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Report

"Avondale Farm" – Odour Assessment

Ellerslie Free Range Farms Pty Ltd

TOOWOOMBA REGIONAL COUNCIL

APPROVED DOCUMENT

referred to in Council's Decision Notice dated

29 April 2026

This plan is subject to conditions of Approval Number

MCUI/2020/1100/A

Assessment Manager

Job: 24-175
Date: 2 September 2025

Astute Environmental Consulting

Astute Environmental Consulting Pty Ltd
PO Box 6147, Clifford Gardens, QLD 4350
ABN - 50 621 887 232
Ph: +61 429 304 644
www.astute-environmental.com.au

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Project Title	Avondale – Odour Assessment
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Astute Environmental Consulting Pty Ltd
15 Argon Street, Carole Park, Qld. 4300
PO Box 6147, Clifford Gardens, Qld. 4350
ABN - 50 621 887 232

admin@astute-environmental.com.au
www.astute-environmental.com.au

1 INTRODUCTION

Astute Environmental Consulting was engaged by Property Projects Australia (PPA) on behalf of Ellerslie Free Range Farms Pty Ltd (Ellerslie) to perform an odour assessment at an existing approved layer farm known as Avondale. Avondale is located off Turralin Road at Turralin on land described as Lot 2 on RP79686 ("the site").

1.1 Background

It is proposed that the site approval be modified so that a 12 shed layer farm be established with each shed containing 70,000 birds per shed for a total number of 840,000 birds. The site layout is shown in Figure 1-1 and overlaid on recent aerial imagery in Figure 1-2. The locations of the sheds have been digitised by Astute and some spatial inaccuracies may have occurred in this process.

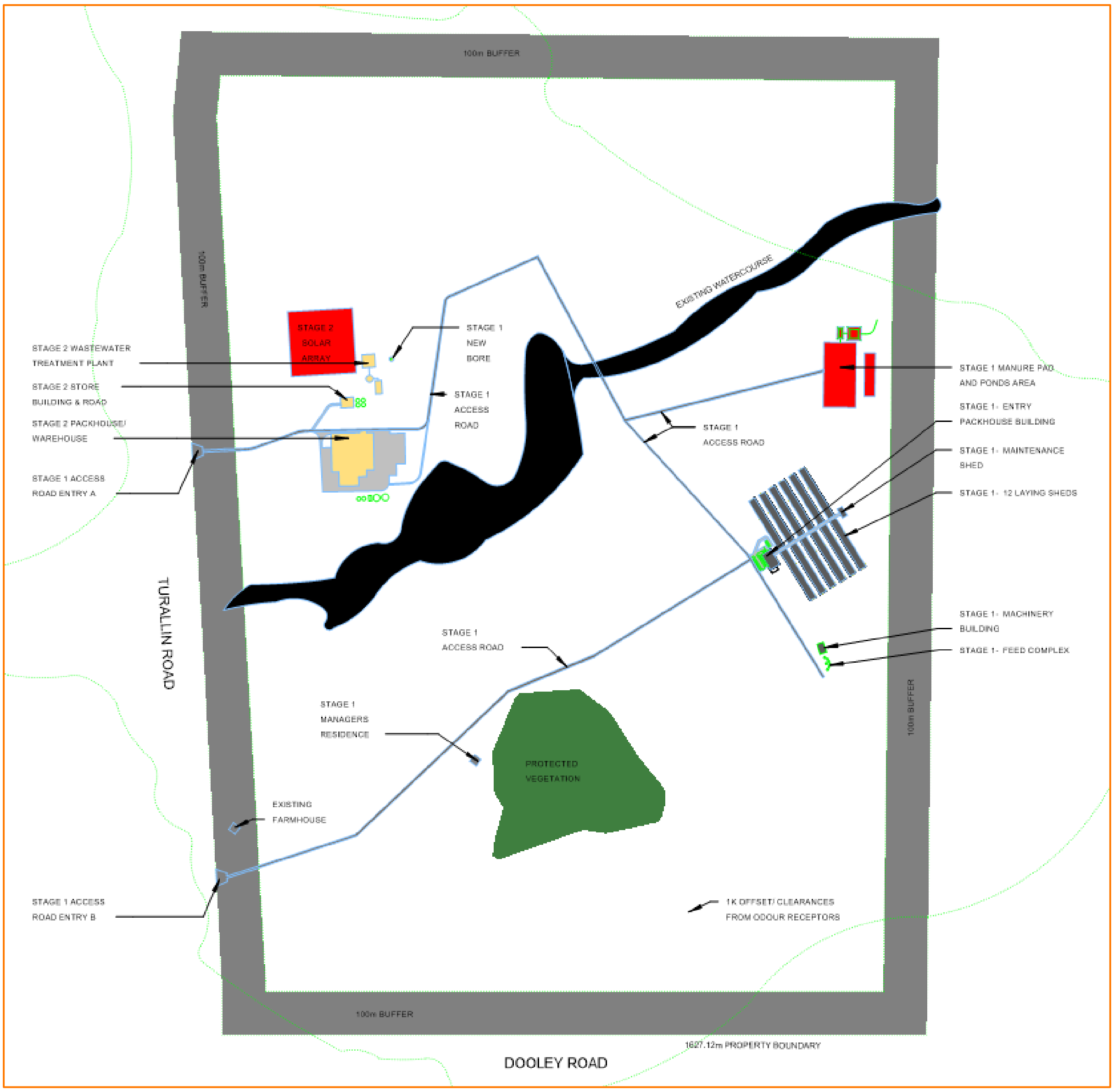


Figure 1-1: Site Layout (source Client)

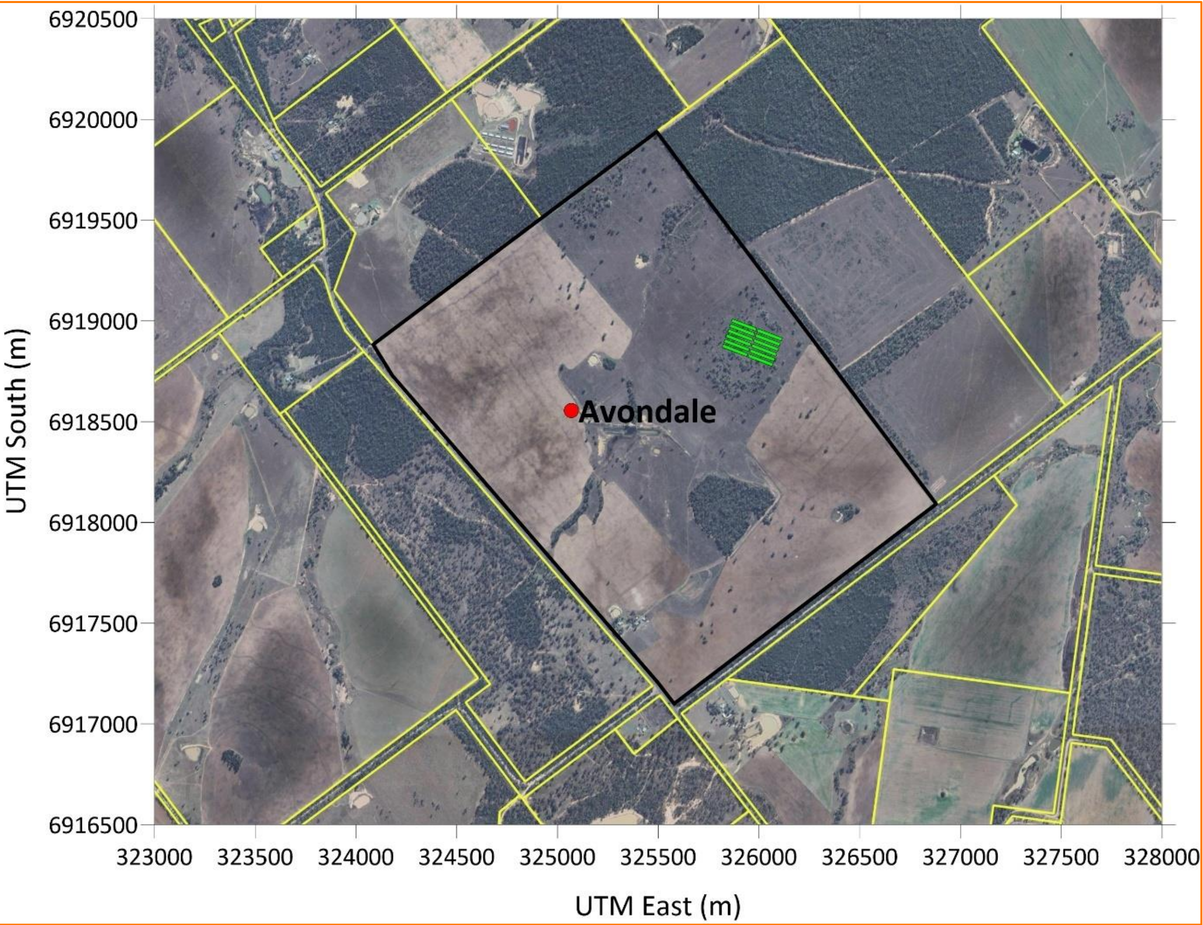


Figure 1-2: Proposed Shed Layout (Source Client)

The site is located approximately 5 km to the east of the existing Ellerslie layer farm and 6 km to the southeast of the existing Glenferrie layer farm as shown in Figure 1-3.

