AIR QUALITY IMPACT ASSESSMENT
PREPARED FOR
WINTERGREEN FARM
3329 OXLEY HIGHWAY SOMERTON NSW 2340

Prepared for: Wintergreen Farm
[redacted]

Prepared by: [redacted] Senior Engineer
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Report No: 251021_AQIA_Rev3
June 2025
(Released: 27 June 2025)

Benbow
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DOCUMENT REVISION RECORD

Revision	Date	Description	Checked	Approved
1	02-04-2025	Draft / Rev1	[redacted]	
2	20-05-2025	Draft / Rev2		
3	27-06-2025	Rev3		

DOCUMENT DISTRIBUTION

Revision	Issue Date	Issued To	Issued By
1	02-04-2025	Wintergreen Farms	Benbow Environmental
2	20-05-2025	Wintergreen Farms	Benbow Environmental
3	27-06-2025	Wintergreen Farms	Benbow Environmental

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EXECUTIVE SUMMARY

Benbow Environmental has been engaged by Wintergreen Farms to prepare an Air Quality Impact Assessment (Dust and Odour) for the proposed expansion of the poultry farm development in Somerton, NSW. The proposed development is seeking to expand to 299,670 birds in the existing 6 tunnel-ventilated sheds and is seeking to accommodate 510,840 birds in 8 tunnel-ventilated additional sheds (810,510 birds total within 14 sheds).

This assessment aims to examine the potential odour and dust impacts from the proposed development. This report has been prepared to document the methodology utilised and the outcomes obtained in this assessment.

The NSW EPA guidelines *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*; *Technical framework - Assessment and management of odour from stationary sources in NSW* and *Technical notes - Assessment and management of odour from stationary sources in NSW* were utilised in conducting this dust and odour impact assessment. This assessment has adopted the respective methodologies from these guidelines, including the selection of meteorological data, the collection of appropriate and/or conservative emissions data, and the set-up of the dispersion model to simulate the emissions from the subject farm.

This assessment finds that an "Odour Enclosure" system is warranted, where an enclosure is placed at the tunnel fan bank-end of the shed to treat the odour released from the enclosure. A 6 OU criterion has been adopted for the site as only two off-site receptors are predicted to experience odour units of approximately 2 OU. A reduction factor was applied to the model to account for the "Odour Enclosure" system and the highest offsite odour impact occurs at receptor site R2 with an impact of 4.21 OU for cycle 3.

Predicted 99^{th} percentile concentrations comply with this criterion at all sensitive receptors with the odour enclosures in place.

The maximum predicted impacts for PM_{10} and TSP comply with the *Approved Methods* criterion at all sensitive receptors.

This concludes the Executive Summary.

[redacted] [redacted] [redacted]

Chemical Engineer | Senior Engineer | Principal Consultant

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Attachment 2: Odour Emission Sampling
Attachment 3: Weather Analysis
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1. INTRODUCTION

Benbow Environmental has been engaged by Wintergreen Farm to undertake an Air Quality Impact Assessment (AQIA) for the proposed poultry farm expansion located at 3329 Oxley Highway Somerton NSW 2340 (legally designated as 10/DP261839).

Currently, the site accommodates 240,000 birds in 6 tunnel-ventilated sheds. The proposed development is seeking to expand to 299,670 birds in the existing 6 tunnel-ventilated sheds and is seeking to accommodate 510,840 birds in 8 tunnel-ventilated additional sheds (810,510 birds total within 14 sheds).

1.1 PURPOSE OF REPORT

The purpose of this study is to assess the potential impacts of dust and odorous emissions on ambient air quality, as a direct result of the proposal, being the operation of the proposed poultry farm only. Should the results of this assessment show any exceedance of the adopted criteria for the specific emissions, mitigation measures would be recommended, in order to prevent or reduce to an acceptable level any detrimental effects to ambient air quality and any impacts on the local community.

1.2 SCOPE OF WORKS

The dust and odour impact assessment has included the following:

- A review of the proposed site operations;
- Obtain the site specific meteorological data suitable to use in the modelling;
- Undertake research to determine and compile the most suitable data for use in describing the dust and odour emissions from the proposed development;
- Modelling of the proposed operations of the sheds to determine the worst-case potential dust and odour impacts at the nearest potentially affected sensitive receptors;
- An assessment of the predicted levels of dust and odour against NSW EPA guidelines; and
- The compilation of a report containing a summary of methods and a statement of the potential dust and odour impacts from the proposed development.

1.3 RELEVANT LEGISLATION AND PUBLICATIONS

Various publications have been followed for generic guidance and/or utilised to comply with statutory requirements for the preparation of this AQIA report. The most relevant ones are listed as follows:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2022) [referred to as *Approved Methods*];
- *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'* (Atmospheric Studies Group, 2011);
- "Technical Framework – Assessment and Management of Odour from Stationary Sources in New South Wales" (DEC NSW, 2006);
- "Technical Notes – Assessment and Management of Odour from Stationary Sources in New South Wales" (DEC NSW, 2006b);

- Previous studies of air quality from poultry farms undertaken by Benbow Environmental; and
- Engineering controls for dust and odour emissions at poultry farms undertaken by Benbow Environmental.

1.4 Secretary's Environmental Assessment Requirements (SEARs)

The following tables outline the requirements within SEARs No. 1982 from the relevant stakeholders.

Table 1-1: Compliance with Secretary's Environmental Assessment Requirements – Department of Planning and Environment

Secretary's Environmental Assessment Requirements	Reference	
	Section	Page No.
As part of the EIS assessment, the following matters must also be addressed: ***air quality and odour** – including:* • *a quantitative assessment of the potential air quality, dust and odour impacts of the development, during both construction and operation including any cumulative impacts from existing onsite operations, in accordance with relevant NSW Environment Protection Authority guidelines.*	This document	N/A
• *a description and appraisal of air quality and odour impact mitigation and monitoring measures, in line with International Best Practice.*	Section 8	Page 53

Table 1-2: Compliance with Secretary's Environmental Assessment Requirements – NSW EPA

Secretary's Environmental Assessment Requirements	Reference	
	Section	Page No.
Environmental impacts of the project *1.2. Impacts related to the following environmental issues need to be assessed, quantified and reported on:* • ***Air Quality Issues, including Odour** - Identify and assess the potential air quality impacts from the proposal and detail the management and mitigation measures for those impacts.*	This Document	N/A
3. Air issues		

3.1. The EIS must demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations (POEO) Act (1997) and the POEO (Clean Air) Regulation (2002). Particular consideration should be given to section 129 of the POEO Act concerning control of "offensive odour".	251021_EIS_Rev 1 Section 8.1	Page 8-45
3.2. The EIS must include an air quality impact assessment (AQIA). The AQIA must be carried out in accordance with the document, Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2022), available at: https://www.epa.nsw.gov.au/Your-environment/Air/industrial-emissions/Approved-methods-for-the-modelling-and-assessment-of-air-pollutants	This Document Included in 251021_EIS_Rev 1	N/A
3.3. The EIS must detail emission control techniques/practices that will be employed at the site and identify how the proposed control techniques/practices will meet the requirements of the POEO Act, POEO (Clean Air) Regulation and associated air quality limits or guideline criteria.	251021_EIS_Rev 1 Section 12	Page 12-1
Odour		
4.1 An investigation and assessment of odour impacts likely to be associated with cold air drainage effects on all identified and potential receivers.	Section 4.1.5	Page 14
4.2. A requirement to install a meteorological station as soon as possible on or near the site to obtain site-specific meteorological data for a minimum of 3 months and ideally 6 to 12 months to aid in refining odour assessment and modelling.	Attachment 3	-
4.3. Collection of wind speed data using an ultrasonic wind speed sensor to ensure accurate representation of low wind speed frequencies to allow more accurate prediction of likely katabatic impacts on receivers.		
4.4. Include a consideration of 'worst case' emission scenarios, and sensitivity analysis around the timing of peak emissions.	Section 5.2.7	Page 25
4.5. Air dispersion modelling must be conducted in accordance with: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2022) https://www.epa.nsw.gov.au/Your-environment/Air/industrial-emissions/Approved-methodsfor-the-modelling-and-assessment-of-air-pollutants and Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW Australia' (TRC Environmental Corporation, 2011) https://www.epa.nsw.gov.au/sites/default/files/calpuffmodelguidance.pdf	This document	N/A
4.6. Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations (POEO) Act 1997 and the POEO (Clean Air) Regulation 2022. Particular consideration should be given to section 129 of the POEO Act concerning control of "offensive odour".	This document	N/A

4.7. Odour emissions must be assessed in accordance with the Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW and/or the Technical Notes – Assessment and Management of Odour from Stationary Sources in NSW (DEC, 2006) available at: https://www.epa.nsw.gov.au/Your-environment/Air/industrial-emissions/managing-odour/technicalframework-odour	Section 5	Page 19
4.8. Detail emission control techniques/practices that will be employed by the proposal.	Section 8	Page 53

2. SITE IDENTIFICATION

2.1 SITE LOCATION

The subject site is located at 3329 Oxley Highway Somerton NSW 2340 and it is identified as Lot 10/DP261839. The site locality is shown in Figure 2-1. An aerial view of the current site is shown in Figure 2-2.

2.2 SITE DESCRIPTION AND ADJACENT LAND USE

The site covers an area of approximately 2,150,000,m^2 (215 ha), comprising mainly of cleared land, with the existing 6 sheds in the middle of the site and some trees along the road and at the southwestern corner. Sandy Creek runs through the northeastern corner and Black Gully runs from the west to east at the south of the site. The topography of the site presents an overall falling slope from an elevation of 350 m at the southwestern corners towards the north-east and south-east boundaries of the site, with an elevation decline of 25-30 m. The site is accessible via a gravel road, entering from the north-eastern corner, which connects to Oxley Highway (B56).

The subject site is zoned as 'RU1 - Primary Production' under the Tamworth Regional Local Environmental Plan (LEP) 2010 and is surrounded by existing agricultural/rural landscapes, consistent with the primary production land use of the region.

Figure 2-1: Site Location

Source: Google Earth 2023

↑N Not to scale	LEGEND: Site	Benbow Environmental 27-29 Sherwood Street, Northmead NSW 2152

Figure 2-2: Site Aerial

Source: Google Earth 2023

↑N Not to scale	LEGEND: Site	Benbow Environmental 27-29 Sherwood Street, Northmead NSW 2152

2.3 Nearest Sensitive Receptors

The subject site is surrounded by nearby rural developments and a number of residential dwellings that could be potentially affected by odour and dust impacts from the proposed site activities. In AQIA reports, these potentially affected sites are referred to as 'sensitive receptors'. A sensitive receptor is defined in the *Approved Methods* (EPA, 2022) as follows:

> *"A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors."*

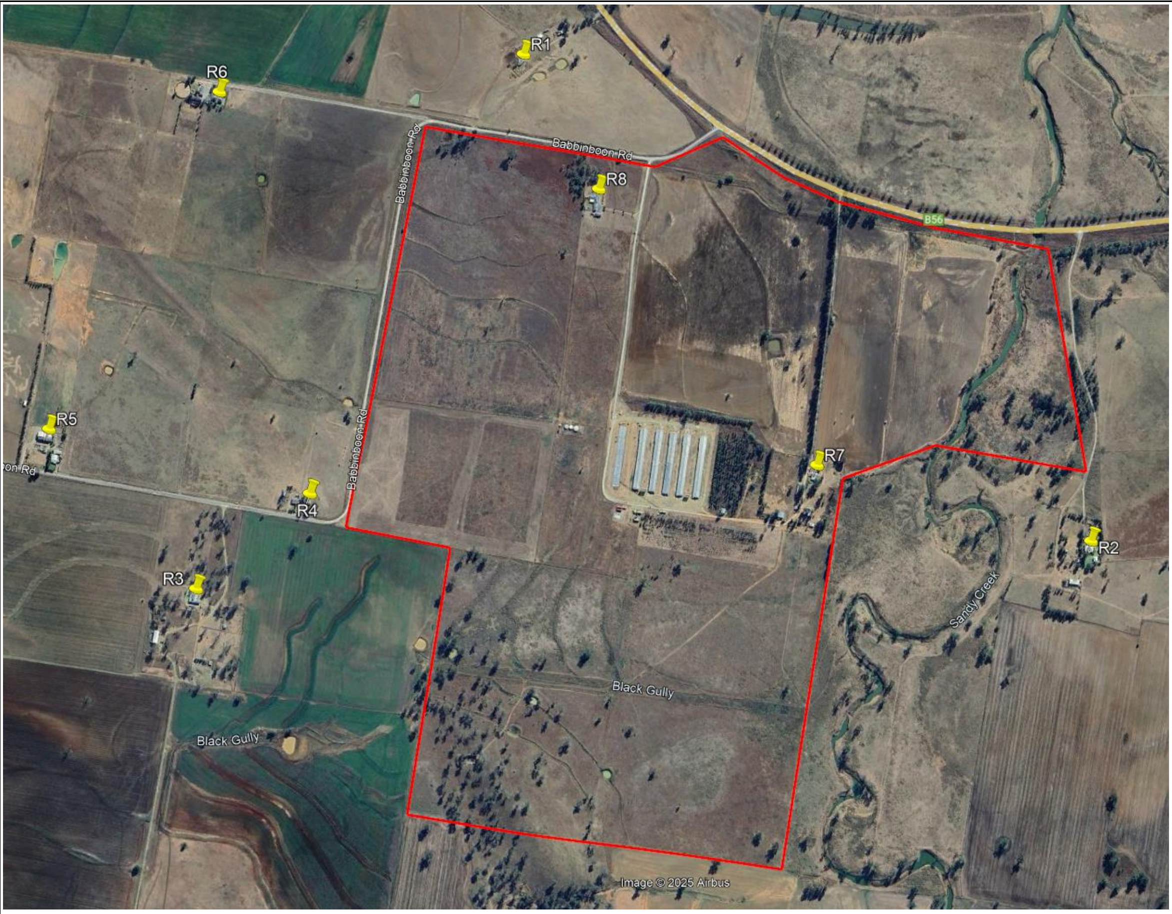
Table 2-1 provides a list of the nearest identified sensitive receptors which consist entirely of residential buildings, while Figure 2-3 shows the location of these receptors in relation to the subject site. The distance between the sensitive receptors and the proposed development is measured as the distance between the potentially impacted building and the nearest poultry shed.

Table 2-1: Nearest Identified Sensitive Receptors

Receptor ID	Address	Lot & DP	Approximate Distance and Direction from Nearest Shed(1)	Receptor Type
R1	Oxley Highway, Somerton	Lot 173/ DP657385	950 m N	Rural-Residential
R2	3269 Oxley Highway Bective	Lot 11/ DP1002595	970 m E	Rural-Residential
R3	207 Babbinboon Road Somerton	Lot 177/ DP755340	1,060 W	Rural-Residential
R4	190 Babbinton Road Somerton	Lot 4/ DP249697	740 m W	Rural-Residential
R5	250 Babbinton Road Somerton	Lot 3/ DP249697	1,370 m W	Rural-Residential
R6	76 Babbinton Road Somerton	Lot 5/ DP249697	1,320 m W	Rural-Residential
R7	3329 Oxley Highway Somerton	Lot 10/ DP261839	270 m E	Caretakers Cottage
R8	3329 Oxley Highway Somerton	Lot 10/ DP261839	540 m NW	Caretakers Cottage

Note: (1) Distance is measured from the nearest proposed or existing shed fan end/corner and nearest residential façade.

Figure 2-3: Nearest Residential Receptors and Site Aerial



Source: Google Earth 2023

↑N	**LEGEND:** Site Location	Benbow Environmental 27-29 Sherwood Street, Northmead NSW 2152

3. FARM DESIGN AND OPERATIONAL DETAILS

3.1 PROPOSED DEVELOPMENT

Currently, the site accommodates 240,000 birds in 6 tunnel-ventilated sheds. The proposed development is seeking to expand to 299,670 birds in the existing 6 tunnel-ventilated sheds and is seeking to accommodate 510,840 birds in 8 tunnel-ventilated additional sheds (810,510 birds total within 14 sheds).

The existing sheds have an internal floor area of 2,323 m^2 and the proposed sheds will have an internal floor area of 2,970 m^2.

The stocking density of approximately 34 kg per square meter will apply to all 14 sheds. This corresponds to a maximum capacity of 49,945 birds for the existing sheds and 63,855 birds for the proposed sheds. The proposed layout of the sheds and other farm structures is shown in Figure 3-1.

3.2 OPERATIONAL DETAILS

Each shed would go through a 9 -10 week production cycle, consisting of approximately 7-8 weeks of growing phase and 2 weeks of break in-between growing phases. Typically, birds are collected for harvesting during the 5th, 7th and last (7th or 8th) week in the growth cycle. The RSPCA require a stocking density of no more than 34 kg per sqm and the birds are weighed towards the last weeks of the growing phase to ensure thin-outs occur such that the RSPCA stocking density is not exceeded.

In the 2 week break period, at the end of every growing phase, a full shed clean out is undertaken, and usually completed in 2 days. The clean out involves the mechanical removal of all spent litter from the sheds and its immediate disposal: the litter is collected by contractors, loaded directly onto trucks and transported off site for further processing elsewhere (usually used as a valuable by-product for other forms of agricultural activities). Shed clean out will be immediately followed by disinfection.

