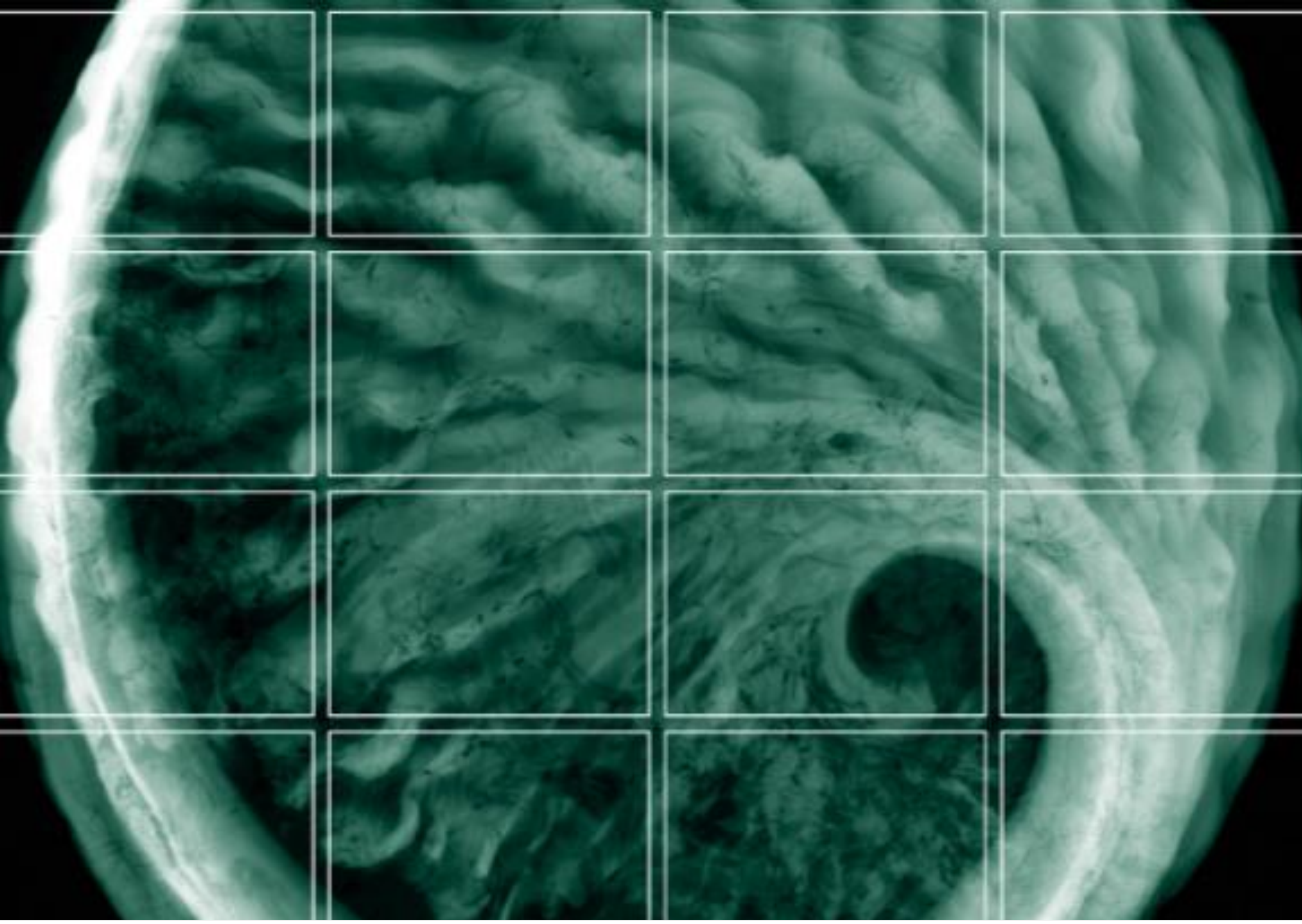

Pondicherry Odour Impact Assessment

25 February 2021

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The business of sustainability

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25 February 2021

Pondicherry Odour Impact Assessment

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1. INTRODUCTION

ERM was engaged by Greenfields Development Company Pty Ltd (Greenfields) care of Elton Consulting to conduct an odour impact assessment for the proposed Pondicherry Precinct development. This report provides a summary of the odour impact assessment methodology as well as the predicted results.

1.1 Subject Site

The subject site is located south west of Sydney and is part of the South West Growth Area. This growth area aims to provide additional housing through a coordinated approach with the NSW Department of Planning, Industry and Environment (DPIE), Camden Council and the local community. The site consists of existing farming land with a small number of rural residential allotments located to the west and north. The location of the Pondicherry Precinct development is provided in Figure 1.1 as the blue shaded area.

1.2 Scope of Work

The scope of work for this assessment includes:

- Estimate emissions for the identified odour emission sources
- Meteorological modelling using CALMET/TAPM suite of models
- Odour dispersion modelling using the CALPUFF dispersion model
- Analysis of modelling results against relevant odour criteria
- Report the assessment methodology, model results and recommendations.

Figure 1.1: Subject site location

2. EMISSION ESTIMATION

2.1 Potential Emission Sources

ERM has previously conducted a preliminary odour assessment in 2017 to investigate and identify potential sources of odour in the vicinity of the subject site. During this initial assessment a site visit was conducted and identified ten odour sources. Since this time, ERM performed an additional site visit on 24 September 2020 to confirm the emission sources and identify the potential for any new odour sources. A summary of the odour sources identified during the preliminary odour assessment and the additional site visit is provided in Table 2.1. Figure 2.1 shows the potential odour emission sources identified.

The sources that were included in this modelling are three chicken farms, a turkey farm and two composting facility. The estimation of emissions from these facilities is provided in the following sections.

Table 2.1: Summary of potential odour sources

Source	Operation	Comments	Modelled for this study?
Point 1	Poultry farm	Located approximately 1.33 km from the northwest corner of the subject land, including 3 sheds for meat chicken (assumed to be chicken).	Yes
Point 2	Market gardens	Located to the north the subject land, considering the distance and that any chemical used on site would need to meet various requirements, the risk of adverse impacts from this source is considering low.	No
Point 3	Resource recovery and recycling (composting)	Located right at the northwest corner of the subject land, licenced to accept garden waste for composting.	Yes
Point 4	Irrigation	Located on the norther section of the subject land, will cease operation once the proposed development takes place.	No
Point 5	Sliage	Located on the subject land, operation will be ceased once the proposed development takes place.	No
Point 6	Wood Chipping Company	Located on the subject land, operation will be ceased once the proposed development takes place.	No
Point 7	Turkey farm	Located approximately 1.3 km to the northeast edge of the subject land, identified as a turkey farm with two sheds.	Yes
Point 8	Greenhouses	Located to the southeast of the subject land, not considered as a source of odour.	No
Point 9	Poultry Farm	Located to the southeast of the subject land, the chicken farm was previously assessed in a report prepared by Pacific Air & Environment (PAE) titled “Odour Assessment Oran Park Redevelopment 21 January 2009”.	Yes
Point 10	Poultry farm	Located approximately 1.8 km southeast to the subject land, including 3 sheds for meat chicken (assumed to be chicken).	Yes
Point 11	Poultry farm	Meat processing facility with 3 dilapidated poultry sheds at the rear of the property that not operational and have not been included in the modelling.	No
Point 12	Composting facility	Located at the northwest corner of the subject land, currently not licenced but site visit observations identified the sorting and stockpiling of odorous materials for composting.	Yes

Figure 2.1: Potential odour emission sources

2.2 Broiler Farm Emission Estimation

Three of the potential odour sources that have been modelled in this assessment are chicken farms (Point 1, 9 and 10). As the specific operation of these farms is unknown, it has been assumed that they are all conventional broiler (meat chicken) farms to be conservative. Conventional broiler farms have the potential to generate more odour than free range, layer or breeder farms due to the increased bird numbers per square meters. The sites of the broiler farms are shown in Figure 2.2 and Figure 2.3.

