Report

Bective South Air Quality Assessment

AAM Investment Group

Job: 24-144

Date: 18 December 2024

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1 INTRODUCTION

Astute Environmental Consulting Pty Ltd (Astute) was engaged by the AAM Investment Group) to perform an air quality study relating to the proposed poultry farm located on land at 2432 Oxley Highway, Bective, NSW 2340 (“the site”) otherwise described as Lot 161 on DP755319. The property has an area of approximately 174 ha and is situated approximately 20 km northwest of Tamworth, NSW.

1.1 SEARs and NSW EPA Requirements

This report has been prepared in accordance with the Secretary’s Environmental Assessment Requirements (SEARS) for SEAR 1890, which outlines the key issues to be addressed with the site.

The SEARS relating to air quality are presented in Table 1-1 along with where they are addressed in this report.

Table 1-1: SEARS Requirements Relating to Air Quality and Odour

SEARS Air Quality Requirements	Response and Section
a description of all potential sources of air and odour emissions during construction and operation	Section 4.3, 6.1
a quantitative assessment of the potential cumulative air quality, dust and odour impacts of this development and nearby development, during both construction and operation, in accordance with relevant Environment Protection Authority guidelines, including Approved Methods for Modelling and Assessment of Air Pollutants in NSW 2022	Section 6
A description and appraisal of air quality impact mitigation and monitoring measures.	Section 7 and 8

In their advice letter of 8 May 2024, NSW EPA requested a number of investigations as part of the EIS. These are summarised in Table 1-2 below along with where they are addressed in this report.

Table 1-2: NSW EPA Requirements Relating to Air Quality and Odour

EPA Requirements	Response and Section
Investigation and assessment of odour impacts likely to be associated with cold air drainage	Sections 4, 6 and 9.3
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.	Section 9.2 below
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.	Section 9.2 below
Include a consideration of 'worst case' emission scenarios, and sensitivity analysis around the timing of peak emissions.	Sections 6.2 and 9.4
Air dispersion modelling must be conducted in accordance with: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2022)	Section 3 and 4 below
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.	This report.
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)	This report.
Detail emission control techniques/practices that will be employed by the proposal.	Section 7 and 8

1.2 Scope of Work

The objective of this assessment is to determine the potential particulate matter impacts in line with methodology in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022a).

The scope of work included:

- selecting a representative meteorological year using local weather station data;
- estimating odour and PM_{10} emissions for the poultry sheds;
- modelling meteorology at the site using TAPM and CALMET;
- performing dispersion modelling using CALPUFF;
- processing model output data;
- analysing model results and comparing them with relevant assessment criteria; and
- reporting on the results and providing recommendations if required.

2 PROJECT DESCRIPTION

2.1 Site Location

It is proposed to construct and operate eighteen (18) poultry sheds where meat chicken birds (broilers) will be grown for human consumption. Each shed will accommodate a maximum of 68,675 birds giving the farm a maximum capacity of 1,236,150 birds. The proposed layout of the shed is shown in Figure 2-1 below where the sheds are shown as grey polygons, and the site boundary is shown as a red polygon.

A typical shed configuration is shown in Figure 2-2 below. It is noted that the sheds, unlike traditional tunnel ventilated sheds, make use of traditional wall fans, but also a dedicated bay at the end of the sheds, where the fans are rotated 90° and discharge above the roof ridgeline. Mounting fans this way enables them to be operated like traditional chimneys. Instead of blowing the air up the chimney, the fan is at the top of the enclosure and discharges vertically.

AAM Investment group operate a poultry farm in the Scenic Rim in Queensland with a similar design to that proposed here. The configuration is shown in Figure 2-3 below.

