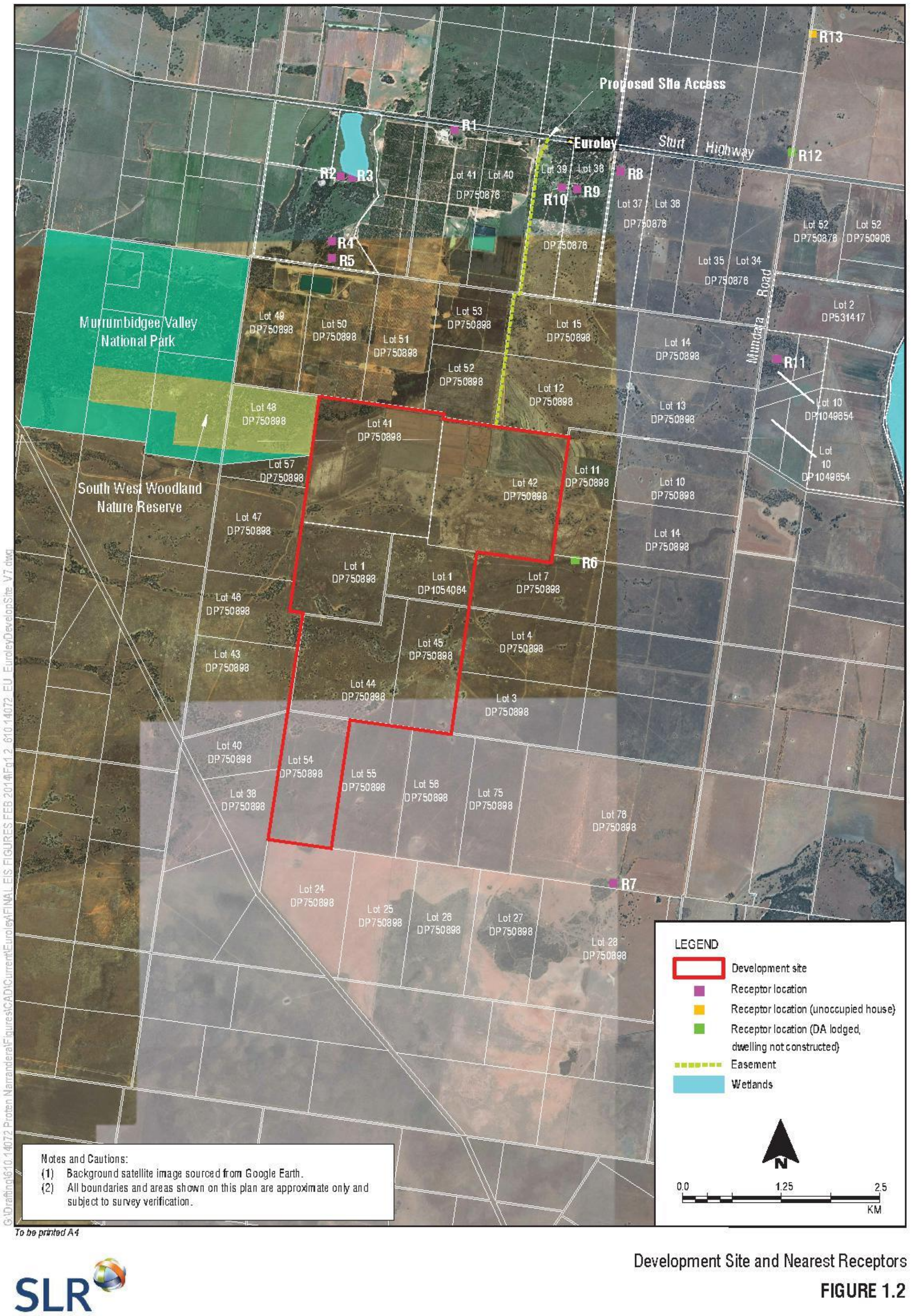

Figure 1-1: Subject Site

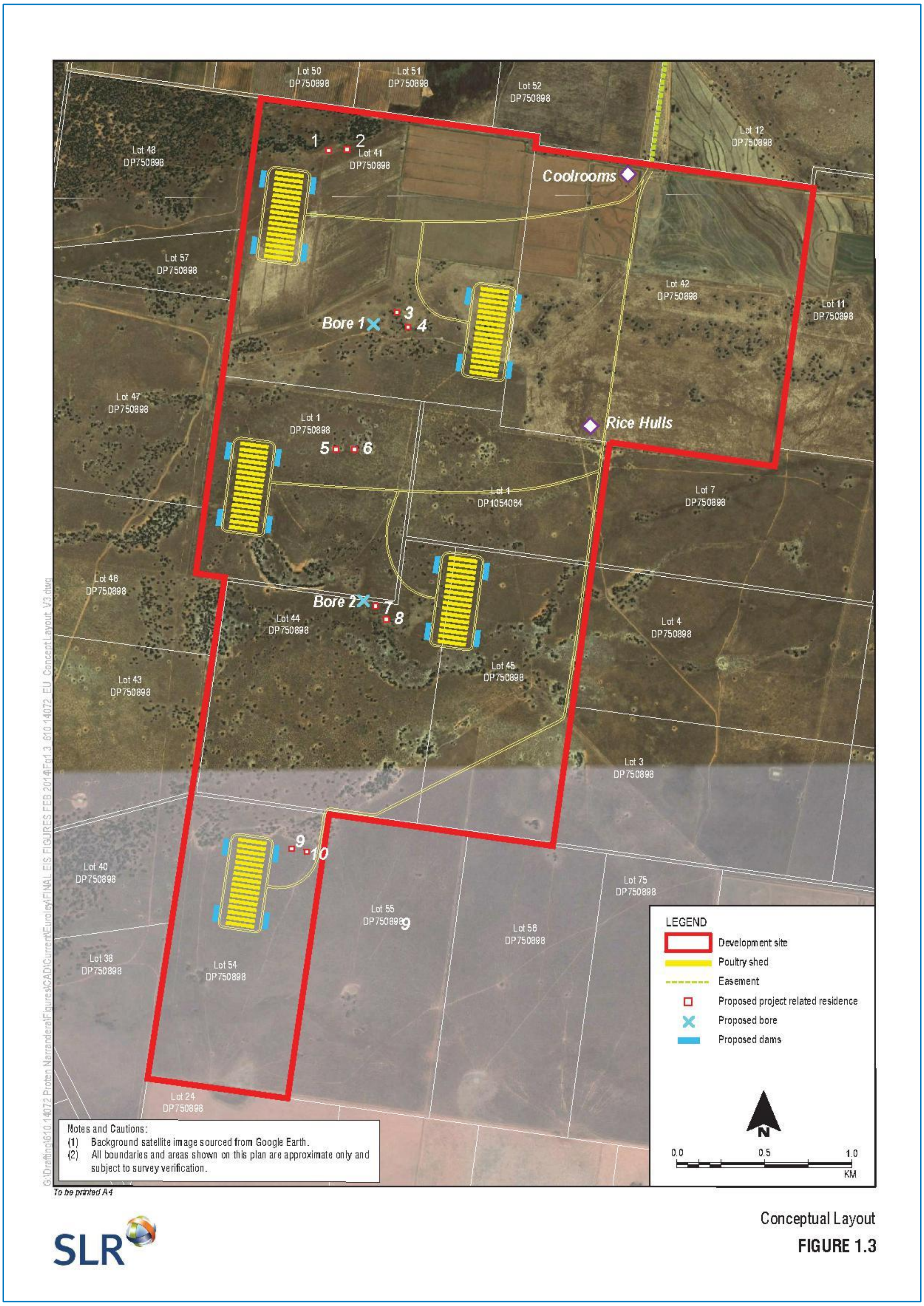

Figure 1-2: Subject Site and Proposed Shed Layout

1.2 Study Objectives

The objective of this assessment is to determine odour and dust impacts from the proposed operation in accordance with relevant methods. The study has been performed in accordance with the Environment Protection Authority's (EPA) "Approved methods for the modelling and assessment of air pollutants in NSW" (NSW EPA, 2005) (herein referred to as the Approved Methods) and the EPA document "Assessment and management of odours from stationary sources in NSW" (NSW EPA, 2006).

The project has also been performed having regard to the Secretary's Environmental Assessment Requirements which requires:

- a description of potential air emission and odour sources (Section 2);
- a quantitative odour and air quality impact assessment in accordance with the relevant Environment Protection Authority guidelines (Section 6);
- a description and appraisal of air quality and odour impact monitoring and mitigation measures (Section 9).

1.3 Study Approach

The methodology for this project included the following stages (see Figure 1-3):

- information and data review
- emissions estimation
- meteorological data processing
- plume dispersion modelling.
- assessment of impacts on surroundings
- reporting.

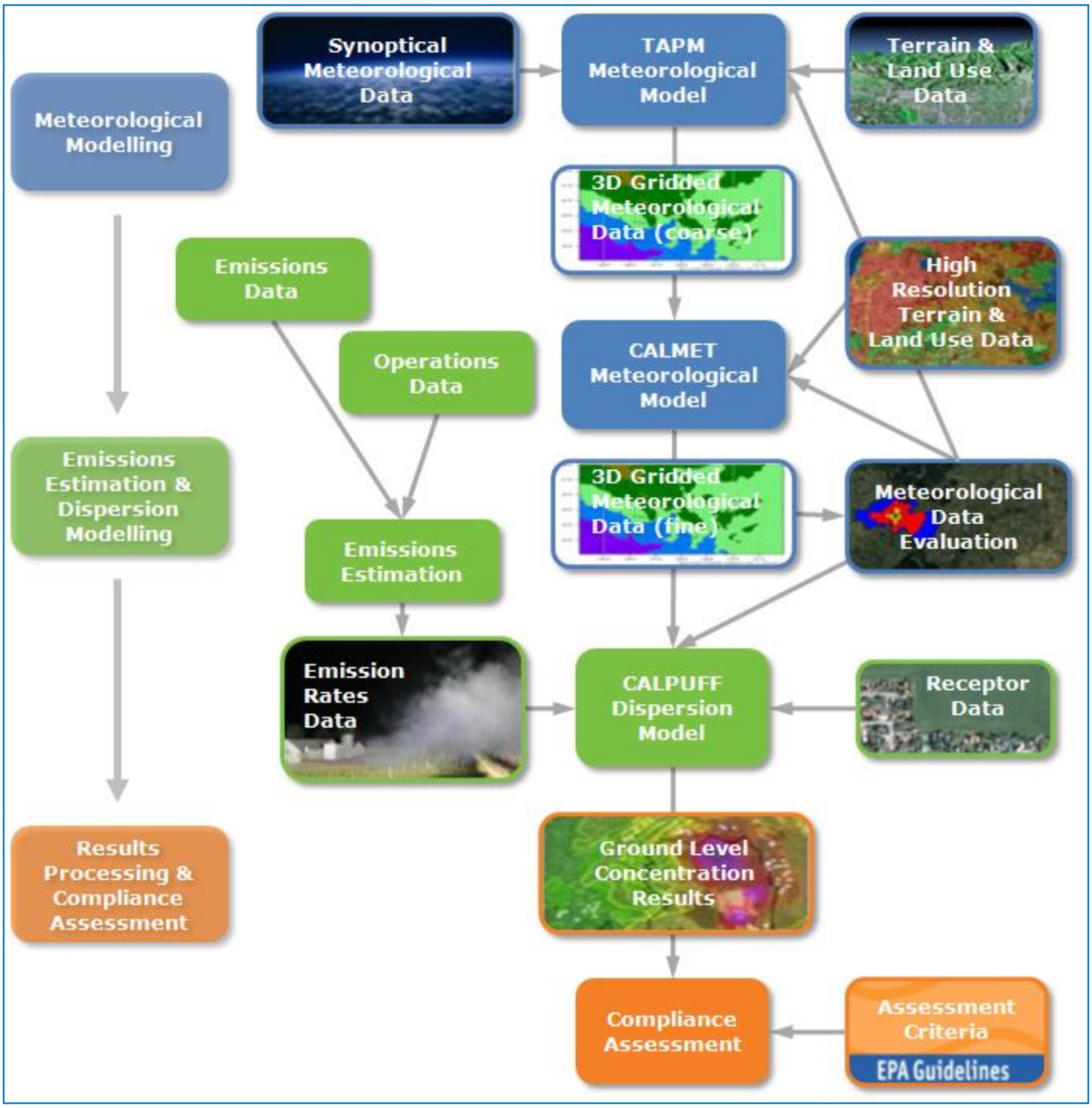

Figure 1-3: Assessment methodology

2 EMISSION ESTIMATION

2.1 Odour Emission Estimation

The odour emissions model of Ormerod and Holmes (2005) was used for this assessment. The methodology is commonly used in Australia and New Zealand and is consistent with that recommended in the *Best Practice Guidance for the Queensland Poultry Industry - Plume Dispersion Modelling and Meteorological Processing* (PAEHolmes, 2011) as prepared for the Queensland Government for inclusion in the *Queensland Guidelines Meat Chicken Farms* (DAFF, 2012).