The odour emissions model of Ormerod and Holmes (2005) has been adopted for this assessment and details of how it has been applied are provided in the following sections. The methodology is commonly used in Australia and New Zealand to estimate emissions from poultry farms.

Figure 2.2: Broiler farm shed locations – Point 1

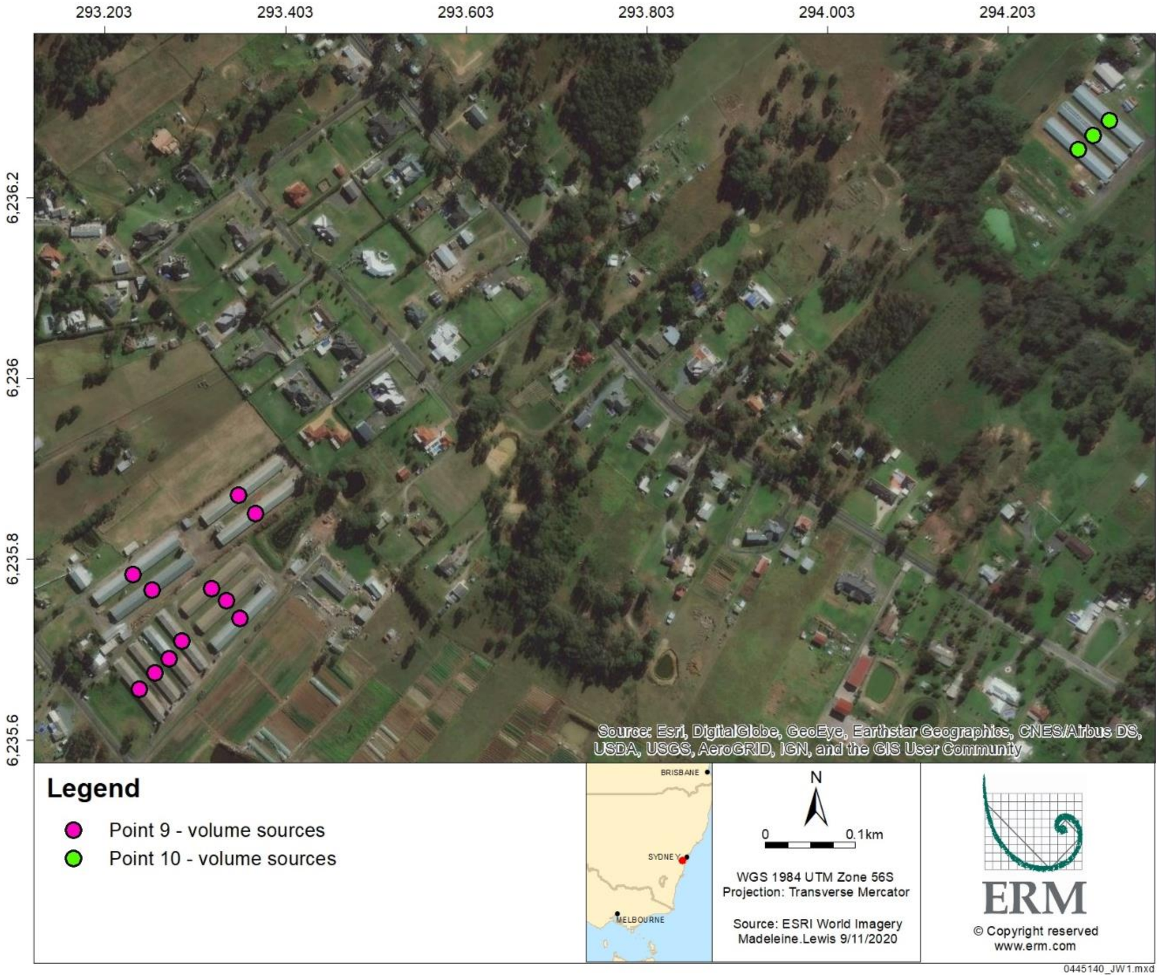

Figure 2.3: Broiler farm shed locations – Point 9 and 10

2.2.1 *Basis of Odour Emissions Data*

Odour emission rates (OERs) for chicken farms have been estimated using a modelling approach based on data from a variety of meat chicken farms in south eastern Queensland and New South Wales, as well as theoretical considerations.

The approach generates hourly varying emission rates from each shed 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.

The dataset is based on data from existing tunnel ventilated sheds (many with nipple drinkers) and chicken batches at approximately five weeks of age or more. For the dataset, the minimum bird age when sampling was performed was four weeks and five days. These samples are considered to represent the maximum odour generating potential.

2.2.2 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 2.4. The data can be segregated into two groups:

- farms operating under typical conditions
- farms which were experiencing elevated odour emissions due to problems with shed design and/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 the use of 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 changes of litter between batches also minimises odour impacts. A vigilant approach to identifying and removing wet litter is now a well-accepted management practice.

Design factors contributing to odour 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 2.4, 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 litter moisture levels (as an example). 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 2.4 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[1]
- daily litter inspection and replacement, if litter becomes wet.

[1] The most recent research has shown no significant difference between single and dual use litter (Australian Poultry CRC, 2011).

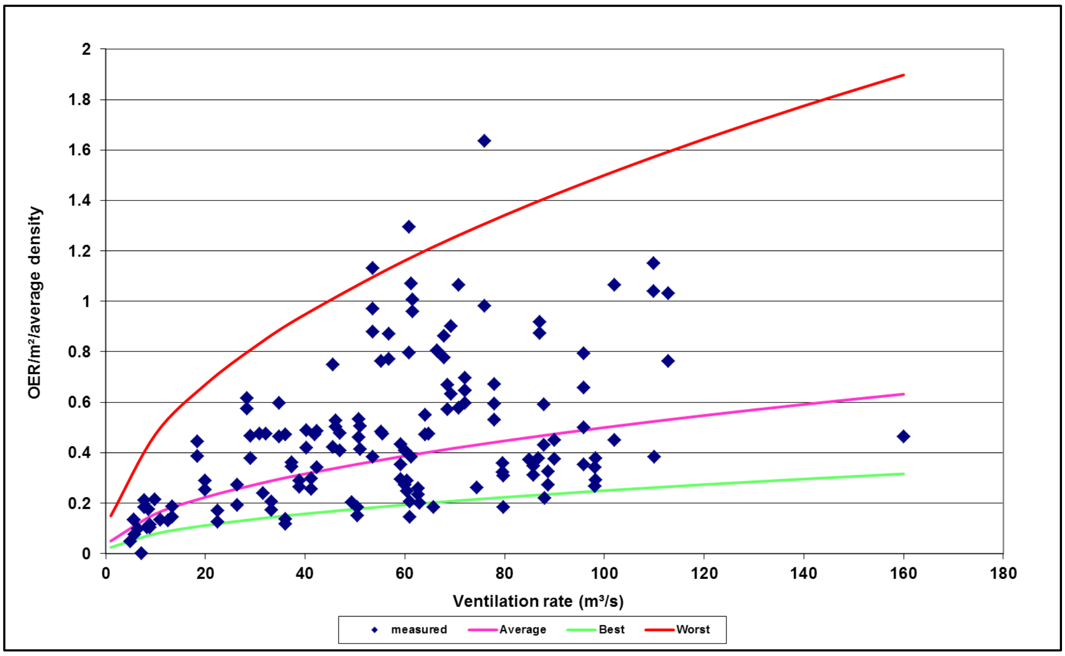

Figure 2.4: Data used in odour emission modelling

2.2.3 Odour Emissions Estimation

From Figure 2.4, the relationship between the 'standardised' OER and shed ventilation is expressed as:

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

where:

$\boldsymbol{OER_S}$ = standardised odour emission rate (ou.m³/s) per unit shed area (m²) per unit of bird density (in kg/m²);

$\boldsymbol{V}$ = ventilation rate (m³/s); and

$\boldsymbol{K}$ = scaling factor between 1 and 5[2] where a value of 1 represents a very well designed and managed shed operating with minimal odour emissions.