Wood shavings would be most commonly used as litter material. Nipple drinkers fitted with catch-cups are used to supply drinking water to the birds, while pneumatically controlled pipelines deliver chicken feed from hoppers.

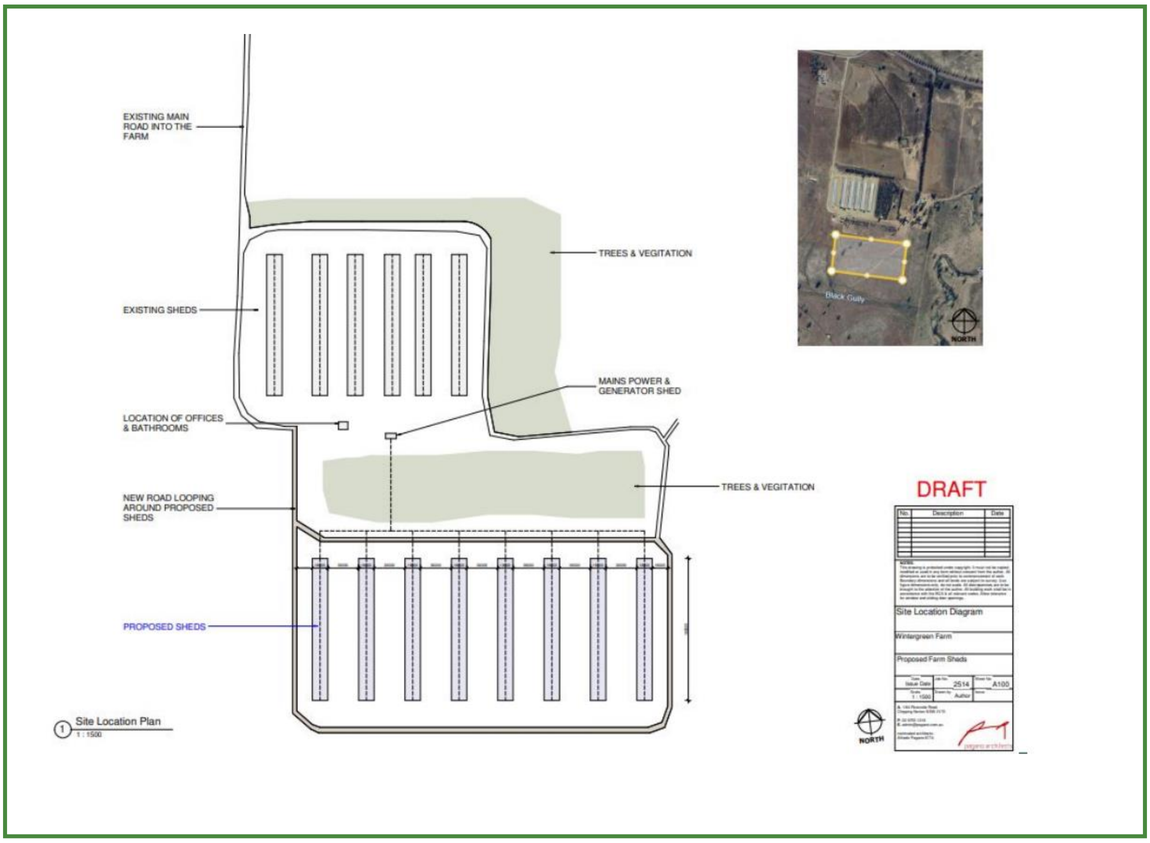
3.2.1 Shed Ventilation

The ventilation requirements of any type of poultry shed depends predominantly upon three factors: the ambient temperatures, the age/bodyweight of the birds, and the number of birds housed. For example, as birds grow larger and heat mass increases, the internal temperature in the shed would need to be lowered accordingly by allowing for more air flow and controlling humidity content within the shed. This can be done through either natural ventilation or mechanical ventilation, which is also referred to as tunnel ventilation. All the sheds that are part of the proposed development would operate as tunnel ventilated sheds.

3.2.2 Free Range Conversion Option

The proposed development may seek to retrofit the tunnel ventilated sheds with the capacity to convert the farm to free range in the future. This would involve installing doors (hinged openings at ground level along the long side of the sheds) to allow the chickens out into an adjacent yard. This would change the ventilation of the sheds to be a combination of natural and tunnel ventilation. This option will be investigated in the Odour Impact Assessment and included in the application if the odour outcomes comply with the complex odour criteria stipulated in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales 2022.

Figure 3-1: Proposed Site Plan with Shed Layout



3.3 Hours of Operation

The existing farm currently operates 24/7. Feed deliveries occur during daytime hours and bird pickup typically occurs during night-time hours for the comfort of the birds.

3.4 Employment

The proposal is expected to provide employment for 48 employees during construction, 7 fulltime employees during operations, and also to generate employment for trucking contractors (feed delivery, bird pickup, manure merchants, wash and sanitizing crews, bedding providers, bedding spreaders, electricians, plumbers and repairs and maintenance teams).

4. METEOROLOGY AND LOCAL AIR QUALITY

The meteorological data used in the modelling of this assessment was no-observation prognostic meteorological data. A representative year is selected based on the evaluation of weather monitoring stations for their proximity to the site, completeness of data, and similarity of topography to the subject site.

A prognostic meteorological data file created by Lakes Environmental with WRF using the representative year was pre-processed using CALMET for use in CALPUFF. Although the meteorological data was not measured at the site, it is generated from WRF satellite imagery for the specific site, and no-obs prognostic data accounts for spatial variability in both horizontal and vertical fields, and limits user error in CALMET inputs.

As part of the report, a weather data analysis was conducted (provided as Attachment 3) to provide a comparison between the WRF weather prediction model and meteorological data obtained from a weather station installed at a nearby farm.

The data analysis indicated that the WRF prediction model is sufficiently accurate to represent the area.

4.1 DISPERSION METEOROLOGY

4.1.1 Site Representative Year

The nearest weather monitoring station operated by the Bureau of Meteorology (BoM) to the subject site is the Tamworth Airport Automatic Weather Station (AWS). The Tamworth Airport station is located approximately 20 km south-east of the subject site. The Tamworth Airport station is considered to be the most appropriate sources of data for determining the representative year due to their proximity to the site, completeness of data, and similar topography to the subject site.

The five most recent years of available data for temperature and wind run were compared to long term averages. The year 2023 was found to be the most representative. This is shown in Attachment 1. A 2023 no-obs prognostic meteorological data file was created by Lakes Environmental using the WRF model. This data file was used as input into CALMET pre-processor to create onsite Surface and profile met data.

Based on an analysis of ridge to ridge distance and wind-field resolution, a TERRAD value of 10 km was used in the CALMET pre-processor.

4.1.2 Wind Rose Plots

Wind rose plots show the direction from which the wind is coming with triangles known as "petals". The petals of the plots in summarise wind direction data into 8 compass directions i.e. north, north-east, east, south-east, etc.

The length of the triangles, or “petals”, indicates the frequency that the wind blows from the direction presented. Longer petals for a given direction indicate a higher frequency of wind from that direction. Each petal is divided into segments, with each segment representing one of the six wind speed classes. Thus, the segments of a petal show what proportion of wind for a given direction falls into each class.

The proportion of time for which wind speed is equal to or less than 0.5 m/s, when speed is negligible, is referred to as calm hours or “calms”. Calms are not shown on a wind rose as they have no direction, but they are noted under each wind rose as a temporal percentage.

The concentric circles in each wind rose are the axes that denote wind frequencies. In comparing the plots it should be noted that the axis varies between wind roses, although all wind roses are the same size. The frequencies shown in the first quadrant (top-left quarter) of each wind rose are stated beneath the wind rose.

4.1.3 Local Wind Trends

Seasonal wind rose plots for this site using no-obs prognostic site specific data (X: 276.81 km, Y: 6570.914 km) have been included in Figure 4-1. The data showed annual average wind speeds of 3.30 m/s and a calms (< 0.5 m/s) frequency of 2.63%. Annual winds from the south were found to be dominant and were present at a frequency of approximately 38%.

The summer wind speed was estimated to be at 3.54 m/s, with a calms frequency of 2.13%. Southerly winds were found to be the most dominant followed by those from the north west at frequencies of ~33% and ~15% respectively.

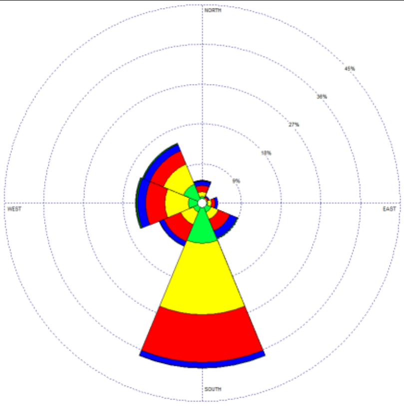
In autumn, southern winds were dominant at ~37%, followed by westerly winds at a frequency of approximately 15%. The average autumn wind speed was 3.27 m/s with a calms frequency of 2.90%.

The winter season data also showed the prevalence of winds from the south, west and north-west directions at approximate frequencies of 44%, 19% and 17%. The average winter wind speed was 2.84 m/s with a calms frequency of 3.13%.

In the spring time, average wind speeds of 3.57 m/s were estimated. Dominant winds were from the south (~34%), west (~15%), north-west (~15%) and the spring calms frequency was 2.34%.

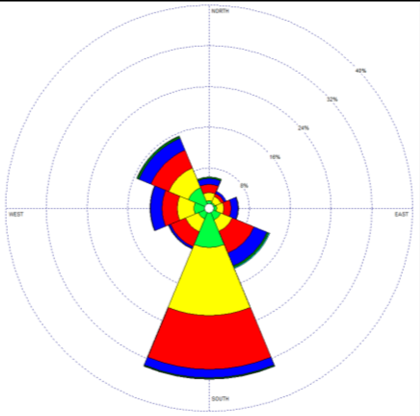
Figure 4-1: Wind Rose Plots for the site specific meteorological data from Lakes Environmental WRF data

All Seasons



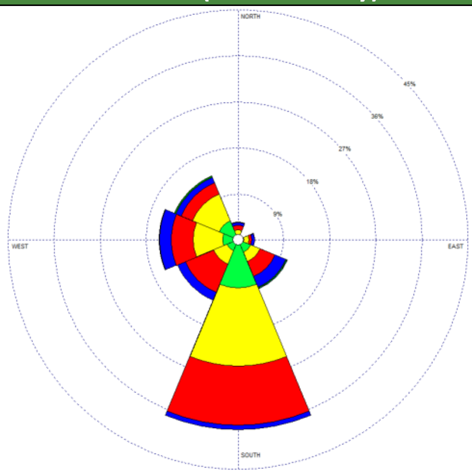
Average Wind Speed: 3.30 m/s
Calms Frequency: 2.63%
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Summer (December – February)



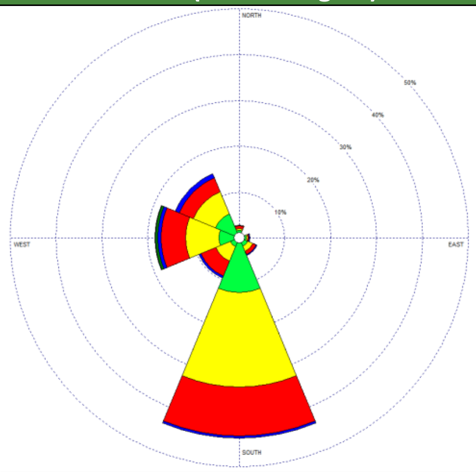
Average Wind Speed: 3.54 m/s
Calms Frequency: 2.13 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Autumn (March – May)



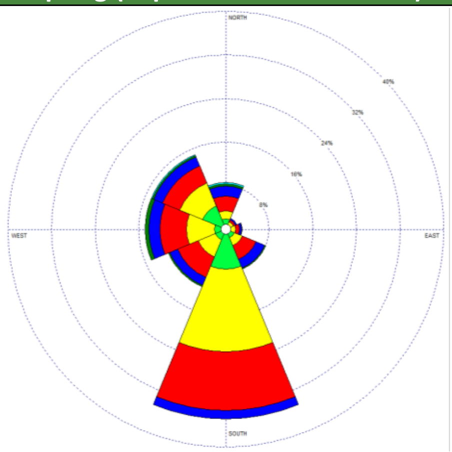
Average Wind Speed: 3.27 m/s
Calms Frequency: 2.90 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Winter (June – August)



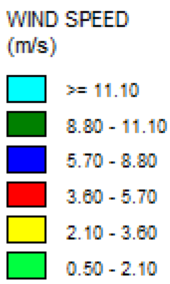
Average Wind Speed: 2.84 m/s
Calms Frequency: 3.13 %
Axis Frequencies: 10%, 20%, 30%, 40%, 50%

Spring (September – November)



Average Wind Speed: 3.57 m/s
Calms Frequency: 2.34 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Legend



Note: Calms are defined as wind events that occur at a wind speed of equal to or less than 0.5 m/s.

4.1.4 Local Climate Date

Climate data available online at the Australian Bureau of Meteorology website for the Tamworth AWS has monthly statistics from 1992-2025 for minimum and maximum temperature, 2006-2025 for daily wind run, and 1993-2025 for mean rainfall. The mean daily wind run was lowest in June and the highest in January. The mean maximum and minimum temperatures were lowest in July and highest in January/February. The mean rainfall was lowest for April and highest in November. The mean number of days of rain ≥ 1mm was lowest in April and highest in November. The monthly and annual average statistics are summarised in Table 4-1.

Recent climate data for humidity, evaporation and cloud cover is not available.

Table 4-1: Climate data from the Tamworth AWS

Month	Mean Maximum Temperature (°C)	Mean Minimum Temperature (°C)	Daily Wind Run (km)	Mean Rainfall (mm)	Mean Number of Days of Rain ≥ 1 mm
January	33.0	17.7	311	61.5	5.4
February	31.7	16.9	308	70.4	5.7
March	29.4	14.5	284	64.2	5.4
April	25.4	10.0	254	28.4	2.9
May	20.8	5.9	216	29.4	3.4
June	17.0	3.6	215	54.8	5.3
July	16.5	2.3	218	40.9	5.0
August	18.6	2.9	240	39.4	4.2
September	22.1	5.8	267	45.4	4.7
October	25.7	9.7	283	57.7	5.6
November	28.6	13.3	305	83.1	7.0
December	30.9	15.6	303	77.1	6.3
Annual	**25.0**	**9.8**	**267**	**653.1**	**60.9**

4.1.5 Terrain and Structural Effects on Dispersion

The meteorological condition known as katabatic flow (or katabatic drift) is often identified as the condition under which maximum environmental impacts from primarily ground-based sources are likely to occur. Katabatic flow is simply the movement of cold air down a slope, generally under stable atmospheric conditions. Under such circumstances, dispersion of airborne pollutants is generally slow and the associated impacts can reach their peak.

Katabatic flow may influence some impacts on sensitive receptors due to emissions from the subject site and the surrounding terrain. To the south west there are slopes that may cause cold air drainage and increase impacts on receptors to the north east. No sensitive receptors are located to the north east of site.

Figure 4-3 shows the terrain with the z-axis (i.e. vertical axis) exaggerated by a factor of 10 (i.e. a given distance on the x-axis or y-axis appears three times as great on the z-axis) in order to provide a clearer description of the topography. A coloured scale bar shows elevations corresponding to the colours used in the figures. It should be noted that these figures are an approximation of the actual terrain, based on terrain information that have been digitised from local contour terrain maps.