2.1.1 Basis of Odour Emissions Data

Odour emission rates (OERs) for this assessment were based on data from a variety of meat chicken farms in Australia, as well as theoretical considerations.

The approach generates hourly varying emission rates from meat chicken farm sheds based on the following factors:

- the number of birds, which varies later in the batch as harvesting takes place
- the stocking density of birds, which is a function of bird numbers, bird age and shed size
- ventilation rate, which depends on bird age and ambient temperature
- design and management practices, particularly those aimed at controlling litter moisture.

Data from existing farms were gathered from tunnel-ventilated sheds (many with nipple drinkers) and chicken batches at approximately five weeks of age or more. Given that maximum emissions occur around 5 weeks and later, these samples represent the maximum odour generating potential.

2.1.2 Analysis of Odour Data

Odour data from various farms and under various conditions were standardised to relate the OER per unit bird density and shed area to the ventilation rate at the time of sampling. The resulting relationship is shown in Figure 2-1. The data can be segregated into two groups:

- farms operating under typical conditions
- farms that were experiencing elevated odour emissions due to problems with shed design or management at the time of sampling.

High moisture litter is a common issue that can lead to increased odour emissions (Clarkson & Misselbrook, 1991). High moisture litter can be caused by using foggers in heatwave conditions, which was once common with older shed designs, and water spillage from drinkers, which can be avoided with newer technology. More frequent changing of litter between batches also minimises odour impacts. A vigilant approach to identifying and removing wet litter is now a well-accepted tenet of management.

Design factors include inadequate ventilation and retrofitted sheds. Many older sheds had lower maximum ventilation rates than newer sheds, thereby reducing the effectiveness of airflow to control litter moisture. Retrofitted sheds also did not often have the insulation properties of new sheds and were therefore more difficult to cool by ventilation in hot weather.

As illustrated by Figure 2-1, the degree to which these issues affect odour levels is highly variable. The curves represent a conservative estimate of the relationship between ambient temperature and odour emissions for tunnel ventilated sheds operating under varying degrees of management. The 'best' curve (green) represents a well-designed and managed shed with a high level of control over (for example) litter moisture levels. The 'worst' curve (red) represents a shed experiencing difficulties due to factors such as adverse weather conditions, equipment failure, poor design or management, or a combination of these factors.

Most of the farms for which data are presented in Figure 2-1 differ significantly from the best practice design and management criteria for modern farms which include:

- efficient mechanical ventilation
- nipple and cup drinkers
- fully insulated sheds
- impervious floors
- single or dual batch litter use[a]
- daily litter inspection and replacement (if litter becomes wet).

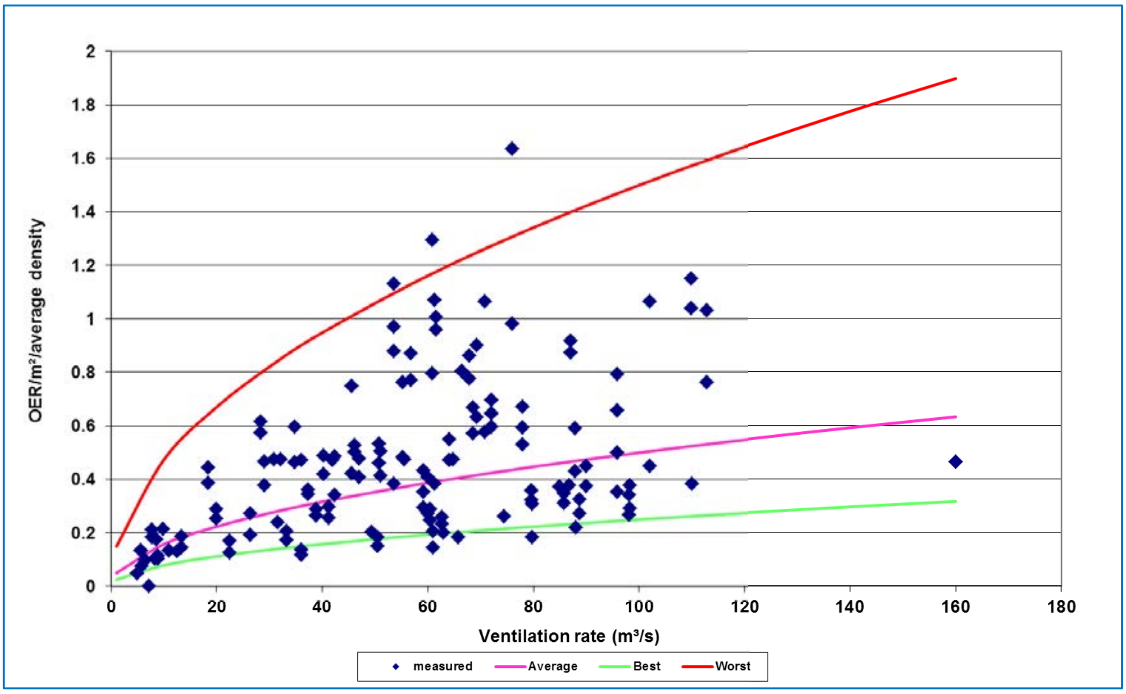

Figure 2-1: Data used in odour emissions modelling

2.1.3 Odour Emissions Estimation

From Figure 2-1, the relationship between the 'standardised' OER and shed ventilation is expressed as:

$$OER_S = 0.025\, K\, V^{0.5} \qquad (1)$$

where:

OER_S = standardised odour emission rate (ou.m³/s) per unit shed area (m²) per unit of bird density (in kg/m²)

V = ventilation rate (m³/s)

K = scaling factor between 1 and 5[b] where a value of 1 represents a very well designed and managed shed operating with minimal odour emissions.

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[a] The most recent research has shown no significant difference between single and dual use litter see Poultry CRC.

[b] Note that a K factor of 4-5 would be very uncommon and would represent a shed with serious odour management issues.

The scaling factor (*K*) referred to in equations 1 and 2 is essentially a scale rating for the design and management of the sheds. The calculation of *K* for any given farm is based on several components of farm management. For new farms conforming to best practice it is recommended that the value of K be set at 2.2 (PAEHolmes, 2011).

Analysis of data for other Proten Farms (held by PE) has shown that the average K factor over time typically is at or below K = 2.

Equation 1 can be expanded to provide a prediction of the OER from a shed at any given stage of the growth cycle as follows:

$$OER = 0.025\ K\ A\ D\ V^{0.5} \qquad (2)$$

where:

OER = odour emission rate ($ou.m^3/s$)

A = total shed floor area (m^2)

D = average bird density (in kg/m^2)

Bird density (*D*) is related to the age of the birds and the stocking density (i.e. the number of birds placed per unit area). It is common practice within the meat chicken industry to vary the stocking density with the time of year and market demands. Lower ambient temperatures during the winter months allow for higher bird densities. For this assessment, based on proposed operations, a maximum stocking density of 18 birds/m^2 has been used. With a known stocking density, a value of the mass per unit area can be estimated based on the relationship shown in Figure 2-2.

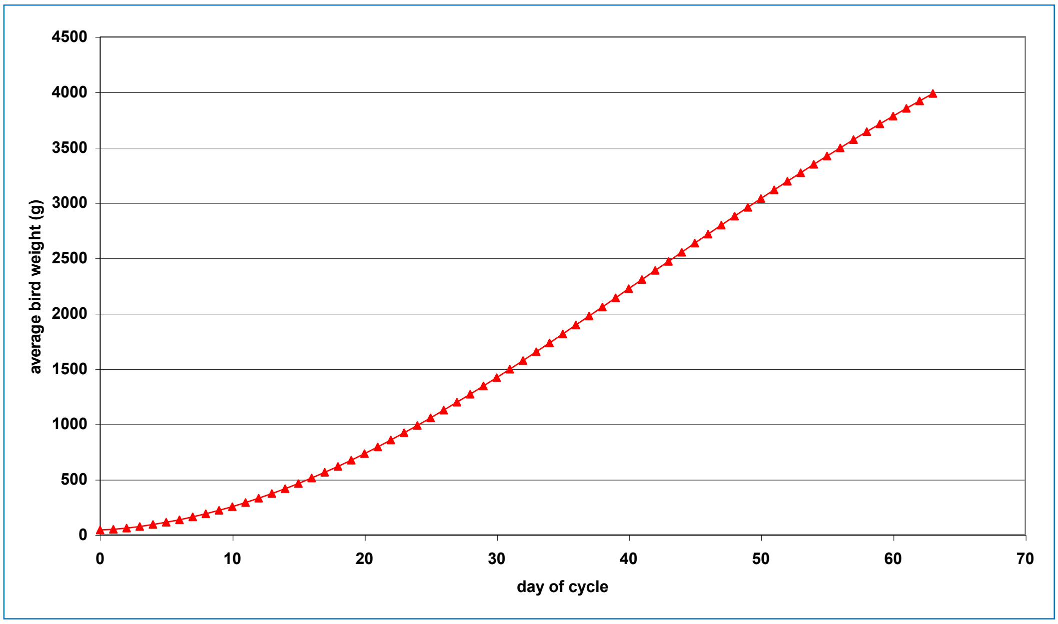

Figure 2-2: Average bird weight by age[c]

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[c] Source: Ross Broiler Manual www.ross-intl.aviagen.com.

The ventilation rate (V) at any given time is a function of the age of the birds and the ambient temperature and humidity. Table 2-1 provides an estimate of the ventilation required for a tunnel ventilated shed as a percentage of the maximum for summertime conditions.

For this project, based on data provided by the client, we assumed a 52 day batch, with a 10 day cleanout. Thinning was assumed to occur on day 32, with 75% of birds placed remaining, again at day 38, with 50% of birds placed remaining and a third thin at day 44, with 25% of birds remaining, with all birds gone by the end of day 52. Finisher feed is introduced at around day 37 of the cycle. Finisher feed is used to slow down the growth of the birds, resulting in less waste and therefore lower emissions per bird toward the end of the batch.

For conservatism, we assumed that all sheds in all PPUs were placed on the same day. In reality the placement is likely to be spread out over a number of days.

Table 2-1: Example - Shed ventilation as a percentage of maximum ventilation

Bird Age (weeks)	1	2	3	4	5	6	7	8
Temperature (°C) above Target	**Ventilation Rate (as a Percentage of the Maximum)**							
<1	1.7	2.6	5.1	7.7	9.8	11.5	17.0	17.0
1	1.7	12.5	12.5	25.0	25.0	25.0	25.0	25.0
2	1.7	25.0	25.0	37.5	37.5	37.5	37.5	37.5
3	1.7	37.5	37.5	50.0	50.0	50.0	50.0	50.0
4	1.7	37.5	37.5	50.0	50.0	50.0	50.0	50.0
6	1.7	37.5	37.5	62.5	75.0	75.0	75.0	75.0
7	1.7	37.5	37.5	62.5	75.0	75.0	87.5	100.0
8	1.7	62.5	62.5	62.5	75.0	75.0	100.0	100.0
9	1.7	62.5	62.5	87.5	100.0	100.0	100.0	100.0

Based on data from the University of Georgia www.poultryventilation.com

Figure 2-3 below shows the variability of odour emissions for the farm during a grow-out cycle based on Equation 2.