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:

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

where:

OER = odour emission rate (ou.m³/s);

A = total shed floor area (m²);

D = average bird density (in kg/m²);

V = ventilation rate (m³/s); and

K = scaling factor between 1 and 5.

[2] 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 farms in NSW (held by PE) has shown that the average *K* factor over time typically is at or below *K* = 2.2. Due to the nature of the proposed development and the age of the poultry sheds observed during the site visit, a K factor of 5 has been adopted for this assessment to be conservative.

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, a maximum stocking density of 28 kg/m^2 has been applied based on the requirements set by The Commonwealth Scientific and Industrial Research Organisation (CSIRO) (CSIRO, 2002) and the Royal Society for the Prevention of Cruelty to Animals (RSPCA) (RSPCA, 2020b) for non-mechanically ventilated sheds. With a known stocking density, the number of birds per unit area can be estimated based on the relationship between bird age and average bird weight. An example of such relationship is shown in Figure 2.5 for the poultry sheds located at Point 1.

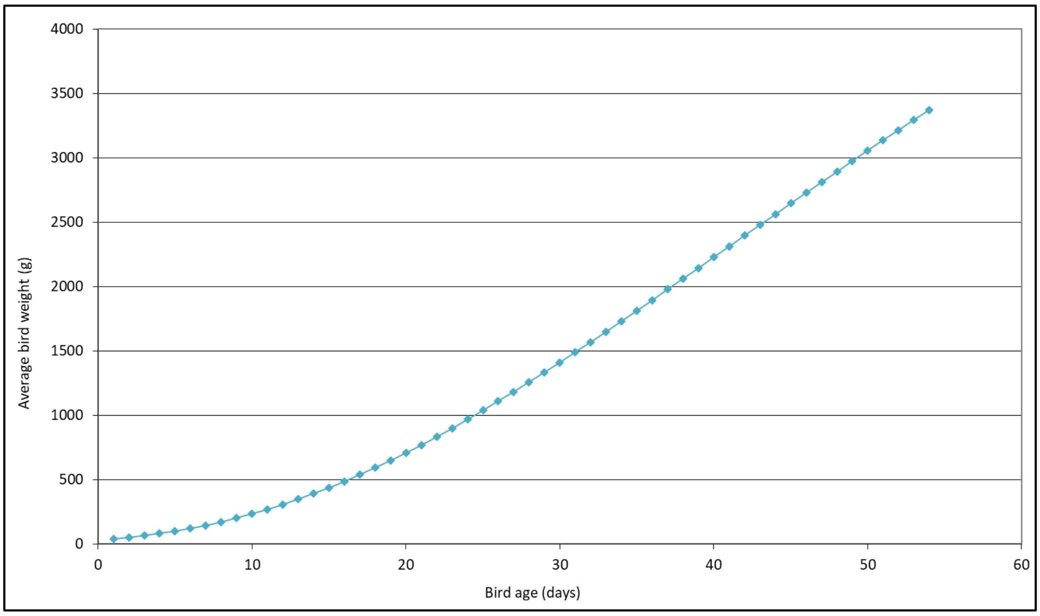

Figure 2.5: Average bird weight by age[3]

The ventilation rate (V) used at any given time is a function of the age of the birds, wind speed and the ambient temperature and humidity. Table 2.2 provides an estimate of the ventilation required for a given tunnel ventilated shed as a percentage of the maximum. Given the lack of available data on naturally ventilated sheds it has been assumed that the ventilation requirements for a tunnel ventilated shed may be used to approximate those of naturally ventilated sheds.

In this study a maximum ventilation rate was calculated based on a need to potentially achieve 10 m^3/hr/bird. The actual modelled ventilation rate was calculated as the lower of the ventilation rate presented in Table 2.2, (representing the effects of opening or closing louvres) or the ventilation rate provided by multiplying the wind velocity by the width and height of the shed (simulating tunnel

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

ventilation). Failure to maintain at least 50% of the desired ventilation rate for four hours or more would trigger foggers to simulate the need to cool stressed birds.

Table 2.2: 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	1.3	2.5	5.1	7.7	9.8	11	17	17
1	1.3	13	13	25	25	25	25	25
2	1.3	25	25	38	38	38	38	38
3	1.3	38	38	50	50	50	50	50
4	1.3	38	38	50	50	50	50	50
6	1.3	38	38	63	75	75	75	75
7	1.3	38	38	63	75	75	88	100
8	1.3	63	63	63	75	75	100	100
9	1.3	63	63	88	100	100	100	100

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

The assumed broiler farm operational parameters are provided in Table 2.3. Figure 2.6 shows an example of the variability of OER for a poultry shed located at Point 1 during grow-out cycles over a year based on equation 2 and assumed operational details. The decline in emissions at the end of each batch represents the clean out of the shed. 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 (i.e. closed doors during materials handling) and cleaning only during the daytime when atmospheric dispersion is most effective.

Table 2.3: Broiler farm operational parameters

Source ID	Shed numbers	Length	Width	Shed Height	Number of Birds	Batch length	Cleanout length
		m	m	m	-	days	days
Point 1	All (3)	78	14	4.5	17,400	45	14
Point 9	Small (7)	80	13	4.5	16,600	45	14
	Large (4)	108	15	4.5	25,850	45	14
Point 10	All (3)	90	13	4.5	18,650	45	14