Figure 4-2: Local terrain

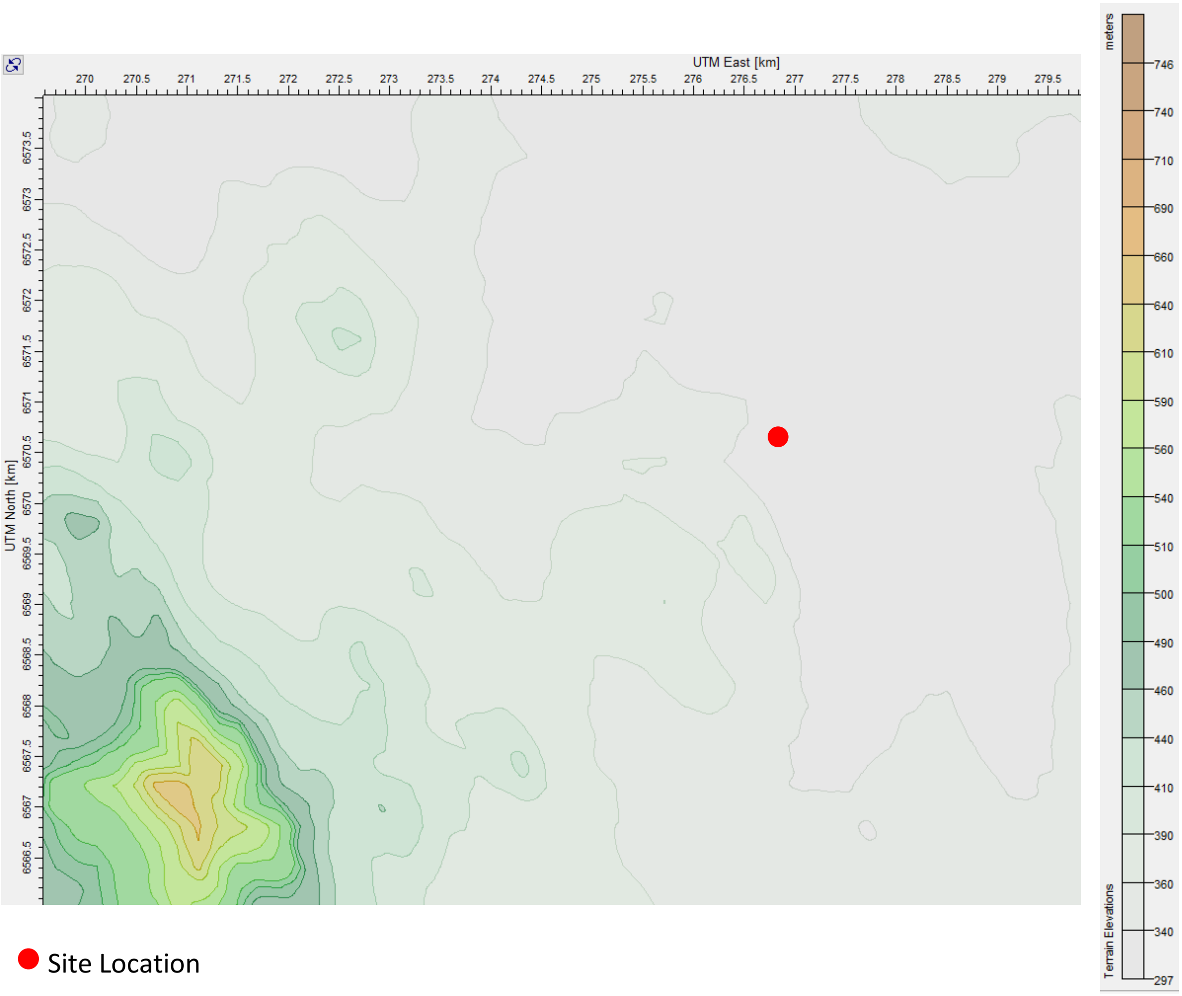
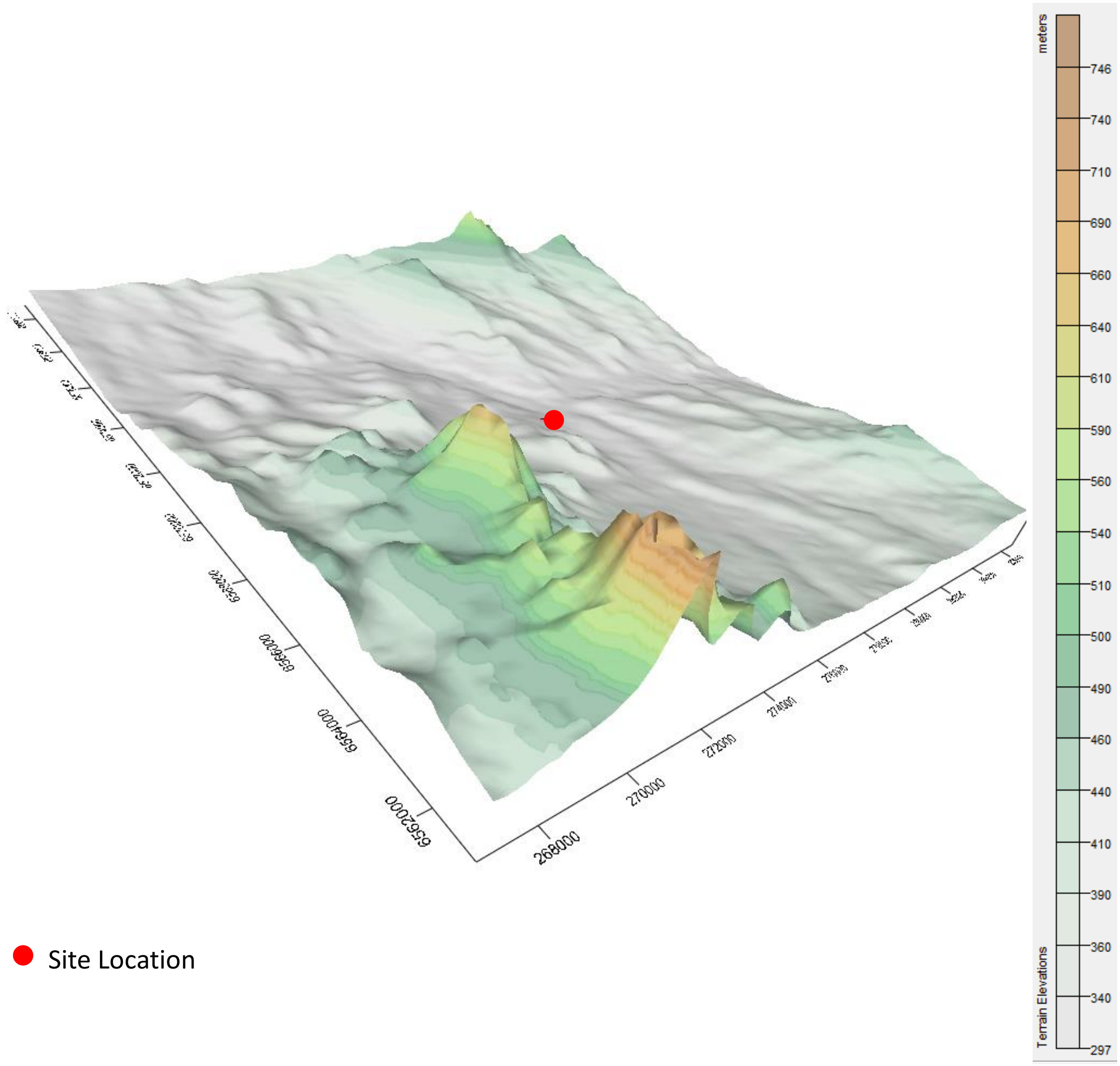


Figure 4-3: Local terrain



● Site Location

4.2 LOCAL AIR QUALITY

No air quality measurements have been undertaken specifically for this project. Instead, the nearest available air quality monitoring data was used to gain an understanding of what current pollutant levels may be around the site and to provide background air quality parameters for the assessment.

Ambient air quality data for $PM_{2.5}$ and PM_{10} levels were obtained for the year 2023 from the NSW EPA air quality monitoring station at Tamworth.

A summary of the background air quality levels from Tamworth air quality monitoring is provided in Table 4-2.

Table 4-2: Ambient Air Quality Data for Pollutants Levels 2024

Pollutant	Averaging Period	Concentration (µg/m³)
$PM_{2.5}$	Max 24-Hours (3/11/2023)	23.4
	Annual	6.6
PM_{10}	Max 24-Hours (17/12/2023)	40.4
	Annual	15.1

Note: Bold values exceed the *Approved Methods* criteria.

The data collected from the Tamworth air quality monitoring station in 2023 shows background levels of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO that are not exceeding the *Approved Methods* 24-hour and annual average criterion.

In cases of elevated background concentrations, the *Approved Methods* states:

> *In some locations, existing ambient air pollutant concentrations may exceed the impact assessment criteria from time to time. In such circumstances, a licensee must demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.*

Using the worst-case particle size distribution data provided by the U.S. Environmental Protection Agency (USEPA) AP-42 Emissions Database, a PM_{10}-to-TSP ratio of 0.51 was used to estimate the TSP background concentration level of 29.6 µg/m^3 for an annual averaging period.

A summary of the adopted background air quality levels for assessment is provided in Table 4-3.

Table 4-3: Adopted Particulate Matter Background Levels for Assessment

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)
Total Suspended Particulates (TSP)	Annual	29.6
PM_{10}	24-Hours	40.4
	Annual	15.1
$PM_{2.5}$	24-Hours	23.4
	Annual	6.6

5. ODOUR IMPACT ASSESSMENT

This section assesses the effects of potential odorous emissions on the existing ambient air quality as a direct result of the proposal. The assessment methodology, modelling configurations, results and discussion of the potential impacts as well as any recommendations on mitigation measures are described in detail, as follows.

5.1 ADOPTED CRITERIA AND GUIDELINES

The NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2016), referred to as the *Approved Methods*, has designed the impact assessment criteria for complex mixtures of odour to take in consideration the size of the affected population. Statistically, as the population density increases, the proportion of individuals particularly sensitive to odours is also likely to increase, indicating that more stringent criteria are necessary in these situations, as summarised in Table 5-1.

Table 5-1: Impact Assessment Criteria for Complex Mixtures of Odour

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (Population ≥ ≈ 2000)	2.0 OU/m^3
Population ≈ 500	3.0 OU/m^3
Population ≈ 125	4.0 OU/m^3
Population ≈ 30	5.0 OU/m^3
Population ≈ 10	**6.0 OU/m^3**
Single residence (≤ ≈ 2)	7.0 OU/m^3

The *Approved Methods* provides the following formula to determine the appropriate impact assessment criteria for complex mixtures of odorous air pollutants:

Impact Assessment Criteria (OU) = $[\log_{10}(\text{population})-4.5]/-0.6$

The affected community is based on the population within the 2 OU contour. This means the criteria varies dependant on the modelling results and the average household size in the Tamworth LGA is 2.4 people according to the 2016 Census (ABS, 2018 (Statistics, 2016)).

Within the 2 OU contour there is ~2 off-site residential homes hence the impact assessment criteria is **6 OU.**

5.2 Emission Rate Derivation

The odour emission rate for each poultry shed was calculated for each hour of the meteorological file according to the standard formula shown in the following equation:

$$OER = \frac{P \times O \times BAF \times V \times N}{1000}$$

where *OER* – Shed Odour Emission Rate, OU.m^3/s
P – Peak to Mean Ratio
O – Peak Odour, OU/1000 birds (measured during weeks 5-8)
V – Temperature and Age Adjusted Ventilation Rate, m^3/s
N – Number of Birds
BAF – Batch Age Factor

OU/1000 chickens is 13.5

This is data used in other chicken odour impact assessments that have been approved and are operating without complaints.

5.2.1 Emission Calculations – Chickens

5.2.1.1 Odour Input

An OU/1000 chicken of 13.5 OU was adopted for the purpose of this assessment. Odour sampling was undertaken on 20/10/11 at the site 120 Kendall Street, Thirlmere NSW at a tunnel ventilated chicken farm by Benbow Environmental. Details of this sampling results provided in attachment 2.

Table 5-2: Odour sampling results

Sample ID	Result (OU)	No. birds during sampling	Average OU per 1000 birds
BEO 1	569	35,000	16.25
BEO 2	378	35,000	10.8
Average	**473.5**	**35,000**	**13.5**

A simplified calculation of odour emission would be as follows: 171 m^3/s airflow by 13.5 OU/1000 birds peak-to-mean corrected is an OER of 265477.5 OU/s.

5.2.2 Ventilation

The ambient external temperature influences odour emissions from the sheds as ventilation rates are adjusted in response to changes in temperature. Although the aim of the shed control system is to maintain a constant target temperature, increasing temperatures outside the shed will mean more ventilation would be required to maintain the comfortable conditions for the birds whilst decreasing temperatures will mean that ventilation will need to be reduced.

Ventilation requirements subsequently increase as grow-out of the batch proceeds. Younger birds require a higher temperature and as the birds feather and grow larger, the target temperature changes from around 35°C in the first week reducing by approximately 2 degrees per week to approximately 21°C by week 8.

The ventilation rate at any time during a batch can be estimated approximately using guidance such as the PAE Holmes Best Practice Guidance for the Queensland Poultry Industry – Plume Dispersion Modelling and Meteorological Processing prepared for the Queensland Department of Employment, Economic Development and Innovation (2011) report data for chicken summarised in Table 5-2.

Table 5-2: The Percentage of Maximum Ventilation Rate of a Shed as Varied with Temperature and Age of Birds

Bird Age (weeks)	1	2	3	4	5	6	7	8+
Temperature (°C) above Target	Ventilation Rate (% of maximum)							
<1	1.3	2.5	5.1	7.7	9.8	11.5	17	17
1	1.3	12.5	12.5	25	25	25	25	25
2	1.3	25	25	37.5	37.5	37.5	37.5	37.5
3	1.3	37.5	37.5	50	50	50	50	50
4	1.3	37.5	37.5	50	50	50	50	50
6	1.3	37.5	37.5	62.5	75	75	75	75
7	1.3	37.5	37.5	62.5	75	75	87.5	100
8	1.3	62.5	62.5	62.5	75	75	100	100
9	1.3	62.5	62.5	87.5	100	100	100	100

Temperatures for every hour are extracted from the prognostic meteorological data and used to calculate adjusted airflows for each potential cycles with varying batch start dates as described in Section 5.2.7.

5.2.3 Bird Mortality Rate

A death rate of 10% of the total number of birds over a period of 8 weeks, has been assumed in this assessment. A weekly 1.25% loss of birds was applied from week 2 to week 9.

5.2.4 Bird Thin Out

The site is required to meet its RSPCA max stocking densities of 34 kg/m^2. Based on bird numbers, standard growth factors for broiler chickens and shed size, it is estimated that thin-out pickups would be required from week 6 onwards to ensure that this max stocking density is not exceeded. Thin out requirements varies depending on the shed size. In practice various pickup regimes will be implemented on site depending on the demand, however this scenario represents the worst case odour emissions. The following table provides details of the thin out assumptions used in this assessment.

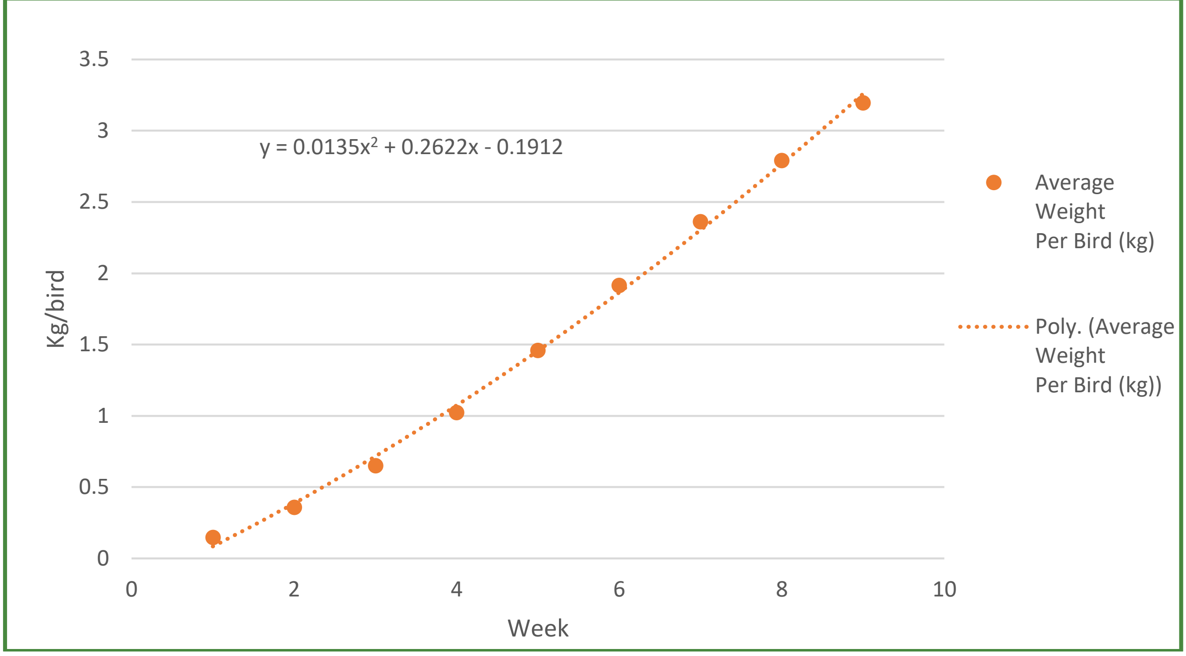
Table 5-3: Simplified Existing Bird Pickups per shed

Week	Shed 1 (2,322 sqm)					Sheds 2-6 (2,322 sqm)					Sheds 7-14 (2,970 sqm)				
	Number of Chickens	Chickens Removed	Chicken Death	Calculated Total Mass (kg)	Calculated Density kg/sqm	Number of Chickens	Chickens Removed	Chicken Death	Calculated Total Mass (kg)	Calculated Density kg/sqm	Number of Chickens	Chickens Removed	Chicken Death	Calculated Total Mass (kg)	Calculated Density kg/sqm
1	49,945	0	0	4,220	2	49,945	0	0	4,220	2	63,855	0	0	5,396	2
2	49,321	0	624	19,339	8	49,321	0	624	19,339	8	63,057	0	798	24,416	8
3	48,704	0	617	35,806	15	48,704	0	617	35,806	15	62,269	0	788	44,640	15
4	48,095	0	609	53,621	22	48,095	0	609	53,621	22	61,490	0	778	66,016	22
5	47,494	0	601	72,785	30	47,494	0	601	72,785	30	60,722	0	769	88,490	30
6	41,901	5,000	594	78,353	34	41,901	5,000	594	78,353	34	53,963	6,000	759	100,802	34
7	33,377	8,000	524	64,433	33	33,377	8,000	524	64,433	33	44,288	9,000	675	102,115	34
8	27,960	5,000	417	77,419	33	27,960	5,000	417	77,419	33	36,734	7,000	554	101,769	34
9	0	27,960	349	0	0	0	27,960	349	0	0	0	36,275	459	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5.2.5 Batch and Weight Age Factors

Odour emission rates for chicken sheds are a function of bird age (and in effect body weight). The figure below provides an indicative of the bird weights for growth cycle.