The decline in emissions after day 52 represents the clean-out of the sheds. The shed clean-out may result in elevated odour release during disturbance of the litter, but odour emissions from the sheds can be easily managed by minimising the amount of air exchange through the shed during clean-out and cleaning only during the daytime when atmospheric dispersion is most effective.

In line with the Queensland poultry best practice guide, we have used a K factor of 2.2.

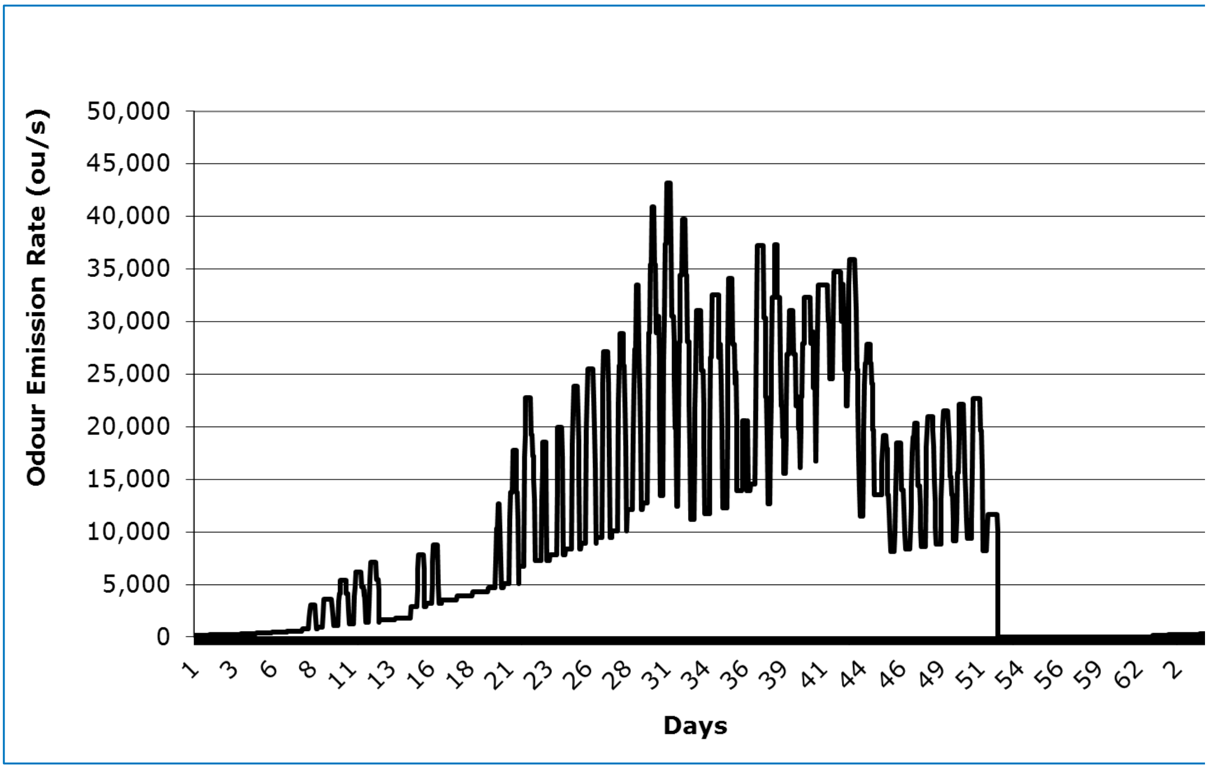


Figure 2-3: Example of modelled shed OER variations over time for the proposed sheds (K=2.2)

Figure 2-4 below shows the variability of estimated odour emissions for the Project for a year of operations as the emissions vary based on Equation 2. The drop in overall emissions midway through the year corresponds to lower temperatures in the late autumn and winter months which result in lower ventilation rates and therefore less odour emissions from the PPUs.

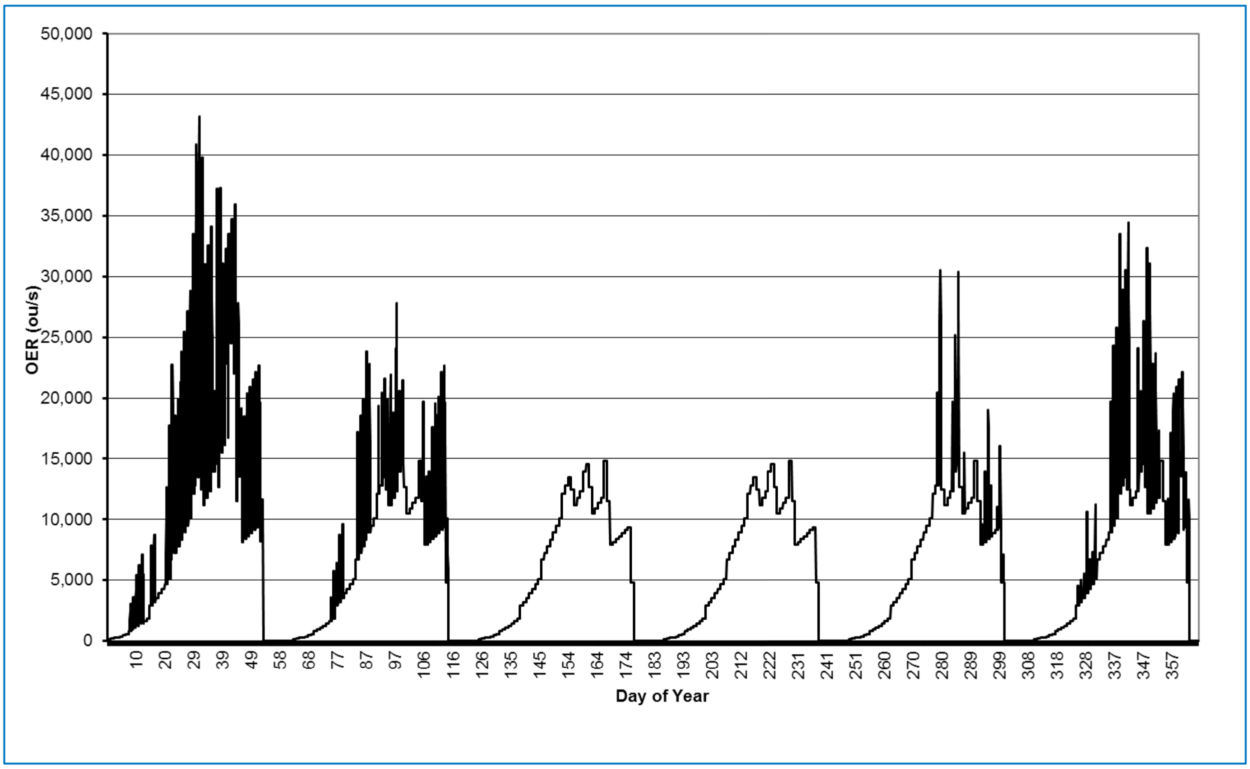


Figure 2-4: Modelled Shed OER Variations Over Time for the Project (k=2.2)

2.2 Particulate Emissions

As there are no NPI emission factors for dust from poultry in Australia. Therefore we estimated particulate emission rates for this study using a modelling approach based on data from meat chicken farms in NSW and Queensland as well as theoretical considerations.

The approach generates hourly varying emission rates from each shed based on the following factors:

- the total weight of all of birds, which varies later in the batch as harvesting takes place
- ventilation rate, which depends on bird age and ambient temperature
- design and management practices.

First we examined data from an existing farm in NSW with tunnel-ventilated sheds and cup drinkers. Data were gathered a limited number of times for chicken batches between one to eight weeks of age. These samples represent particulate emissions over a full batch cycle.

The data detailed in Mirrabooka (2002) were standardised to relate the particulate matter concentration to the total bird mass at the time of sampling. The resulting relationship is shown in Figure 2-5. The shed ventilation rate was also related to particulate matter concentration (as a fraction of the maximum) and is presented in Figure 2-6.

The data were gathered between July and August and therefore may not represent all meteorological conditions. When collected, Mirrabooka (2002) showed that the emission factors generated from these data were comparable to Victorian EPA recommended emission rates. However since 2002 significant improvements have been made in poultry production.

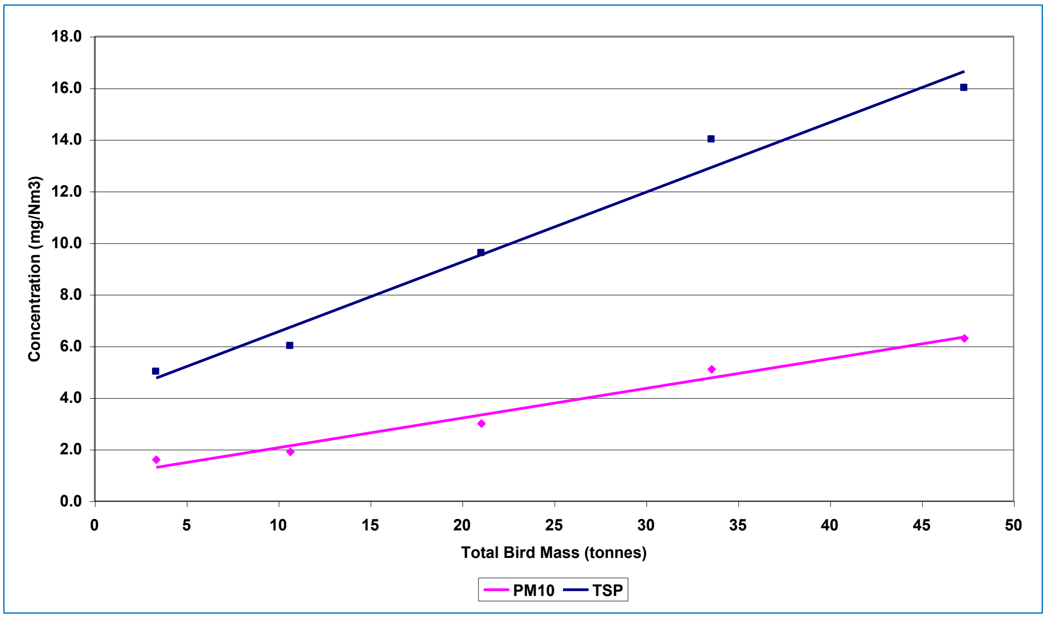


Figure 2-5: Mirrabooka Data

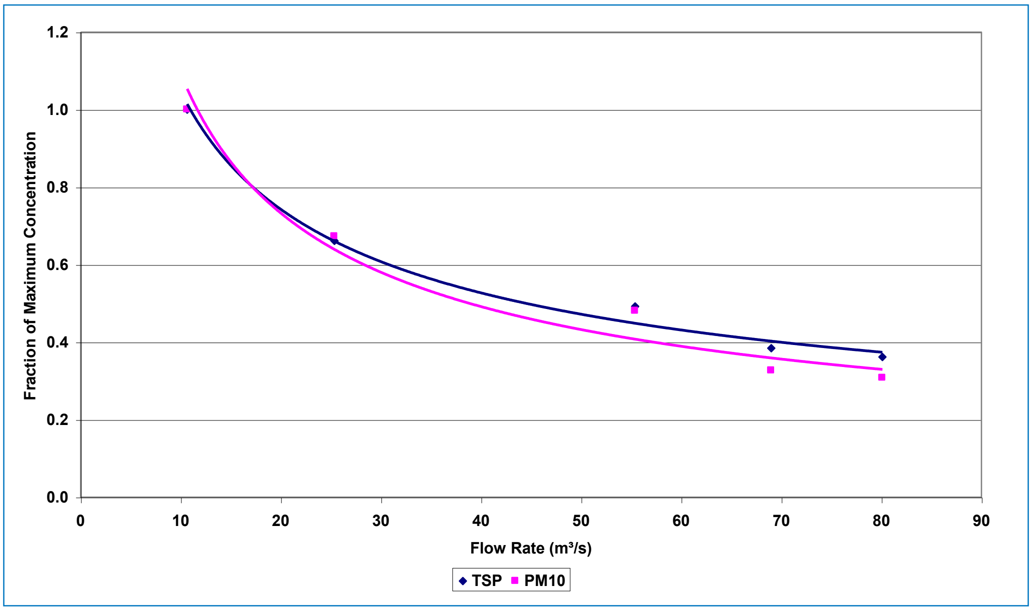


Figure 2-6: Relationship Between Particulate Concentration and Flow Rate

Using Figure 2-5(Mirrabooka data) a relationship between the maximum particulate emission concentration (PEC) and bird mass, assuming a single fan operating, is expressed as:

$$PEC = aM + b \qquad (3)$$

where:

PEC = maximum particulate emission concentration (mg/m³)

M = Total mass of birds (tonnes)

a = 0.270 for TSP or 0.115 for PM_{10}

b = 0.385 for TSP or 0.917 for PM_{10}

To account for the dilution that occurs under higher flow rates, equation (4) has been taken from Figure 2-6:

$$PEC_v = PEC * (cV^d) \quad (4)$$

where:

PEC_v = particulate emission concentration (mg/m³)

PEC = maximum particulate emission concentration (mg/m³)

V = Ventilation rate (m³/s) and

c = 3.3 for TSP and 4.11 for PM_{10}

d = -0.49 for TSP and –0.58 for PM_{10}

A particulate matter emission rate (PER) can be calculated by multiplying the PEC by the ventilation rate (V).

The ventilation rate (V) used at any given time is a function of the age of the birds and the ambient temperature and humidity.

It is noted that the method above is based on 2002 data. The data was collected to provide supporting information in an application for a meat chicken farm known as “Silverweir” which was never constructed. Given the time since the collection of the data, it is worthwhile to compare the 2002 data to the latest data collected for the Australian industry. This data is summarised in a report by the Australian Poultry CRC titled Dust and odour emissions from meat chicken sheds (Australian Poultry CRC, 2011). Whilst the odour emission rate data in the report is questionable, the particulate emission rate information is none the less relevant. The data was collected at a number of farms throughout Australia.

As part of another project (PAEHolmes, 2012), we measured dust concentrations in an operating meat chicken shed after first thin out. Sampling was performed in late December 2011 a period where maximum ventilation rates, and likely maximum particulate emission rates would be expected.

The data was collected using an E-Sampler and the concentration measured by the real time analyser in the E-Sampler was calibrated gravimetrically using a pre and post weighed filter. Due to budget constraints we were unable to measure the changes in ventilation rate over time.

However, the data is still relevant in that we had a PM_{10} concentration range near peak density over a period of two days. We compared the predicted emission rate data for the farm (based on the Mirrabooka method above) with the data range collected on the farm at the known bird age, and also the range measured by the CRC project for the same bird age. The data was standardised to mg/m3 per 1000 birds in the shed at the time of sampling. Given that bird growth rates for meat chickens are relatively constant across the industry, this method enable data from different sites to be easily compared. This is shown in Figure 2-7. It can be seen in the figure that the data measured at the Queensland farm and the CRC data compare well. The Mirrabooka based method tended to overestimate emission rates.

Therefore the data used in this assessment is considered conservative.

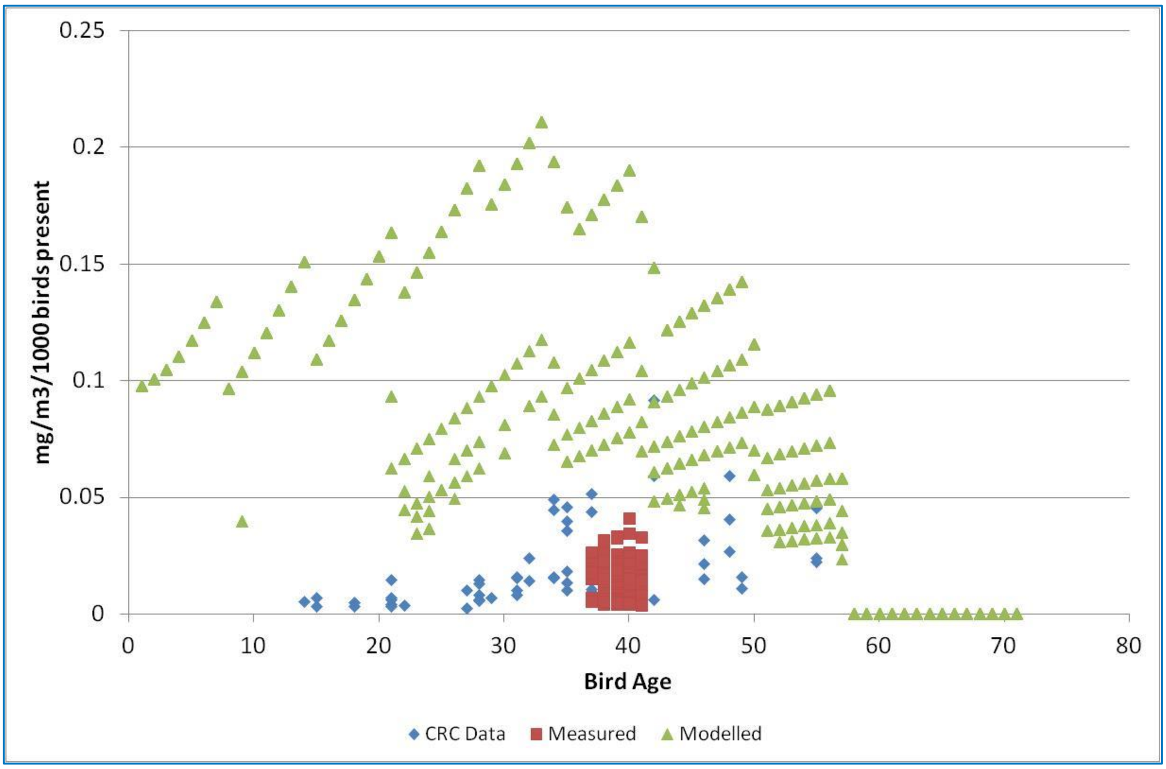


Figure 2-7: Summary of Measured PM_{10} data, CRC Data and Modelled Data (PAEHolmes, 2012)

3 METEOROLOGICAL MODELLING

The climate and meteorology of a site are fundamentally important to the dispersion of atmospheric emissions. A good quality meteorological dataset is therefore necessary to model the dispersion of air emissions.

A representative meteorological year of 2010 was selected for use in this project based on long-term averages at Narrandera Airport. We compared the observed data from the Bureau of Meteorology Website for 2010 to long term averages for wind speed, temperature, humidity, mean maximum temperature, mean minimum temperate and mean rainfall. The data were found to be consistent for 2010 with long term averages. A comparison of wind speed and direction data for 2007 to 2010 was also performed, and the data was consistent over the period checked.

After selecting a year to model we examined both TAPM generated and observed data for Narrandera. We had intended to use the no observation approach (see below), but found the model generated data was inconsistent with the observed data from the Bureau of Meteorology station. That is prognostic data was not representative of the region. These data are shown in Figure 3-1 for TAPM (left) and Narrandera BOM station data (right). Note that the outward scale for the TAPM data shows a maximum frequency of 10%, whereas the observed data outer ring shows 15%

The wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (north, north-north-east, north-east etc). The bar at the top of each wind rose 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 and width of the bar sections correspond to wind speed categories, as per the legend. Thus it is possible to visualise how often winds of a certain direction and strength occur over any period of time.

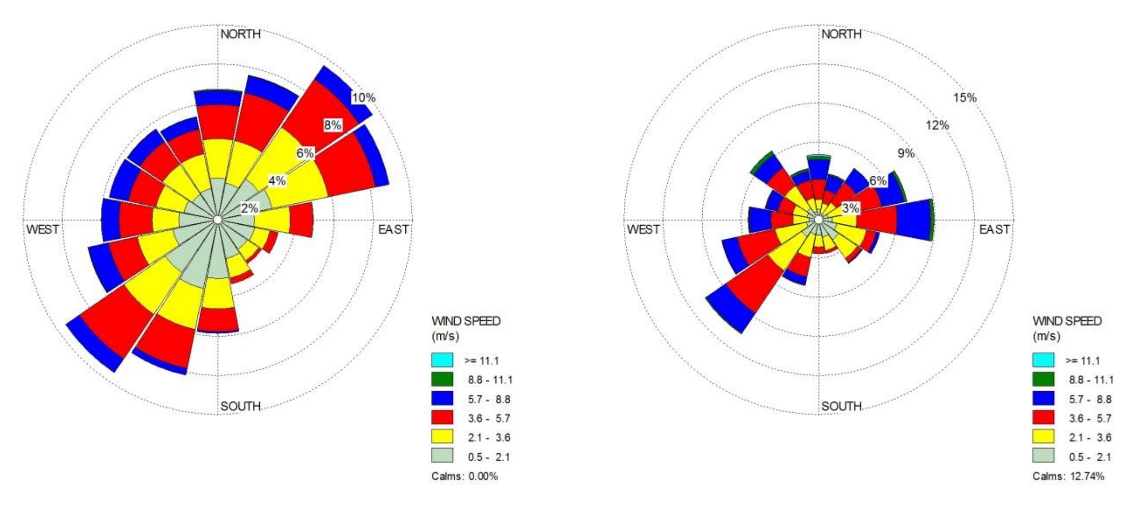


Figure 3-1: Comparison of TAPM (left) and Narrandera BOM (right) Data

Looking at the figures it can be seen that TAPM predicts more winds across a variety of directions and importantly, TAPM predicts no winds under 0.5 m/s. These low wind speeds can be critical with regard to odour dispersion. However, the BOM data shows nearly 13% of winds for the year 2010 were below 0.5 m/s.

As the area is relatively flat, we selected the observation only approach to ensure that the light wind frequency reflected reality. The observation only approach is discussed in the Generic Guidance and Optimum Model Settings for the CALPUFF modelling system for inclusion into the 'Approved methods for the Modeling and Assessment of Air Pollutants in NSW (NSW OEH, 2011). For flat areas such as the subject site, the reliance on observed data over model generated data such as TAPM is appropriate as it gives more weight to measured wind. Where data gaps existed, in line with good practice we infilled the observed data with observed data from the Yanco BOM station.

The meteorological data used in the dispersion modelling was processed in two steps. Synoptic scale meteorological data were first processed in The Air Pollution Model (TAPM) to generate upper air data and then further processed in CALMET along with surface data measured at Narrandera to produce the wind field and weather data suitable for dispersion modelling with CALPUFF.

3.1 TAPM

TAPM (version 4), is a three dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research. Detailed description of the TAPM model is provided in the TAPM user manual (Hurley P, 2008a). The Technical Paper on TAPM (Hurley P, 2008b) describes technical details of the model equations, parameterisations, and numerical methods. A summary of some verification studies using TAPM is also available (Hurley P, 2008c).

TAPM v4 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.

The upper air data generated by TAPM was input into CALMET.

3.2 CALMET

CALMET is the meteorological pre-processor to CALPUFF and includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects, and terrain blocking effects. The pre-processor uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict a gridded three dimensional meteorological field (containing data on wind components, air temperature, relative humidity, mixing height, and other micro meteorological variables) for the domain used in the CALPUFF dispersion model.

CALMET uses the meteorological data input in combination with land use and geophysical information to predict a gridded meteorological field for the modelling domain. The gridded TAPM generated data were processed in CALMET with fine terrain resolution (100 m grid point spacing) for an inner domain of approximately 15 km x 15 km.