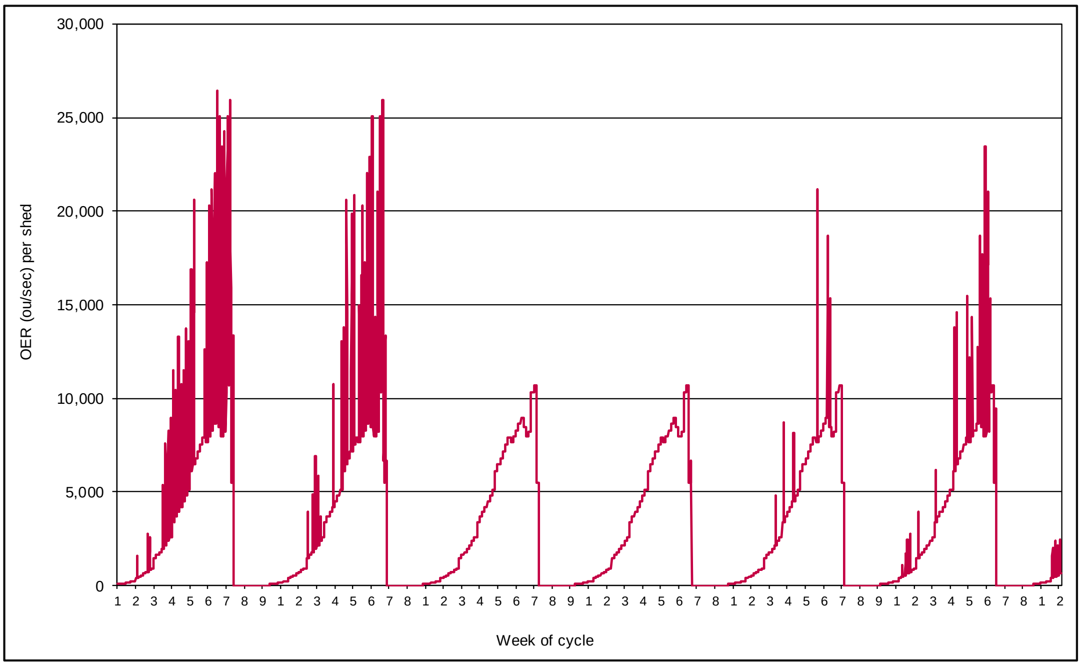

Figure 2.6: Example of broiler shed OER

2.3 Turkey Farm Emission Estimation

The turkey farm consists of two sheds as shown in Figure 2.7. OERs for the turkey farm have been estimated using a similar methodology to the broiler farms as discussed in Section 2.2 but using turkey specific growth rates and temperature data.

The turkey growth rates were sourced from a technical publication from Aviagen Turkeys (Aviagen Turkeys, 2015) as shown in Figure 2.8. The turkey batch length was assumed to be 20 weeks while the cleanout length was assumed to remain the same as the broiler farms at 14 days.

The maximum recommended turkey stocking density according to housing type under good management conditions are defined by CSIRO (CSIRO, 2002) and provided in Table 2.4. Source Point 7 is an existing turkey farm and the shed dimensions were measured using aerial mapping. The maximum turkey density based on these dimensions was set to be 46 kg/m² to provide a conservative assessment as the RSPCA standards recommend only 28 kg/m² for naturally ventilated systems (RSPCA, 2013a). The assumed turkey farm operational parameters are provided in Table 2.5. Figure 2.9 shows an example of the variability of OER for a turkey shed during grow-out cycles over a year based on these assumptions.

Figure 2.7: Turkey farm shed locations

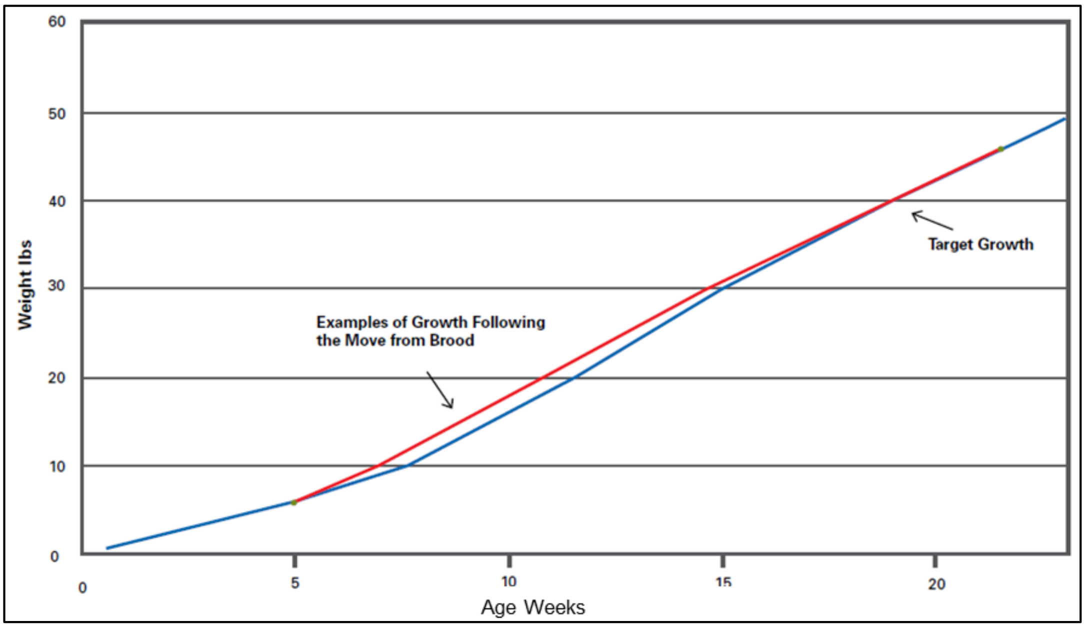

Figure 2.8: Turkey growth rates (Aviagen Turkeys, 2015)

Table 2.4: Stocking densities for turkeys

Age	Stage	Housing type	Density allowance
0-6 weeks	Brooding	-	110 birds/m² within surrounds decreasing to 8-10 birds/m² of total area at 6 weeks
6-12 weeks	Growing	Intensive	46 kg/m²
	Growing	Extensive	1.5 kg/m²
12 weeks to market	Growing	Intensive	46 kg/m²
	Growing	Extensive	2.5 kg/m²
Breeding stock	Growing	Intensive	46 kg/m²
	Growing	Extensive	2.5 kg/m²

Table 2.5: Turkey farm operational parameters

Source ID	Shed numbers	Length	Width	Shed Height	Number of Birds	Batch length	Cleanout length
		m	m	m	-	days	days
Point 7	All (2)	107	13	4.5	3,930	140	14

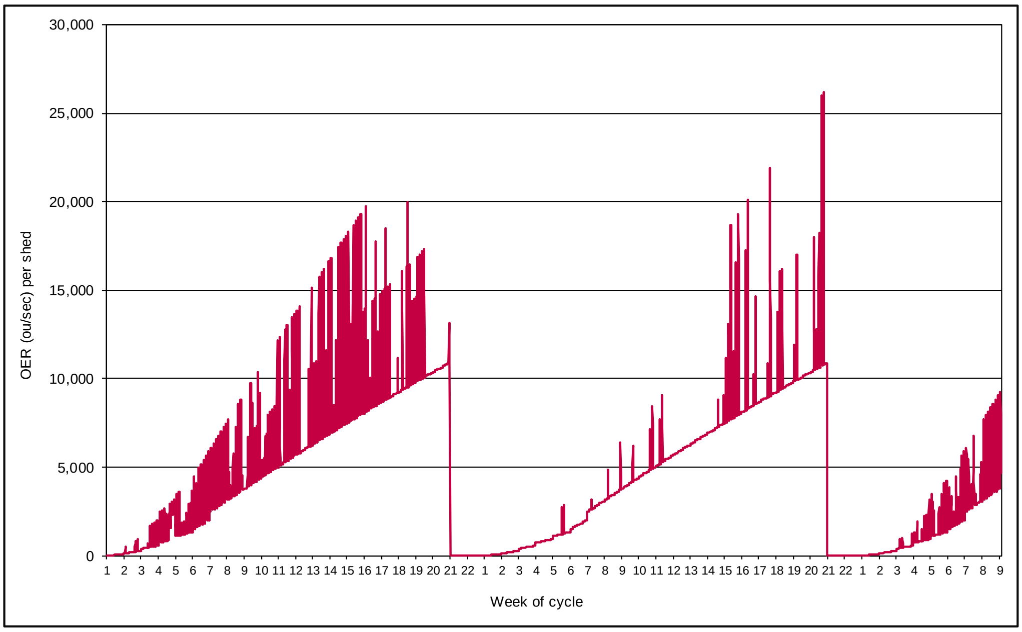

Figure 2.9: Example of turkey shed OER

2.4 Composting Facility Emission Estimation

Two sites were identified as having the capacity to receive and compost organic materials. The resource recovery and recycling facility (Point 3) is operated by the Hi Quality Group and is licenced to accept soil, wood waste, garden waste, urea and building and demolition waste. It has a >5,000-50,000 tonnes of annual capacity to receive organics for composting (NSW EPA, 2018).