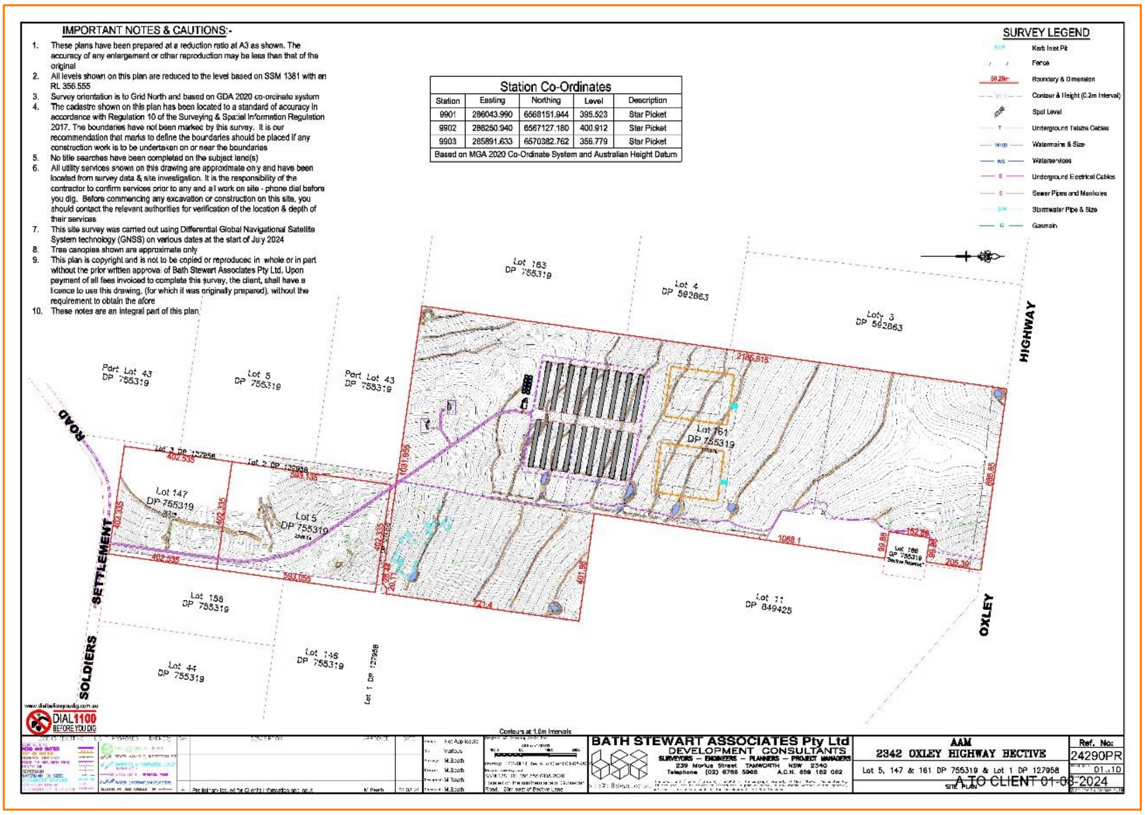


Figure 2-1: Proposed Shed Fan Configuration

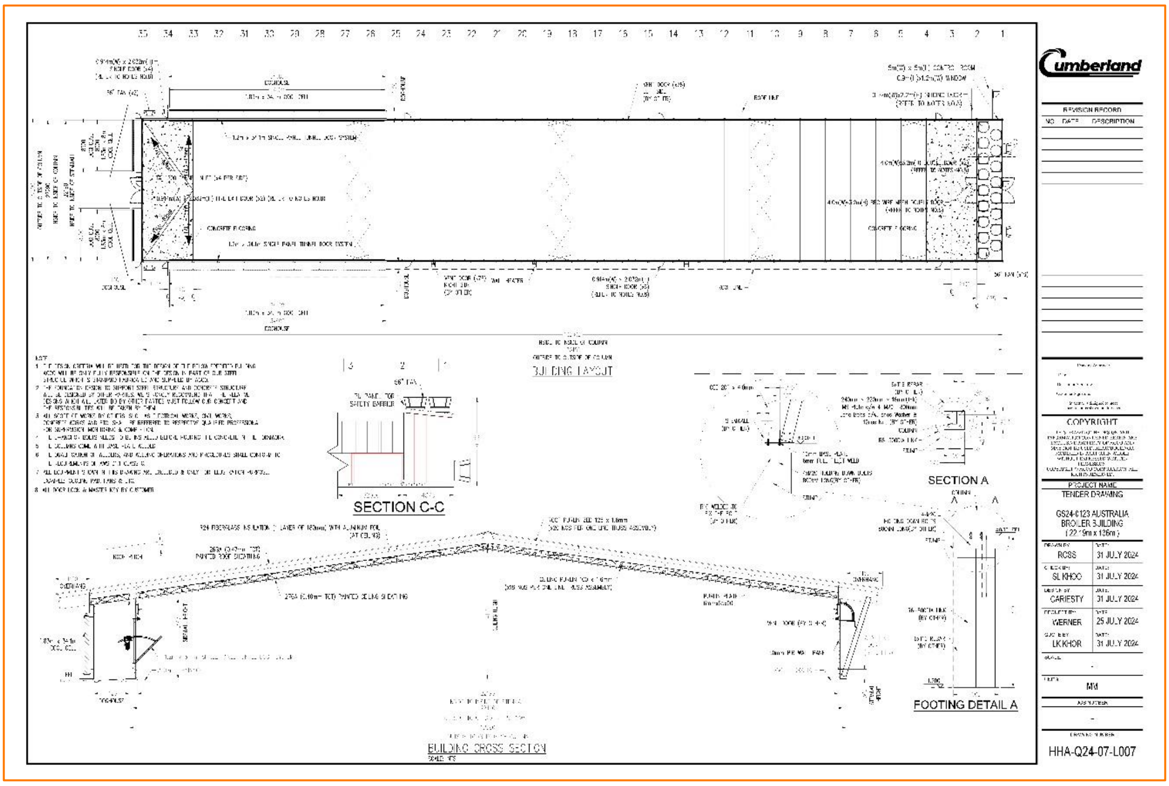


Figure 2-2: Proposed Shed Fan Configuration

The location of the sheds in Figure 2-4 are shown in Figure 2-5 where the lot boundary along with other lots that form part of Bective station are shown as a dark blue polygon, and the shed outlines are shown as light blue polygons. The yellow markers in the figure show nearby sensitive locations. The larger area in which the site sits is shown below in Figure 2-5 where the yellow markers show sensitive locations. Receptors that form part of Bective Station are not shown in the figure.