As noted above, surface data for the year 2010 from Narrandera was used to drive the model.

4 EXISTING ENVIRONMENT

4.1 Site Meteorology

The primary meteorological parameters involved in modelling plume dispersion from poultry sheds are wind direction, wind speed, turbulence (atmospheric stability) and mixing height (depth of turbulent layer). The meteorological data for 2010 as generated by CALMET and used in the dispersion modelling are discussed below.

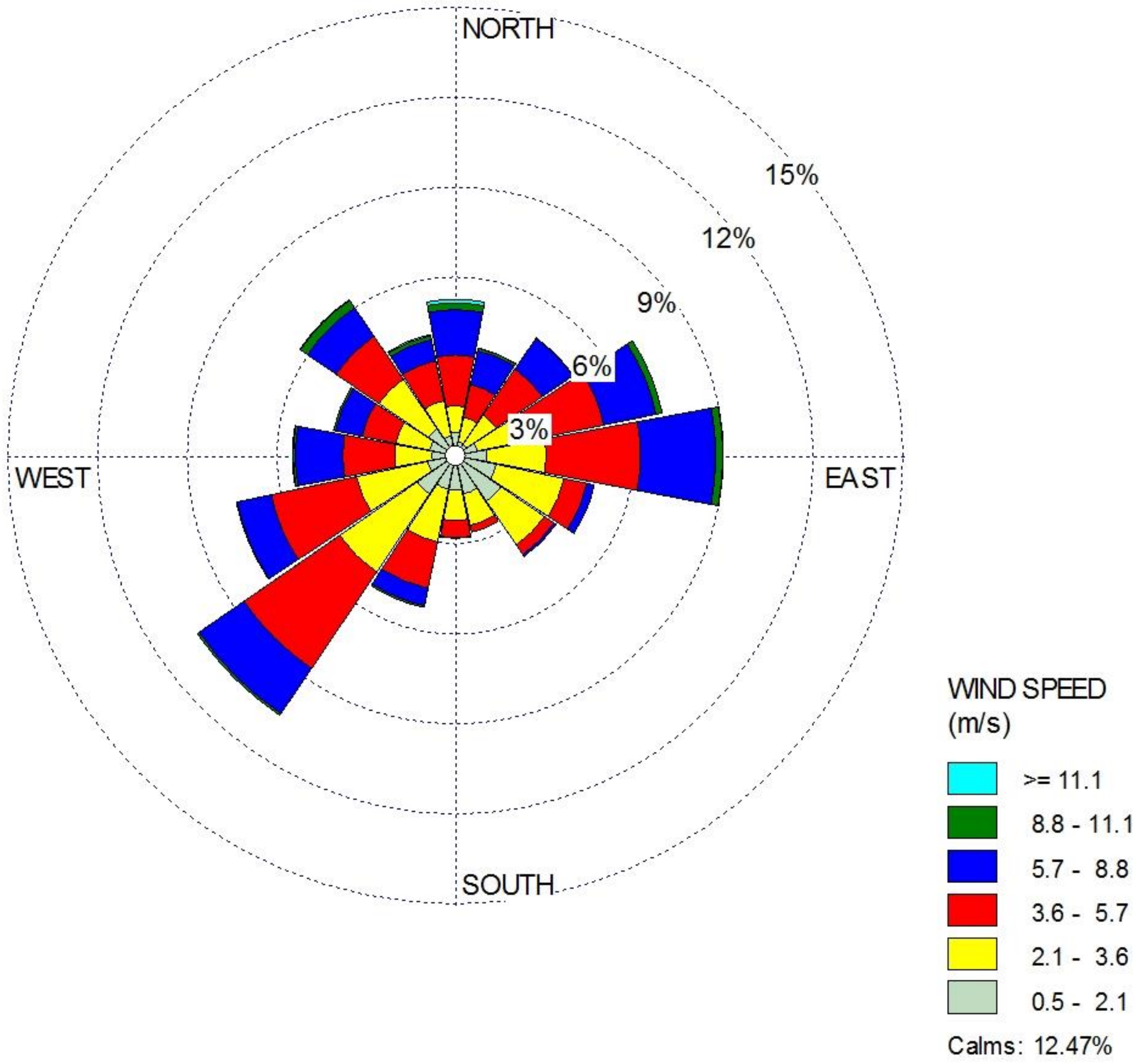
4.1.1 Wind

The wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (north, north-north-east, north-east etc). The bar at the top of each wind rose 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 and width of the bar sections correspond to wind speed categories, as per the legend. Thus it is possible to visualise how often winds of a certain direction and strength occur over any period of time.

The wind roses plotted from data extracted from CALMET is presented in Figure 4-1 and Figure 4-2. The annual wind rose (Figure 4-1) shows that the wind commonly blows from all directions, but with a low frequency of southerly and south easterly winds. The morning winds shown in Figure 4-2 are consistent with those observed in the area with a similar percentage of calms at 9am (~11-12%).

In the early morning and late at night, winds are typically light (<3 m/s) and from the southwest or northeast depending on the time of year. During the morning (7am to 12 noon) the winds are typically stronger than overnight and from a variety of directions, but with a low frequency from the southeast. During the early afternoon the winds are also from these directions, but are on occasion stronger and with a higher frequency of winds from the south west.

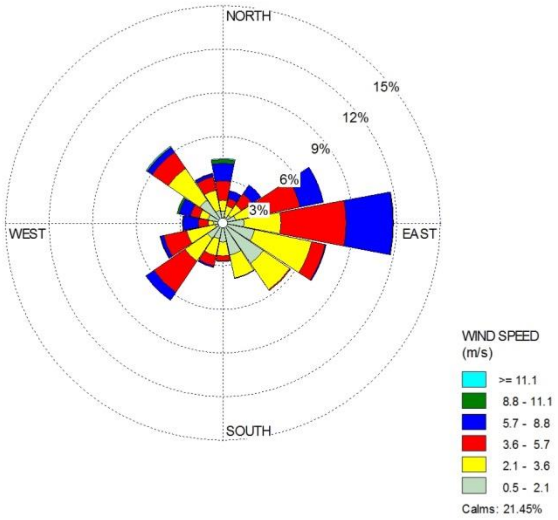
Overall the wind data show a high frequency of calm to light winds (up to 3 m/s), occurring 48% of the time, with calm winds occurring 12.47% of the time.



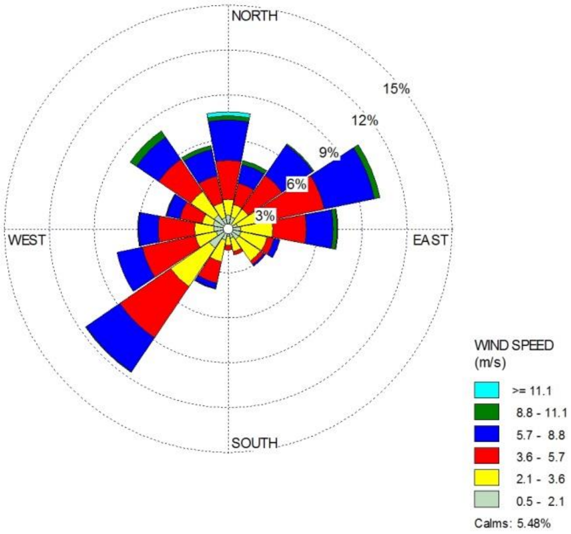
Location:	**Data Period:**	**Data Type:**
Proposed Euroley Poultry Production Complex	2010	CALMET extract
Calm winds:	**Average wind speed:**	**Plot:**
12.5%	3.4 m/s	G. Galvin

Figure 4-1: Wind rose for the proposed site

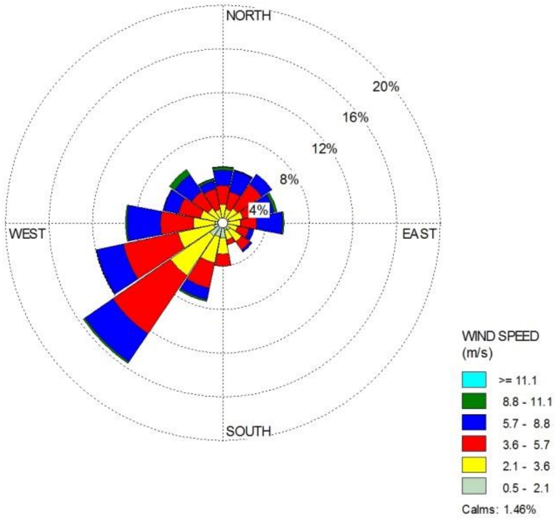
12 AM to 6 AM



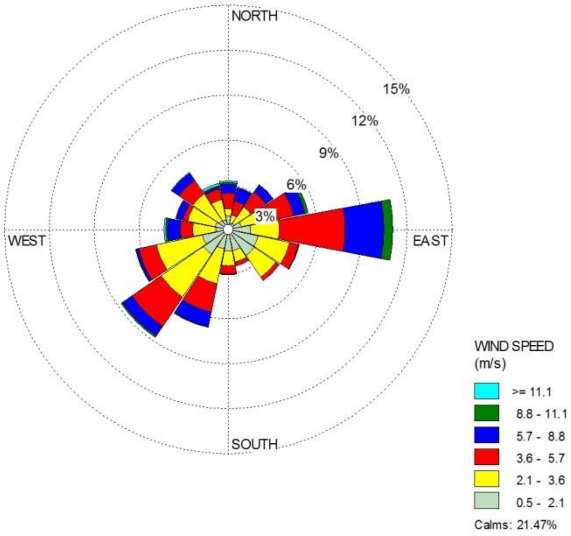
7 AM to 12 PM



1 PM to 6 PM



7 PM to 12 AM



Time of day	Average wind speed (m/s)	Calm winds frequency %	WIND SPEED (m/s)
12 AM to 6 AM	2.7	21.5	>= 11.1 8.8 - 11.1 5.7 - 8.8 3.6 - 5.7 2.1 - 3.6 0.5 - 2.1
7 AM to 12 PM	4.1	5.5	
1 PM to 6 PM	4.2	1.5	
7 PM to 12 AM	2.7	21.5	

Location:	Data Period:	Data Type:	Plot:
Proposed Euroley Poultry Production Complex	2010	CALMET extract	G. Galvin

Figure 4-2: Time of day wind roses for the proposed site

The wind speed frequency is shown in Figure 4-3.

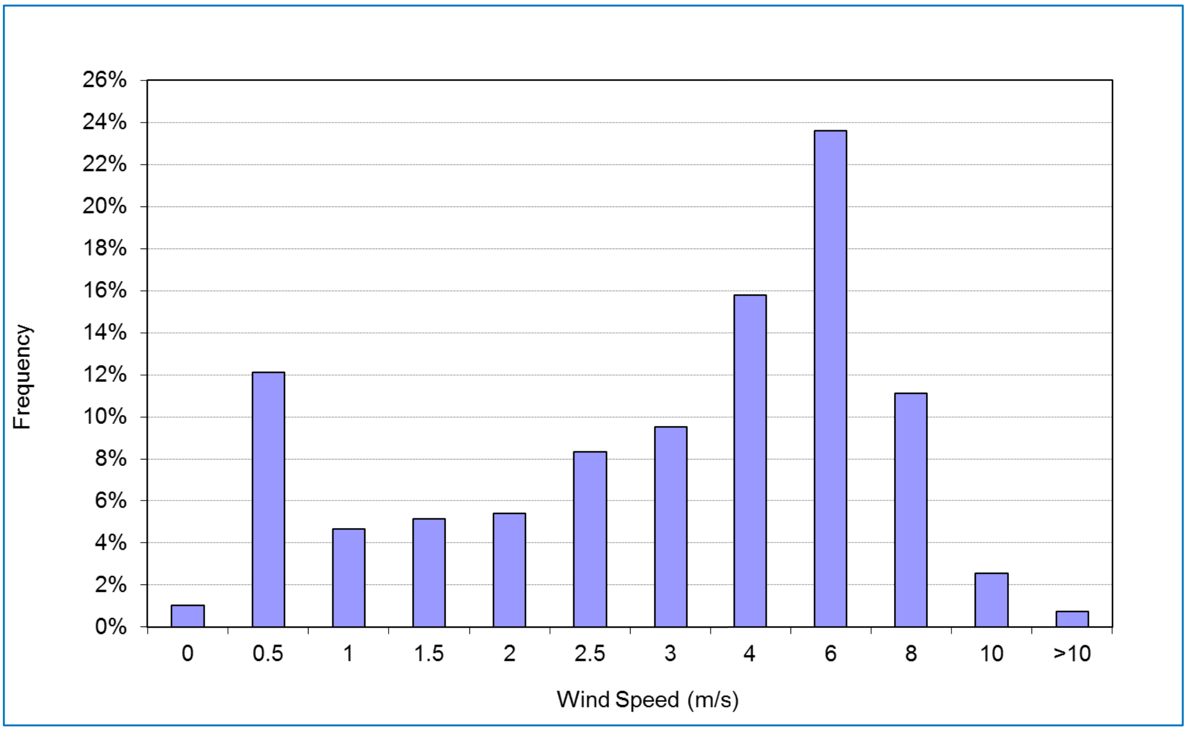


Figure 4-3: Wind Speed Frequency (hourly average) for 2010

4.1.2 Stability

Atmospheric turbulence is an important factor in air 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. Turbulence is related to the vertical temperature gradient, 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, 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 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.