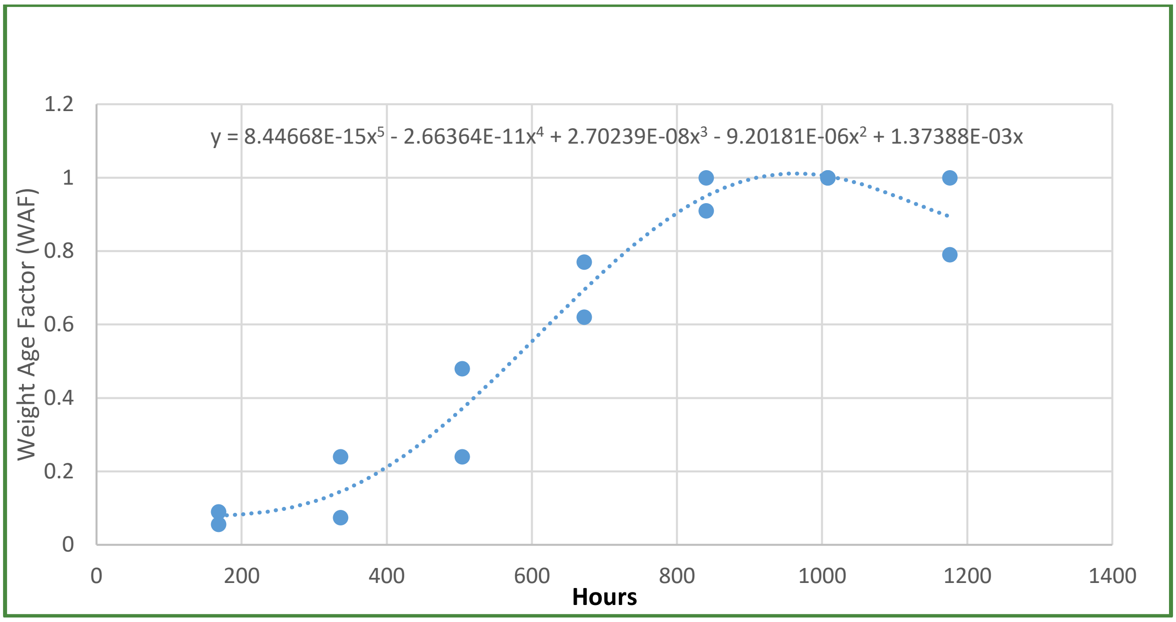
Figure 5-1: Chicken weight during batch cycle



As the birds themselves are a source of odour, with odour resulting to differing degrees from excrement, rectal gases, respiration, and feathers, and all these aspects increase as the bird grows in size, it is appropriate that odour emissions be related to bird growth and in effect body weight.

The variation of OER with bird growth is best accommodated by employing batch-age or weight age factors as with chickens. Weight age factors have from Pollock and Friebel (2002) and from a new poultry farm in the Griffith area of New South Wales were used to create a fifth order polynomial. This polynomial has been applied implemented to in this assessment to estimate WAFs as shown in Figure 5-2.

Figure 5-2: Weight age factor comparison



5.2.6 Peak to Mean Ratios

One of the parameters that need to be set to run in dispersion models is the averaging time parameter. In the case of odour, the NSW EPA Approved Methods require that an averaging time of one hour be used. This makes sense given that one hour is usually the shortest time spacing available for the meteorological data needed for modelling.

However, the modelling of odour faces a serious limitation in that human noses generally detect odour over a period of approximately one second or less. The comparatively long one hour model averaging time means that the peak odour concentrations of modelled plumes at levels that would cause annoyance would effectively be averaged during modelling to a point of being non-offensive, and thus makes a source seem less of a nuisance odour-wise than it actually might be.

To compensate for this and allow more realistic predictions of odour impacts, peak-to-mean ratios, which relate long-term modelled averages to the short-term averages that would better approximate peak concentrations, are applied to odour emission rates.

Peak-to-mean ratios are dependent on the distance of the receptor to the source, the stability of weather during the transport of the odour through the air, the type of source, and length of the averaging time used in the model.

NSW EPA-recommended factors developed by Katestone Scientific are shown in Table 5-4, reproduced from Section 6.6 of the NSW EPA Approved Methods.

The ratio of 2.3 for volume sources were applied to the odour emissions from the sheds.

Table 5-4: Peak to Mean Ratio for Estimating Peak Odour Concentrations

Source Type	Pasquill-Gifford Stability Class	Near-field P/M60*	Far-field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A – F	6	6
Surface wake-free 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

Note: * Ratio of peak 1-second average concentrations to mean 1-hour average concentrations.
Source: NSW EPA Approved Methods, Section 6.6.

5.2.7 Batch Start Date Sensitivity Analysis

Odour emissions from the birds is dependent on the number of birds (including thin out), the weight/age of the birds, and shed ventilation. The worst emissions generally occur towards the end of the cycle when birds are the largest. Odour impacts from these emissions are dependent on meteorological effects, with batch start date dictating when the worst will occur during the year.

A batch starting in the 1st week of the year will have different impacts than a batch starting in the 2nd week of the year, or in the 3rd week of the year (and so on). To assess the impacts of the emission rates and bird growth cycles, we must assess which possible batch starting date in the year (and the resulting cycle) will cause the highest emission rates. First, we determined the number of possible annual cycles of batches that would occur, depending on when their first batch week would occur.

Table 5-5 provides an approximate visualisation of how odour impacts (green = low, red = high) throughout the year would vary dependent on batch start date.

One cycle of birds (start to finish) lasts 10 weeks. The 11th potential cycle repeats the same pattern as the 1st cycle, with the earliest batch starting on 1st Jan. There are a maximum 10 potential cycles of start dates to be assessed.

Table 5-5: Potential cycles start dates

Week in year	Number of potential cycles start dates for 2015										
	1st (01 Jan)	2nd (08 Jan)	3rd (15 Jan)	4th (22 Jan)	5th (29 Jan)	6th (05 Feb)	7th (12 Feb)	8th (12 Feb)	9th (19 Feb)	10th (26 Feb)	11th (01 Jan)
1st	1	0	0	8	7	6	5	4	3	2	1
2nd	2	1	0	0	8	7	6	5	4	3	2
3rd	3	2	1	0	0	8	7	6	5	4	3
4th	4	3	2	1	0	0	8	7	6	5	4
5th	5	4	3	2	1	0	0	8	7	6	5
6th	6	5	4	3	2	1	0	0	8	7	6
7th	7	6	5	4	3	2	1	0	0	8	7
8th	8	7	6	5	4	3	2	1	0	0	8
9th	0	8	7	6	5	4	3	2	1	0	0
10th	0	0	8	7	6	5	4	3	2	1	0
11th	1	0	0	8	7	6	5	4	3	2	1
12th	2	1	0	0	8	7	6	5	4	3	2
13th	3	2	1	0	0	8	7	6	5	4	3
14th	4	3	2	1	0	0	8	7	6	5	4
15th	5	4	3	2	1	0	0	8	7	6	5
16th	6	5	4	3	2	1	0	0	8	7	6
17th	7	6	5	4	3	2	1	0	0	8	7
18th	8	7	6	5	4	3	2	1	0	0	8
19th	0	8	7	6	5	4	3	2	1	0	0
20th	0	0	8	7	6	5	4	3	2	1	0

These 10 annual cycles of batches were then assessed for maximum odour emissions. The entire year of hourly odour emission rates for each potential cycle start date were calculated. Odour emission rates were calculated based on the number of expected birds as described in Section 5.2.4, the appropriate batch age factor as described in Section 5.2.5, the appropriate air flow as described in Section 5.2.2, according to the nominated cycle start date and corrected for peak to mean ratio.

This process can be conducted independently for sheds varying in size, bird numbers, or ventilation parameters. It also assumes that all birds would be placed at the same time.

The farm owner has indicated that the batch cycle for all sheds will be operated in sync. A sensitivity analysis was performed to determine the worst-case timing for the batch start dates over the given meteorological period. A single shed, Shed 1, was modelled with batch start days starting from 1 January at weekly intervals for the 10 weeks that make up the batch cycle (including the 2 weeks shed clean out). The week starting 15 January produced the highest maximum results. Therefore, the modelling has been performed utilising 15 January as the batch start date for all sheds.

5.3 Model Design

The CALPUFF Gaussian plume dispersion model was used for the prediction of potential off-site odour impacts.

The modelling for this assessment has been designed using guidance from the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'.*

The following sections provide details regarding the parameters and settings used in the model for this assessment.

5.3.1 CALMET & Meteorological data

A year of meteorological data, described in Section 4.1, was obtained and input into the CALPUFF dispersion modelling program. The data is considered representative of the wind climate at the subject site and study region in general and has been utilised as appropriate input into the model.

The wind speed defined in the model for calm conditions is <0.1 m/s and the plume element modelling method selected was Puff, with puff splitting turned OFF. The minimum turbulence velocity (svmin) used for this assessment was 0.20 m/s. A TERRAD value of 10 km was used in the CALMET pre-processor. Additional CALMET parameters are available on request.

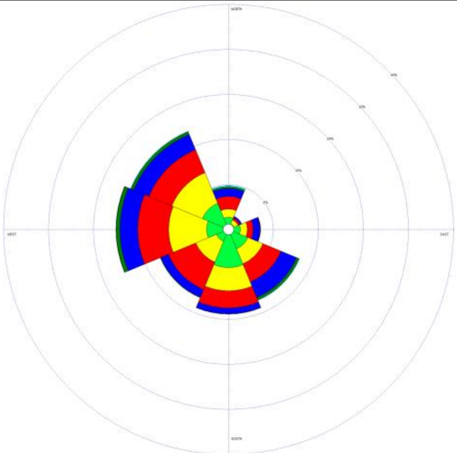
Wind roses are provided below for the period day, evening, and night periods, defined as the following:

- **Day** is defined as 7.00am to 6.00pm
- **Evening** is defined as 6.00pm to 10.00pm
- **Night** is defined as 10.00pm to 7.00am

The wind roses are produced for the centre of the site (X: 276.81 km, Y: 6570.914 km).

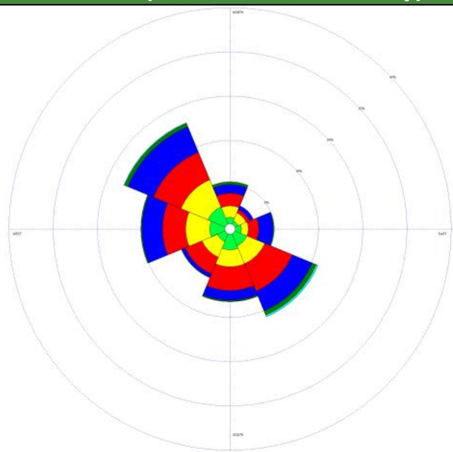
Figure 5-3: Wind Rose Plots for day period (7:00 am to 6:00 pm) site specific meteorological data from (No-obs prognostic data from Lakes Environmental)

All Seasons



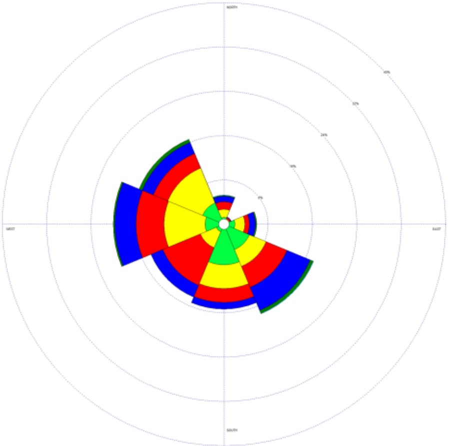
Average Wind Speed: 3.52 m/s
Calms Frequency: 3.47 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Summer (December – February)



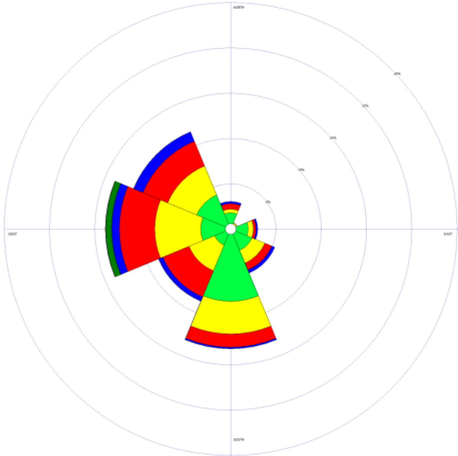
Average Wind Speed: 3.92 m/s
Calms Frequency: 2.31 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Autumn (March – May)



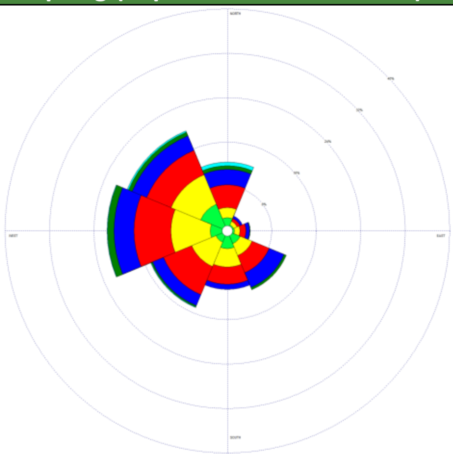
Average Wind Speed: 3.51 m/s
Calms Frequency: 3.89 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Winter (June – August)



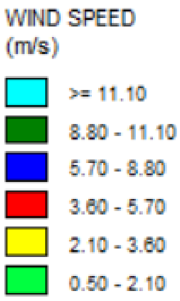
Average Wind Speed: 2.72 m/s
Calms Frequency: 5.07 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Spring (September – November)



Average Wind Speed: 3.95 m/s
Calms Frequency: 2.56 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

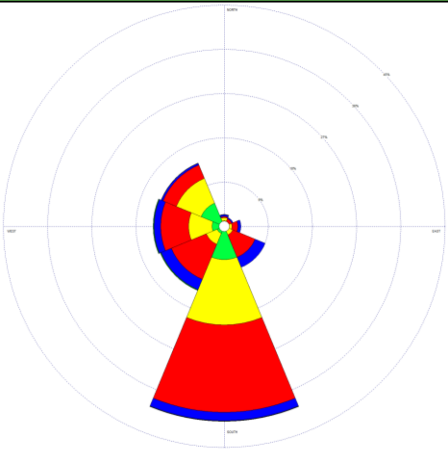
Legend



Note: Calms are defined as wind events that occur at a wind speed of equal to or less than 0.5 m/s.