The second facility that was observed during the most recent site visit to be processing organic materials is operated by Vitocco Enterprises (Point 12). This facility does not have a license so the annual capacity for its organics processing is unknown. In the absence of this information, similar emission sources to the Hi Quality Group were assumed with the addition of a sorting/shredding source which was observed being used during the most recent site visit.

Given that the site specific data are not available for both of these sites, assumptions have been made based on ERM's recent experience in assessing composting operations of similar capacity. Three area sources with constant emission rates were modelled representing three stages of the composting process as presented in Figure 2.10. Emission rates were sourced from odour assessments of similar sized compositing facilities in NSW, which was performed by ERM. Table 3.3 provides a summary of the odour emission rates applied in this assessment.

Table 2.6: Modelled composting emission rates

Source	Measured odour concentration (ou)	Specific odour emission rate for area sources (ou.m^3/m^2/s)	Odour emission rate (ou.m^3/s)
Fresh garden wastes	520	0.30	-
Turned garden wastes	2,000	1.1	-
Final stage garden wastes	1,100	0.63	-
Garden waste sorter/shredder	-	-	42,200

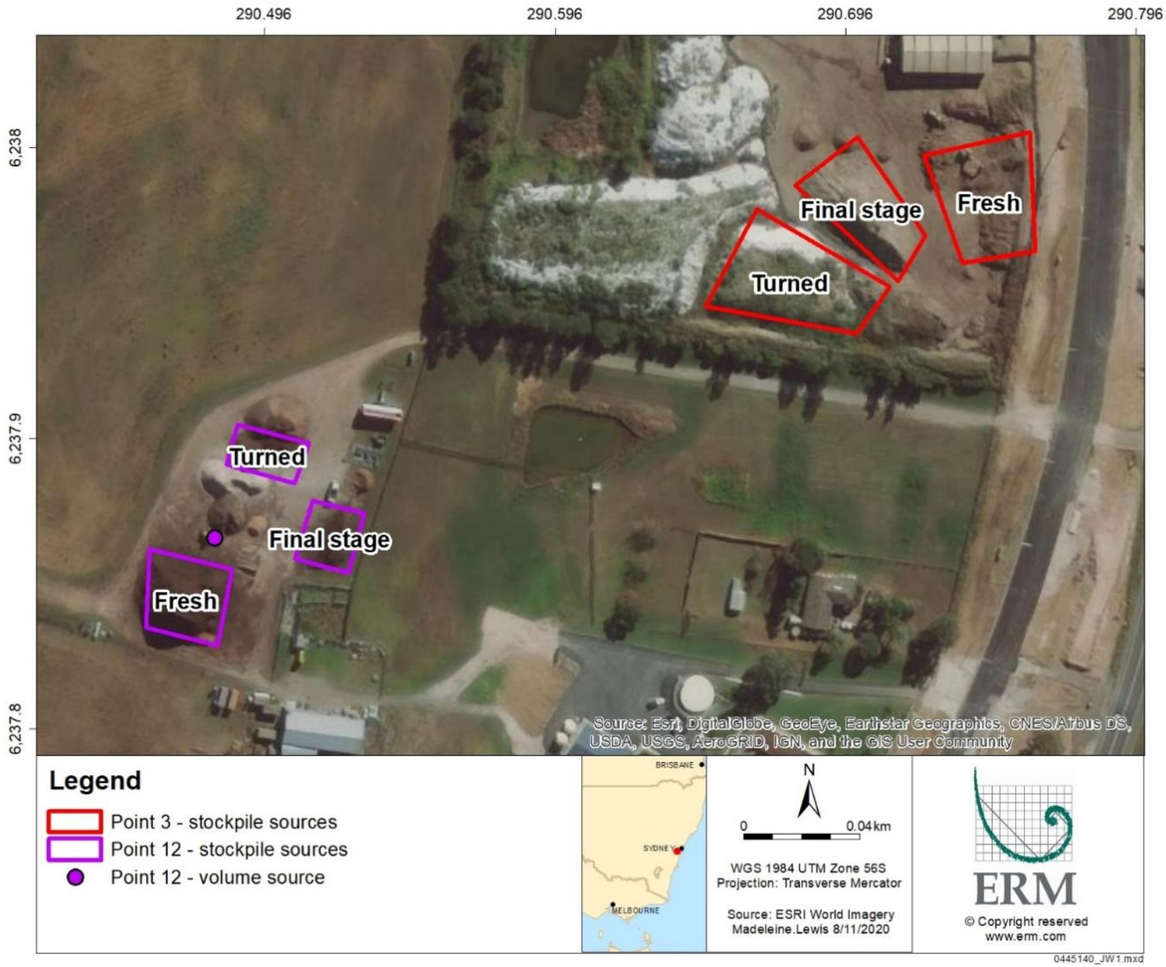

Figure 2.10: Composting emission source locations

3. MODELLING METHODOLOGY

The local meteorology has been modelled using observations from the Camden Airport AWS Bureau of Meteorology (BoM) weather station in conjunction with the TAPM and CALMET models as described in Sections 3.2. Output from TAPM, plus local and regional observational weather station data were entered into CALMET, a meteorological pre-processor recommended for use in non-steady state conditions. From this, a 1-year representative meteorological dataset was compiled, suitable for use in the 3-dimensional plume dispersion model CALPUFF as described in Section 3.3. Details on the model configuration and data inputs are provided in the following sections.

3.1 Selection of Meteorological Representative Year

The previous meteorological dataset developed in 2018 as part of the Oran Park odour impact assessment (ERM, 2018) was for 2017 and so the dataset developed as part of this assessment has been updated to include an assessment of more recent years. One year of hourly meteorological data is required for the dispersion modelling. There is a preference for assessments to be based on a representative meteorological year with demonstration of the basis for the selection criteria.

To evaluate which year is representative of long-term averages, meteorological data of individual years were compared to long-term averages. The Camden Airport AWS BoM station was used to determine the representative year (data from 2015 to 2019) as it is the closest BoM station located within approximately 7 km of the subject site. The Mann-Whitney U test for large sample sizes was used to analyse the data for wind speed, temperature and relative humidity. These meteorological parameters were selected for the analysis as they show a clear diurnal cycle. The Mann-Whitney U test is a statistical comparison with a null hypothesis that there is no significant difference between an individual year and long-term average values.

A summary of the best performing to least performing year for wind speed, temperature and relative humidity are presented in Table 3.1. The year 2018 was selected as the most representative year for this assessment as it performed on average better than any other year.

Table 3.1: Representative year analysis

Statistical rank	Wind speed	Temperature	Relative humidity
Rank 1	2018	2018	2019
Rank 2	2016	2017	2016
Rank 3	2017	2016	2017
Rank 4	2019	2019	2018
Rank 5	2015	2015	2015

3.2 Meteorological Modelling

Meteorology is a critical input in dispersion modelling of substances. Wind speed and direction is influenced by a number of factors ranging from large scale synoptic patterns, to vegetation and terrain influences. This assessment used a suite of modelling tools to estimate air quality impacts.

Upper air data were generated over the study region using the CSIRO prognostic model TAPM (The Air Pollution Model). TAPM is a three dimensional meteorological model that reproduces hourly three-dimensional weather conditions using archived gridded global weather data. Detailed description of the TAPM model is provided in the TAPM user manual (Hurley P, 2008a). The TAPM-generated upper air data and observed surface meteorological data were entered into the CALMET diagnostic meteorological model.