Pasquil-Gifford stability classes indicate the characteristics of the prevailing meteorological conditions and are estimated based on a number of meteorological parameters. Pasquil-Gifford stability classes are not specifically used as input data for the CALPUFF dispersion modelling, and are used here to help describe conditions at the site. A summary of atmospheric stability classes is provided in Table 4-1.

Table 4-1: Description of Atmospheric Stability Class

Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

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 distributions of stability classes estimated from the CALMET meteorological file are presented in Figure 4-4. The data show that the combined frequency of E and F stability classes, the most critical for air quality impacts, is 44%. The frequency of neutral conditions is also relatively high, occurring 25% of the time. The data is consistent with the expectations for sites in inland southern regions of Australia.

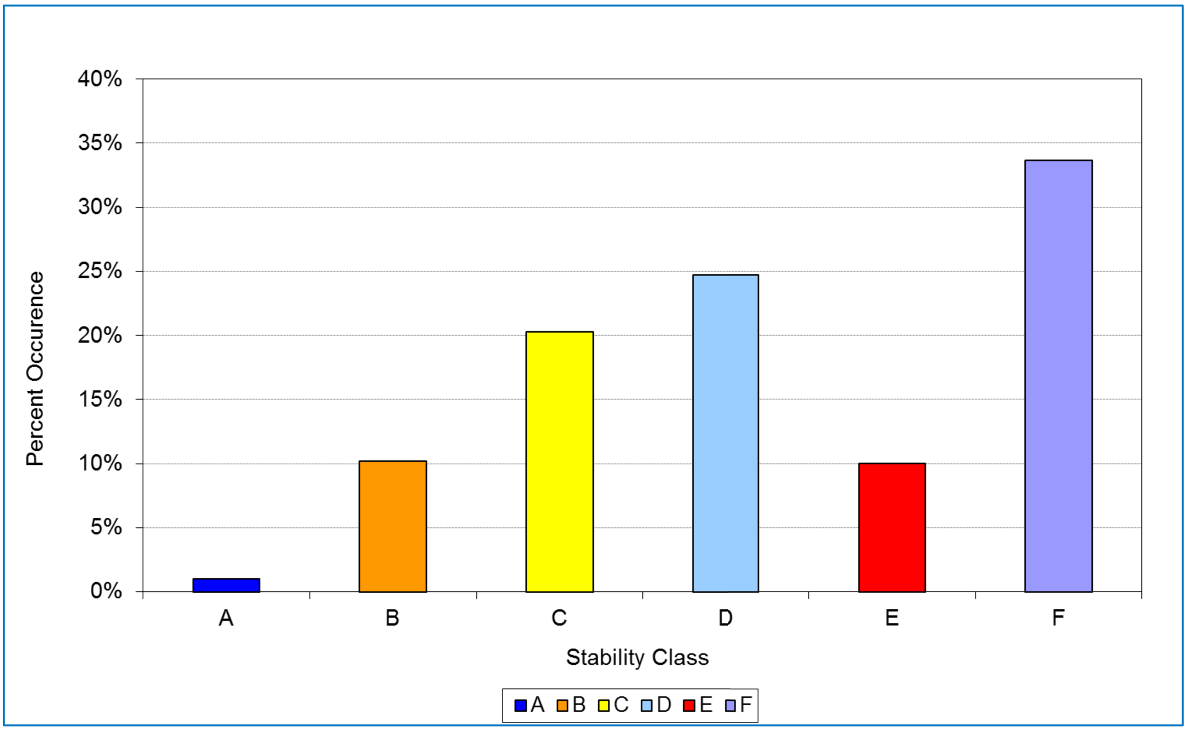


Figure 4-4: Frequency Distribution of Estimated Pasquill- Gifford Stability Classes for 2010

4.1.3 Mixing Height

Mixing height is the depth of the atmospheric mixing layer beneath an elevated temperature inversion. It is an important parameter in air pollution meteorology as vertical diffusion or mixing of a plume is limited by the mixing height. This is because the air above this layer tends to be stable, with restricted vertical motions.

The estimated diurnal variation of mixing height at the site is presented in Figure 4-5. The diurnal cycle is clear in this figure. At night, mixing height is normally relatively low. After sunrise, it increases in response to convective mixing due to solar heating of the earth's surface. The estimated mixing height behaviour is consistent with what would be expected at inland locations such as Euroley.

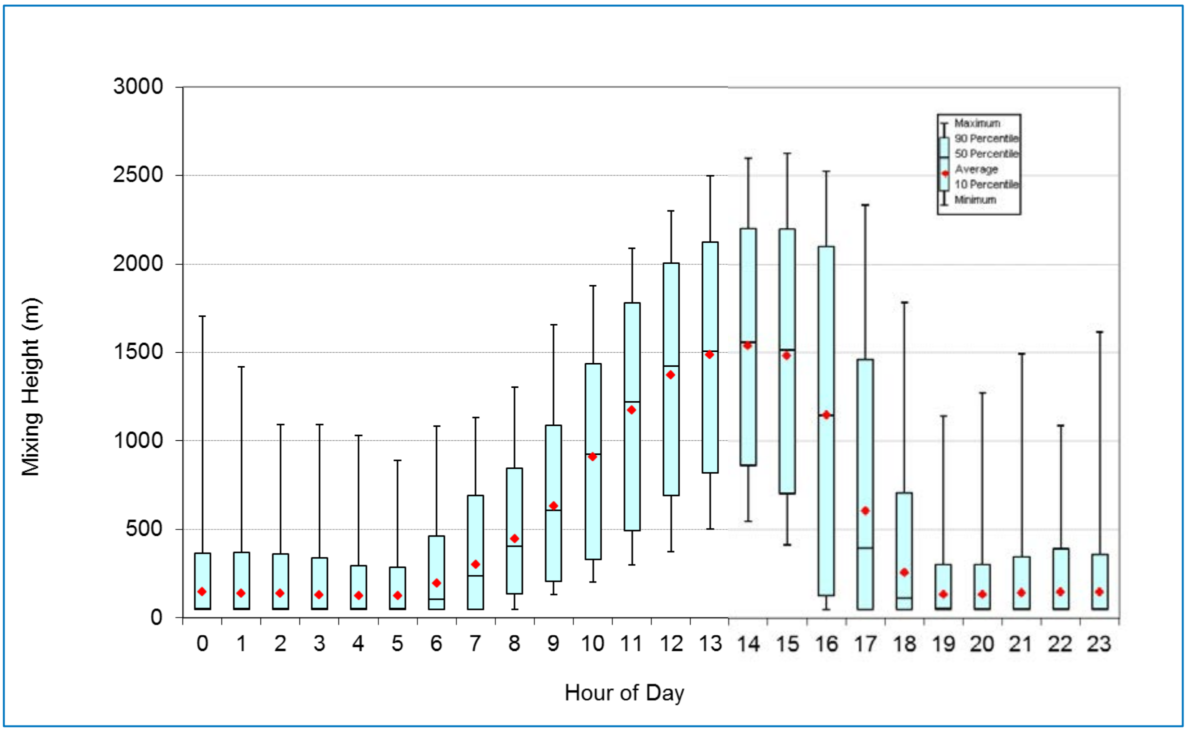


Figure 4-5: Estimated Mixing Height versus Hour of Day for 2010

4.2 Existing Air Quality

No air quality measurements have been made specifically for the Project and there are no EPA monitoring sites located in the vicinity. However, as the Project Site is situated in a rural area with no major sources of air pollution, the local air quality is likely to be good and concentrations of pollutants are unlikely to exceed any of the air quality criteria.

Although there are no available monitoring data in the vicinity of the Project Site, it is useful to assess the nearest available monitoring data and/or data from a similar land-use site to gain an understanding of what current pollutant levels may be around or near the Project Site.

The air quality on and surrounding the Project Site is likely to be similar to other rural areas in NSW. The EPA collects PM_{10} data in the rural areas of Albury, Bathurst and Wagga Wagga. These data were collected using a TEOM (Tapered Element Oscillating Microbalance), which provides continuous recordings of PM_{10} concentrations. PM_{10} concentrations in rural areas are heavily influenced by agricultural activities and the use of solid fuel heaters. From the three rural EPA monitoring sites, the Albury site is considered to be most representative of the Project area as the Bathurst and Wagga Wagga EPA sites are located within densely populated towns where PM_{10} concentrations are likely to be dominated by urban sources. These locations are also potentially impacted by other significant seasonal sources such as agricultural stubble burning.

Table 4-2 presents a summary of recent PM_{10} data collected at the Albury EPA monitoring station. The annual average PM_{10} concentrations for the last six years of monitoring are below 25 µg/m^3. The average PM_{10} concentration across all years is 16 µg/m^3 which is well below the EPA annual average impact assessment criterion of 30 µg/m^3.

Table 4-2: PM_{10} TEOM data from the EPA Albury monitoring station

Year	Annual Average (μg/m^3)
2007	21
2008	17
2009	19
2010	13
2011	12
2012	14
Annual average over all years	**16**

The climate around Euroley is somewhat drier than at Albury and more exposed to the effects of strong winds that can raise dust from sparsely vegetated ground. Hence, natural regional events with elevated PM_{10} concentrations are likely to be more common than at Albury. However, the effect on annual average concentration is likely to be modest.

In view of the above, as well as a review of nearby sources of particulate, a cumulative assessment of particulate (i.e. accounting for other potential sources in the vicinity) is not deemed necessary. However, for consistency with the NSW Approved Methods, the EPA Albury TEOM data set has been referenced in an exercise to estimate cumulative impacts.

5 DISPERSION MODELLING

5.1 Background

For this project, in line with good practice, we used the dispersion model 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 released puffs and takes into account the complex arrangement of emissions from point, area, volume and line sources.

In addition to the three-dimensional meteorological data output from CALMET; CALPUFF requires the following input data:

- emission data and plant layout
- receptor information.

CALPUFF is a USEPA regulatory model for long-range transport or for modelling in regions of complex meteorology. It is a preferred dispersion model for use in coastal and complex terrain situations in most parts of Australia. Detailed description of CALPUFF is provided in the user manual (TRC, 2006).

5.2 CALPUFF Setup

The receptor grid for the dispersion modelling of concentration was, as for the meteorological modelling, at a grid spacing of 100 m with additional discrete receptors representing the nearest houses to the site.

Each shed was represented as a pseudo point source on the western or eastern end of each shed depending on the pad location (see Section 1 and Figure 1-2).