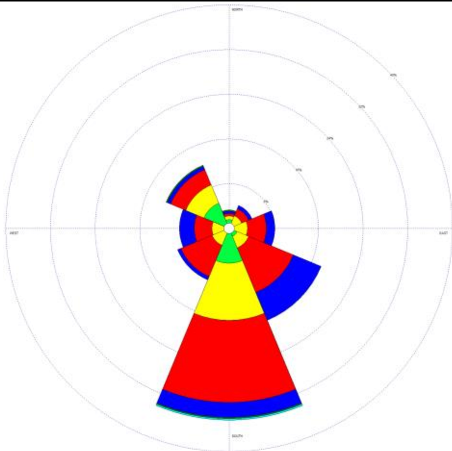
Figure 5-4: Wind Rose Plots for evening period (6:00 pm to 10:00 pm) site specific meteorological data from (No-obs prognostic data from Lakes Environmental)

All Seasons



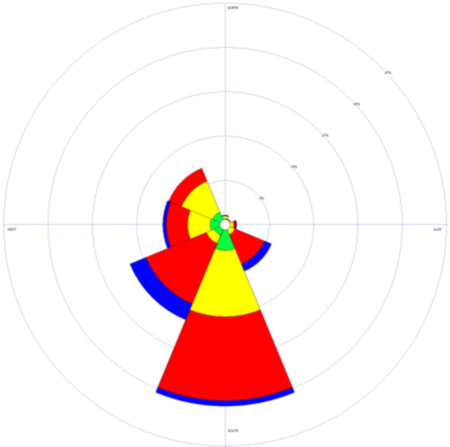
Average Wind Speed: 3.60 m/s
Calms Frequency: 1.10 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Summer (December – February)



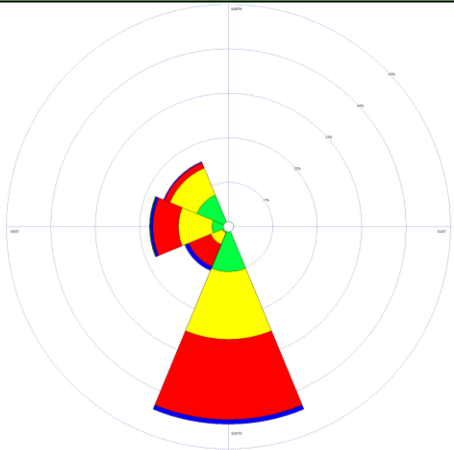
Average Wind Speed: 3.92 m/s
Calms Frequency: 0.89 %
Axis Frequencies: 8%, 16%, 24%, 32%, 40%

Autumn (March – May)



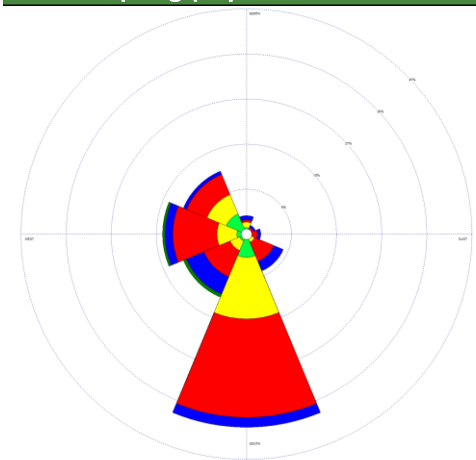
Average Wind Speed: 3.55 m/s
Calms Frequency: 1.52 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Winter (June – August)



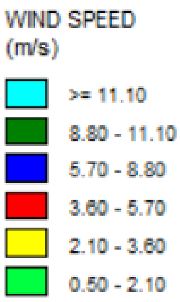
Average Wind Speed: 3.08 m/s
Calms Frequency: 0.87 %
Axis Frequencies: 11%, 22%, 33%, 44%, 55%

Spring (September – November)



Average Wind Speed: 3.87 m/s
Calms Frequency: 1.10 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

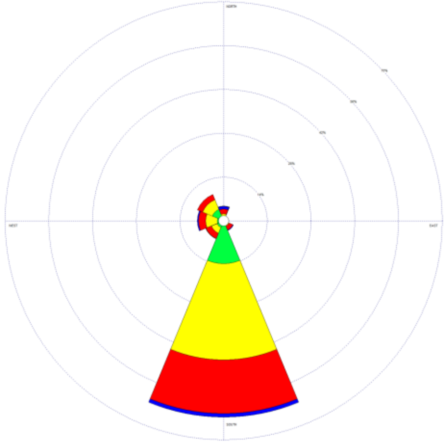
Legend



Note: Calms are defined as wind events that occur at a wind speed of equal to or less than 0.5 m/s.

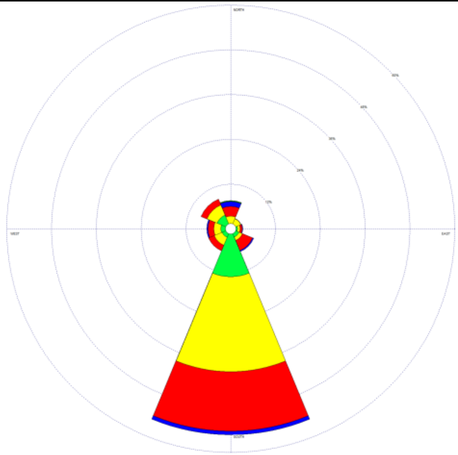
Figure 5-5: Wind Rose Plots for Night period (10:00 pm to 7:00 am) site specific meteorological data from (No-obs prognostic data from Lakes Environmental)

All Seasons



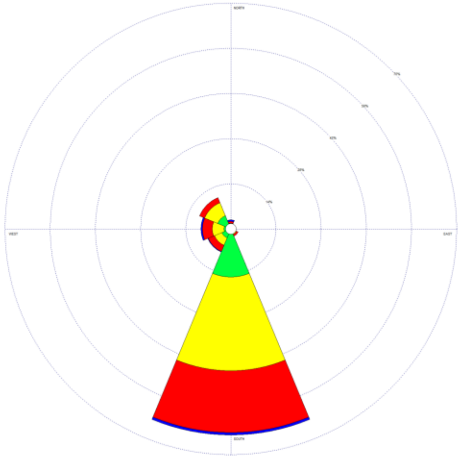
Average Wind Speed: 2.89 m/s
Calms Frequency: 2.49 %
Axis Frequencies: 14%, 28%, 42%, 56%, 70%

Summer (December – February)



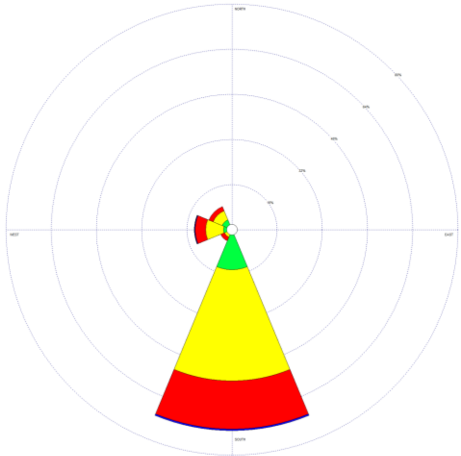
Average Wind Speed: 2.88 m/s
Calms Frequency: 2.89 %
Axis Frequencies: 12%, 24%, 36%, 48%, 60%

Autumn (March – May)



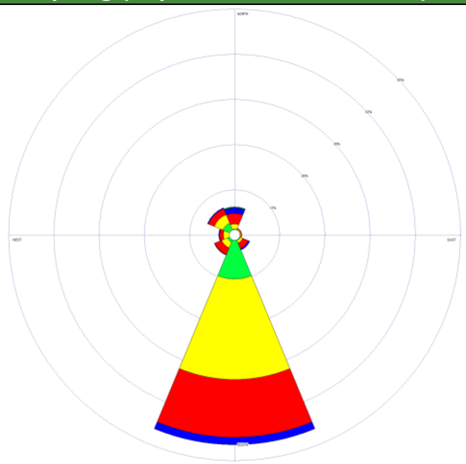
Average Wind Speed: 2.82 m/s
Calms Frequency: 2.28 %
Axis Frequencies: 14%, 28%, 42%, 56%, 70%

Winter (June – August)



Average Wind Speed: 2.86 m/s
Calms Frequency: 1.52 %
Axis Frequencies: 16%, 32%, 48%, 64%, 80%

Spring (September – November)



Average Wind Speed: 3.00 m/s
Calms Frequency: 3.30 %
Axis Frequencies: 13%, 26%, 39%, 52%, 65%

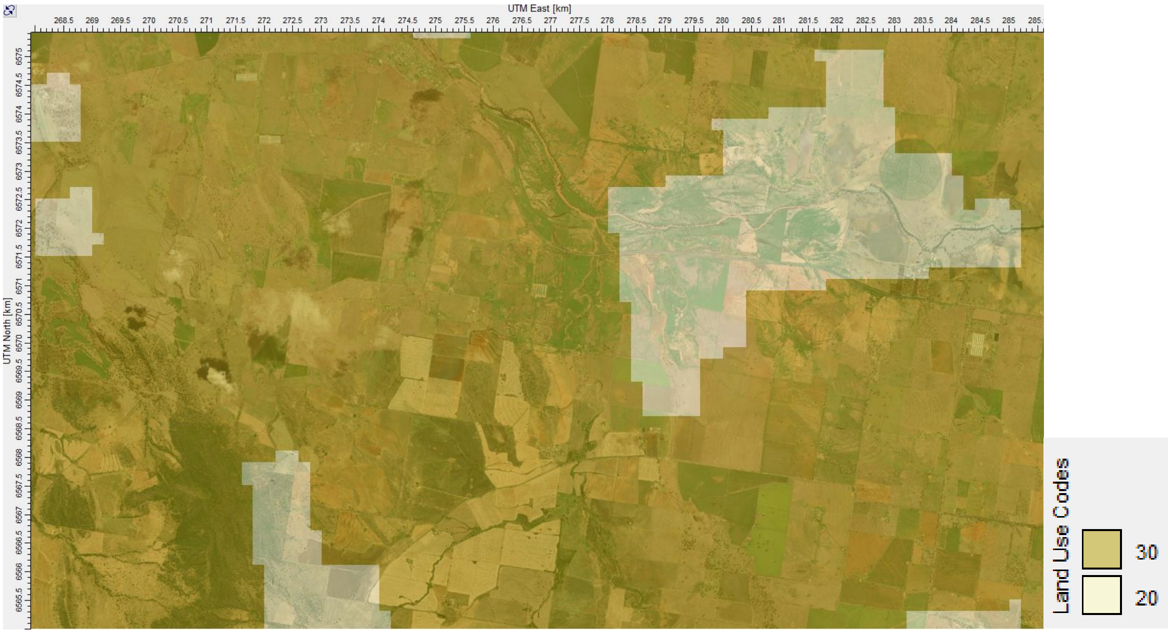
Legend

Note: Calms are defined as wind events that occur at a wind speed of equal to or less than 0.5 m/s.

5.3.1.1 Terrain

Digital terrain information was obtained from the US National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) database. Resolution of data is 30 m, and was considered sufficient in the CALPUFF GEO processor. Land use files were based on the Global Land Cover Characterization (GLCC) land use system, and created using an auto-generator and input into the CALPUFF GEO processor. Land use file input is provided in the following figure.

Figure 5-6: Land use file – overlay aerial photo



5.3.2 CALPUFF

The domain size is set to 20 km x 20 km, which provides sufficient area to inspect terrain. The grid spacing of 0.2 km is sufficiently small enough to capture terrain effects. Land use files were site specifically made using the land use creator tool to ensure there were no incorrect or missing categories. Windfields were inspected after CALMET run and looked as expected. The minimum turbulence velocity (svmin) used for this assessment was 0.20 m/s.

The wind speed defined in the model for calm conditions is <0.1 m/s and the plume element modelling method selected was Puff, with puff splitting turned OFF.

To simulate the odorous emissions from the existing and proposed poultry sheds, emission files were created as input data for CALPUFF. The procedure and methodology of calculating the emissions was provided in Section 5.2. The variable emission file is available on request.

5.4 Source Configuration and Parameters

One scenario was modelled considering the proposed development of 768,840 birds total within 14 sheds.

The following assumptions were incorporated into the CALPUFF modelling:

- The maximum air flow for existing sheds is assumed to be 188.8 m^3/s for existing shed 1 and 169.9 m^3/s for existing sheds 2-6. The maximum air flow for the proposed sheds is assumed to be 171.0 m^3/s for the proposed sheds 7-14.
- Volume source configuration was used;
- Shed dimensions are provided in Figure 5-7;
- Details of the chicken bird numbers, growth cycle, death rates, thin outs and batches are provided in Section 5.2; and
- Scope of odour emissions are limited to the birds themselves, and litter, as a source of odour.

All sheds are modelled using the same variable emission file, input into CALPUFF as a DAT file into the external sources option.

The layout of the sheds is shown in the figure below.

Figure 5-7: Volume source layout (14 sheds)

5.5 ODOUR EMISSION SOURCE INVENTORY

The odour emission source inventory has been provided in Table 5-6 as a summary of inputs used to describe the odour emission sources utilised for each scenario.

It is important to note that a variable emissions file has been generated for each scenario, to account for the changes in odour emissions per hour, as per the assumptions listed in Section 5.4.

Table 5-6: Source Inventory

Source ID	Type	X MGA56 Coordinates (m)	Y MGA56 Coordinates (m)	Source Height (m)	Initial Sigma y	Initial Sigma z	Elevation (m)	Maximum Odour Emission Rates* (OU/s)	Comments
Shed 1	Volume	276700.18	6570924.2	1	11.22	0.47	328.98	237280.84	Variable Emissions File Used
Shed 2	Volume	276898.7	6570900.9	1	11.21	0.47	329.43	213552.75	
Shed 3	Volume	276861.2	6570908.7	1	11.21	0.47	330.17	213552.75	
Shed 4	Volume	276825.3	6570912.6	1	11.21	0.47	331.77	213552.75	
Shed 5	Volume	276789.2	6570916.6	1	11.21	0.47	332.52	213552.75	
Shed 6	Volume	276751.4	6570920.1	1	11.21	0.47	334.06	213552.75	
Shed 7	Volume	277060.7	6570539.6	1	12.67	0.47	325.54	276808.04	
Shed 8	Volume	277012.6	6570544.7	1	12.67	0.47	326.48	276808.04	
Shed 9	Volume	276962.7	6570549	1	12.67	0.47	327.74	276808.04	
Shed 10	Volume	276912.2	6570553.7	1	12.67	0.47	328.25	276808.04	
Shed 11	Volume	276861.3	6570557.5	1	12.67	0.47	328.87	276808.04	
Shed 12	Volume	276813.8	6570563.5	1	12.67	0.47	329.92	276808.04	
Shed 13	Volume	276763.4	6570573.8	1	12.67	0.47	331.39	276808.04	
Shed 14	Volume	276711.9	6570577.5	1	12.67	0.47	332.18	276808.04	

*Note: these odour emission rates have a peak-to-mean ratio of 2.3 applied.

5.6 ODOUR CONTROL USING VERTICAL DISPERSION SYSTEM (ODOUR ENCLOSURES)

Benbow Environmental has developed an odour control, designed specifically for tunnel ventilated sheds. The design, called an “Odour Enclosure”, is an enclosure placed at the tunnel fan bank-end of the shed to treat the odour released from the enclosure. This design is developed based on the following principles:

- Centralised odour control;
- Maximised residence time;
- Maximised surface contact with odour particles in the tunnel ventilated air stream;
- Ability to promote vertical momentum, which would promote dispersion;
- Minimal running costs compared to power-consuming technologies such as electro-static precipitators; and
- Flexibility of the design

The system consists of the following core items:

- Three walls made out of steel and wood, constructed to surround the main fan bank.
- Shade cloth wrapped on top of three walls to act as a ceiling of the enclosure, engineered to have a capability to open a part of the shade cloth ceiling. The shade cloth is UV protected and is of high quality to provide many years of service.
- Water foggers/fine misters installed below the height of the shade cloth ceiling such that the air flow passes firstly under the sprays and then above the sprays the double passage of the air provides for increased residence time.
- Effective engineering design by Benbow Environmental.

The Odour Enclosure achieves the following aspects in relation to odour control:

- Sufficient residence time maximises contact of fine water droplets with dust and odour particles;
- Shade cloth effectively captures dust particles;
- Enhanced dispersion by inducing a vertical momentum;
- Centralising control of emissions at one location and treated all under the same condition; and
- An odour reducing chemical is able to be added to the fine water droplets to react with the ammonia and other odorous substances in the air released from the shed.

Further details regarding the “Odour Enclosure” system is provided in Attachment 4.

A unique design is prepared the farm depending on the location of surrounding receptors and the design mode preferred by the farm operators. Sizing of the enclosures is critical, and location, number and types of foggers are important factors in ensuring the odour is reduced by up to 58%.

An enclosure is added to the tunnel ventilated end of the poultry shed. This consists of impervious walls, a shade cloth roof and a bank of water atomising nozzles that fog the air within the enclosure.

The odorous air passes through the bottom half of the enclosure, making contact with millions of fine droplets (i.e. a fog) of water. The air is reflected off the end wall of the enclosure and passes back across the top half of the enclosure and the air makes more contact with the fog.

The air is then released through openings which can either be in the roof of the enclosure or through the side walls, hence allowing the air to be dispersed in a direction to favour dispersion of the remaining odour remnants in the air being discharged. The odour enclosures have been proven by dynamic olfactometry testing to be approximately 58% effective in reducing total quantity of odorous air discharged from tunnel ventilated sheds.

Additions can be made to the odour enclosure to enhance vertical dispersion and further reduce impacts.

A 58% reduction factor was applied to the model to account for the "Odour Enclosure" system.

5.7 Results

Modelling results from CALPUFF have been provided below.