CALMET is a meteorological pre-processor that provides the meteorological inputs required to run the CALPUFF dispersion model (Exponent, 2011). CALMET creates a three-dimensional meteorological field and includes a wind field generator that takes into account slope flows, terrain effects and terrain blocking effects. CALMET produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for each hour of the modelling period.

The hourly data from the Camden Airport AWS BoM station for 2018 were included in an observational file as an input into CALMET. The anemometer height for the station is 10 m and the observed surface wind speed, wind direction, temperature, relative humidity, and mean sea level pressure data were extracted. The weather station is approximately seven kilometres away from the subject site.

Summaries of the TAPM and CALMET meteorological model settings are provided in Table 3.2. The meteorological data generated with TAPM/CALMET and used in the dispersion modelling is evaluated in Appendix A and is considered representative of the meteorological conditions of the region.

Table 3.2: TAPM and CALMET model settings

Parameter	Value
TAPM	
Number of grids and spacing	4 grid domains: 30,000 m, 10,000 m, 3,000 m, 1,000 m
Number of grid points	nx = 25, ny = 25, nz = 25
Duration of analysis	2017/12/31 to 2019/01/01
Centre of TAPM model domain	X: 293.000 km Y: 6236.000 km
CALMET	
South west corner of CALMET model domain	X: 288.000 km Y: 6231.000 km
NOOBS	1 = use surface and overwater stations (no upper air observations use MM4/MM5/3D upper air data
Meteorological grid domain	10 km x 1 km (100 x 100 grid points)
Meteorological grid resolution	0.1 km
Surface meteorological stations	Camden Airport AWS BoM station
Radius of influence R1=RMAX1, R2=RMAX2	4 km, 5 km
TERRAD (radius of influence of terrain features)	2.5 km

3.3 Dispersion Modelling

CALPUFF (Exponent, 2011) 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 emissions 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 substance removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of emissions 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
- site layout
- source release parameters.

Detailed description of CALPUFF is provided in the user manual (Exponent, 2011). The release parameters assumed for each of the different sources included in this assessment are provided in Table 3.3. Shed and stockpile sizes were estimated using aerial mapping. In line with common practice for naturally ventilated sheds, each shed was modelled as a volume source with variable emission rates.

Table 3.3: Release parameters for modelled sources

Source	Source type	Area size (m^2)	Effective height (m)	σ_z (m)	σ_y (m)
Point 1 – Broiler Farm					
All broiler sheds (3)	Volume	-	2.25	1	3.26
Point 3 – Hi Quality Group					
Fresh garden waste stockpile	Area	1,227	1	0.5	-
Turned garden wastes stockpile	Area	1,535	1	0.5	-
Final stage garden waste stockpile	Area	974	1	0.5	-
Point 7 – Turkey Farm					
All turkey sheds (2)	Volume	-	2.25	1	3.02
Point 9 – Broiler Farm					
Small broiler sheds (7)	Volume	-	2.25	1	3.02
Large broiler sheds (4)	Volume	-	2.25	1	3.49
Point 10 – Broiler Farm					
All broiler sheds (3)	Volume	-	2.25	1	3.02
Point 12 – Vitocco Enterprises					
Fresh garden waste stockpile	Area	726	1	0.5	-
Turned garden wastes stockpile	Area	355	1	0.5	-
Final stage garden waste stockpile	Area	392	1	0.5	-
Garden waste sorter/shredder	Volume	-	2	1	0.7

4. ASSESSMENT CRITERIA

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 procedures for assessing odour impacts using dispersion models have been refined significantly but there is still considerable debate in the scientific community about appropriate odour goals as determined by dispersion modelling.

The 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 Frequency of the exposure;
- the Intensity of the odour;
- the Duration of the odour episodes;
- the Offensiveness of the odour; and
- the Location 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 sulphide and landfill gas 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.

The EPA Approved Methods include ground-level concentration criteria for complex mixtures of odorous air pollutants. They have been refined by the EPA to take account of population density in the area. Table 4-1 lists the odour thresholds, to be exceeded not more than 1% of the time (up to 88 hours per year), for different population densities.

Table 4-1: Odour performance criteria for the assessment of odour

Population of affected community	Odour performance criteria (nose response odour units at the 99th percentile)
Single rural residence (≤ ~2)	7
~10	6
~ 30	5
~ 125	4
~ 500	3
Urban (~ 2000) and/or schools and hospitals	2

The difference between odour goals is based on considerations of risk of odour impact and not 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. An important point to note is that the odour assessment criteria are not intended to achieve 'no odour'. They are concerned with controlling odours to ensure offensive odour impacts will be effectively managed.

Camden Council has revised its development application (DA) review policy for urban development within the South West Growth Centre to include a 'transitional' assessment criterion. This criterion will allow urban development up to 4.5 OU based on 250 hours of odour impact per year (97th percentile).

Potential odour impacts from operational facilities surrounding the proposed development have therefore been assessed against this transitional assessment criteria.

5. RESULTS

The modelling results are presented as a contour figure for the transitional assessment criteria of 4.5 OU in Figure 5.1. These results are for the predicted rank 250 (that is, the 250th highest predicted concentration, or 97th percentile) cumulative ground level concentration due to all six emission sources (Point 1, 3, 7, 9,10 and 12) operating simultaneously.

The predicted impacts are limited to the northwestern corner of the Pondicherry Precinct development, and are due to the emissions from the composting facilities on The Northern Road. It is noted that the resource recovery and recycling site (Point 3) is not currently operating, but as it still has a licence to operate has been included as a potential source. The adjacent composting facility (Point 12) included active shredding and stockpiling and was a source of odour at the time of the second site visit.

Figure 5.1: Predicted ground level odour concentration

6. CONCLUSIONS AND RECOMMENDATIONS

This report has assessed the potential odour impacts of existing operations on the proposed Pondicherry development located within the Camden City Council, south-west of Sydney. Dispersion modelling has been used to predict odour concentrations at proposed residential receptors. The dispersion modelling took account of local meteorological conditions and terrain information and used odour measurements of similar facilities to determine odour emission rates.

Results from the dispersion modelling indicate that the 4.5 OU contour extends from the composting facilities at the north-western boundary of the development which is part of Stage 5. Given the Vitocco Enterprises site will have more of a direct impacts on the Lowes Creek Maryland development, it is expected that this will not be an issue by the time Stage 5 is delivered. Further investigation of impact may be required at that time should this not be the case. The risk of odour impacts throughout the rest of the development site is predicted to be low.

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APPENDIX A GENERATED METEOROLOGY

GENERATED METEOROLOGY

The primary meteorological parameters involved in dispersion modelling are wind direction, wind speed, turbulence (atmospheric stability) and mixing height (depth of turbulent layer). The meteorological data for 2018 as generated by CALMET and used in the dispersion modelling are discussed in detail in the following sections below.