Each point source was assigned a diameter the same as the shed width. The source diameter and vertical velocity were set as to ensure the momentum of the plume was maintained. The vertical momentum of the point sources was set to zero by using the 'rain hat' switch in CALPUFF. This switch accounts for the horizontal release of emissions from tunnel-ventilated poultry sheds. It then removes the need to apply dimensional adjustments to source parameters (i.e., increasing diameter to achieve minimal exit velocity while conserving volumetric flow rate) to achieve the same end result.

There are a number of sensitive receptors (e.g. dwellings) in the vicinity of the Project. These were shown in Figure 1-1 (provided to PEL by SLR) as coloured squares. These receptors were included in the CALPUFF setup and predicted concentrations at these receptors are the focus of this study.

6 IMPACT ASSESSMENT CRITERIA

6.1 Particulate Matter

NSW modelling and assessment guidelines specify air quality assessment criteria relevant for assessing impacts from dust generating activities (NSW EPA, 2005). Table 6-1 summarises the air quality criteria for dust that are relevant to this assessment.

Table 6-1: Air Quality Impact Assessment Criteria for Particulate Matter Concentrations

Pollutant	Standard / Criteria	Averaging Period	Agency
Particulate matter < 10µm (PM_{10})	50 µg/m^3	24-hour maximum	NSW EPA
	30 µg/m^3	Annual mean	NSW EPA

6.2 Odour

6.2.1 Measuring odour concentration

There are no instrument-based methods that can measure an odour response in the same way as the human nose. Whilst electronic noses are available, they, at present, cannot detect odour at the same level as the human nose. Therefore “dynamic olfactometry” is typically used as the basis of odour management by regulatory authorities.

Dynamic olfactometry (Standards Australia, 2001) is the measurement of odour by presenting a sample of odorous air diluted to the point where a trained panel of assessors cannot detect a change between the odour free air and the diluted sample. The concentration is then doubled until the difference is observed with certainty where the panellist can detect the difference between clean air and diluted air. It does not mean that the odour is recognisable. The correlations between the dilution ratios where they cannot and can detect an odour is then used to the odour concentration as “odour units” (ou). Odour units are dimensionless and are effectively “dilution to threshold” as used in the United Sates.

The theoretical minimum concentration is referred to as the “odour threshold” and is the definition of 1 odour unit (ou). Therefore, an odour concentration of less than 1 ou means there is no detectable difference between clean air and the odorous sample.

6.2.2 Odour performance criteria

6.2.2.1 Introduction

The determination of air quality criteria 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 criteria as determined by dispersion modelling.

The EPA has developed odour criteria 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:

- What "level of exposure" to odour is considered acceptable to meet current community standards in NSW?
- How can dispersion models be used to determine if a source of odour meets the criteria 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 criteria need to take account of these factors.

6.2.2.2 Complex mixtures of odorous air pollutants

The Approved Methods (NSW EPA, 2005) include ground-level concentration (glc) criterion for complex mixtures of odorous air pollutants. They have been refined by the EPA to take account of population density in the area. Table 6-2 lists the odour glc criterion to be exceeded not more than 1% of the time, for different population densities.

Table 6-2: Odour Performance Criteria for the Assessment of Odour

Population of affected community	Criterion for complex mixtures of odorous air pollutants (ou)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

The different odour criteria are 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.

Thirteen sensitive receptors have been identified within approximately 5 km of the site. All of these receptors are private receptors and their locations were presented in Figure 1-1. It is noted that of these, two receptors (R6 and R12) represent properties for which development applications (DAs) have been lodged with Council, however it is understood that these DAs have not been determined and as such residential dwellings have not been constructed. We note that R13 is an unoccupied house.

Based on previous discussions between Proten and the EPA, we have adopted an odour criterion of $C_{99\ 1\ sec}$ = 7 ou.

6.2.2.3 Peak-to-mean ratios

It is common practice to use dispersion models to determine compliance with odour criteria. 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 EPA commissioned a study by (Katestone Scientific, 1995; Katestone Scientific, 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 this assessment we have assumed a peak-to-mean ratio of 2.3 (to convert from 1 hour averaging periods to 1 second) for all stability classes as all sources are treated as point sources. A summary of the factors is provided in Table 6-3.

Table 6-3: Factors for estimating peak concentrations on flat terrain

Source Type	Pasquil-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

The EPA Approved Methods take account of this peaking factor and the criteria shown in Table 6-2 are based on nose-response time, which is effectively assumed to be 1 second.

7 RESULTS

7.1 Odour and Dust

Figure 7-1 shows a contour plot of the one second peak to mean odour concentrations for the proposed poultry complex. The number of each contour shows the $C_{99\ 1\ sec}$ concentration the contour represents. Each receptor (sensitive location) is shown on the figure as a coloured circle.

It is predicted that the odour criterion of $C_{99\ 1sec}$ = 7 ou will not be exceeded at any of the receptors with all receptors being at or below $C_{99\ 1sec}$ = 5 ou.

Figure 7-2 and Figure 7-3 show the predicted 24-hour maximum and annual average PM_{10} levels respectively. Modelling results show that maximum 24 hour and annual average PM_{10} are below the respective assessment criterion at the sensitive receptors (without background included).

The potential impact with background considered is discussed in Section 7.2.