Figure 2-3: AAM Investment Group Stack Configuration

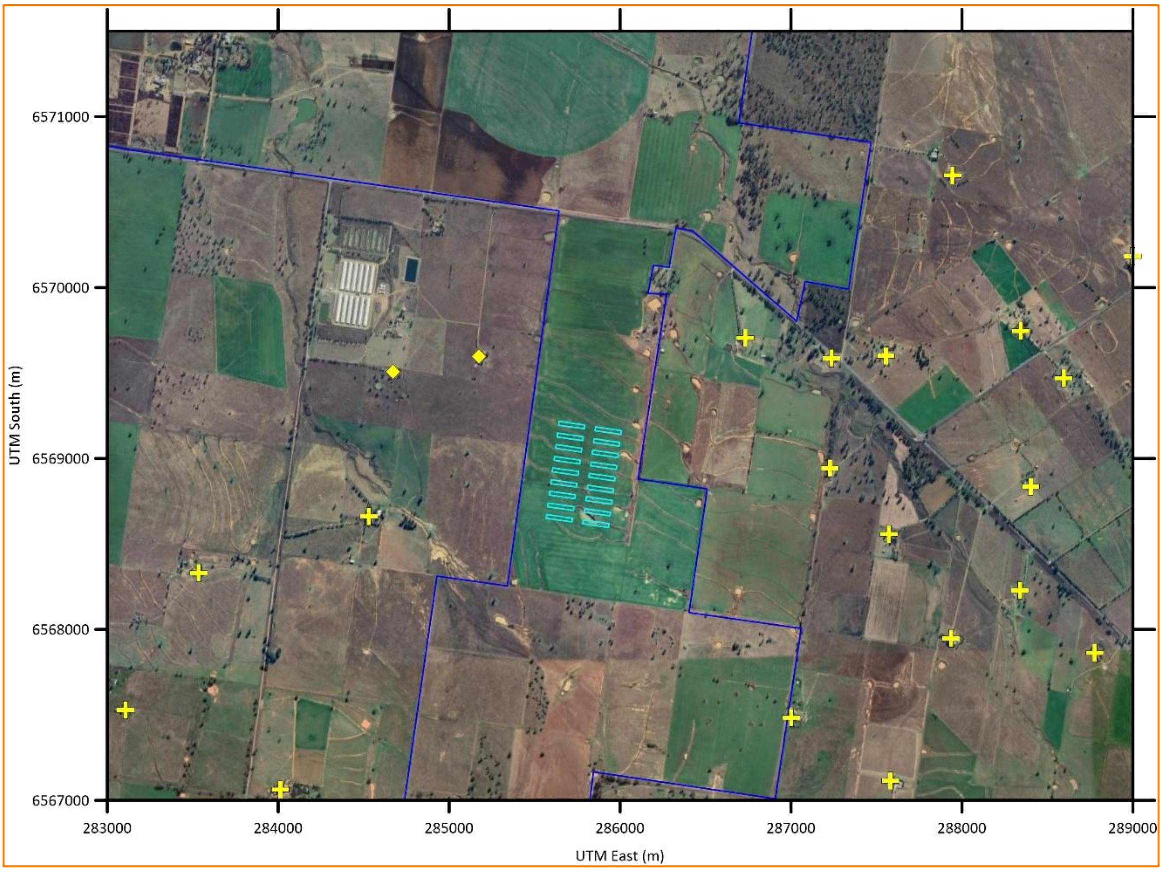


Figure 2-4: The Site

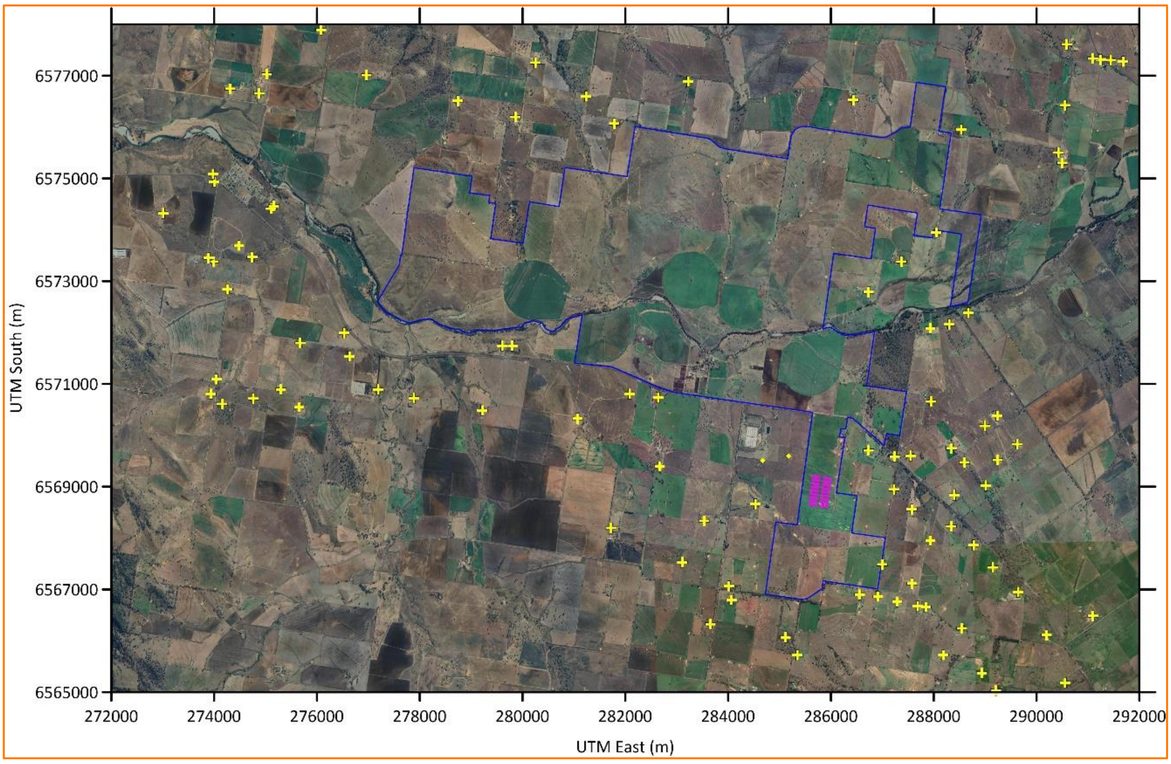


Figure 2-5: Site and Area

2.2 Potential Emissions to Air

2.2.1 Construction

During construction the primary emissions will be dust from construction activities. The following potential sources have been identified as potential sources of dust and particulate matter during construction:

- wheel generated from vehicles moving on unsealed roads;
- earthmoving equipment used to dig, load, haul and store excavated material;
- materials handling and transfer (dust from loading and unloading trucks); and
- windblown dust from open areas and stockpiles.

Assessing the impacts of fugitive dust emissions on sensitive receptors from construction projects using dispersion modelling has inherent uncertainty and is rarely completed. The uncertainty relates to the assumptions used to calculate emissions (for e.g. silt content), equipment type and number and the exact location of activities

Using the management measures detailed in Section 6.1 below, as well as making use of good practice construction dust management principles, the potential impacts of the construction is considered to be low. We are of the opinion that the risk of adverse dust impact ‘during construction is low when managed correctly, and therefore a refined qualitative assessment is not required.