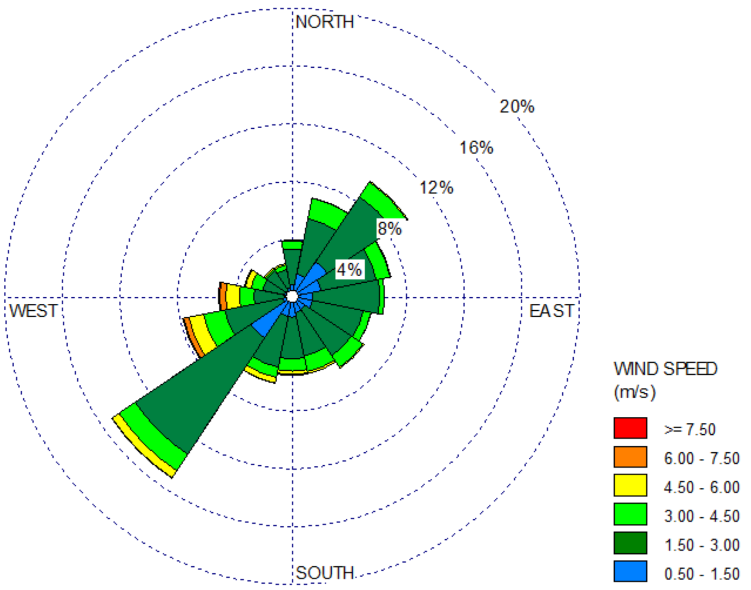
Wind

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 model-generated site-specific wind rose for 2018 is shown in Figure A1. The winds are generally lighter with the most dominant wind directions from the southwest. Winds from the north and northwest directions are rarer with the most dominant directions generally following the valley direction.

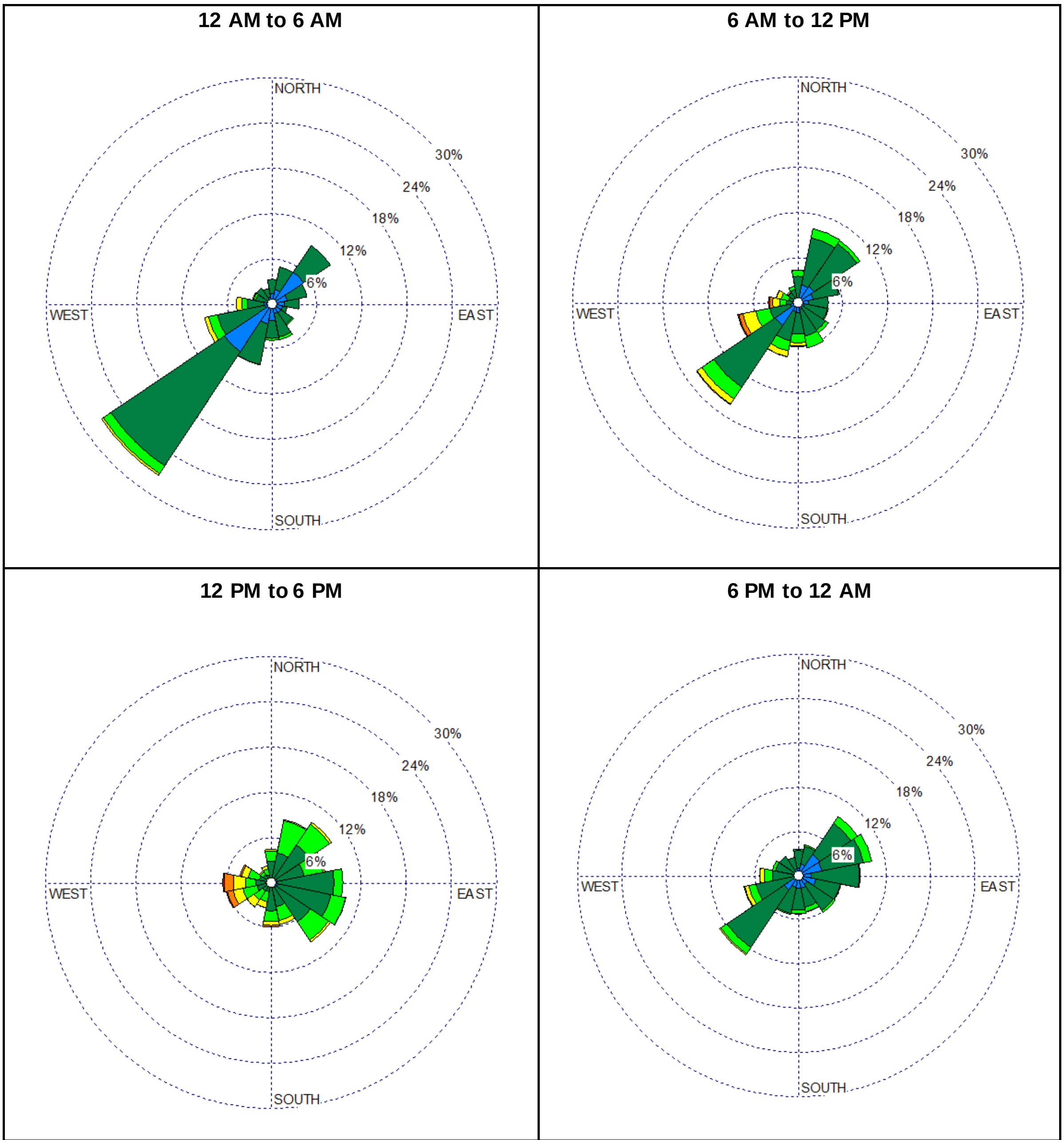
Wind roses for different periods of the day are shown in Figure A2. During the midnight to 6am period, the winds are typically light and from the southwest. During the morning, wind speeds increase with an increasing northeast component. During the afternoon, the wind speed further increases and the southwest component is no longer dominating. For the evening period, the wind speed reduces and are mainly from the southwest and northeast.

The frequency distribution of hourly averaged wind speed values is shown in Figure A3. Light wind speeds (less than 2 m/s) occur relatively frequently, at approximately 61% of the time. Moderate winds (between 2 and 6 m/s) occur approximately 38% of the time. Moderate to strong winds (greater than 6 m/s) are rare and occur only about 1% of the time.



Location:	**Data Period:**	**Data Type:**
Subject Site	2018	CALMET extract
Calm winds: 0.75%	**Average wind speed:** 2.06 m/s	**Plot:** J.Wang

Figure A1: Annual wind rose



Time of day	Average wind speed (m/s)	Calm winds frequency %	WIND SPEED (m/s)
12 AM to 6 AM	1.58 m/s	1.1%	>= 7.50
6 AM to 12 PM	2.13 m/s	1.23%	6.00 - 7.50 4.50 - 6.00
12 PM to 6 PM	2.80 m/s	0.14%	3.00 - 4.50 1.50 - 3.00
6 PM to 12 AM	1.75 m/s	0.55%	0.50 - 1.50
Location: Subject site	**Data Period:** 2018	**Data Type:** CALMET extract	**Plot:** J.Wang