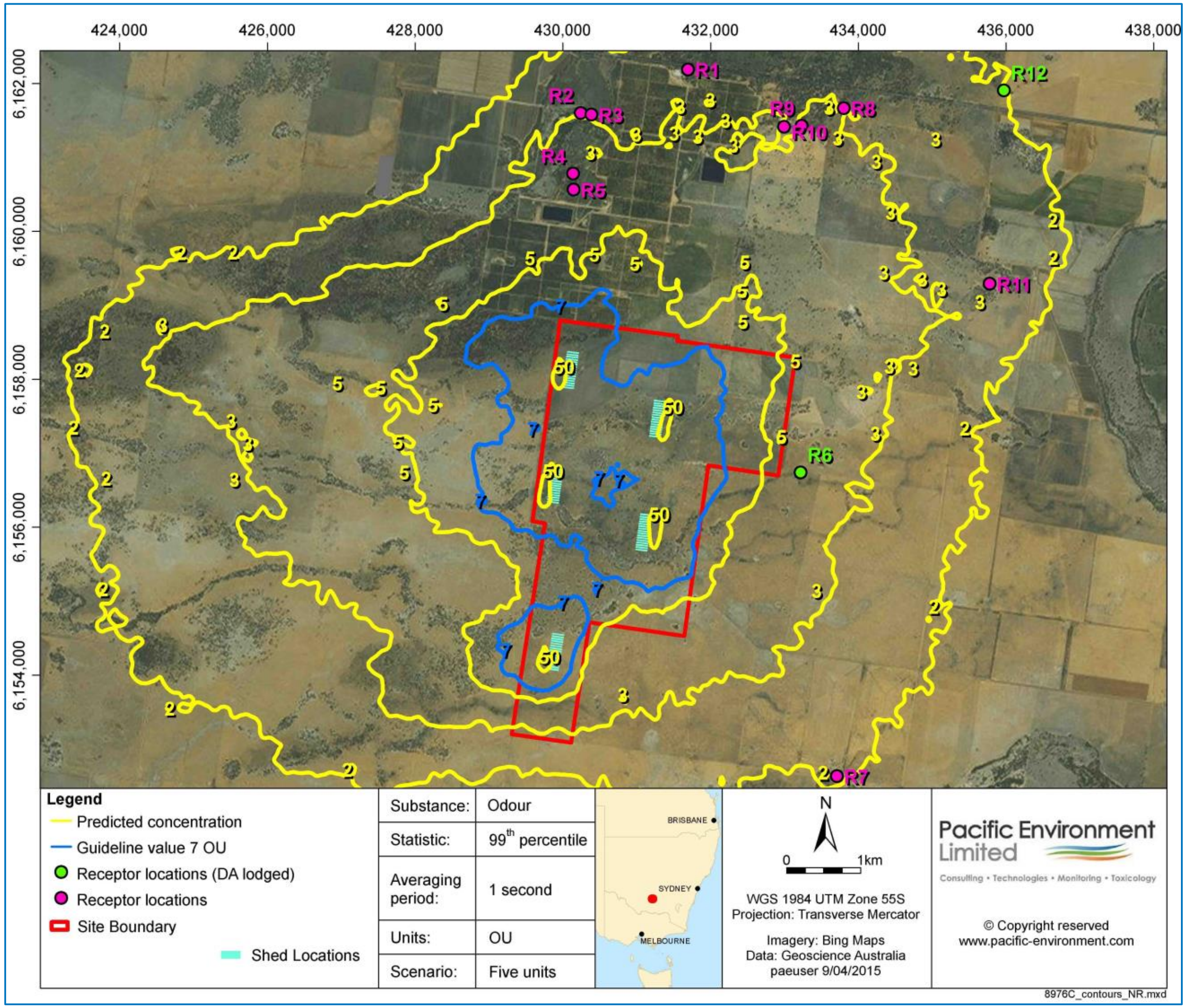


Figure 7-1: Predicted 99th percentile 1-second odour concentration

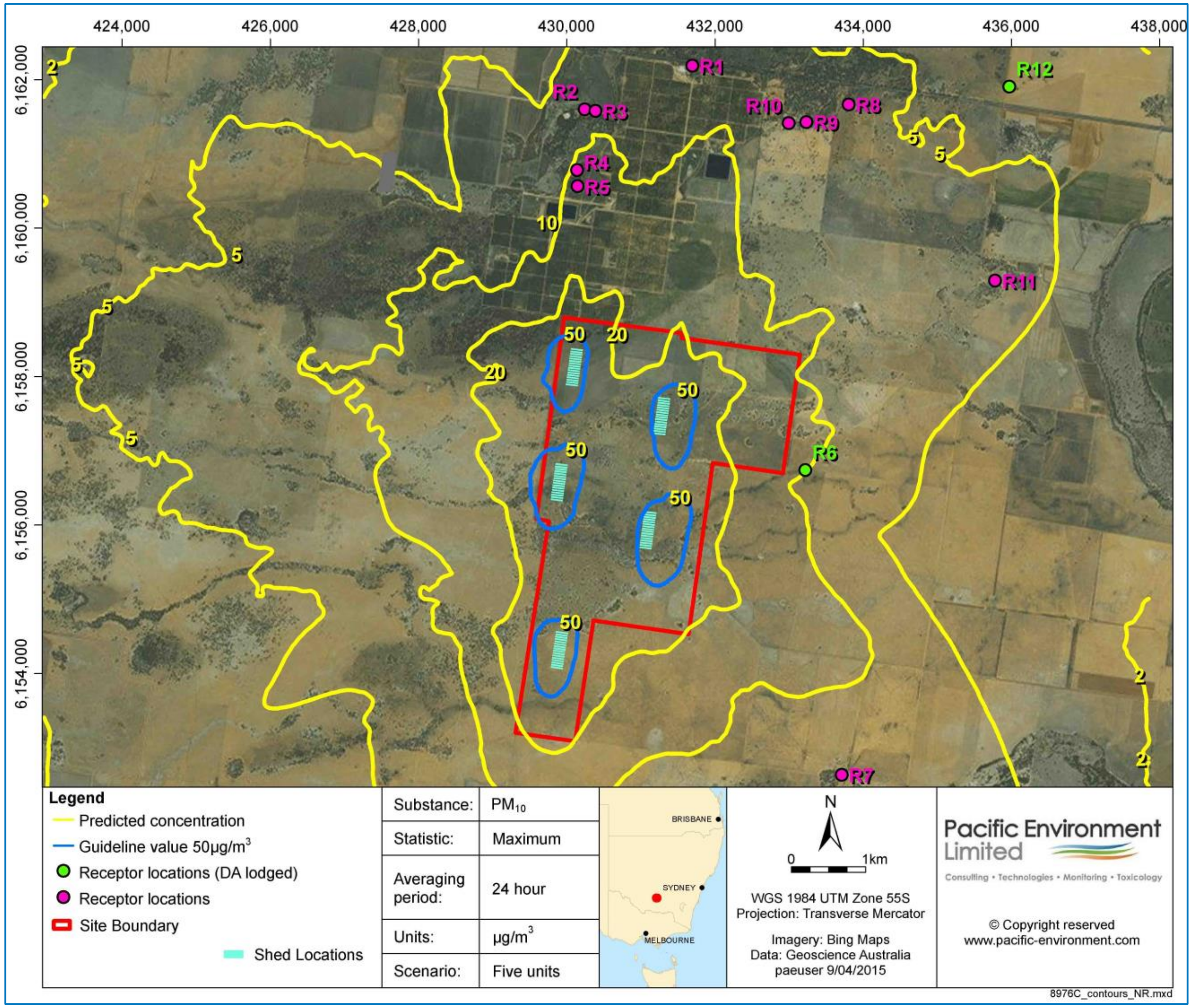


Figure 7-2: Predicted Maximum 24-hour PM_{10} concentration, without background

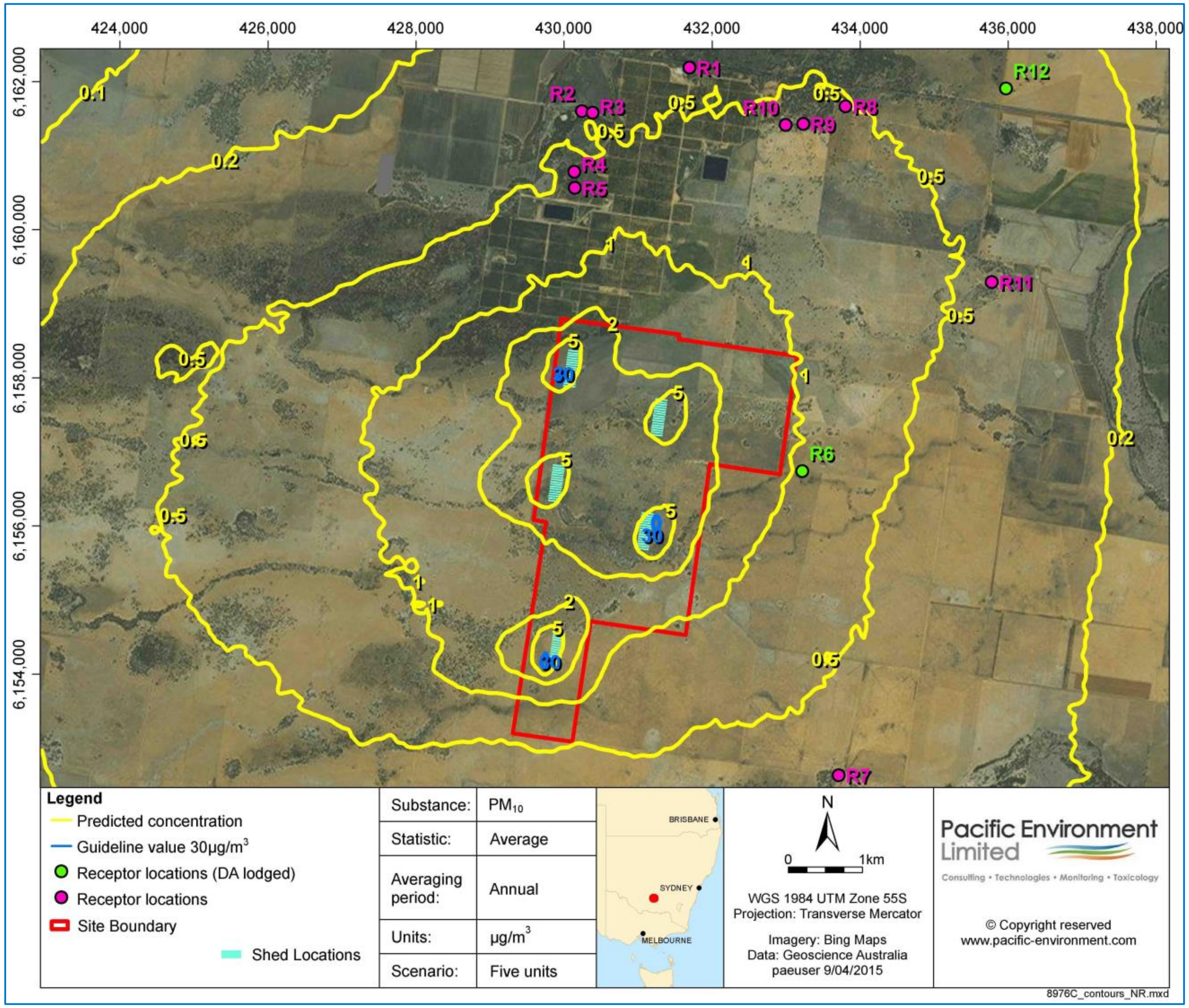


Figure 7-3: Predicted annual average PM_{10} concentration, without background

Given the size of the property, the extent of internal roads may be significant with regard to particulate emissions. We understand that the roads will be 7 metres wide and consist of:

- Compacted clay base to 98%
- 200mm of road base as per below.
    - 120mm of 80mm "Jawbone" rock
    - 80mm of 40mm "DGS" gravel on top

Given that the road will be constructed as opposed to being an unformed track, the emission potential of the road will not be significant due to a lower silt loading on the constructed road surface. Should dust emissions become an issue, standard control methods could be applied i.e. internal speeds limited, and the dusty areas of the roads could be watered.

7.2 Cumulative Assessment

7.2.1 Odour

It is not always practical to assess the cumulative odour impact of all odour sources that may impact on discrete receptors. However, it is common in odour assessments to assess the incremental increase in odour from a proposed development against the assessment criteria, particularly where no other sources of similar odour character are present.

As there are no poultry farms close to the site, we have not performed a cumulative assessment for odour.

7.2.2 Annual average PM_{10}

The highest annual average PM_{10} concentration measured at the EPA Albury monitoring station was recorded in 2007 with a result of 21 $\mu g/m^3$ (see Section 4.2). When this value is added to the annual average PM_{10} prediction at the most exposed receptor (R5) the cumulative value would be 21.9 $\mu g/m^3$ which is below the EPA assessment criterion of 30 $\mu g/m^3$.

7.2.3 24 hour average PM_{10}

Cumulative 24-hour PM_{10} impacts (i.e. assuming rural areas have other agricultural dust sources) have been evaluated using a statistical approach (e.g., Monte Carlo simulation), focussing on the sensitive receptors nearest the development. The Monte Carlo simulation is a statistical approach that combines the frequency distribution of one data set (in this case, measured 24-hour average PM_{10} concentrations representative of the site) with the frequency distribution of another data set (modelled concentrations at a given receptor). This is achieved by randomly and repeatedly sampling and combining values within the two data sets to create a third, 'cumulative' data set and associated frequency distribution. To generate greater confidence in the statistical robustness of the results, the Monte Carlo simulation was repeated 250,000 times for each of the chosen receptors.

Monte Carlo simulations provide results in terms of the statistical probability that an event may occur. For this assessment, the results are the statistical probability that a certain concentration of 24-hour average PM_{10} concentration will occur in a single one year period (i.e. 365 days).

The results of the Monte Carlo analysis for the eleven closest receptors are presented graphically in Figure 7-4. The plots show the statistical probability (presented as number of days) of 24 hour average PM_{10} concentrations being above the NSW EPA 24-hour average PM_{10} criterion of 50 $\mu g/m^3$ and also compares the cumulative probability with the measured background (dashed red line).

Figure 7-4 shows that the background levels are estimated to exceed the criterion on approximately 4 days per year. It also shows that it is not expected that there will be any additional exceedances due to the project as cumulative ground level concentrations at all receptors are largely indistinguishable from background at the 50 µg/m³ levels. Note that in Figure 7-4 the predicted concentration curves strongly overlap.

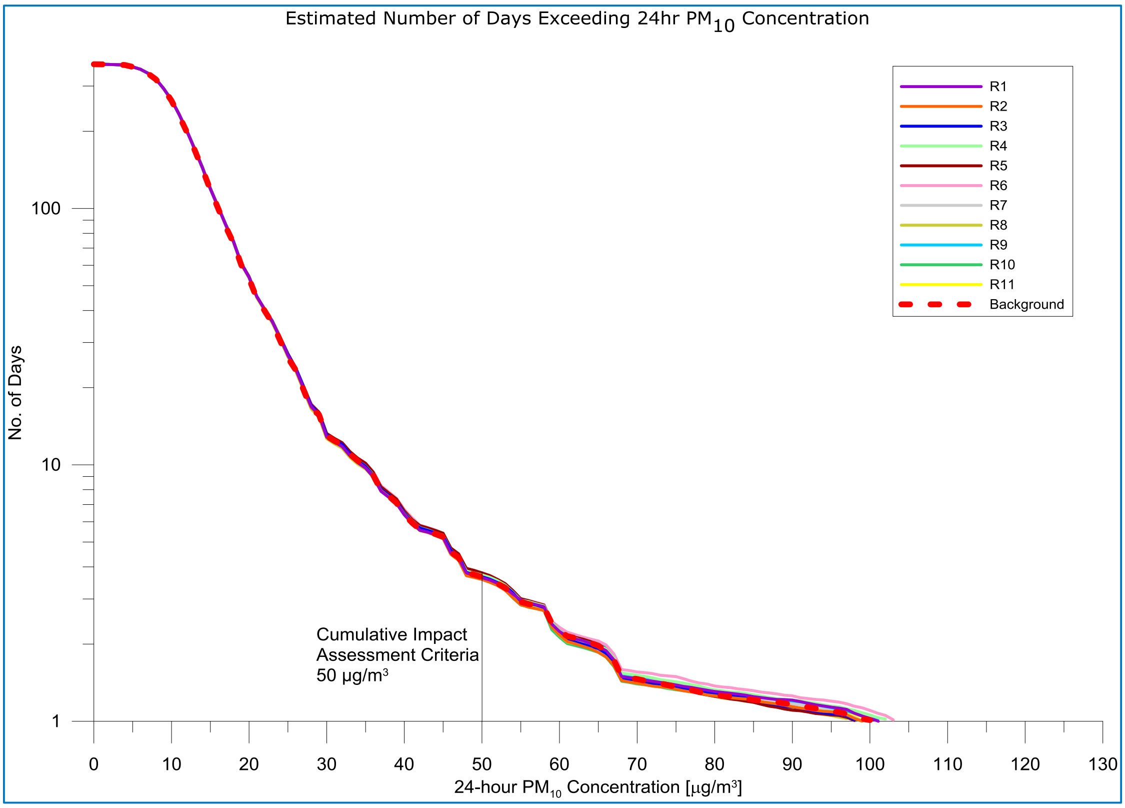


Figure 7-4: Predicted Number of Days Over 24-Hour average PM$_{10}$ Concentration

8 CONCLUSION

This report has assessed potential odour and dust impacts associated with the proposed ProTen Euroley poultry broiler operation located near Euroley, NSW. Local land use, terrain and meteorology have been considered in the assessment and dispersion modelling was conducted using CALPUFF.

The predicted odour levels at the nearest receptors are predicted to be below the NSW EPA assessment criterion of $C_{99\ 1sec}$ = 7 ou.

The predicted PM_{10} concentrations at the receptors when background levels are included are also predicted to be below the EPA assessment criterion.

9 RECOMMENDATIONS

Based on our assessment we make the following recommendations:

- The farm is to be operated and managed in line with Best Practice Management for Meat Chicken Production in New South Wales - Manual 2 – Meat Chicken Growing Management (Department of Primary Industries, 2012).
- A vegetative buffer is to be established around the perimeter of each group of sheds to enhance the dispersion of air emitted from the sheds, and to assist in filtering airborne particles.
- Thought be given to installing a weather station at a suitable location to collect meteorological data for the production complex.

As the site is expected to comply with relevant odour and dust criteria, mitigation measures beyond farm management to industry best practice are not expected to be required.

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