2.2.2 Operation

The primary emissions from the farm during operation will be odour and dust from the sheds, as well as dust from the roads.

Dust from the roads can be managed via maintenance of the roads, limiting vehicle speeds and also using water as a suppressant if required.

Odour and dust form the sheds will occur on a cyclical basis, with emissions increasing during a batch, and then dropping away as birds are removed and the sheds are cleaned, before the process starts again. Emissions from the sheds are assessed in Section 4.3.

Generator emissions can occur from the use of emergency generators on site. As these are not expected to run more than 200 hours a year, they have not been assessed.

3 ASSESSMENT CRITERIA

Emissions to air from activities in NSW are regulated under the *NSW Protection of the Environment Operations*[1] *(Clean Air) Regulation 2022 (POEO Clean Air Regulation), and Protection of the Environment Operations (General) Regulation 2022, and Protection of the Environment Operations Act 1997* (POEO Act), *Part 5.4 Air pollution*.

The "Approved Methods for Modelling and Assessment of Air Pollutants in NSW" (Approved Methods) outlines the approach to be applied for the modelling and assessment of air pollutants in NSW in order to demonstrate compliance with the aforementioned regulations and act.

3.1 Air Quality

The criteria relevant to this project are summarised in Table 3-1 below.

Table 3-1: Air Quality Objectives relevant to the site

Indicator	Air Quality Objectives	Averaging Period (µg/m^3)
Particulate matter less than 10 µm (PM_{10})	50	24 hours
	25	1 year

3.2 Odour

The odour criterion used in New South Wales is detailed in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022a)[2]. For a complex mixture of odorants (i.e., odour measured as odour units), the criterion is selected based on the population density in an area. This is based on the concept that as population density increases, the number of people who may be sensitive to an odour increases. The criteria and equivalent population from the Approved Methods are summarised in Table 3-2.

[1] POEO

[2] "the Approved Methods"

Table 3-2: Impact Assessment Criteria from NSW EPA (2022a)

Population of affected Community	Impact assessment criterion for complex mixtures of odorous air pollutants (ou)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Whilst no specific guidance is provided in the Approved Methods, the approach often required by the New South Wales Environment Protection Authority (NSW EPA) for setting the odour criterion for a site is as follows:

- model the site using standard methods (i.e. the site as proposed);
- prepare a contour plot showing the $C_{99\ 1sec}$ = 2 ou contour;
- count the existing houses/dwellings within the 2 ou contour (and also consider any proposed dwellings within the 2 ou contour);
- determine the average population per dwelling based on the average data from the most recent Census data; and
- determine the total population and then determine the criterion to be used based on Equation 7.2 in the Approved Methods.

4 MODELLING METHODOLOGY

4.1 Representative year

Typically, only a single year of a data is included in an assessment. Therefore, the selection of a representative meteorological year for dispersion modelling is critical. Critical meteorological factors for air quality assessments include wind speed, temperature and relative humidity. These are commonly assessed against a period of at least five years to determine which of the years assessed is most similar to the average conditions over time, rather than simply selecting a modelling year at random or based on one variable.

In accordance with the Approved Methods (NSW EPA, 2022a) five years of meteorological data was analysed from the nearest BoM Station at the Tamworth Airport from 2013 to 2017 to capture the most recently available data. The hourly data for wind speed is compared below using a box and whisker plot in Figure 4-2.

The data from the weather station was analysed using box and whisker plots. A box and whisker plot (also called a boxplot) is a graph that presents information based on factors such as minimum and maximum values, the 25th and 75th quartile values and averages. These plots are useful for indicating whether a distribution is skewed and whether there are potential unusual observations (outliers) in a data set(s). They are particularly useful when large numbers of observations are involved and when two or more data sets are being compared (Statistics Canada, 2013).

Figure 4-1 shows how a box plot is structured. In the case of the figure, the maximum, minimum, quartile, median and average values are shown. In short, when looking at the boxes, the box indicates how much spread the dataset has.