Figure A2: Time of day wind roses

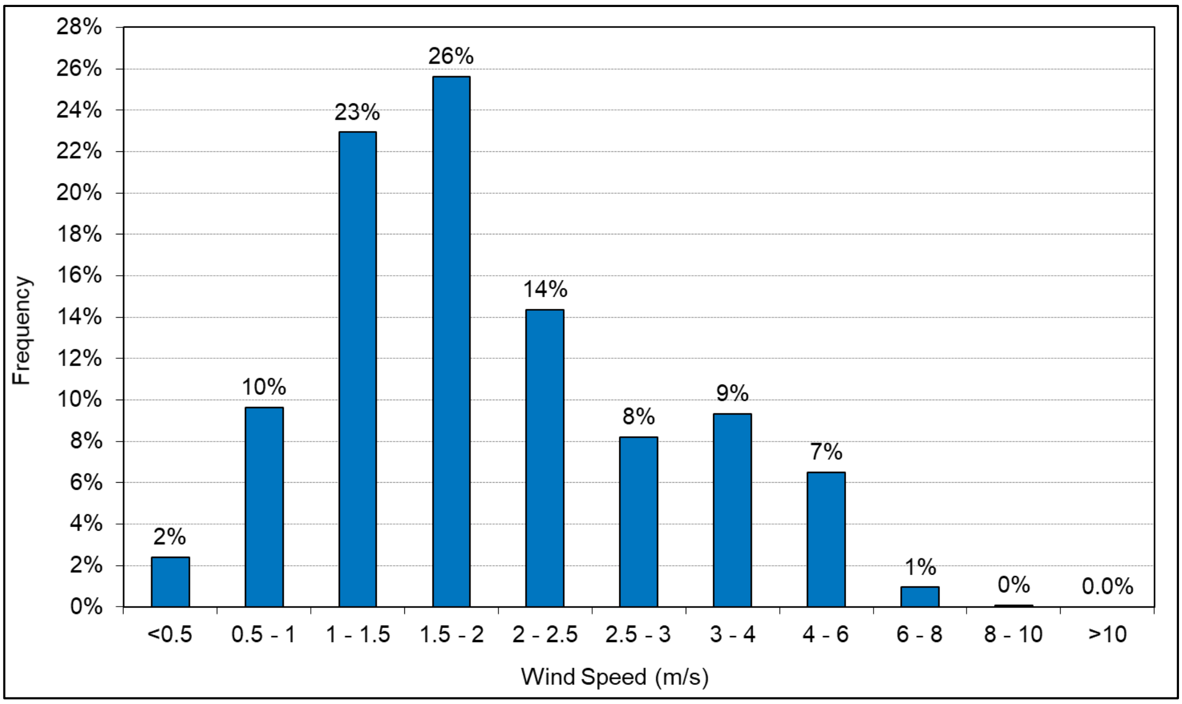


Figure A3: Wind speed profile

Atmospheric 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. This is the atmospheric condition that can lead to odour issues.

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, 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 early mornings. 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 the estimated stability classes in the 2018 CALMET generated meteorological files for the site are presented in Figure A4. The data shows a frequency of occurrence of D (35%) and F stability (35%), which is typical for inland locations.

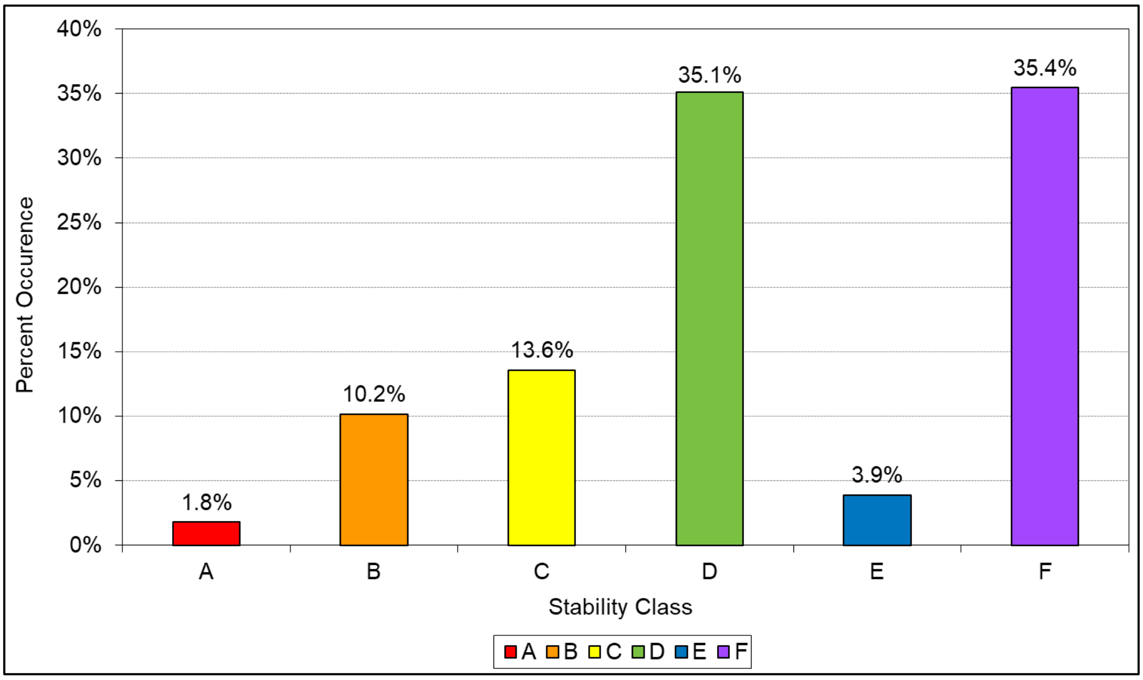


Figure A4: Frequency distribution of stability classes

Mixing Height

Mixing height is the depth of the atmospheric mixing layer beneath an elevated temperature inversion. It is an important parameter in air dispersion meteorology as vertical diffusion or mixing of a plume is generally considered to be 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 A5. 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. Overall, the distribution of mixing heights is representative of inland conditions and is consistent with expectations.

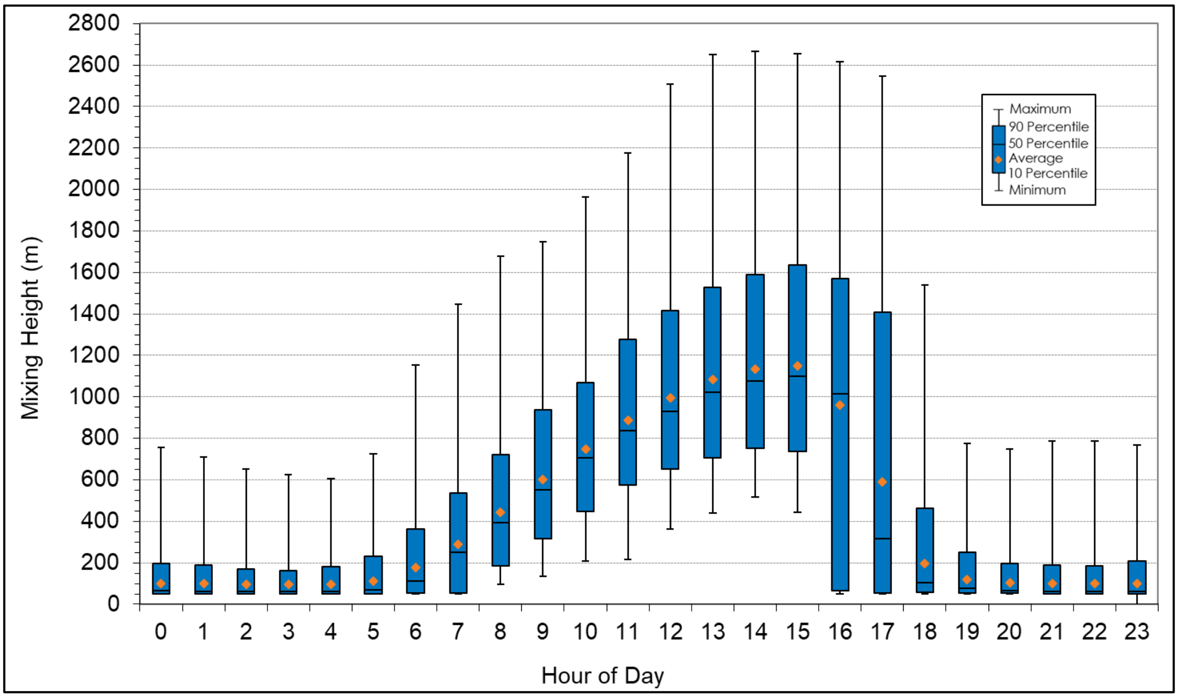


Figure A5: Mixing height of hour of day