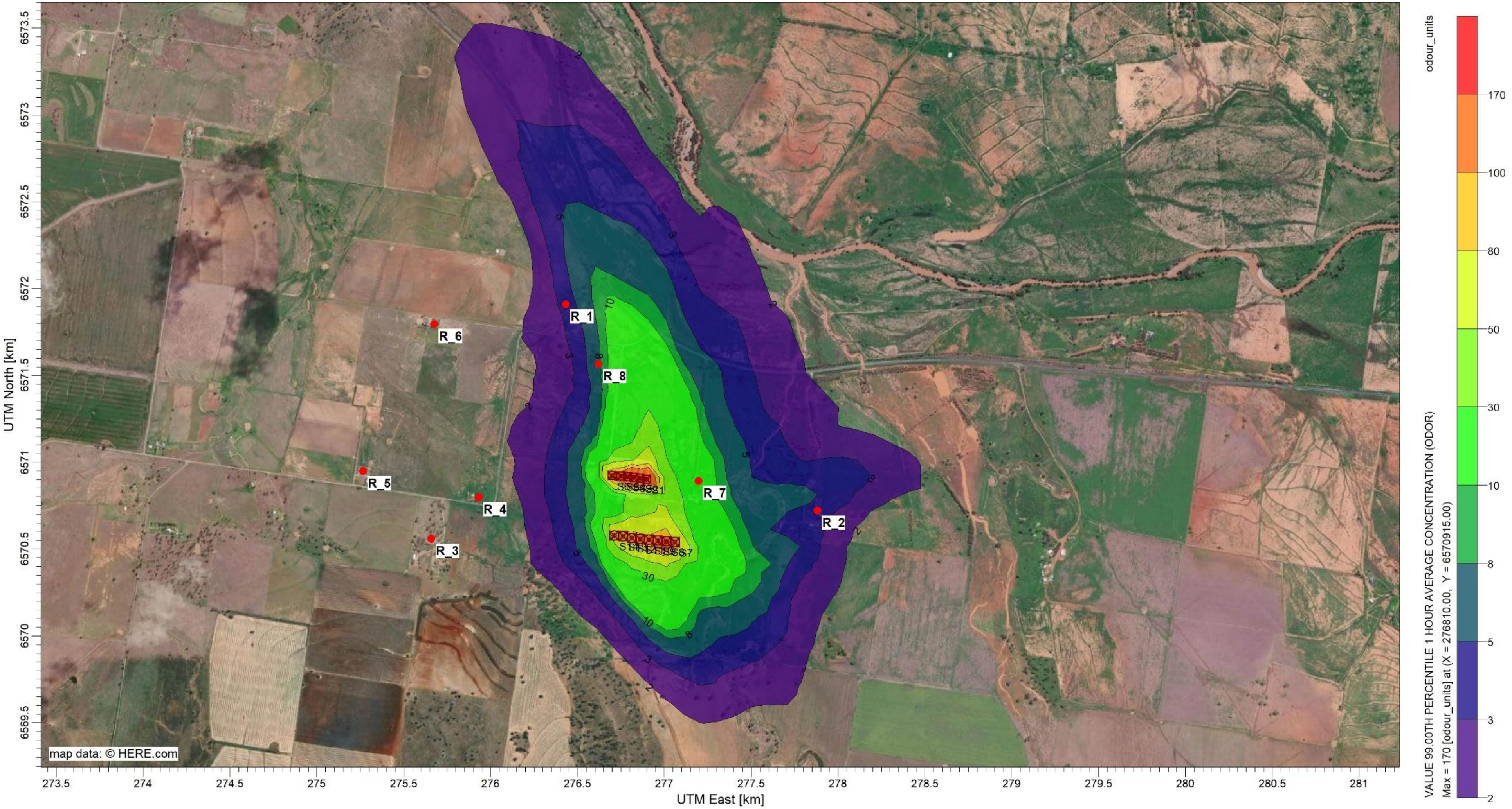
CALPUFF output file, as well as variable emission files for the modelling can be made available on request.

Table 5-7: Odour Impact Modelling Results – 99th percentile

Receptor ID	Cycle 3 OU /m^3	Date	Time	Criteria	Complies?
R1	3.63	16/12/2023	03:00:00	6 OU	Yes
R2	4.21	29/09/2023	19:00:00		Yes
R3	0.46	22/11/2023	7:00:00		Yes
R4	0.91	28/04/2023	8:00:00		Yes
R5	0.35	23/11/2023	7:00:00		Yes
R6	0.68	15/02/2023	14:00:00		Yes
R7*	14.34	9/12/2023	23:00:00	N/A	-
R8*	7.45	14/07/2023	2:00:00		-

*Sensitive Receptors R7 and R8 are caretakers' residences located on site

Figure 5-8: Odour contours – 99th Percentile



5.8 CUMULATIVE IMPACTS

The *Approved Methods* section 7.5 require the incremental impacts to be assessed against the proposed criteria and do not require a cumulative assessment. In addition, there is no significant odour source of a similar development in the immediate surrounding area. No further assessment is considered warranted.

6. CONSTRUCTION IMPACT QUALITATIVE ASSESSMENT

This Construction Impact Assessment has been conducted in accordance with *Air Quality Management (IAQM), 2014 Guidance on the assessment of dust from demolition and construction.*

The risk associated with dust emissions from construction sites is related to:

- Type of activities being undertaken (number of vehicles and plant etc);
- Duration of activities;
- Size of the site;
- Meteorological conditions;
- Proximity to receptors; and
- Adequacy of the mitigation measures and sensitivity of the receptors.

This construction air quality assessment has been conducted utilising the following steps:

Step 1 – Screening assessment
Step 2 – Dust risk assessment
Step 3 – Management strategies

Step 1- An assessment will normally be required where there is a human receptor within 350m of the site. There are no residents or commercial and industrial receptors within 350m.

Step 2A – the potential dust emission magnitude is shown in the following table with bolded values being those that represent the proposed development.

Table 6-1: Magnitude of Construction Emissions

Magnitude	Demolition	Earthworks	Construction
Small	**Total building volume <20,000 m^3**	Total site area <2,500 m^2	**Total building volume <25,000 m^3**
Medium	Total building volume 20,000 m^3 – 50,000 m^3	Total site area 2,500 m^2 – 10,000 m^2	Total building volume 25,000 m^3 – 100,000 m^3
Large	Total building volume >50,000 m^3	**Total site area >10,000 m^2**	Total building volume >100, 000 m^3

Step 2B - The sensitivity is defined in the following table.

Receptor ID	Address	Approximate distance to site boundary	Type of Receptor	Receptor Sensitivity	Sensitivity based on proximity
R1	Oxley Highway, Somerton	950 m N	Rural-Residential	High	Low
R2	3269 Oxley Highway Bective	970 m E	Rural-Residential	High	Low
R3	207 Babbinboon Road Somerton	1,060 W	Rural-Residential	High	Low
R4	190 Babbinton Road Somerton	740 m W	Rural-Residential	High	Low
R5	250 Babbinton Road Somerton	1,370 m W	Rural-Residential	High	Low
R6	76 Babbinton Road Somerton	1,320 m W	Rural-Residential	High	Low
R7*	3329 Oxley Highway Somerton	270 m E	Caretakers Cottage	Low	Medium
R8*	3329 Oxley Highway Somerton	540 m NW	Caretakers Cottage	Low	Medium

*Sensitive Receptors R7 and R8 are caretakers' residences located on site

Step 2C: Summarizes the dust risk to define the site-specific mitigation using the risk matrices provided in tables IAQM guidelines. The summary is as follows:

- Demotion: Medium Risk
- Earth work: High Risk
- Construction: Medium Risk

Step 3: The following construction mitigation measures are recommended.

The following is a summary of the control measures to be provided in the procedure. Local weather conditions should be taken into account in determining the level and suitability of controls required.

Control Measures

- Monitor local weather conditions and cease dust generating operations when conditions result in visible dust emissions, and implement mitigation measures or until weather conditions improve;
- Daily dust inspection on-site and off-site.
- Erection of wind breaks such as fences at the site boundary;

- Locate stockpiled materials away from drainage paths, easement, kerb, or road surface, and near existing wind breaks such as trees and fences;
- Dust suppression/wind breaks on stockpiles;
- Limit stockpile height to 5 m (maximum);
- Vehicles leaving the site to be cleaned of dirt and other materials to avoid tracking onto public roads;
- Enforce appropriate speed limits for vehicle on site. Recommended speed limit is <15 km/hr;
- Cover all loads entering and leaving the site; and
- Inspect the site daily using a Site Dust Control Checklist to aid with the implementation of air quality control measures.

7. OPERATIONAL DUST IMPACT ASSESSMENT

7.1 ADOPTED CRITERIA AND GUIDELINES

The guidelines referenced in this assessment were the New South Wales Environment Protection Authority (NSW EPA) document *"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales"* (EPA 2016).

Table 7-1 provides the applicable criteria for dust emissions from the NSW EPA modelling guidelines.

Table 7-1: Applicable Dust and Particulate Criteria at Sensitive Receptors from the NSW EPA Modelling Guidelines

Pollutant	Averaging Period	Concentration (µg/m^3)
PM_{10}	24 hours	50
	Annual	25
Total Suspended Particulates (TSP)	Annual	90

7.2 DUST IMPACT MODELLING

7.2.1 Dispersion Model

CALPUFF Gaussian plume dispersion model was used for the prediction of potential off-site dust impacts.

The modelling for this assessment has been designed using guidance from the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'.*

A site-specific meteorological data was used (described in Section 4.1) in accordance with the NSW EPA modelling guidelines. Emission rates were estimated using emission factor databases and were used conservatively using reasonable and/or practical assumptions.

7.2.2 Terrain

Digital terrain information was obtained from the US National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) database. Resolution of data is 30 m, and was considered sufficient in the CALPUFF GEO processor. Land use files were based on the Global Land Cover Characterization (GLCC) land use system, and created using an auto-generator and input into the CALPUFF GEO processor.

7.2.3 Dust Emission Sources

The potential dust emission sources resulting from the proposed operations have been identified as:

- Litter contained within each chicken shed (released via ventilation);
- Vehicle movements along unsealed roads located on the site; and
- Removal of manure from sheds during shed cleanout.

Of these activities, the standard operations from sheds were deemed to have the highest potential to generate excessive particulate emissions that could potentially be carried past the boundaries of the site.

Vehicle movements along the unsealed roadways were not considered as having the potential to cause elevated particulate matter emissions. There are several contributing factors that support this assumption. The first being the infrequent use of the internal haul roads by heavy vehicles, the second being the minimal speeds achieved during movement along the access road, and the third is the minor distances of the access roads.

Shed clean-out can be considered as being sporadic in nature and has not been considered in the model.

7.2.4 Adopted Emission Factors

There exists limited reported measurements of dust emission rates from broiler sheds – based on the fact that odour (as opposed to dust) is the critical air emission descriptor with the potential to create adverse off-site impacts.

A detailed sampling program for the measurement of dust emission rates was carried out on two tunnel sheds at a farm near Tamworth. Sampling was undertaken for a 'cup drinker' shed and a 'nipple drinker' shed. Sampling was undertaken throughout the batch with a round of measurements also conducted in August at week 5 of the batch growout cycle. Mirrabooka Consulting (2002) reported the results. Extracts considered to be relevant / consistent with the proposal have been presented below.

Table 7-2: Particulate Monitoring Results – Week 5, Tunnel Shed (Nipple Drinkers)
(Source: Mirrabooka Consulting, 2002)

Week	Airflow Through Shed (m^3/s)	Emission Rates			
		TSP [X]	TSP / 1000 birds [Y]	PM_{10} [X]	PM_{10} / 1000 birds [Y]
5	10.7	0.139	4.5	0.056	1.8
5	25.4	0.218	7.0	0.089	2.9
5	55.4	0.355	11.5	0.139	4.5
5	69	0.345	12.8	0.117	3.8
5	80.1	0.376	13.9	0.128	4.1

Notes: X - g/s
Y - mg/s

The reported peak TSP concentrations are similar to those measured by Egis Consulting (2001). However, the peak TSP dust emission rates / 1,000 birds were noted to be approximately 50% of the Egis reported values and 25% of the reported UK TSP emission levels (Pollock and Friebel, 2002).

In response to this, the Mirrabooka (2002) studies are to a higher level of detail than any previously reported measurements which Benbow Environmental is aware of. The Mirrabooka (2002) studies were also conducted in accordance with AS 4323.1 and AS 4323.2.

The calculated maximum airflow through the sheds for the proposed scenario are approximately 90 m^3/s for each of the 4 sheds based on values calculated by Hayes, Curran and Dodd (2006). The above Mirrabooka measured results were graphed to interpolate the TSP and PM_{10} emission rates for the airflow of each of the sheds. This is illustrated in Figure 7-1 and Figure 7-2.

Figure 7-1: TSP Emission Rates from Mirrabooka Consulting (2002)

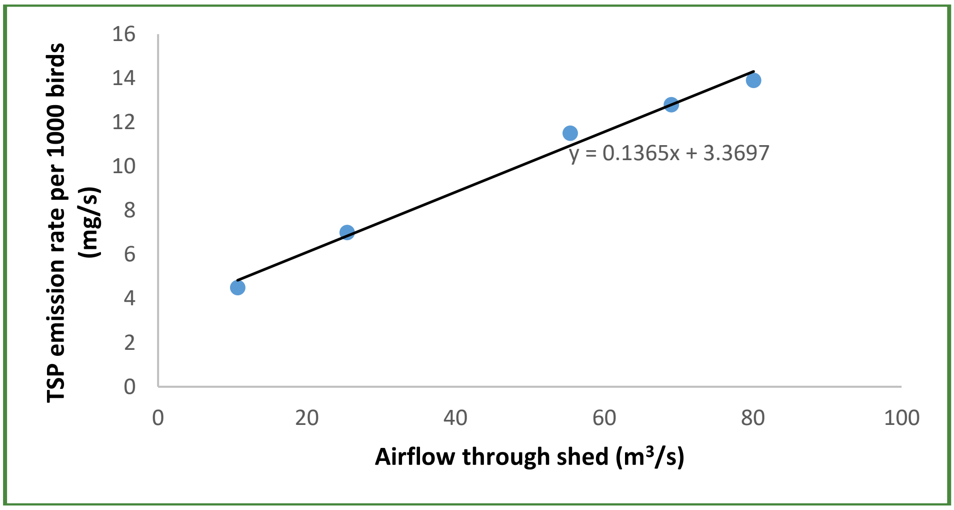
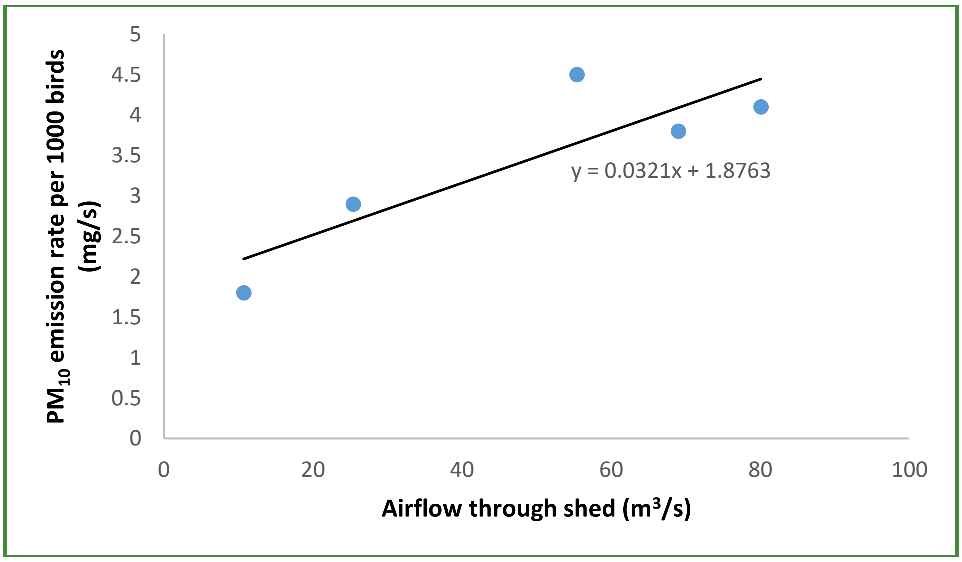


Figure 7-2: PM_{10} Emission Rates from Mirrabooka Consulting (2002)



The regression formulas derived from the Mirrabooka data graphed in The reported peak TSP concentrations are similar to those measured by Egis Consulting (2001). However, the peak TSP dust emission rates / 1,000 birds were noted to be approximately 50% of the Egis reported values and 25% of the reported UK TSP emission levels (Pollock and Friebel, 2002).

In response to this, the Mirrabooka (2002) studies are to a higher level of detail than any previously reported measurements which Benbow Environmental is aware of. The Mirrabooka (2002) studies were also conducted in accordance with AS 4323.1 and AS 4323.2.

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In response to this, the Mirrabooka (2002) studies are to a higher level of detail than any previously reported measurements which Benbow Environmental is aware of. The Mirrabooka (2002) studies were also conducted in accordance with AS 4323.1 and AS 4323.2.

The calculated maximum airflow through the sheds for the proposed scenario are approximately 90 m3/s for each of the 4 sheds based on values calculated by Hayes, Curran and Dodd (2006). The above Mirrabooka measured results were graphed to interpolate the TSP and PM10 emission rates for the airflow of each of the sheds. This is illustrated in Figure 7-1 and Figure 7-2.
Figure 7-1 and Figure 7-2 were used to estimate TSP and PM_{10} emissions on an hourly basis for each batch cycle using the formulas:

TSP g/s = RF(0.1365 x Adjusted airflow + 3.3697) / 1000 x Total number of birds / 1000*
PM_{10} g/s = RF(0.0321 x Adjusted airflow + 1.8763) / 1000 x Total number of birds / 1000*

Where adjusted airflow was calculated as a percentage of maximum airflow using bird age as shown in Table 5-2 and the total number of birds was adjusted to take deaths and thin out into account as described in Section 5.2.3 and Section 5.2.4. A reduction factor (RF) of 0.1 was adopted based on the reduction from the building. The divisions by 1,000 are used to convert the result from mg/s to g/s and from per 1,000 birds to per bird.

A reduction factor of 58% was also applied due to the reduction of emissions from the odour enclosure system surrounding the sheds as detailed in Section 5.6.

7.2.5 Source Configuration and Parameters

One scenario was modelled considering the proposed development of 768,840 birds total within 14 sheds.