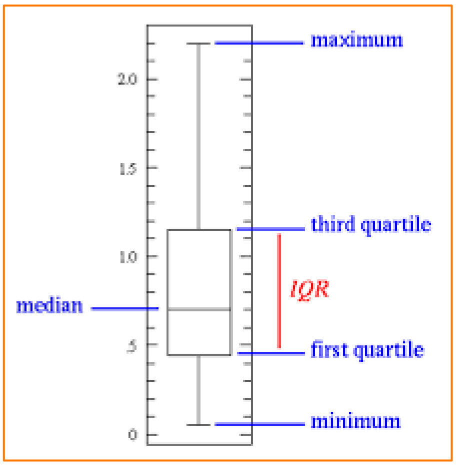


Figure 4-1: Boxplot Structure

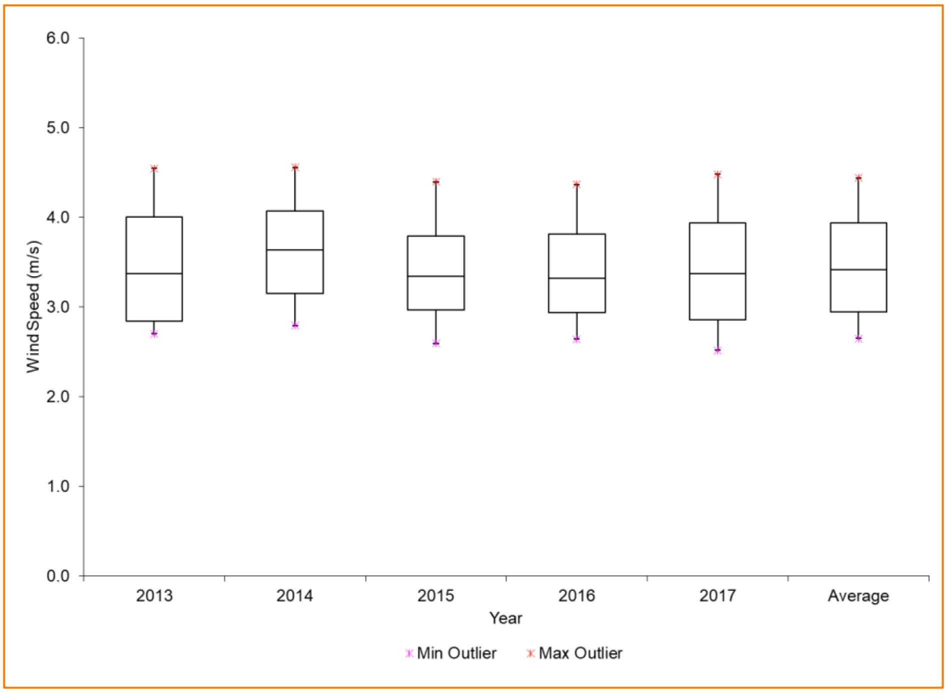


Figure 4-2: Wind Speed – Box and Whisker Plot

The Mann-Whitney U test for large sample sizes was also used to analyse the data for wind speed, temperature and relative humidity, as they often show a clear diurnal cycle. The box and whisker plot used above compares the dataset by year, rather than by hour. The null hypothesis for the U test is there is no significant difference between an individual year and the long-term average values. A summary of the best performing years (ranked 1 to 5) for the data period (2013 to 2017) is presented in Table 4-1. As expected, there was variability between the years.

Table 4-1: Representative year data for Tamworth BoM 2013-2017

Rank (best to last)	Temperature	Wind Speed	Relative Humidity
1	2017	**2014**	2017
2	2016	2013	2013
3	2013	2016	**2014**
4	**2014**	2015	2016
5	2015	2017	2015

The year 2014 was selected as the most representative with priority given to wind speed, the key meteorological parameter in air quality assessments. Furthermore, while not included here, 2014 was the most complete dataset for all meteorological sites including Tamworth BOM station and the Tamworth NSW EPA station.

4.2 Meteorological Modelling

4.2.1 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 of 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 refined to include more accurate land uses within the inner 0.5 km modelling domain.

The model setup is summarised in Table 4-3 below.

4.2.2 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 31.25 km x 17.5 km domain with a terrain resolution of 125 m was modelled with the centre of the domain near the site. A terrain resolution of 30 m was used throughout the domain and was initially taken from the SRTM dataset using CALPUFF view. This dataset was then manually adjusted based a recent aerial image at a resolution of 125 m (0.125 km) using CALPUFF View.

The model setup is summarised in Table 4-3 below.

4.3 Emissions

The methodology below has been used for the proposed farm.

4.3.1 Odour

The odour emissions model of Ormerod and Holmes (2005) was used as the basis of this assessment. The methodology is referred to in the *Best Practice Guidance for the Queensland Poultry Industry - Plume Dispersion Modelling and Meteorological Processing* (PAEHolmes, 2011) and also the *Planning and environment guideline for establishing meat chicken farms, Guide 1 Assessment guide* (McGahan, et al., 2021) . 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 1**

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 m³/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 farm we have used a K factor of 1.9 which is relevant for modern farms (McGahan, et al., 2021).

Maximum shed ventilation rates were based on the proposed shed ventilation rates based on the industry standard values (~10 m^3/hr/bird at maximum). Table 4-2 shows the shed ventilation rate (% of maximum) as a function of temperature above target temperature based on the method in PAEHolmes (2011). Target temperatures were based on industry standard values. A 65 day batch was modelled with 55 day grow out, 25% of birds placed removed at day 32, a further 25% of birds placed removed at day 38, and a third thin of 25% of birds placed on day 44, with all birds gone by day 55. A cleanout period of 10 days was included in the modelling method.

Table 4-2: 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 (% 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

An example emission profile for existing shed 1 is shown below in in Figure 4-3. The removal of birds can be seen in the profile where the emissions drop at days 32, 38 and 44.