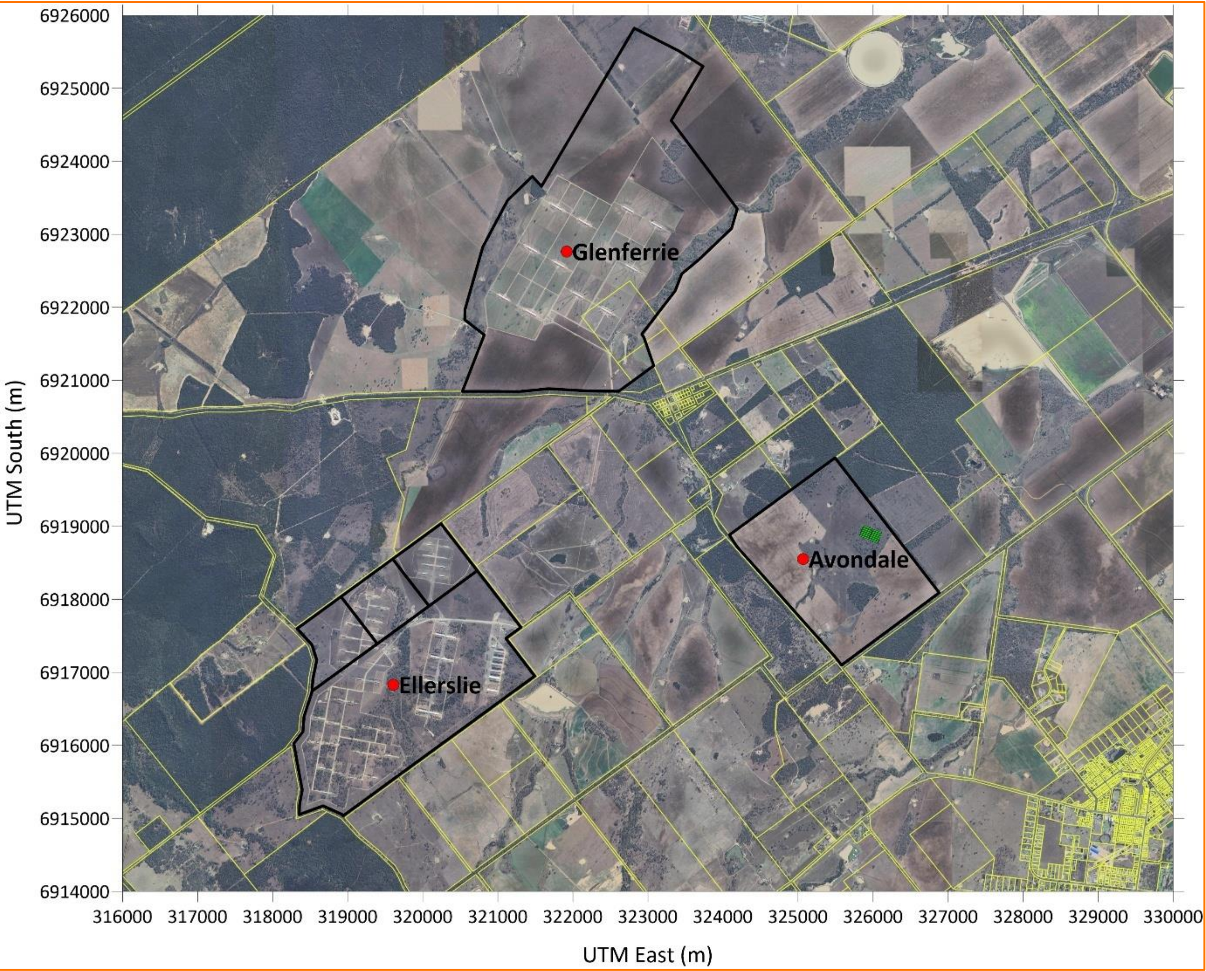


Figure 1-3: Avondale, Ellerslie and Glenferrie

1.2 Scope of Work

The scope of work for the assessment included:

- Obtaining information about the proposed sheds;
- Analysing regional weather data;
- Modelling meteorology for the area using TAPM/CALMET;
- Estimating emissions for the shed in line with standard methods;
- Predicting odour dispersion using CALPUFF; and
- Preparing a report.

The methodology used is summarised graphically in Figure 1-4.

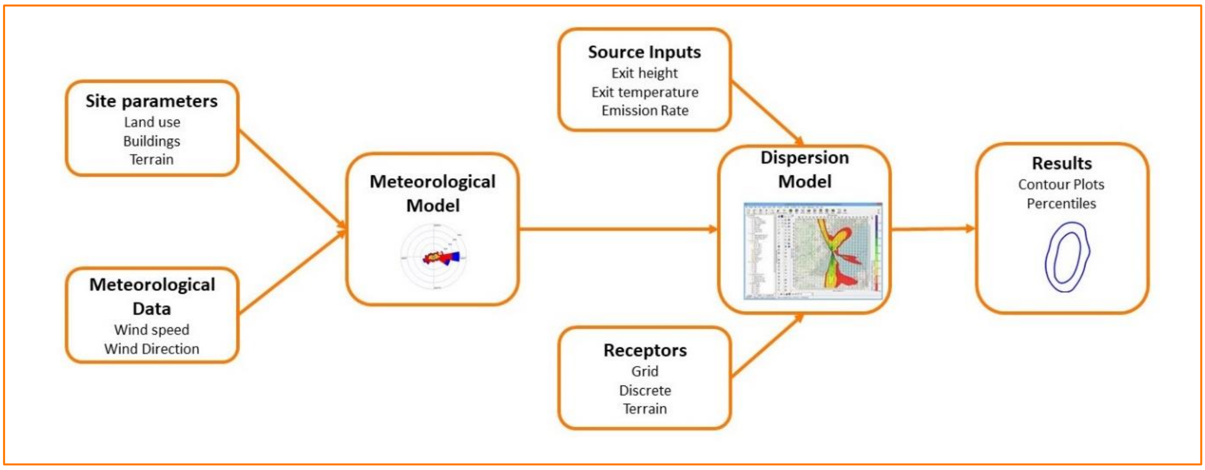


Figure 1-4 Modelling Methodology

2 ASSESSMENT CRITERIA

The *Guideline: Odour Impact Assessment from Developments* (DESI, 2024)is the principal guidance document used in Queensland for assessing odour impacts.

In addition to providing guidance on how to estimate odour emissions and model the dispersion of odour, the guideline states that odour concentrations predicted by the modelling at the "most exposed existing or likely future off-site sensitive receptors" should be compared with the following guideline values:

- 0.5 ou, 1-hour average, 99.5th percentile for tall stacks; and
- 2.5 ou, 1-hour average, 99.5th percentile for ground-level sources and down-washed plumes from short stacks.

As the poultry sheds are considered to be ground-level sources the appropriate odour criterion is 2.5 ou 1-hour average, 99.5th percentile ($C_{99.5\ 1hr}$ = 2.5 ou).

3 MODELLING METHODOLOGY

3.1 Representative year

The selection of a representative meteorological year for dispersion modelling is critical. Typically, only a single year of a data is included in and assessment which therefore represents the predicted impacts for any given time. It is critical that this year represents longer term averages. Critical meteorological factors include wind speed, temperature and relative humidity and they need to be assessed against long term data for the selected area to select the modelling year.

We obtained wind speed and direction data from the Dalby BOM station. Dalby was selected as there are no stations near the site with publicly available data. Stations such as Toowoomba and Oakey were not assessed as they have highly localised wind profiles due to their distance to the Great Dividing Range.

Checks of the Dalby data were made for temperature, relative humidity and wind speed with an aim of selecting a year which was not significantly different to the long term averages. Several years were analysed, and 2013 was selected. The results of the assessment are shown below in Table 3-1 for the year modelled, 2013.

Table 3-1: Summary of Statistical Results - 2013

Variable	Z Score	Z_{crit}	Conclusion
Temperature	0.84	±2.575	Representative
Wind Speed	-2.41		Representative
Humidity	-1.74		Representative
Rainfall	-0.298 (t Stat)	±2.201 (t Critical)	Not significantly different to long term average dataset.

3.2 Meteorological Modelling

For this project, we used the hybrid approach as detailed in the Generic Guidance and Optimum Model Settings for the CALPUFF modelling system for inclusion into the Approved (OEH, 2011).

3.2.1 Background to use of TAPM in Area

For this project we have relied on The Air Pollution Model (TAPM) . This is consistent with DESI (2024) which allows a user to derive site specific meteorology for an area using prognostic models including TAPM.

Previous project work we have performed has shown that TAPM compares well to observed data for other sites. An example of local data is the data from the Millmerran AWS operated by the state government during the early 2000s (Casey, et al., 1998).

To check the performance of TAPM, a comparison of key meteorological variables predicted by TAPM (300m grid, default inputs) were compared to measured data using the benchmarks detailed in Emery et. al (2001) and Johnson (2019). The results are shown below in Table 3-2. It can be seen in the table that the model performs well for the area and that TAPM is suitable for use where there is no local observed data for the period that is to be modelled.

Table 3-2: Summary of Meteorological Model Performance at Millmerran 2002

Variable	Benchmark	Averaging Period	Calculated Value	Comment
Wind Speed				
Bias	±0.5	Hourly	-0.1	Pass
RMSE	<2	Hourly	1.3	Pass
IO	>0.6	Hourly	0.8	Pass
Wind Direction				
Bias	±10	Hourly	8.6	Pass
Gross Error	<30°	Daily	25	Pass
Temperature				
Bias	±0.5	Hourly	0.0	Pass
IO	>0.8	Hourly	1.0	Pass

3.2.2 TAPM

TAPM (version 4), is a three-dimensional meteorological and air pollution model developed by CSIRO. The model is a prognostic model which uses synoptic scale data to predict hourly meteorology in the area modelled. Details about TAPM can be found in the TAPM user manual (Hurley, 2008a) and details of the model development and underlying equations can be found in Hurley (2008b). Details of validation studies performed for TAPM are also available and include Hurley et. al. (2008c).

TAPM v4 predicts meteorological data including wind speed and direction in an area using a series of fluid dynamics and scalar transport equations (Hurley, 2008b) and it has both prognostic meteorological and air pollution (dispersion) components. The benefit with using TAPM is that key meteorological aspects including the influence of terrain induced flows are predicted both locally and regionally.

The TAPM default land use database was further refined as it poorly represented the land use within the 300m modelling domain. The default and adjusted land use files are presented in Figure 3-1. The TAPM setup is summarised in and is consistent with good practice and the requirements in NSW EPA (2017).

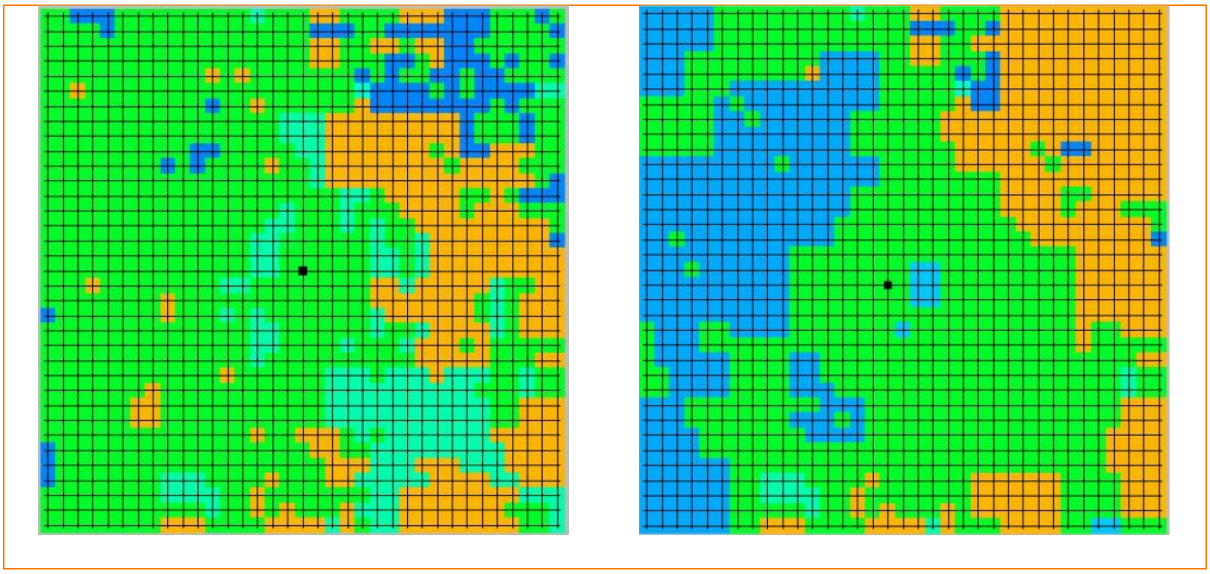


Figure 3-1: Default TAPM (left) and Adjusted Landuse (right) for the Site

3.2.3 CALMET

CALMET is the meteorological pre-processor to CALPUFF and generates wind fields which include slope flows, terrain effects, and can incorporate factors including terrain blocking. CALMET uses meteorological inputs in combination with land use and terrain information for the modelling domain to predict a three-dimensional meteorological grid (which includes wind speed, direction, air temperature, relative humidity, mixing height, and other variables) for the area (domain) to be modelled in CALPUFF.