The following assumptions were incorporated into the CALPUFF modelling:

- The maximum air flow for existing sheds is assumed to be 188.8 m^3/s for existing shed 1 and 169.9 m^3/s for existing sheds 2-6. The maximum air flow for the proposed sheds is assumed to be 171.0 m^3/s for the proposed sheds 7-14.
- Bird mortality and thin outs as described in in Section 5.2.3 and Section 5.2.4.
- The existing vegetation buffer will provide a reduction factor of 46% as described in Section 5.6.
- Wheel generated dust from vehicles travelling on site will be negligible due to very minor traffic movements, the nature of the vehicles used (e.g. most often buggies), and the use and maintenance of paved and/or vegetated areas to prevent erosion; and
- Particulate emissions are limited to what has been described in Section 7.2.3.
- A batch start date for the week starting 15 January was implemented (see Section 5.2.7).

7.2.6 Batch Start Date

The worst case model result for dust occurs with the batch start day occurring on the week starting 15 January. Therefore, the modelling has been performed utilising 15 January as the batch start date for all sheds.

7.2.7 Dust Emissions Inventory

The dust emission source inventory has been provided in Table 7-3 overleaf as a summary of inputs used to describe the dust emission sources utilised for each scenario.

It is important to note that a variable emissions file has been generated for each scenario, to account for the changes in dust emissions per hour, as per the assumptions listed in Section 7.2.5.

Table 7-3: Dust Emissions Inventory

Source ID	Type	X MGA56 Coordinates (m)	Y MGA56 Coordinates (m)	Source Height (m)	Initial Sigma y	Initial Sigma z	Elevation (m)	Maximum TSP Emission Rates (g/s)	PM_{10} Emission Rates (g/s)	Comments
Shed 1	Volume	276700.18	6570924.2	1	11.22	0.47	328.98	0.138	0.038	Variable Emissions File Used
Shed 2	Volume	276898.7	6570900.9	1	11.21	0.47	329.43	0.128	0.035	
Shed 3	Volume	276861.2	6570908.7	1	11.21	0.47	330.17	0.128	0.035	
Shed 4	Volume	276825.3	6570912.6	1	11.21	0.47	331.77	0.128	0.035	
Shed 5	Volume	276789.2	6570916.6	1	11.21	0.47	332.52	0.128	0.035	
Shed 6	Volume	276751.4	6570920.1	1	11.21	0.47	334.06	0.128	0.035	
Shed 7	Volume	277060.7	6570539.6	1	12.67	0.47	325.54	0.162	0.045	
Shed 8	Volume	277012.6	6570544.7	1	12.67	0.47	326.48	0.162	0.045	
Shed 9	Volume	276962.7	6570549	1	12.67	0.47	327.74	0.162	0.045	
Shed 10	Volume	276912.2	6570553.7	1	12.67	0.47	328.25	0.162	0.045	
Shed 11	Volume	276861.3	6570557.5	1	12.67	0.47	328.87	0.162	0.045	
Shed 12	Volume	276813.8	6570563.5	1	12.67	0.47	329.92	0.162	0.045	
Shed 13	Volume	276763.4	6570573.8	1	12.67	0.47	331.39	0.162	0.045	
Shed 14	Volume	276711.9	6570577.5	1	12.67	0.47	332.18	0.162	0.045	

7.2.8 Dust Impact Modelling Results

Dust impact modelling results have been summarised in the tables below and visualised in the figures following.

Table 7-4: Predicted Dust Impacts – PM_{10} 24 hour 100th percentile

Receptor ID	PM_{10} 24-hour impact (µg/m³)	Background (µg/m³)	Total impact (µg/m³)	Complies with criteria of 50µg/m³?
R1	0.74	40.4	41.14	Yes
R2	1.62		42.02	Yes
R3	0.30		40.70	Yes
R4	0.75		41.15	Yes
R5	0.20		40.60	Yes
R6	0.19		40.59	Yes
R7	2.58		42.98	Yes
R8	1.45		41.85	Yes

Table 7-5: Predicted Dust Impacts – PM_{10} Annual 100th percentile

Receptor ID	PM_{10} annual impact (µg/m³)	Background (µg/m³)	Total impact (µg/m³)	Complies with criteria of 25µg/m³?
R1	0.11	15.1	15.21	Yes
R2	0.10		15.20	Yes
R3	0.01		15.11	Yes
R4	0.03		15.13	Yes
R5	0.01		15.11	Yes
R6	0.02		15.12	Yes
R7	0.49		15.59	Yes
R8	0.24		15.34	Yes

Table 7-6: Predicted Dust Impacts –TSP Annual 100th percentile

Receptor ID	TSP annual impact (µg/m³)	Background (µg/m³)	Total impact (µg/m³)	Complies with criteria of 90µg/m³?
R1	0.25	29.6	29.85	Yes
R2	0.24		29.84	Yes
R3	0.03		29.63	Yes
R4	0.07		29.67	Yes
R5	0.02		29.62	Yes
R6	0.04		29.64	Yes
R7	1.15		30.75	Yes
R8	0.55		30.15	Yes

Figure 7-3: 24 hour incremental impact PM_{10} contours

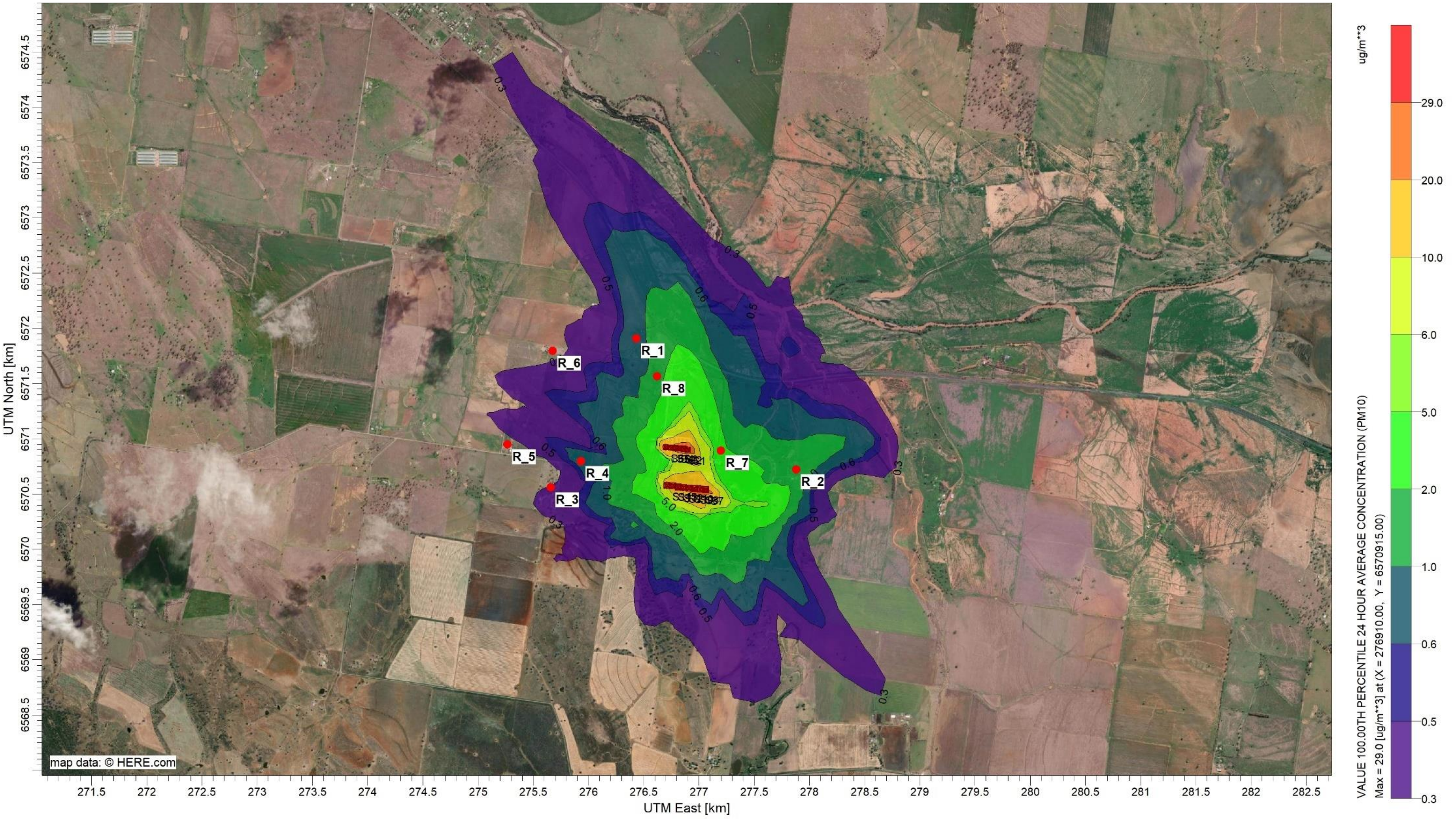


Figure 7-4: Annual incremental impact PM_{10} contours

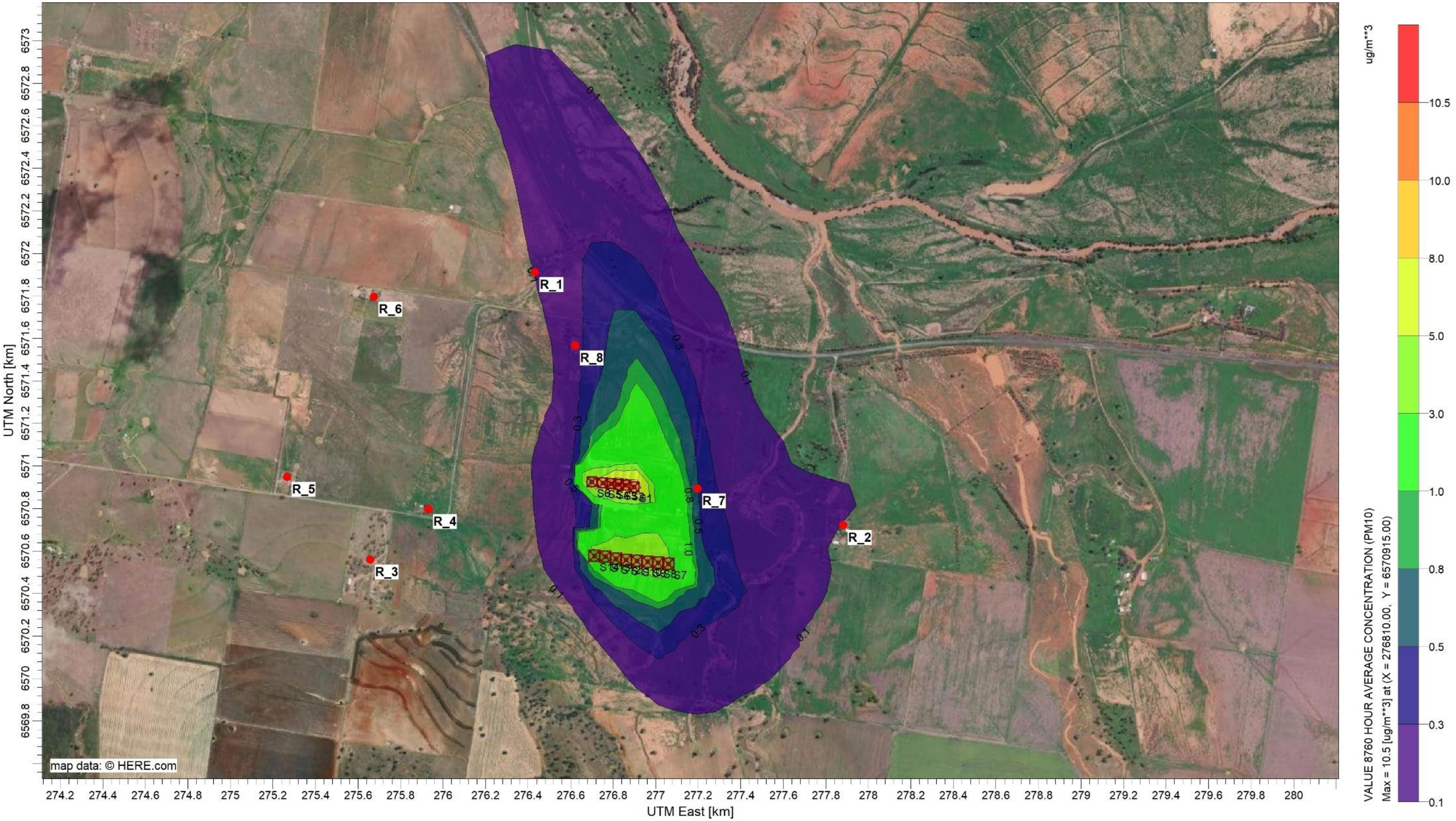
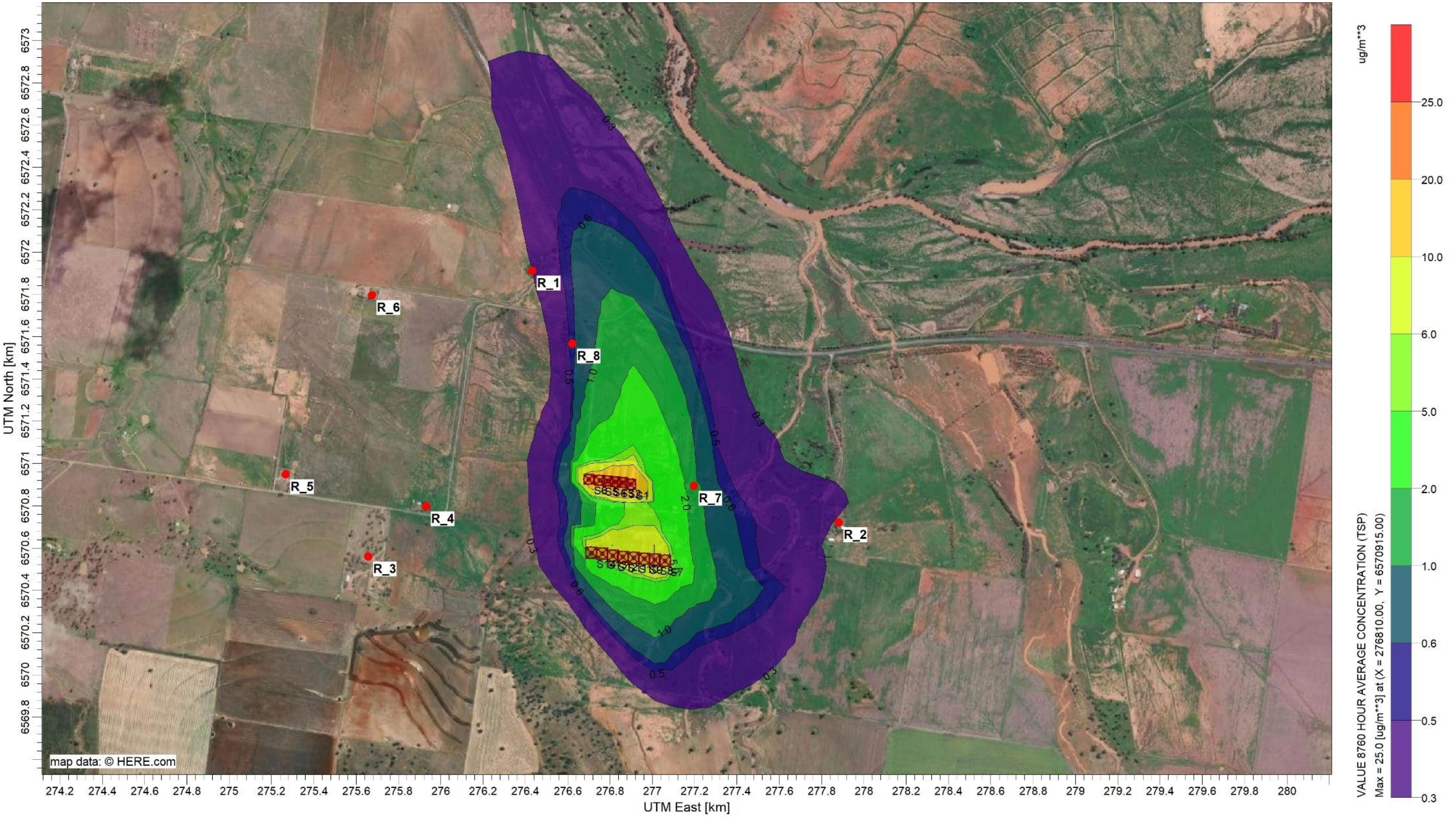


Figure 7-5: Annual incremental impact TSP contours



7.2.9 Contemporaneous Impact and Background

In the event of high background levels of PM_{10} or TSP, the *Approved Methods* requires a demonstration that no additional exceedances of the impact assessment criteria will occur as a result of the proposed site activities.

As the background levels of PM_{10} or TSP and the maximum predicted impacts for PM_{10} and TSP comply with the Approved Methods criterion at all sensitive receptors, a contemporaneous impact assessment is not considered warranted.

7.3 Discussion of Results and Summary of Dust Impact

The maximum predicted impacts for PM_{10} and TSP comply with the Approved Methods criterion at all sensitive receptors.

8. CONTINGENCY MEASURES

As odour impacts are affected by many factors including the weather, litter management, cleaning techniques, and dead bird disposal, there is some degree of uncertainty with regards to predicting impacts. Furthermore there is debate in the field about the most accurate way to model and establish emission rates due to the limited sampling data available. Due to this uncertainty this section presents contingency measures that may be implemented to further reduce odour impacts.