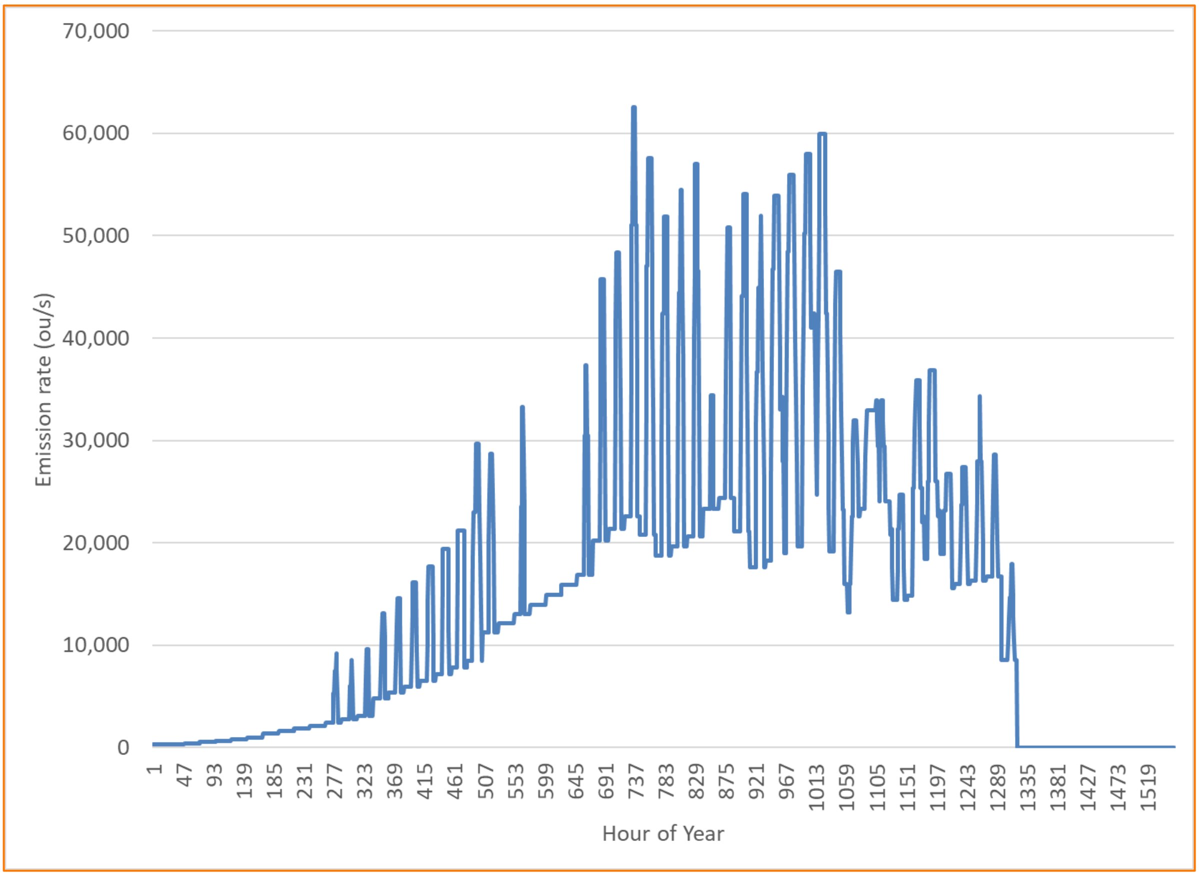


Figure 4-3: Example Emission Profile Single Batch – Day 1 Placement (68,674 birds)

For the existing ProTen Bective farm, and the farm located to the west off x, the standard method has been used. Bird numbers for the ProTen farm were taken from the latest modelling of that site (12 sheds at 52,917. Bird numbers for Valdimah Park were based on the shed areas at 16.7 birds per square metre. Day 1 placements only were modelled for these farms.

For the site, the fans were vertically mounted. Based on advice from Agribiz, up to an airflow of 14.6 m3/s where the birds were 25 days or less, emissions were ventilated using ground level fans. Outside of this, emissions were directed to the tunnel fans, which discharged at velocity of 6 m/s at a height of 7 m based on the ventilation steps in Table 4-2. A velocity of 6 m/s was selected as a conservative value as most fans can achieve higher velocities than this. The diameter of the source for each ventilation step was adjusted to ensure that the predicted ventilation rate matched the diameter and velocity for each step using Equation 2 where Q is the airflow in m^3/s, V is the velocity in m/s, and A is the area of the point source in m^2.

$$Q = V \times A \qquad \textbf{Equation 2}$$

4.3.2 Particulate Matter

Particulate emissions were based on the latest methods detailed in the *Planning and environment guideline for establishing meat chicken farms, Guide 1 Assessment guide* (McGahan, et al., 2021).

Particulate matter (PM_{10}) emission rates in mg/s/1000 birds at a point in time can be estimated using the following equation:

$$D(PM_{10})C = 0.0367 \times A$$ **Equation 3**

Where ***A*** = bird age in days, **D** = maximum PM_{10} emissions at growth cycle age (mg/s/1000 birds at age **A**).

Hourly varying PM_{10} emissions were modelled based on Equation 3..

4.4 CALPUFF

CALPUFF (Exponent, 2011) is a USEPA regulatory dispersion model. It is a non-steady state puff dispersion model that simulates the effects of varying meteorological conditions on the emission of pollutants.

CALPUFF 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 can simulate 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. CALPUFF is widely recognised as being the best model for studies where terrain and light wind effects can be critical. Key inputs used in CALPUFF for the project are summarised below in Table 4-3. Note that the domain was constructed larger east west to best capture drainage flows along the river and a peak to mean of 2.3 was applied to the odour results.

Table 4-3: TAPM, CALMET And CALPUFF Setup

Model	Parameter	Value
TAPM (v 4.0.5) R1	Number of grids (spacing)	20 km, 8 km, 3 km, 1.2 km, 0.5 km
	Number of grid points	66 x 38 x 35 (vertical)
	Year of analysis	2014
	Centre of analysis	30°57.0' South (latitude), 150°40.5' East (longitude)
	Meteorological data assimilation	No
CALMET (v 6.5.0)	Meteorological grid domain	31.25 km x 17.5 km
	Meteorological grid resolution	0.125 km
	South-west corner of domain	X = 262.375 km, Y = 6564.750 km
	Surface meteorological stations	N/A
	Upper air meteorological data	N/A
	3D Windfield	m3D from TAPM (0.5km) input as in initial guess in CALMET
	Year of analysis	2014
	Terrad	3 km
	Cloud	4 – Gridded cloud cover from Prognostic Relative Humidity at all levels
CALPUFF (v 6.42)	Method used to compute dispersion coefficients	2 – dispersion coefficients using micrometeorological variables
	Building wakes included?	Yes; ISC[3]
	SVMIN	0.2
	Default settings	All other CALPUFF defaults

4.5 Excluded Sources

The following potential emission sources are considered to be minor, or infrequent in nature, and have not been included in this assessment:

- other combustion emissions – No emissions from the delivery trucks and mobile equipment have been modelled as they are expected to be minor in the context of the regional airshed and total emissions from the site; and
- cumulative sources –cumulative non poultry sources have not been modelled in this air quality assessment however background air quality data has been added to the PM_{10} modelling results to account for this.