A 30 km x 30 km domain was modelled for the proposed modification with the centre of the domain near the existing farm. A terrain resolution of 30m was used throughout the domain and was initially taken from the SRTM dataset using CALPUFF view. This was then converted to a 150m resolution for the model runs.

Landuse was initially based on the Australia Pacific Global Land Cover Characterisation (GLCC) dataset at 1km resolution. The land use was then manually edited at 150m resolution based on a recent aerial photograph of the area using Google Earth Pro and CALPUFF View.

3.2.4 CALPUFF

CALPUFF (Exponent, 2011) is a US EPA regulatory, non-steady-state puff dispersion model that simulates the effects of varying meteorological conditions on the emission of pollutants. The model contains algorithms for near source effects including building downwash, partial plume penetration as well as long range effects such as chemical transformation and pollutant removal. CALPUFF is widely recognised as being the best model for odour studies as it handles light wind conditions and terrain effects better than simpler steady state models such as AUSPLUME and AERMOD. As such it is accepted as a regulatory model in all states of Australia.

CALPUFF simulates complex effects including vertical wind shear, coastal winds including recirculation and katabatic drift. The model employs dispersion equations based on a Gaussian distribution of puffs released within the model run, and it takes into account variable effects between emission sources.

In line with good practice, all sheds have been assumed to be tunnel ventilated and therefore have been represented as pseudo point sources at the fan end of the sheds. This means that each shed had a point source on the tunnel fan end of each shed with a diameter the same as the shed width. If positive ventilation were used, the flows would be spread over a larger area and therefore not significantly different from what has been modelled. The vertical velocity in the point source was varied as a function of the maximum predicted ventilation rate to ensure that the momentum of the plume (and thus plume mass) was maintained. The vertical momentum was set to zero by using the 'rain hat' switch in CALPUFF. This ensures that the plume did not move vertically in the model but starts near ground level and disperses slowly from there.

Building wake has been shown to have a negligible effect on the predicted concentrations of low-level sources such as chicken sheds therefore building wake has not been included in the modelling.

Table 3-3: TAPM, CALMET and CALPUFF Setup

Model	Parameter	Value
TAPM (v 4.0.5)	Number of grids (spacing)	30km, 10km, 3km, 1km
	Number of grid points	35 x 35 x 25 (vertical)
	Year of analysis	2013
	Centre of analysis	27° 49'30" South (latitude), 151° 13'00" East (longitude)
	Meteorological data assimilation	NA
CALMET (v 6.334)	Meteorological grid domain	30km x 30km
	Meteorological grid resolution	0.15km
	South-west corner of domain	X = 309.000 km, Y = 6905.500 km
	Surface meteorological stations	NA
	Upper air meteorological data	NA
	3D Windfield	m3D from TAPM (0.3km) input as in initial guess in CALMET
	Year of analysis	2013
	Terrad	2.5 km
CALPUFF (v 6.42)	Method used to compute dispersion coefficients	2 - dispersion coefficients using micrometeorological variables
	Minimum turbulence velocity (Svmin)	0.2 m/s
	Building downwash included	No
	Default settings	All other CALPUFF defaults have been used in line with OEH (2011).

3.3 Farm Information

The inputs used to estimate emissions for the Avondale sheds as well the neighbouring farms of Ellerslie and Glenferrie are detailed below in Table 3-4.

Table 3-4: Poultry Sheds

Farm	Shed number	Shed type	Cycle day start	Number of birds per shed	Total birds
Avondale	A1 – A12	Layers	1	70,000	840,000
				TOTAL	**840,000**
Glenferrie	G1 – G18	Layers	1	40,000	720,000
				TOTAL	**720,000**
Ellerslie	E1-5	Free range layers	1	25,000	125,000
	E6	Free range layer	1	40,000	40,000
	E7-E14	Open range layers	1	21,000	168,000
	E15-E44	Organic layers	1	4,600	138,000
	E45-E48	Rearing	1	20,000	80,000
				TOTAL	**551,000**

3.4 Emissions Estimation

3.4.1 Layers

The basis of the emissions estimation method is detailed in *Odour Review of Layer Farms and Development of S-Factor Formula* (McGahan & Galvin, 2018). The method is based on published data from Australian layer farms.

The method conservatively assumes that all sheds are tunnel ventilated and therefore the first step is to estimate the required airflow at any given point in time based on the ambient temperature and number of birds present. This is done using (Equation 1.

$$Q = 0.1104 \times e^{0.1118 \times \mathrm{T}x}$$ **Equation 1**

Where Q is airflow in m^3/s/1000 birds and T is the ambient temperature in °C.

The next step is to estimate odour emissions based on the airflow, this was done using Equation 2. This methodology assumes large birds are continually present and the sheds are full over the whole year.

$$\frac{OER}{1000\ birds} = 104.25 \times \ln(Q) - 183.73$$ **Equation 2**

Where OER is ou/s/1000 birds and Q is the total shed airflow in m^3/s.

Note when using Equation 1 and Equation 2 checks were made to ensure that the minimum and maximum predicted airflows are consistent with typical minimum and maximum design rates. This was achieved by examining the flow rate data in Dunlop et. al. (2008) as well as other publicly available discussed in McGahan & Galvin (2018). As Equation 2 can sometimes result in no or very low emissions below 5 m^3/s, for flows in that range we used a modified version of Equation 2 where if required, we used Equation 2 but forced it through the x and y intercept. Even though this was performed, if the predicted flows were below the minimum rates in Dunlop et. al. (2008), they were scaled up to the minimum flow rates per bird detailed in Dunlop et. al. (2008).

An example odour emissions profile for the year modelled for a single shed at Avondale is shown below in Figure 3-2.

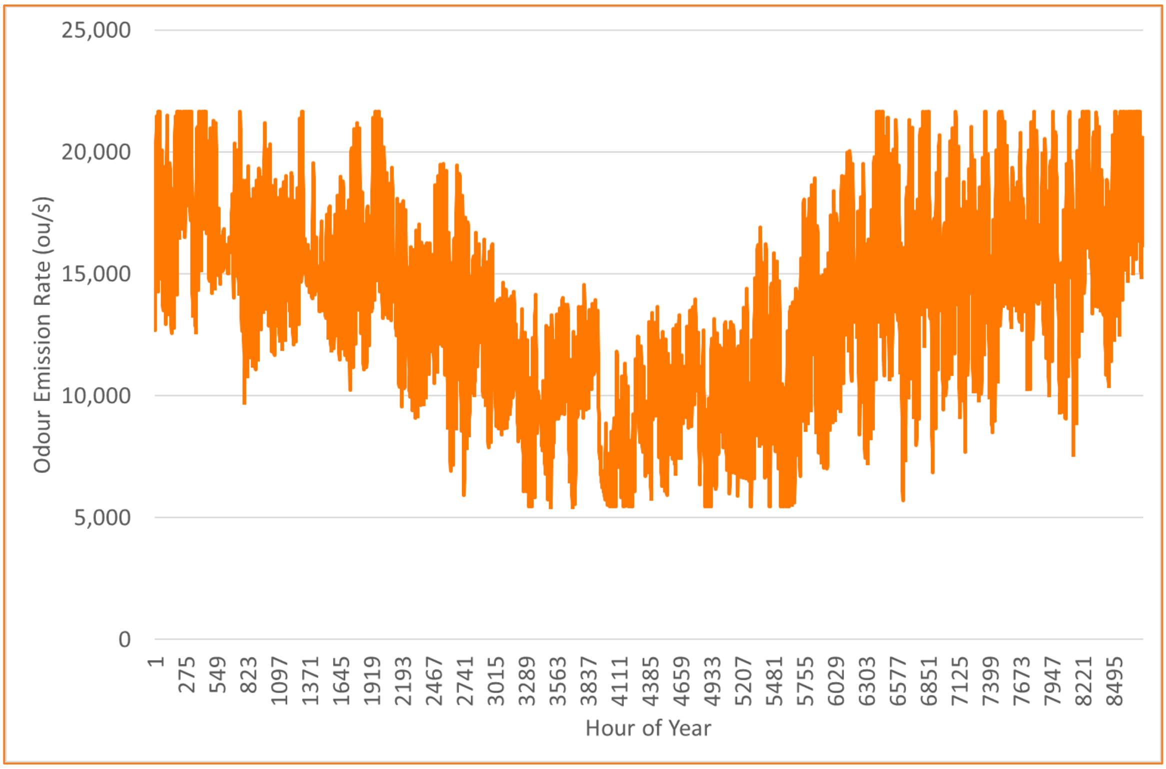


Figure 3-2: Example Layer Profile – Avondale

3.4.2 Rearers

As Ellerslie has rearer sheds we have used a different method. As their name suggests rearer sheds rear young birds until they are at point of lay. Rather than assuming large birds are continually present, the method used includes young birds being placed and increasing in weight over time.

The odour emissions model of Ormerod and Holmes (2005) was used as the basis of the rearer method. The methodology is referred to in the *Best Practice Guidance for the Queensland Poultry Industry - Plume Dispersion Modelling and Meteorological Processing* (PAEHolmes, 2011) and is widely used in Australia. The method is based on odour test data at a number of farms and uses a series of equations, which enable emissions to be predicted as a function of:

- the size and number of birds present;
- the stocking density of birds; and
- the ventilation rate, which varies by bird age and ambient temperature.

The odour emissions rate is predicted using the following equation (Ormerod & Holmes, 2005; PAEHolmes, 2011):

$$OER = 0.025 \times K \times A \times D \times V^{0.5}$$ **Equation 3**

Where ***OER*** = odour emission rate (ou/s), ***A*** = total shed floor area (m²), ***D*** = average bird density (in kg/m²), **V** is the ventilation rate in m^3/s and **K** if the K factor.

The K factor is a scaling factor which is used to reflect the performance of a farm. For the proposed modification, a K factor of 1 was used based on odour emission data for other rearer farms.

Maximum shed ventilation rates were based on the proposed shed ventilation rates which were modelled based on 10 m^3/hr/bird at maximum ventilation rate. Table 3-5 shows the shed ventilation rate (% of maximum) as a function of temperature above target temperature based on PAEHolmes (2011). A target temperature of 31°C for day old birds down to 21° at 29 days of age was used based on Cobb Vantress (2016).

Table 3-5: Calculated Shed Ventilation As Percentage Of Maximum Ventilation

Bird Age (weeks)	1	2	3	4	5	6	7	8
Temperature (°C) above Target	Ventilation Rate (Percent of maximum)							
<1	1.7	2.5	5.1	7.6	9.8	11.5	17.0	17.0
1	1.7	12.5	12.5	25.0	25.0	25.0	25.0	25.0
2	1.7	25.0	25.0	37.5	37.5	37.5	37.5	37.5
3	1.7	37.5	37.5	50.0	50.0	50.0	50.0	50.0
4	1.7	37.5	37.5	50.0	50.0	50.0	50.0	50.0
6	1.7	37.5	37.5	62.5	75.0	75.0	75.0	75.0
7	1.7	37.5	37.5	62.5	75.0	75.0	87.5	100.0
8	1.7	62.5	62.5	62.5	75.0	75.0	100.0	100.0
9	1.7	62.5	62.5	87.5	100.0	100.0	100.0	100.0

3.4.3 Litter Stockpile

It is proposed that an 800 ton litter stockpile be placed on site. It is important to note that unlike meat chicken farms, the spent litter is relatively clean, as the manure generated by the birds is generally excreted onto the manure belts (via the design and layout of the sheds) and the manure is removed from the sheds via the belts, rather than being deposited entirely on the floor.