Generally, odour controls are applied at the site in the first instance, and at the receiver there after.

8.1 SOURCE CONTROLS (POULTRY FARM)

The following controls can be put in placed in a staged approach dependent on the requirement for odour suppression, and when combined will have a cumulative impact of odour reductions. They are listed below in order of application and effectiveness, and are discussed further below:

1. Tunnel ventilation
2. Odour enclosures
3. Vegetative buffer

These are the most common controls implemented at poultry farms. The development that has been assessed already utilised tunnel ventilation, however it is explored further below to illustrate the level of control existing already at the site.

8.1.1 Tunnel Ventilation

Ventilation in poultry sheds allows farmers to control temperature, humidity and air contamination and litter moisture content. These are all variables in odour impacts on surrounding receivers. Considerations for a ventilation requirement are dependent of time of day/year, weather, climate, bird age and density. Natural ventilated sheds are more subject to local wind patterns than tunnel ventilated.

Tunnel ventilation systems use exhaust fans at one end of the shed and large openings at the other end to effectively create a wind tunnel. Tunnel ventilation is especially effective during high temperature periods due to the cooling effect produced by the greater air movement. This reduced heat from shed caused by bird body heat and solar radiation.

Tunnel ventilation is a preferred method of ventilation as it not only reduces impacts from worst case temperatures, but its odour reducing qualities are further enhanced by allowing for combination with wind breaks, vertical stacks, or odour enclosures.

It is common practice in the industry to convert naturally ventilated sheds to tunnel ventilated sheds. This involves installing a bank of exhaust fans on one end of the shed and permanently closing the natural ventilation openings.

This site already utilises tunnel ventilation in its existing sheds, and will too for the proposed sheds.

8.1.2 Odour Enclosures

Benbow Environmental has developed an odour control, designed specifically for tunnel ventilated sheds. The design, called an "Odour Enclosure", is an enclosure placed at the tunnel fan bank-end of the shed to treat the odour released from the enclosure. This design is developed based on the following principles:

- Centralised odour control;
- Maximised residence time;
- Maximised surface contact with odour particles in the tunnel ventilated air stream;
- Ability to promote vertical momentum, which would promote dispersion;
- Minimal running costs compared to power-consuming technologies such as electro-static precipitators; and
- Flexibility of the design

The system consists of the following core items:

- Three walls made out of steel and wood, constructed to surround the main fan bank.
- Shade cloth wrapped on top of three walls to act as a ceiling of the enclosure, engineered to have a capability to open a part of the shade cloth ceiling. The shade cloth is UV protected and is of high quality to provide many years of service.
- Water foggers/fine misters installed below the height of the shade cloth ceiling such that the air flow passes firstly under the sprays and then above the sprays the double passage of the air provides for increased residence time.
- Effective engineering design by Benbow Environmental.

The Odour Enclosure achieves the following aspects in relation to odour control:

- Sufficient residence time maximises contact of fine water droplets with dust and odour particles;
- Shade cloth effectively captures dust particles;
- Enhanced dispersion by inducing a vertical momentum;
- Centralising control of emissions at one location and treated all under the same condition; and
- An odour reducing chemical is able to be added to the fine water droplets to react with the ammonia and other odorous substances in the air released from the shed.

A unique design is prepared the farm depending on the location of surrounding receptors and the design mode preferred by the farm operators. Sizing of the enclosures is critical, and location, number and types of foggers are important factors in ensuring the odour is reduced by up to 58%.

An enclosure is added to the tunnel ventilated end of the poultry shed. This consists of impervious walls, a shade cloth roof and a bank of water atomising nozzles that fog the air within the enclosure.

The odorous air passes through the bottom half of the enclosure, making contact with millions of fine droplets (i.e. a fog) of water. The air is reflected off the end wall of the enclosure and passes back across the top half of the enclosure and the air makes more contact with the fog.

The air is then released through openings which can either be in the roof of the enclosure or through the side walls, hence allowing the air to be dispersed in a direction to favour dispersion of the remaining odour remnants in the air being discharged. The odour enclosures have been proven by dynamic olfactometry testing to be approximately 58% effective in reducing total quantity of odorous air discharged from tunnel ventilated sheds.

Additions can be made to the odour enclosure to enhance vertical dispersion and further reduce impacts.

8.1.3 Vegetative Buffer

Should the development site require further mitigation it is recommended that the level of reduction required is first assessed and then measures are applied in a staged approach and then reassessed for efficacy before applying further mitigation measures. A Vegetative Environmental Buffer (VEB) may be implemented as a contingency measure only should further mitigation be required.

It is important to note that vegetation buffers have two significant disadvantages:

- Fire hazard; and
- Biosecurity risk (as they attract other avian species).

They are an effective control method when appropriate, and their efficacy is discussed further below.

The Australian Government Rural Industries Research and Development Corporation Vegetative Environmental Buffers for Australian Meat Chicken Farms: A Guide for Growers (Prentice, Bielefeld and McGahan, 2015) discusses the use of vegetative environmental buffers (VEB) to reduce the off-site air quality impacts of dust and odour from chicken meat farms.

VEBs are a dense multiple-row planting of trees or shrubs and grasses and are positioned immediately downwind of fans for tunnel ventilated livestock buildings to filter air. VEBs intercept and adsorb particulates (dust) and aerosols (odour and ammonia) from the exhaust fans' emission plume and thus could be effectively used at the subject site to reduce odour impacts on the surrounding area.

The above guidelines should be consulted to assist in VEB design and plant selection.

Much more extensive investigations of the effectiveness of vegetation for odour and dust control from various farms have been undertaken in the USA.

Malone *et al.* (2006) at the University of Delaware examined the effectiveness of vegetation in odour control. In this study, vegetative environmental buffers (VEB) have installed a system consisting of the following: three-row planting of a 16 ft (4.9 m) tall bald cypress at 30 ft (9 m) downwind of the tunnel fans, 14 ft (4.3 m) tall Leyland cypress at 40 ft (12.2 m) downwind of the tunnel fans, and 8 ft (2.4 m) tall Eastern red cedar at 48 ft (14.6 m) from the tunnel fans. Results from installation of this VEB showed a reduction of approximately 49% ± 27% for dust and 46% ± 31% for ammonia concentrations. The margin of standard deviation observed (27% and 31% respectively) were found to be due to the wind directions caused during the sampling events.

Parker, et al. (2012) found that at two separate 8-barn swine finisher sites in Missouri, in comparison to a control site, a simple VEB reduced odour concentrations by almost 50% in the VEB and by two-thirds at a distance of 15 m downwind of the VEB.

Lin et al. (2007) describe field data that shows under variable atmospheric conditions VEB can reduce what is called the "maximum odour dispersion distance" (MODD) or the distance required to dilute odour below acceptable levels. According to this study, depending on air temperature, wind direction and speed, VEB reduced MODD at field sites by up to 40%.

For certain constituents of odour such as H_2S however, the downwind effects of VEB are not always consistent. For example Hofer (2009) measured decreasing effectiveness of a VEB in terms of H_2S concentration at downwind distances greater than 500 m. Along with field level data, various laboratory and experimental research has pointed to odour mitigation outcomes due to VEBs.

Wind tunnel and computer simulations have quantified reduced particulate and odour movement due to the presence of strategically located trees (Laird, 1997; Lammers, 2001). For example, at Iowa State University, Laird (1997) recorded via wind-tunnel modelling a 56% reduction in simulated off-farm dust movement. Experimental investigation of vegetative environment buffers in reducing particulate matters emitted from ventilated poultry house showed that the VEB had the best PM concentration reduction rate of 47.24% ± 4.33% and 41.13% ± 5.83% for $PM_{2.5}$ and PM_{10}, respectively.

Figure 8-1: Photograph of a Vegetative Environmental Buffer

Image Source: Malone et al, 2006

This above vegetation environmental buffer can be further improved by first placing an earth berm of typically 1.5 m height and planting dense vegetation to a minimum width of 5 m and heights of the vegetation ranging from 3 m to 5 m or higher. Vegetation types need to retain leaf cover through all seasons of the year.

An effective layout for the vegetation environmental buffer is provided in Figure 8-2 and An effective arrangement to apply the plantation arrangement is shown in Figure 8-3. The rectangular shape represents the screening area whilst the green circles represent the required position of the plants.

Figure 8-2: Effective vegetative environmental buffer layout

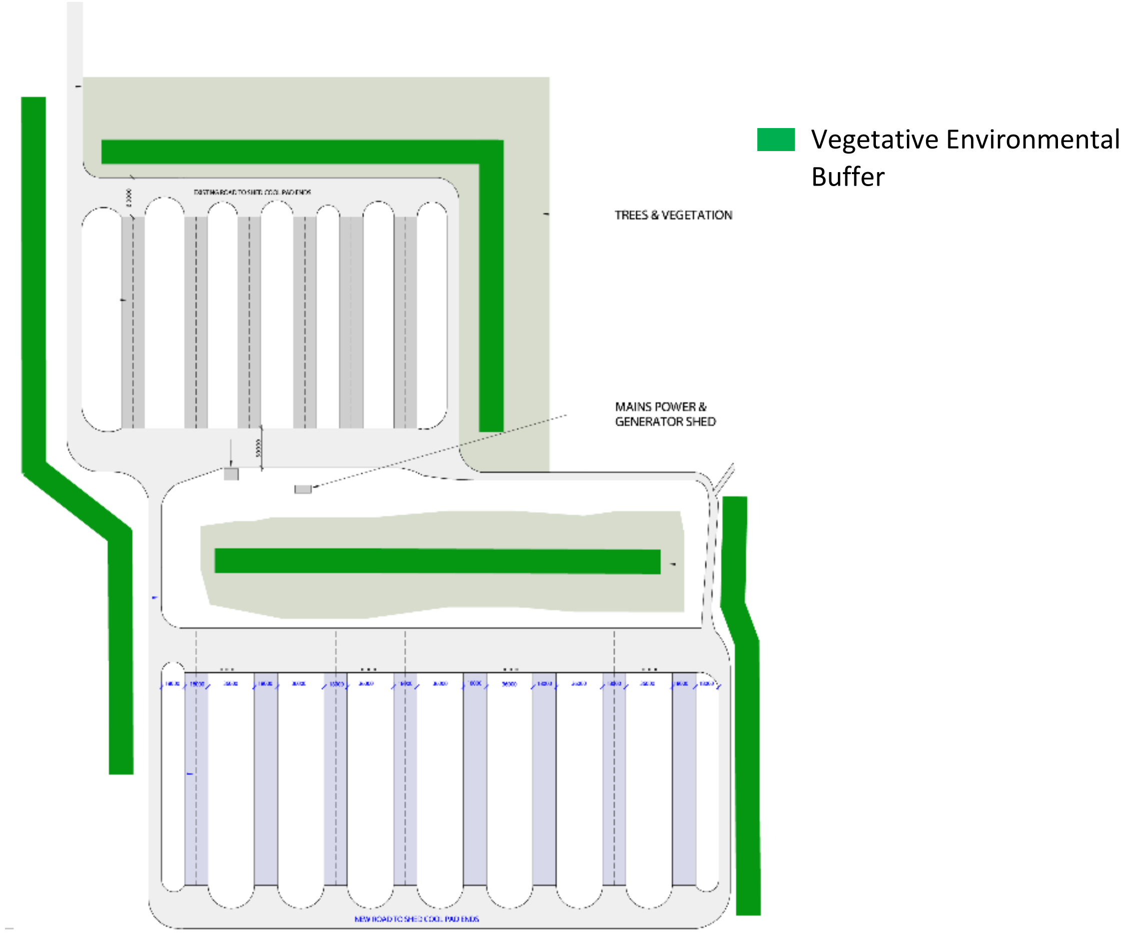
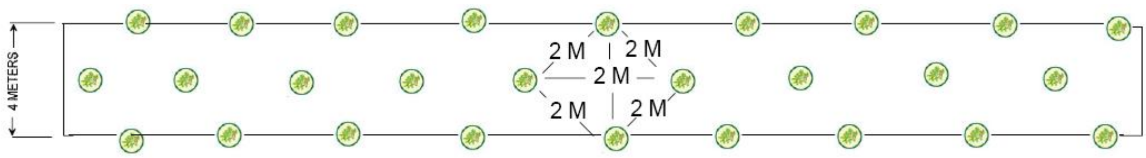


Figure 8-3: Planting Configuration for Effective Odour Reduction.



8.2 RECEIVER CONTROLS

Odour impacts are in general worst case at ground level where additional odour controls may be considered appropriate. An additional vegetation buffer an impacted receiver would be a low cost and aesthetically enjoyable odour control to be used at the receiver.

8.3 MITIGATION MEASURES REQUIRED

This assessment finds that the "Odour Enclosure" system is required for compliance. Further details regarding the "Odour Enclosure" system is provided in Attachment 4. Should the development site require further mitigation it is recommended that the level of reduction required is first assessed and then measures are applied in a staged approach and then reassessed for efficacy before applying further mitigation measures. A Vegetative Environmental Buffer (VEB) may be implemented as a contingency measure should further mitigation be required.

As predicted 99th percentile concentrations comply with this criterion at all sensitive receptors with the odour enclosures in place, no odour monitoring measures are considered warranted.

9. RISK ASSESSMENT OF DEVELOPMENT

Odour is considered the highest risk of this development. The close proximity of the nearby sensitive receptors requires that thorough evaluation of the potential risk. The highest offsite odour impact occurs at receptor site R2 with an impact of 4.21 OU for cycle 3.

The level of uncertainty regarding predictive modelling results depends on the uncertainty in both the inputs and the model performance. CALPUFF is the preferred model for odour assessments by the NSW EPA. It is noted that dispersion models are generally more reliable at predicting the highest concentrations at an approximate area and approximate time and estimate at a specific time and site are poorly correlated with actual observed concentrations. These limitations are outlined in the Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the ‘Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia’.

Uncertainty regarding inputs can be reduced by validation at various stages of the assessment. The domain size is 20 km x 20 km, which provided sufficient area to inspect terrain. The grid spacing of 0.2 km is sufficiently small enough to capture terrain effects. Land use files were site specifically made using the land use creator tool to ensure there were no incorrect or missing categories. A comparative analysis of TERRAD numbers where conducted. Windfields were inspected after CALMET run and looked as expected.

Although the meteorological data was not measured at the site, it is generated from WRF satellite imagery for the specific site, and no-obs prognostic data is preferred data set by NSW EPA as it accounts for spatial variability in both horizontal and vertical fields, and limits user error in CALMET inputs It is sufficiently accurate to represent the area.

The assessment has used emission data that is representative of the worst-case operations, discussed in Section 5.2. In the emission rate calculation utilised in the modelling the odour emission rate is proportional to the airflow such that a higher airflow will results in a higher odour emission rate. In practice however, higher air flows reduce the impacts of odour from the chickens in the sheds as continual airflow helps to reduce odour build up and reduces litter moisture. As such, using a higher airflow for all will produce higher emission rates in total and thus is a conservative assessment. It is highly unlikely that the assessment has underpredicted impacts.

The assessment was conducted with guidance from the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the ‘Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia’* and inspected at every possible stage to assess the model performance. The uncertainty surrounding user inputs is considered to be sufficiently controlled.

Additional mitigation measures including an “Odour Enclosure” system is warranted and are described in Section 8. Further details regarding the “Odour Enclosure” system is provided in Attachment 4.

Proposed odour mitigation measures are not complex in design and are readily available should they be necessary due or if unforeseen circumstances arise in the future. Although simple measures, they are costly and require resource use to construct and run, as well as taking up valuable land.

Poultry developments are economically valuable to regional areas, and as this area is an existing poultry development, Council may consider it beneficial to the community to maintain the area zoning and ensure that future residential developments are in areas that are amenable to that use.

10. STATEMENT OF POTENTIAL DUST AND ODOUR IMPACT

The NSW EPA guidelines *"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales"*, *"Technical framework - Assessment and management of odour from stationary sources in NSW"* and *"Technical notes - Assessment and management of odour from stationary sources in NSW"* were utilised for the preparation of this dust and odour assessment report.

This assessment has adopted the respective methodologies from these guidelines, including the selection of the most up to date meteorological data, the application of site specific odour measurements for calculation of emissions data, and the set-up of the dispersion model to simulate the emissions from the subject farm.

This assessment finds that an "Odour Enclosure" system is warranted, where an enclosure is placed at the tunnel fan bank-end of the shed to treat the odour released from the enclosure. A 6 OU criterion has been adopted for the site as only two off-site receptors are predicted to experience odour units of approximately 2 OU. A reduction factor was applied to the model to account for the "Odour Enclosure" system and the highest offsite odour impact occurs at receptor site R2 with an impact of 4.21 OU for cycle 3.

Predicted 99th percentile concentrations comply with this criterion at all sensitive receptors with the odour enclosures in place.

The maximum predicted impacts for PM_{10} and TSP comply with the *Approved Methods* criterion at all sensitive receptors.

[redacted] [redacted] [redacted]

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12. LIMITATIONS

Our services for this project are carried out in accordance with our current professional standards for site assessment investigations. No guarantees are either expressed or implied.

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