[3] Prime was not used as it is not appropriate for long narrow sources such as chicken sheds. See Petersen et al. (2009) and elsewhere.

5 EXISTING ENVIRONMENT

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

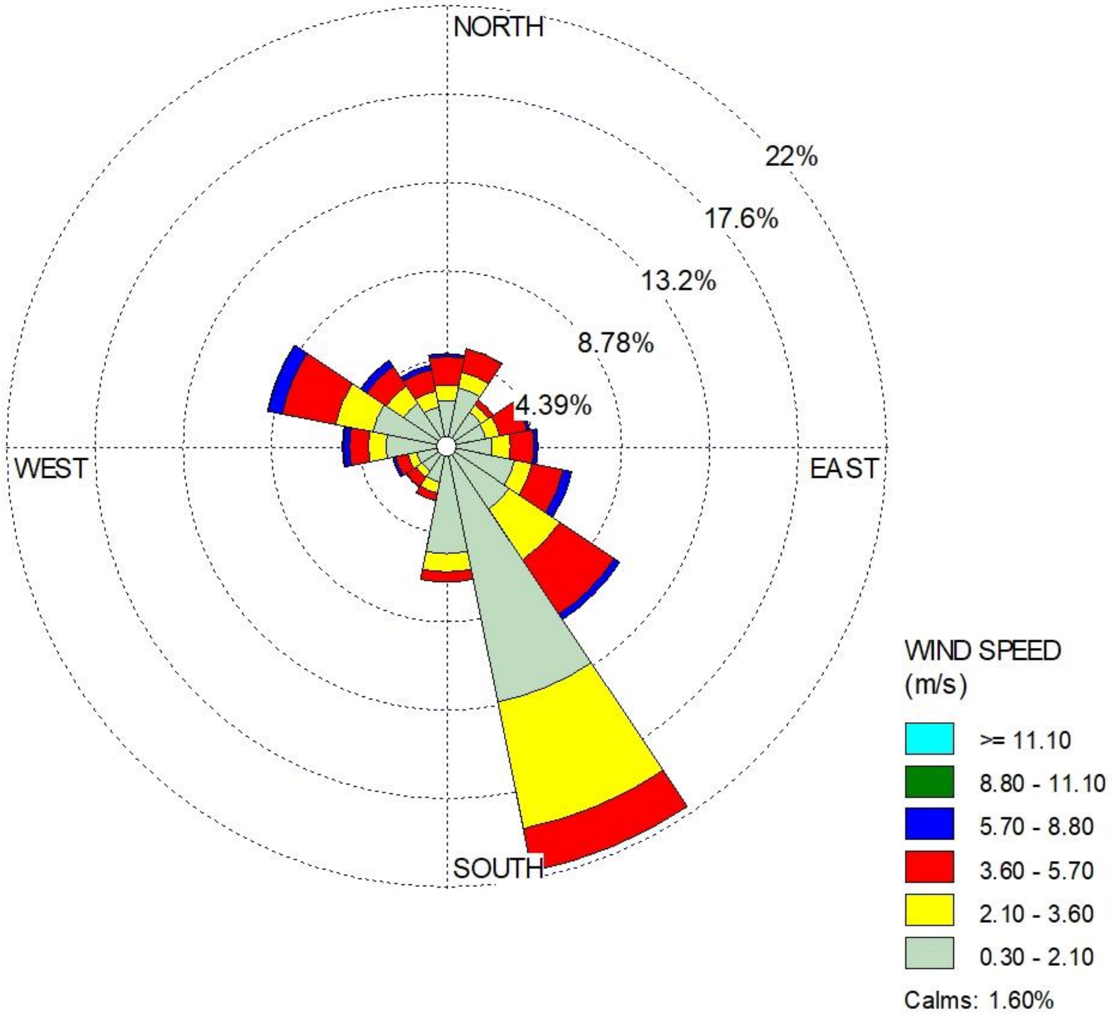
5.1 Metrological Data

5.1.1 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 5-1 and Figure 5-2. The annual wind rose shows that the site is dominated by south easterly winds during most hours of the day, with the exception of westerly winds which most often occur in the afternoons. This as function of synoptic scale features, as well as the terrain in the area.

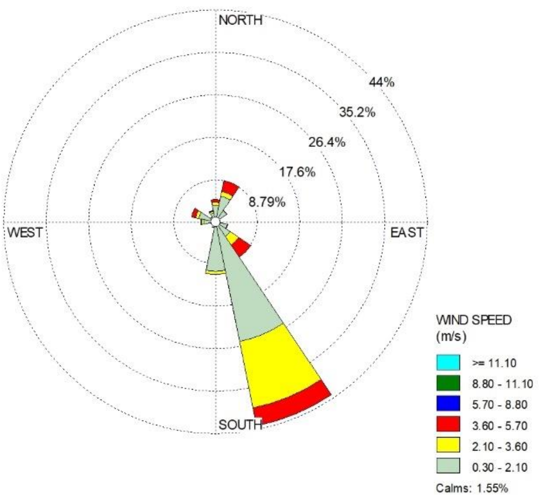
The wind roses show a low proportion of calm winds (~1.6%) with light winds over the year (up to 3 m/s) occurring ~71% of the time. The wind speed frequencies are summarised graphically in Figure 5-3.