The Odour Unit were previously engaged to collect odour emission rates from litter on a stockpile at a nearby site.

The average odour emission rate of 0.108 ou/m^2/s was converted to enable the use of the wind speed and stability method in Watts (2000) as discussed in DESI (2024). It was assumed due to the conditions within the flux chamber test method, that the flux chamber results were consistent with F class stability, low wind speeds (i.e. 30% value). The emission rate was then divided by 30 and multiplied by 100 to set the emission rate to 100% (i.e. multiplied the emission rate by 3.33). The emission rate over time was then predicted based on wind speed and stability class for each hour of the year based on a wind speed at the peak height of the windrow.

Based on information provided to us by Integrity Agriculture a density of 0.55 tons/m^3, and a volume of 1,454 m^3 was modelled. Using a curved windrow profile and a side area of 3.5 m^2, 411 lineal metres of windrow were spread across the pad.

Due to the shape of the windrow (i.e. not flat and having a larger surface area than their length and width), the surface area of the windrows was calculated to be 1,939 m^2.

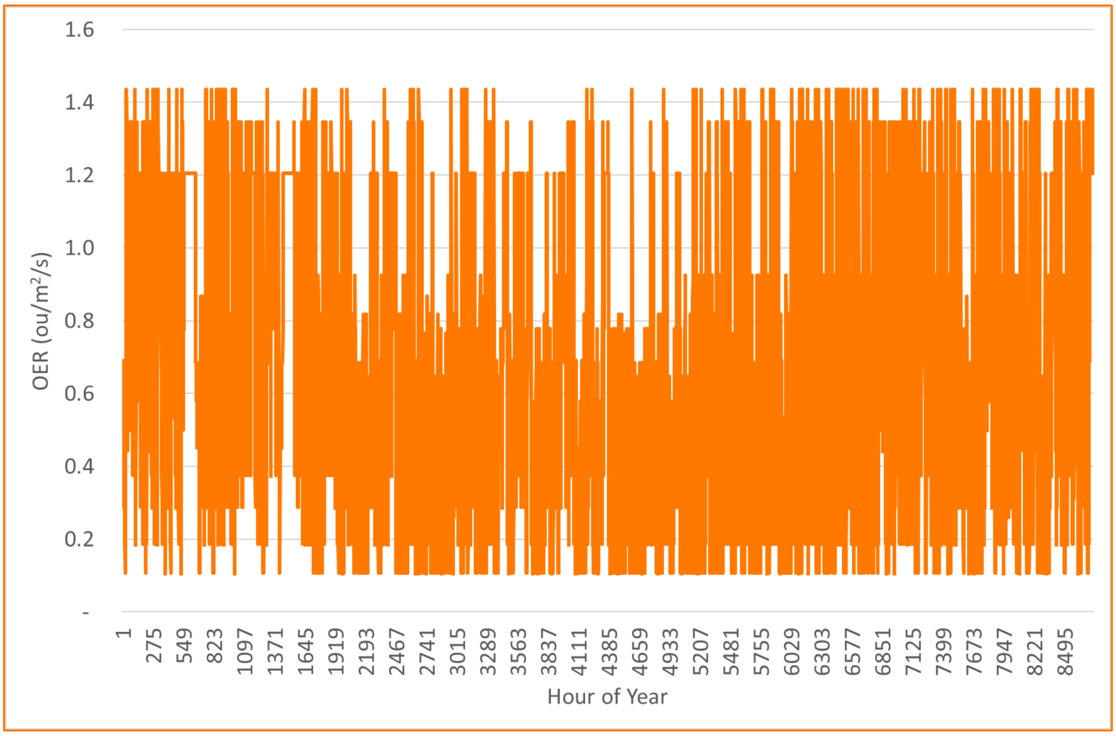


Figure 3-3: Annual Stockpile Unit Emission Rate (ou/m²/s)

4 EXISTING ENVIRONMENT

4.1 Meteorological Data

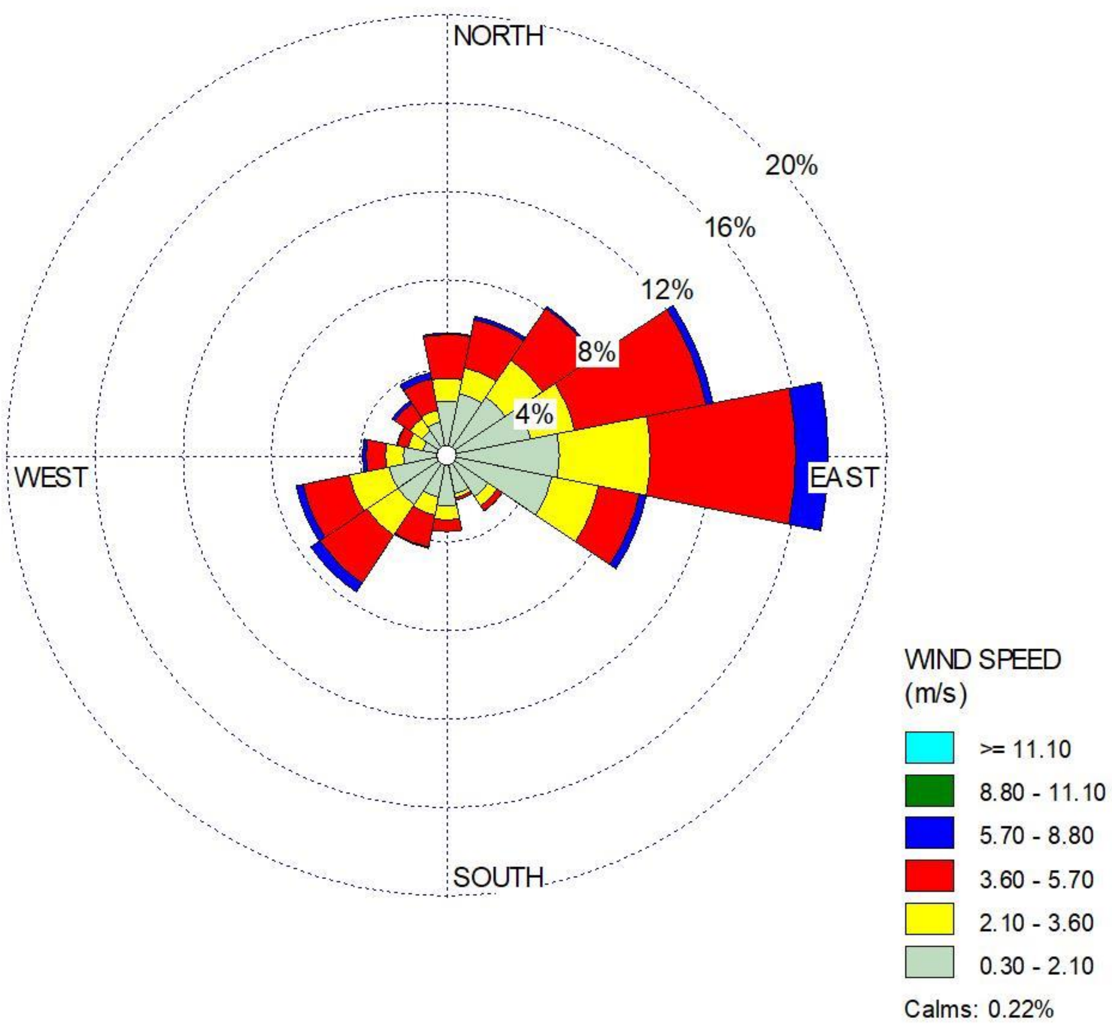
The principal meteorological parameters that influence plume dispersion are wind direction, wind speed, atmospheric stability (turbulence) and atmospheric mixing height (height of turbulent layer). This section presents a summary of the key meteorological features

4.1.1 Wind Speed and Direction

Wind roses are used to show the frequency of winds by direction and strength. The bars show the compass points (north, north-north-east, north-east etc) from which wind could blow. The length of each bar shows the frequency of winds from that direction and the different coloured sections within each bar show the wind speed categories and frequency of winds in those categories. In summary, wind roses are used to visually show winds over a period of time.

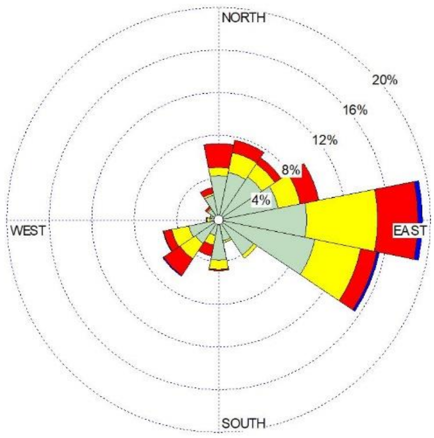
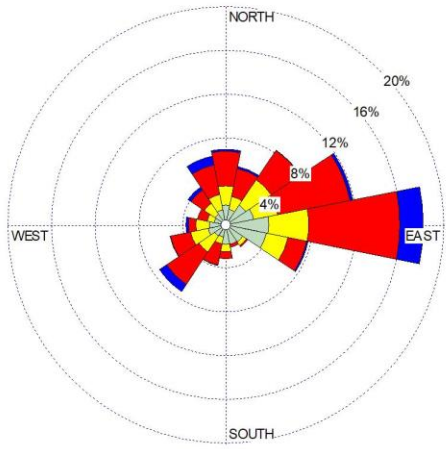
The wind roses below were created from data extracted from CALMET and are presented in Figure 4-1 and Figure 4-2. The annual wind rose (Figure 4-1) shows that the site is dominated by Easterly winds, but has a noticeable westerly component, which typically occur in the cooler months of the year.

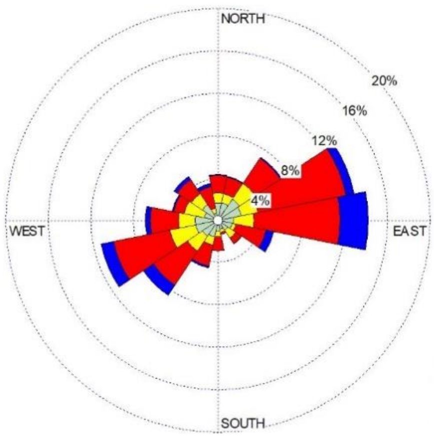
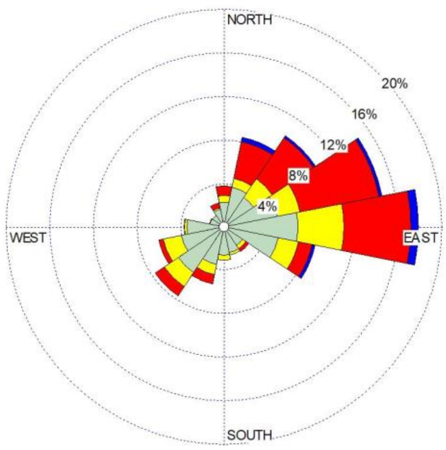
The wind roses show a relatively low proportion of calm winds (~0.2%) with light winds over the year (up to 3 m/s) occurring ~58% of the time. The wind speed frequencies are summarised graphically in Figure 4-3.



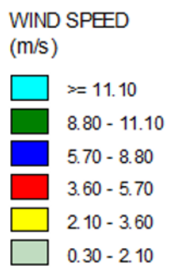
Location: Centre of domain	*Year:* 2013	*Data Source:* CALMET extract
Calm winds: 0.22 %	*Average wind speed:* 2.99 m/s	*Creator:* W. Shillito

Figure 4-1: Annual Wind Rose for the Site

1 AM to 6 AM	7 AM to 12 PM
	

1 PM to 6 PM	7 PM to 12 AM
	

Period	*Average wind speed (m/s)*	*Calm winds %*
1 AM to 6 AM	2.40	0.14
7 AM to 12 PM	3.24	0.41
1 PM to 6 PM	3.61	0.18
7 PM to 12 AM	2.71	0.14



Location:	*Year:*	*Data Source:*	*Creator:*
Centre of domain	2019	CALMET extract	W. Shillito

Figure 4-2: Time of Day Wind Rose for the site

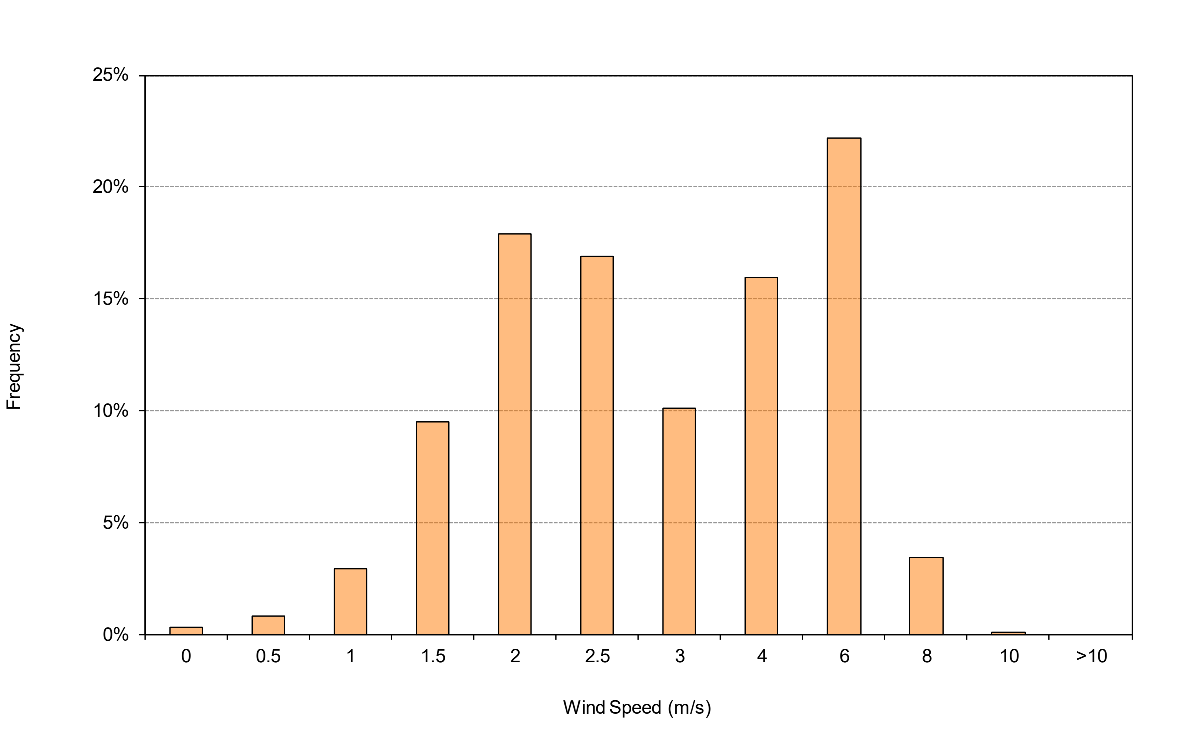


Figure 4-3 Wind Speed Frequency from CALMET

4.1.2 Atmospheric Stability

Atmospheric stability is a key factor in dispersion modelling and is used to describe turbulence in the atmosphere. Turbulence is an important factor in plume dispersion. Turbulence increases the width of a plume due to random motion within the plume. This changes the plume cross-sectional area (width and height of the plume), thus diluting or spreading the plume. As turbulence increases, the rate at which this occurs also increases. Limited or weak turbulence therefore does not dilute or diffuse the plume as much as strong turbulence, and therefore leads to high downwind concentrations. This is often associated with very low wind speeds (<0.3 m/s).

The Pasquill-Gifford stability scheme has been in use for many years to define turbulence in the atmosphere. The scheme uses stability classes from A to F[1]. Class A is highly unstable and at the other end of the scheme are class F conditions, which are very stable conditions that commonly occur at night and in the early morning. As noted above, under stable conditions, plumes do not disperse as well as during the day (unstable conditions), and can lead to impacts, especially for ground level sources.

Between Class A and Class F are stability classes which range from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are most often associated with clear skies, class D is linked to sunset and sunrise, or cloudy and/or windy daytime conditions. Unstable conditions most often occur during the daytime and stable conditions are most common at night.

The stability classes predicted by CALMET for the site are summarised in Figure 4-4. The data shows that E and F class stability (which can only occur at night, along with D class winds which can occur

[1] Note that CALPUFF uses a more accurate micrometeorological scheme for turbulence.

day or night) occurs 37% of the time. The elevated frequency of D class stability (39%) is commonly seen in areas with winds above 2.5 m/s at night or site with a high frequency of cloudy days.

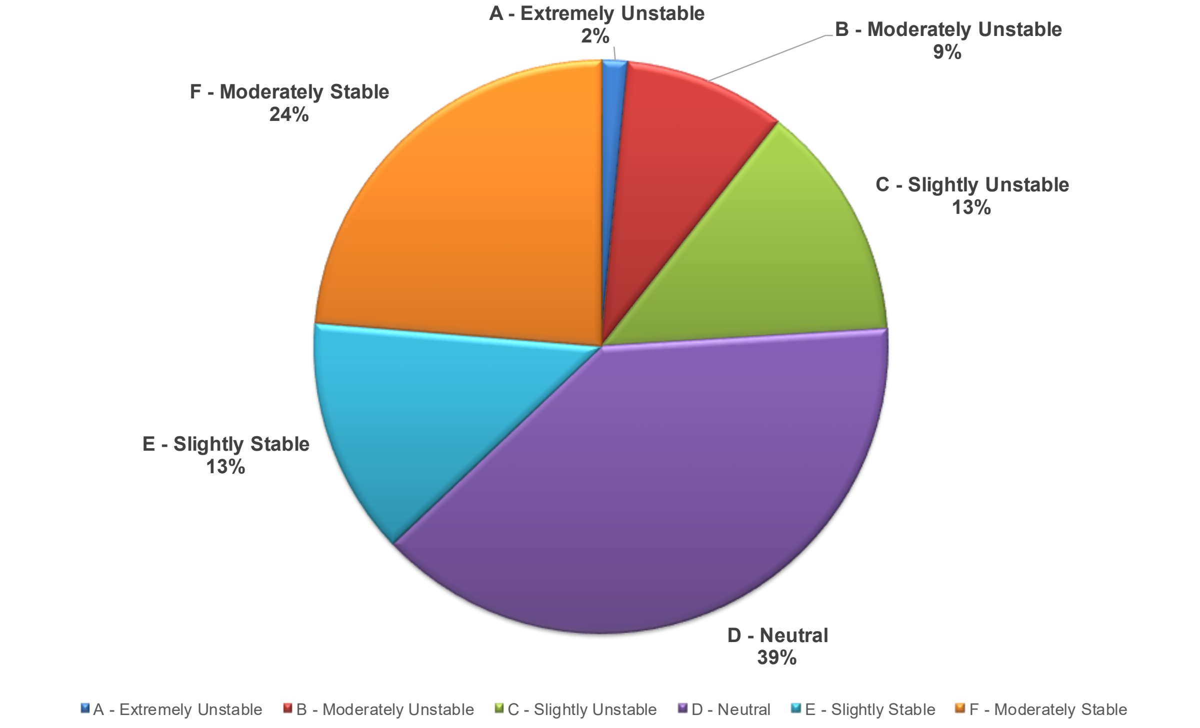


Figure 4-4: Atmospheric Stability

4.1.3 Atmospheric Mixing Height

The mixing height is the height of vertical mixing of air and suspended gases or particles above the ground. This height can be measured by the observation of the atmospheric temperature profile. A parcel of air rising from the surface of the Earth will rise at a given rate (called the dry-adiabatic lapse rate). As long as the parcel of air is warmer than the ambient temperature, it will continue to rise. However, once it becomes colder than the temperature of the environment, it will slow down and eventually stop (University of Michigan , 2004).

The mixing height is commonly referred to as an inversion layer. It is an important parameter when assessing air emissions as it defines the vertical mixing of a plume. This is because the air below the layer has restricted dispersion vertically.

The estimated variation of mixing height over time predicted at the site by CALMET is shown in Figure 4-5. The diurnal cycle is clear in this figure whereby at night the mixing height is normally relatively low and after sunrise it increases as a result of heat associated with the sun on the Earth's surface. Overall, the estimated mixing height shown below is as expected.

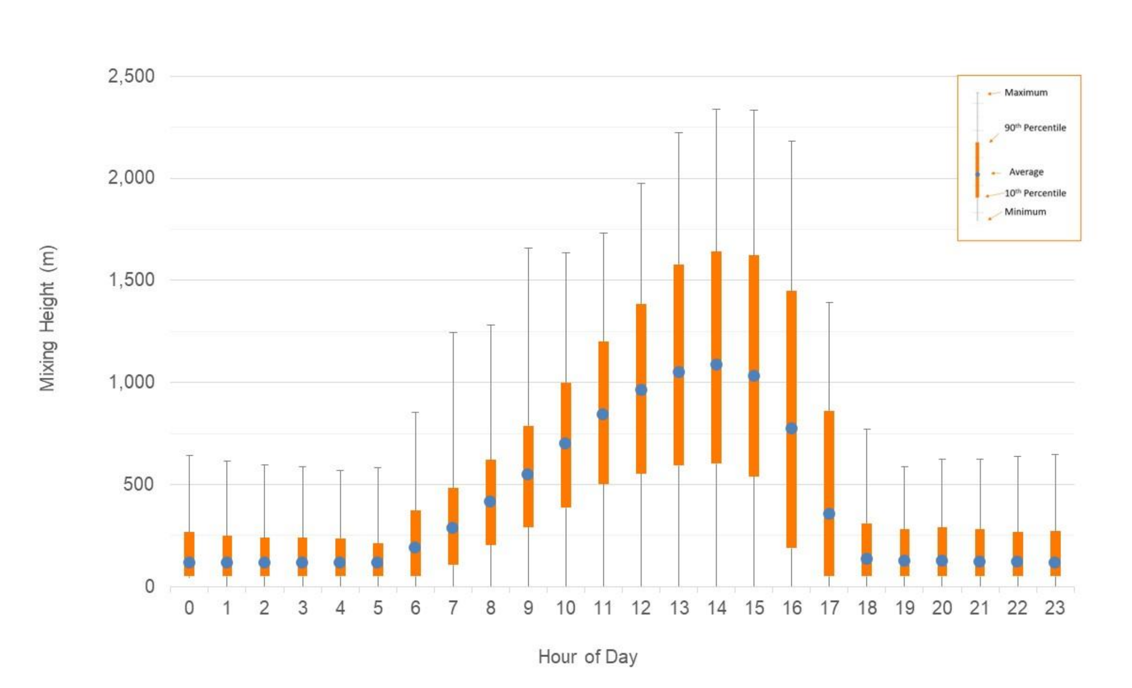


Figure 4-5: CALMET Extract – Predicted Mixing Heights

4.2 Sensitive Receptors

Sensitive receptors are locations that have the potential to be impacted by air emissions from a project. The sensitive receptors were selected based on the definition in DESI (2024). The location of the receptors identified using available aerial imagery are detailed below in Table 4-1 and presented Figure 4-6. We have not confirmed the status of the receptors in that we have not checked for building approvals.

Table 4-1: Identified Receptors (UTM m WGS84)

Number	Easting	Northing
SR1	317,663	6,914,604
SR2	316,986	6,914,621
SR3	316,083	6,914,875
SR4	317,909	6,917,400
SR5	318,027	6,918,039
SR6	322,382	6,920,728
SR7	322,628	6,920,672
SR8	323,177	6,920,663
SR9	323,225	6,920,538
SR10	323,269	6,920,460
SR11	323,426	6,920,506
SR12	323,749	6,920,300
SR13	323,877	6,919,980
SR14	323,617	6,919,813
SR15	324,098	6,919,550
SR16	323,765	6,919,408
SR17	323,667	6,918,708
SR18	322,119	6,917,391
SR19	325,119	6,917,160
SR20	325,423	6,916,970
SR21	325,808	6,917,084
SR22	324,975	6,915,521
SR23	325,907	6,914,785
SR24	325,442	6,915,156
SR25	325,286	6,914,567
SR26	324,555	6,914,133
SR27	324,649	6,913,029
SR28	323,830	6,913,166
SR29	323,169	6,912,112
SR30	319,664	6,913,146
SR31	328,302	6,917,232
SR32	329,837	6,918,247
SR33	327,247	6,919,822

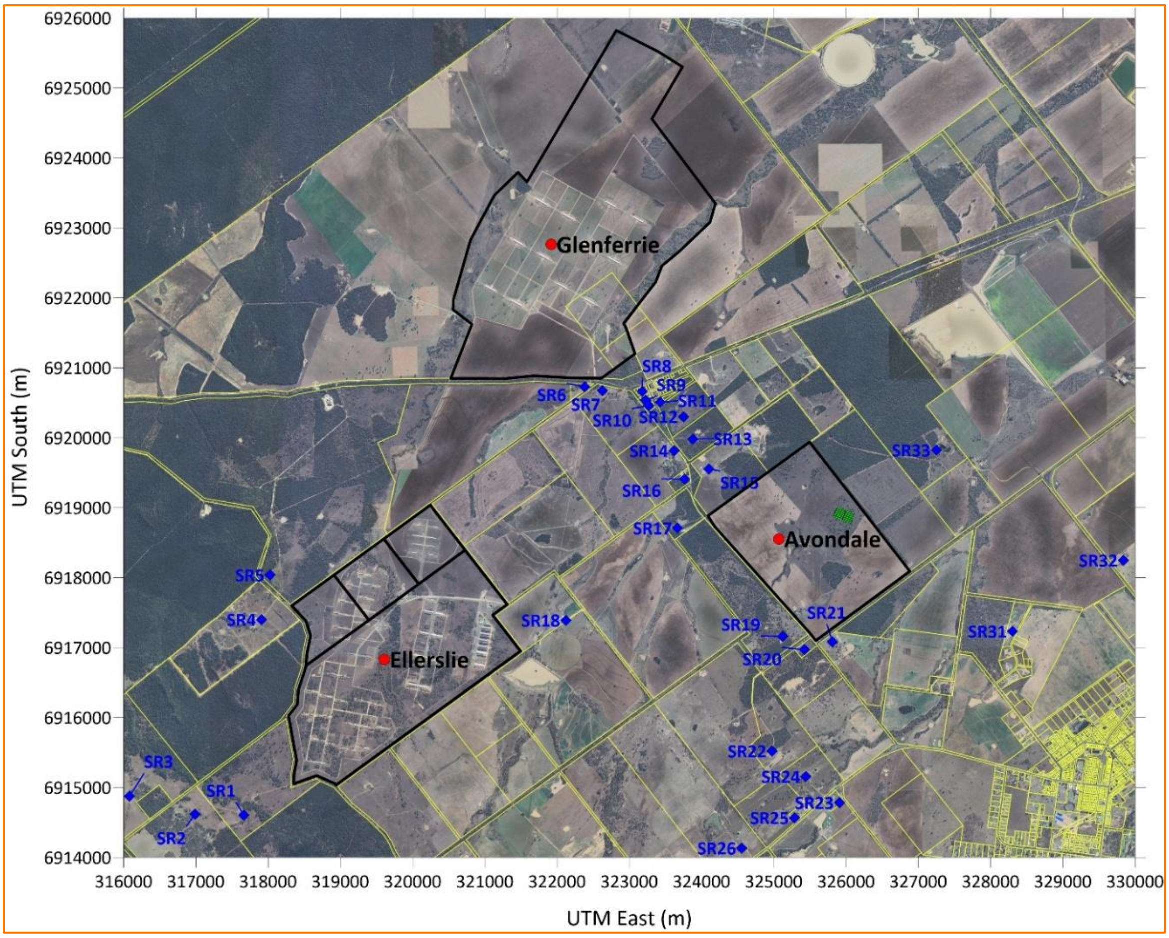


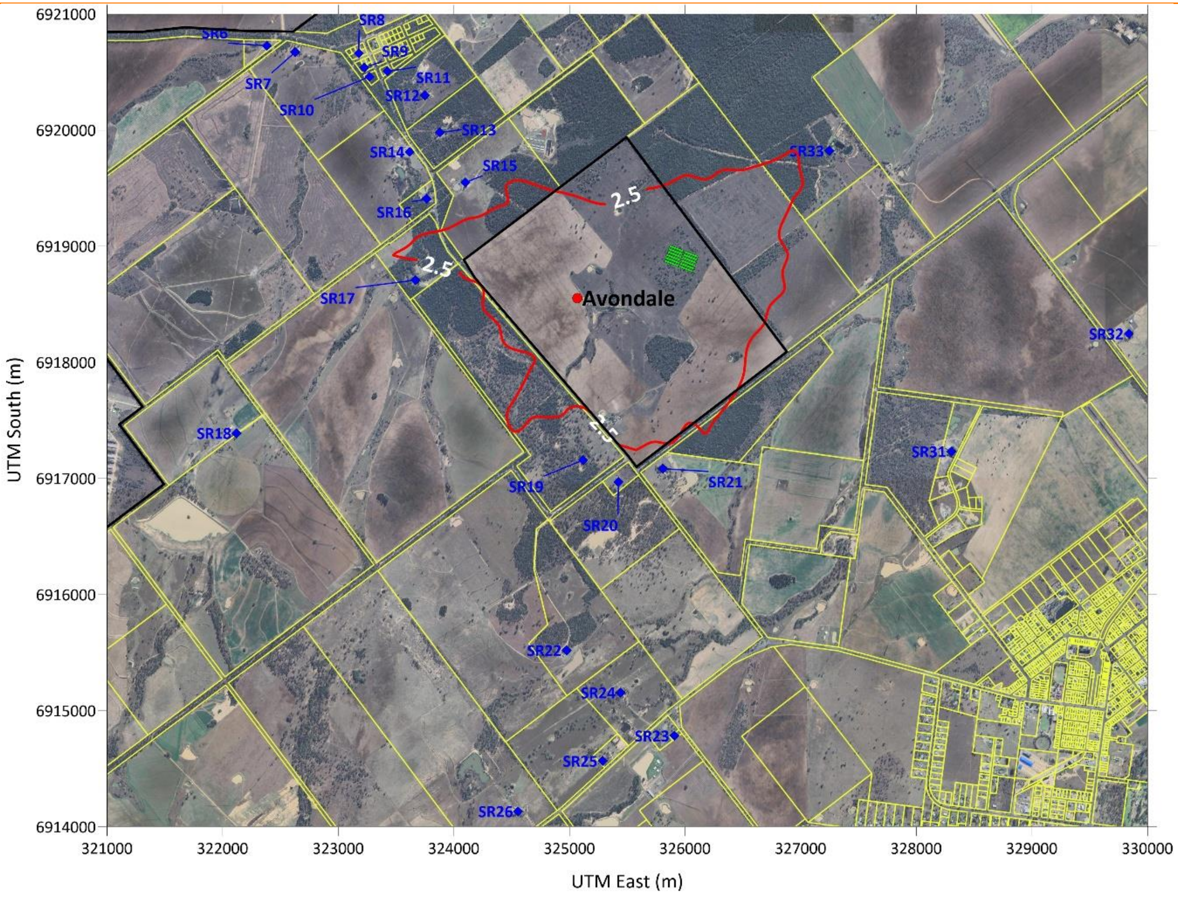
Figure 4-6: Sensitive Receptors

5 RESULTS

The results are provided below for Avondale in isolation (sheds and litter stockpile) as well as cumulatively with the Ellerslie and Glenferrie Farms.

5.1 Isolation

The predicted concentrations for the Avondale farm in isolation are shown graphically in Figure 5-1 and by receptor in Table 5-1. The results show compliance at all receptors. As indicated in Section 3.4 above the contribution of the stockpile is minimal compared to the total emissions from the sheds.



Species: Odour	**Site:** Avondale	**Scenario:** Avondale – 12 layers and shed litter pile	**Averaging Period:** 1 hour	**Percentile:** 99.5th
Criterion: 2.5	**Units:** ou	**Meteorology:** 2013	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 5-1: Predicted Concentrations – Avondale as Proposed

Table 5-1: Predicted Receptor Concentrations

Number	$C_{99.5\ 1hr}$	Number	$C_{99.5\ 1hr}$
SR1	0.5	SR18	1.1
SR2	0.4	SR19	2.3
SR3	0.5	SR20	2.3
SR4	0.7	SR21	2.1
SR5	0.9	SR22	1.5
SR6	0.7	SR23	1.2
SR7	0.6	SR24	1.3
SR8	0.5	SR25	1.3
SR9	0.6	SR26	1.3
SR10	0.7	SR27	1.6
SR11	0.6	SR28	1.6
SR12	0.7	SR29	1.3
SR13	1.2	SR30	0.9
SR14	1.5	SR31	0.3
SR15	1.8	SR32	0.2
SR16	1.6	SR33	1.8
SR17	1.8		

5.2 Cumulative Assessment

The potential for cumulative impacts is normally assessed by modelling surrounding farms, and analysing the results along with the Avondale farm. Here, Ellerslie and Glenferrie are nearby.

A key assumption when modelling odour is that conservation of mass occurs. This means that the odour doesn't break down or change, but it remains the same forever, or until it disperses fully. Moreover, although odour perception changes with concentration, it assumes that even at low concentrations it is additive.

Recent work detailed by Asimakis et al. (2024) at meat chicken farms found that when three farms were separated by a relatively short distance (i.e. under 1 km) were modelled, the observed odour concentrations in the field were less than that predicted by the modelling.

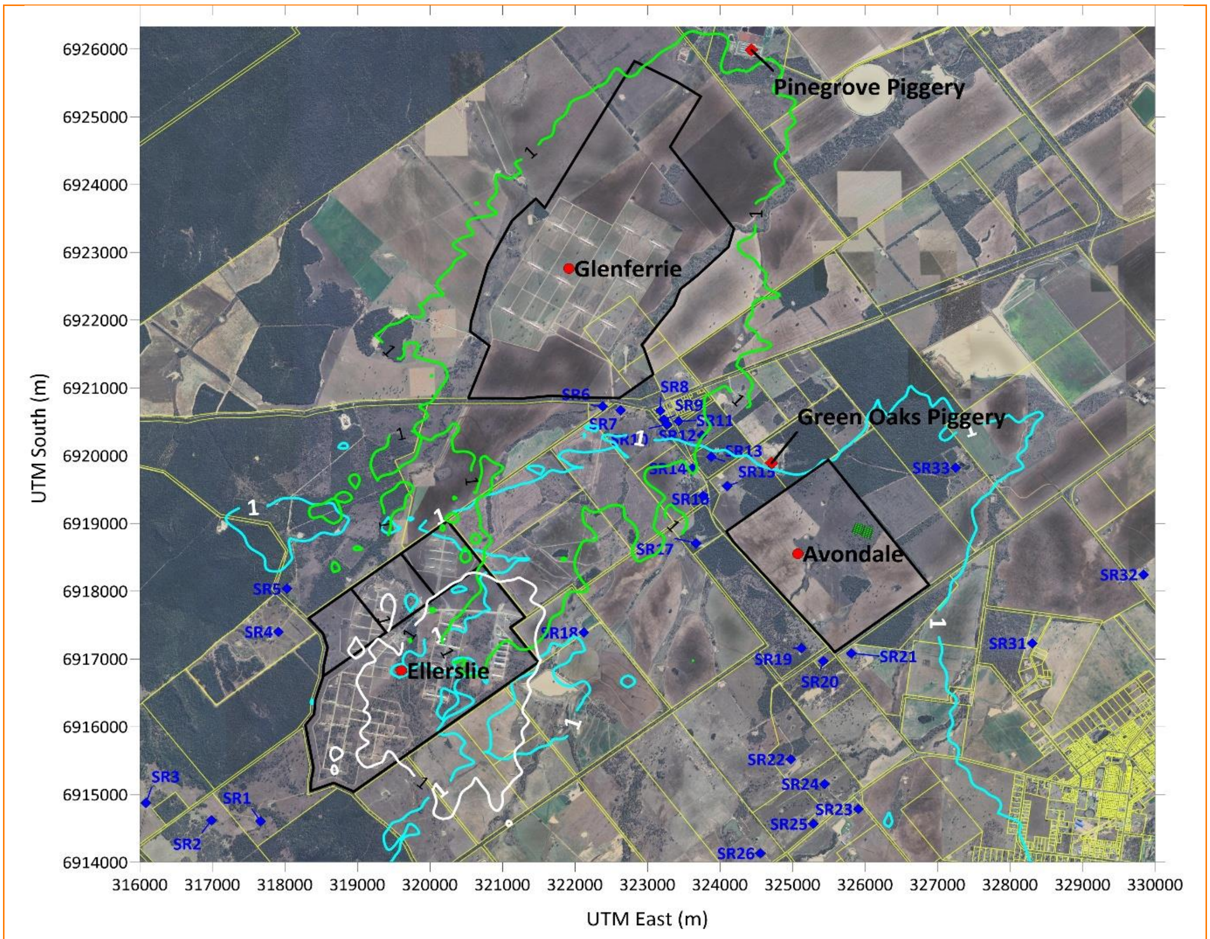
Irrespective of this, a practical method for determining if cumulative impacts could occur is to analyse the potential odour impact of each individual farm at 1 ou. 1 ou is by definition (AS/NZS 4323.3:2001) the point at which someone can ascertain if an odour is present in the air (i.e. distinguish with certainty between odour free air, and diluted odour). Under 1 ou, by definition, The odour is not recognisable, and therefore cannot be described.

An initial analysis is presented below in Figure 5-2 for the Avondale, Glenferrie and Ellerslie farms. There is overlap of the contours particularly between Avondale and Glenferrie and on the eastern boundary of the Ellerslie farm. Therefore, the three farms were cumulatively assessed and the results are presented as follows:

- Figure 5-3: Predicted Concentrations – Cumulative Assessment;
- Figure 5-4: Predicted Concentrations – Avondale Comparison; Isolation and Cumulative; and
- Table 5-2: Avondale in Isolation and Cumulative

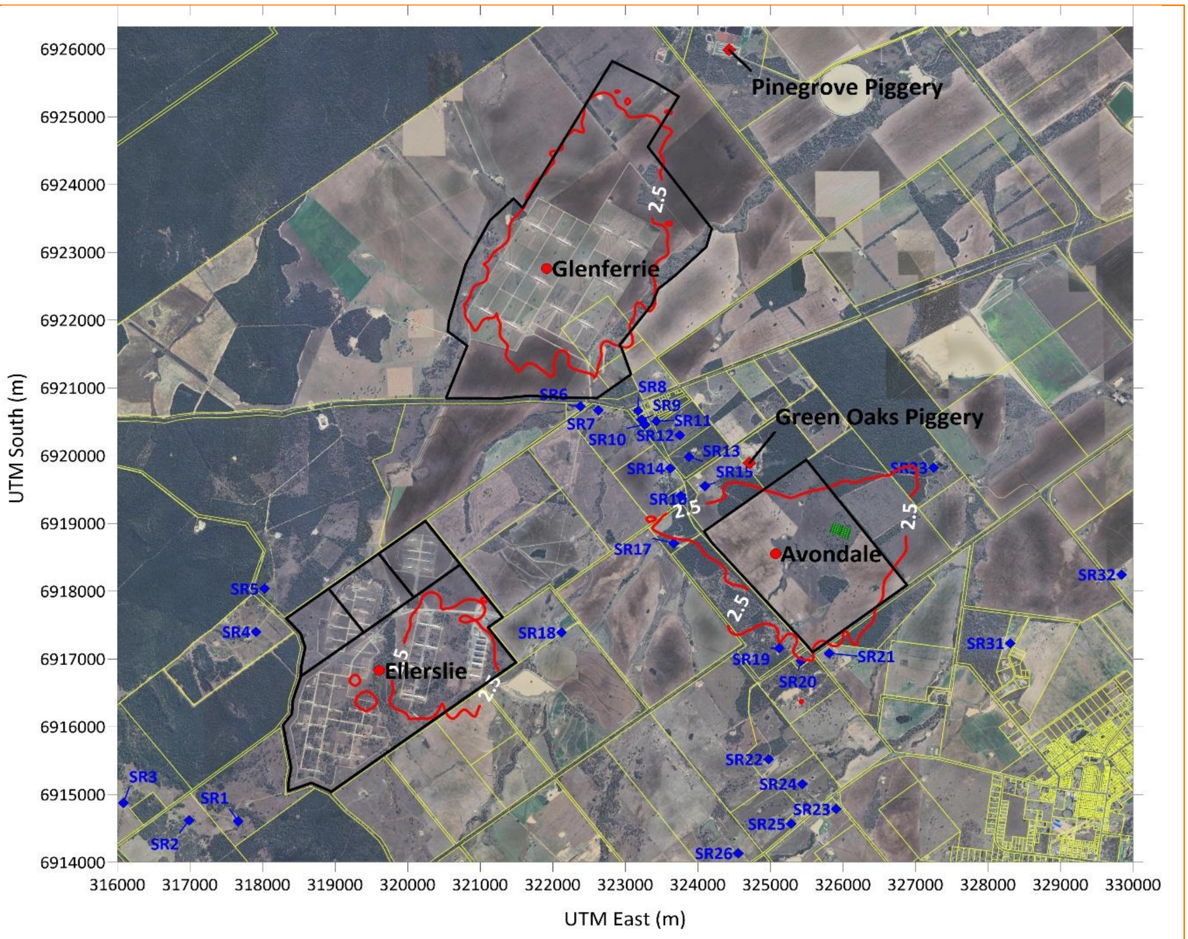
The results show an increase in odour ($C_{99.5\ 1hr}$) at the most affected sensitive receptors to the south of Avondale (SR19, SR20 and SR21) is a maximum approximately 0.2 ou when considered cumulatively.

This change is unlikely to be perceptible, and is a result of dispersion modelling where fractions of odour units spread across a large area are added. This is discussed below, however, the addition of small odour unit values at a concentration below that being perceptible is likely to be conservative.



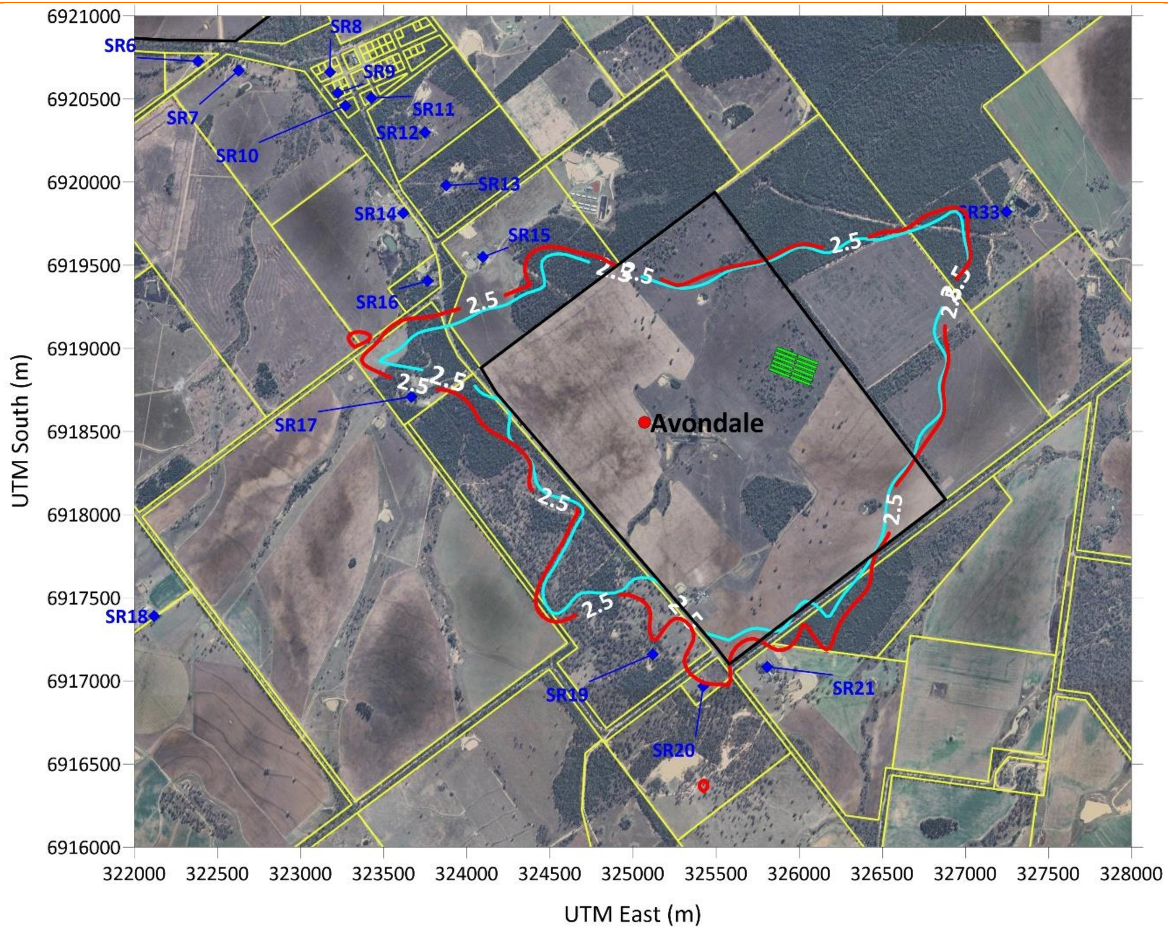
Species: Odour	Site: Avondale, Ellerslie and Glenferrie	Scenario: Farms in isolation	Averaging Period: 1 hour	Percentile: 99.5th
Criterion: NA	Units: ou	Meteorology: 2013	Model: CALPUFF v 6.42	Author: W. Shillito

Figure 5-2: Predicted Concentrations – Neighbouring Farms in isolation (1 ou)



Species: Odour	**Site:** Avondale	**Scenario:** Cumulative	**Averaging Period:** 1 hour	**Percentile:** 99.5th
Criterion: 2.5	**Units:** ou	**Meteorology:** 2013	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 5-3: Predicted Concentrations – Cumulative Assessment



Species: Odour	Site: Avondale	Scenario: Avondale Isolation – Blue Cumulative - Red	Averaging Period: 1 hour	Percentile: 99.5th
Criterion: 2.5	Units: ou	Meteorology: 2013	Model: CALPUFF v 6.42	Author: W. Shillito

Figure 5-4: Predicted Concentrations – Avondale Comparison; Isolation and Cumulative

Table 5-2: Avondale in Isolation and Cumulative

Number	Isolation	Cumulative	Difference in Odour Units
SR1	0.51	0.91	0.40
SR2	0.45	0.74	0.29
SR3	0.48	0.69	0.21
SR4	0.71	1.01	0.30
SR5	0.88	1.26	0.37
SR6	0.70	1.70	1.00
SR7	0.64	1.89	1.25
SR8	0.55	1.97	1.42
SR9	0.64	1.79	1.15
SR10	0.70	1.76	1.06
SR11	0.60	1.73	1.13
SR12	0.68	1.70	1.02
SR13	1.20	1.81	0.62
SR14	1.47	1.91	0.44
SR15	1.78	2.05	0.27
SR16	1.65	2.00	0.35
SR17	1.83	2.16	0.33
SR18	1.07	1.57	0.49
SR19	2.27	2.30	0.03
SR20	2.34	2.47	0.13
SR21	2.09	2.28	0.19
SR22	1.47	1.75	0.28
SR23	1.21	1.35	0.14
SR24	1.30	1.54	0.24
SR25	1.30	1.62	0.32
SR26	1.31	1.50	0.20
SR27	1.60	1.74	0.14
SR28	1.64	1.68	0.04
SR29	1.25	1.28	0.03
SR30	0.93	1.17	0.24
SR31	0.28	0.59	0.31
SR32	0.17	0.35	0.18
SR33	1.83	1.85	0.02
Criterion		**2.5**	

6 DISCUSSION

6.1 Poultry Farms

Odour modelling of the proposed layer sheds at Avondale (including litter stockpile) along with cumulative impacts from the Ellerslie and Glenferrie operations has also been performed. As shown in Figure 4-1 above, the winds in the area are primarily easterly with some south-westerly winds.

When the results for Avondale are examined in isolation (Figure 5-1), compliance is predicted at all receptors. Whilst not shown above, the predicted concentrations from the litter stockpile in isolation was at or below $C_{99.5\ 1hr}$ = 0.05 ou for all receptors. This is because the layer sheds dominate the emissions on site and therefore dominate the odour footprint.

When the cumulative results are considered (which assumes conservation of mass, Figure 5-4), the odour footprint at Avondale changes, but not significantly. The change is associated with low concentrations of odour from the other sites being predicted.

6.2 Vegetative Buffers

While vegetation is included in the model in terms of surface roughness (i.e. trees are in the land use, this case), no reduction in impacts associated with the influence of trees on dust and odorants was included.

As noted by Dunlop (2009) multiple studies have shown a link between dust and odour. Concerning this, research has shown that dust concentrations from livestock operations can be reduced by 35% to 65% using vegetative buffers (Laird, 1997; Thernelius, 1997; Malone, et al., 2006; Malone, et al., 2008; Hernandez, et al., 2012). As a specific example, Malone *et. al.* (2006; 2008) showed an average dust reduction over three years of 56%. This was found to be associated with the dust impacting on the trees and depositing out. For those studies, the vegetation was not as significant in extent (it was under 20 metres thick) as that here, which extends over a significant distance in all directions.

Reductions in odour in the order of 60% (Parker, et al., 2012) downwind of a vegetative barrier at a pig farm. In a different study, Patterson et. al. (2009) reported a 34% odour reduction downwind of a poultry layer farm with a four-row vegetative planting, and 46-54% reductions downwind of a five-row (~ 8 m deep) vegetative barrier. Hernandez et al. (2012) also showed a 40-60% reduction in odour compounds 50-100 m downwind of a piggery. In short, limited vegetation can have significant effects.

Based on the above, it is likely that the far field odour impacts predicted by the model will be conservative, as no allowances have been made for the effect of vegetation.

6.3 Other Cumulative considerations

Intensive livestock operations in the area include the Pinegrove and Green Oaks Piggery as shown in Figure 6-1 below.

Regarding cumulative impacts, documents including DESI (2024) note that it is reasonable to expect multiple sources of the same type of odorant (e.g. multiple sheds on poultry farms) to be additive in nature. DESI (2024) also notes, emissions from dissimilar sources should not be added to other odour types. Where multiple odour types exist, the one with the highest relationship between concentration and intensity is likely to make the dominant contribution to odour impact.

It is similar in New South Wales. For example, within the *Technical Framework - Assessment and management of odour from stationary sources in NSW* (DEC NSW, 2006) for areas with multiple odorous operations each operation is typically assessed separately, unless of a similar character.

The Green Oak Piggery compared to the Pinegrove Piggery has the greater potential to impact the sensitive receptors around the Avondale Site as layer odour is regarded as having a lower offensiveness. Based on the proximity of the piggery to the receptors, it would be expected that if impacts were to occur, they would be dominated by the piggery based on the separation distances and the prevailing winds.

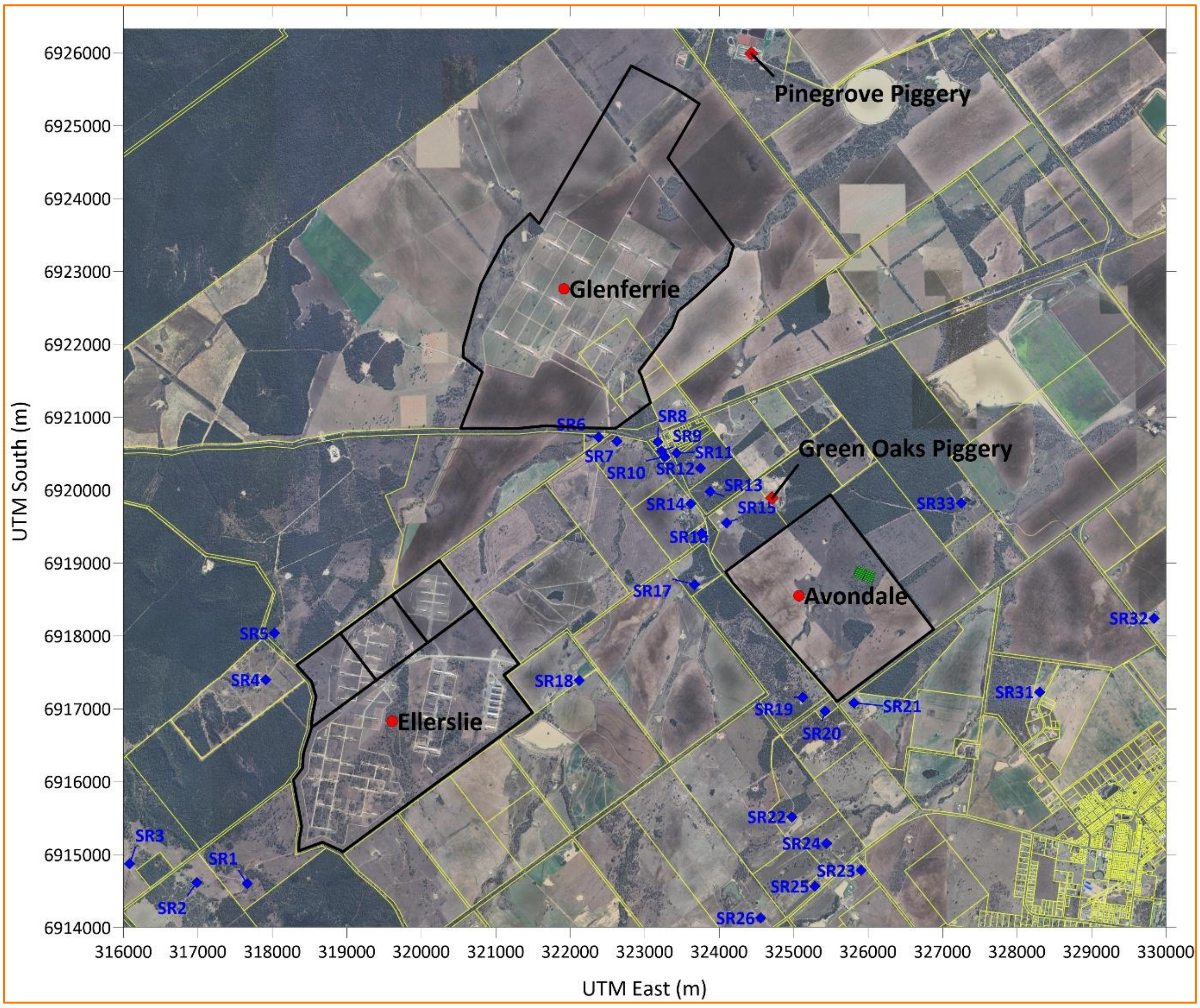


Figure 6-1: Piggery Operations

7 CONCLUSION

Dispersion modelling of odour impacts for the Avondale site have been performed using TAPM/CALMET/CALPUFF model suite and by using standard emission estimation methods.

The predicted odour concentrations at the sensitive receptors for Avondale in isolation are predicted to be below the odour criterion of 2.5 ou both in isolation and cumulatively.

Given the distances, the potential for additional odour is considered conservative and the difference between $C_{99.5\ 1hr}$ concentrations at SR20 at 2.34 ou and 2.47 ou will be imperceptible. The difference is a result of dispersion modelling where fractions of odour units are summed together. Moreover, as described above, the influence of vegetation in the area has not been included in the modelling, but would likely mitigate against the potential impacts of the farm.

Based on our assessment we recommend the development be approved and operated in line with current industry best practice to achieve the emission rates assumed here, and have standard amenity conditions included in its approval.

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