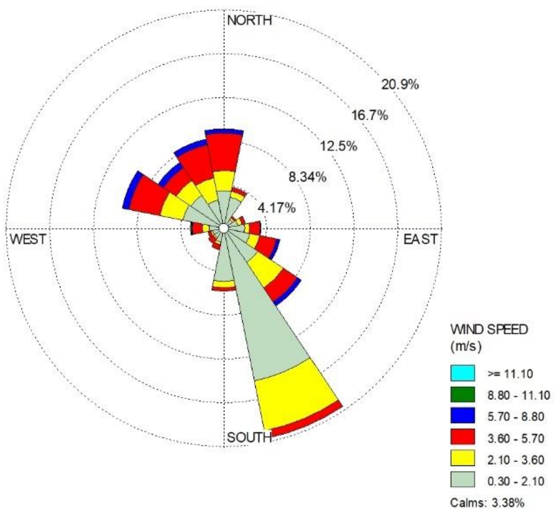
Location:	*Year:*	*Data Source:*
The Site X: 286,000 Y: 6,569,000	2014	CALMET extract
Calm winds:	*Average wind speed:*	*Creator:*
1.6%	2.5 m/s	G. Galvin

Figure 5-1: Annual Wind Rose for the Site

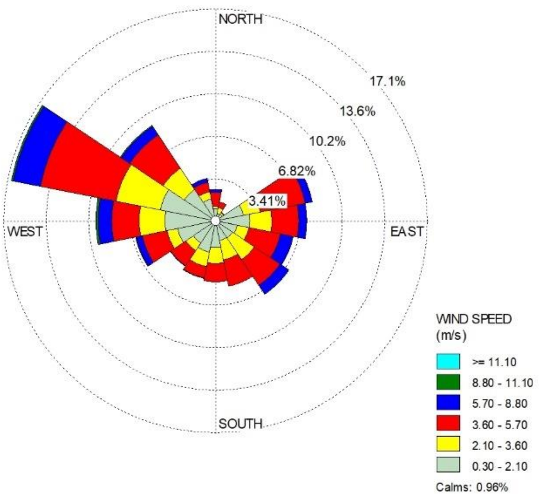
1 AM to 6 AM



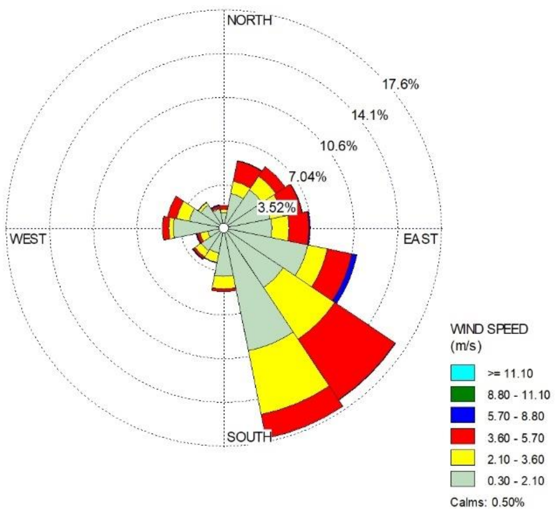
7 AM to 12 PM



1 PM to 6 PM



7 PM to 12 AM



Period	*Average wind speed (m/s)*	*Calm winds %*
1 AM to 6 AM	2	1.6
7 AM to 12 PM	2.3	3.4
1 PM to 6 PM	3.2	1.0
7 PM to 12 AM	2.3	0.5

Location:	*Year:*	*Data Source:*	*Creator:*
X: 286,000 Y: 6,569,000	2014	CALMET extract	W. Shillito

Figure 5-2: Time of Day Wind Roses

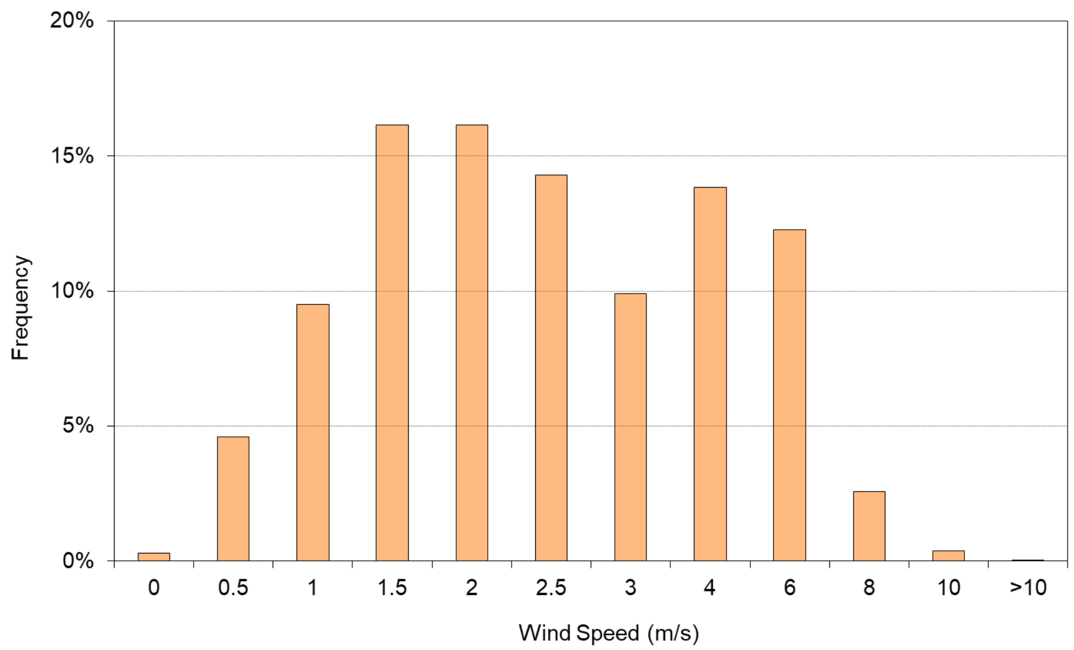


Figure 5-3: Wind Speed Frequency from CALMET

5.1.2 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 leads to high downwind concentrations. This is often associated with calm 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[4]. 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 these conditions 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 5-4. The data shows that E and F class stability occurs ~45% of the time. The frequency of D class stability (30%) is

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

commonly seen in areas with winds above 2.5 m/s at night or site with a high frequency of cloudy days.

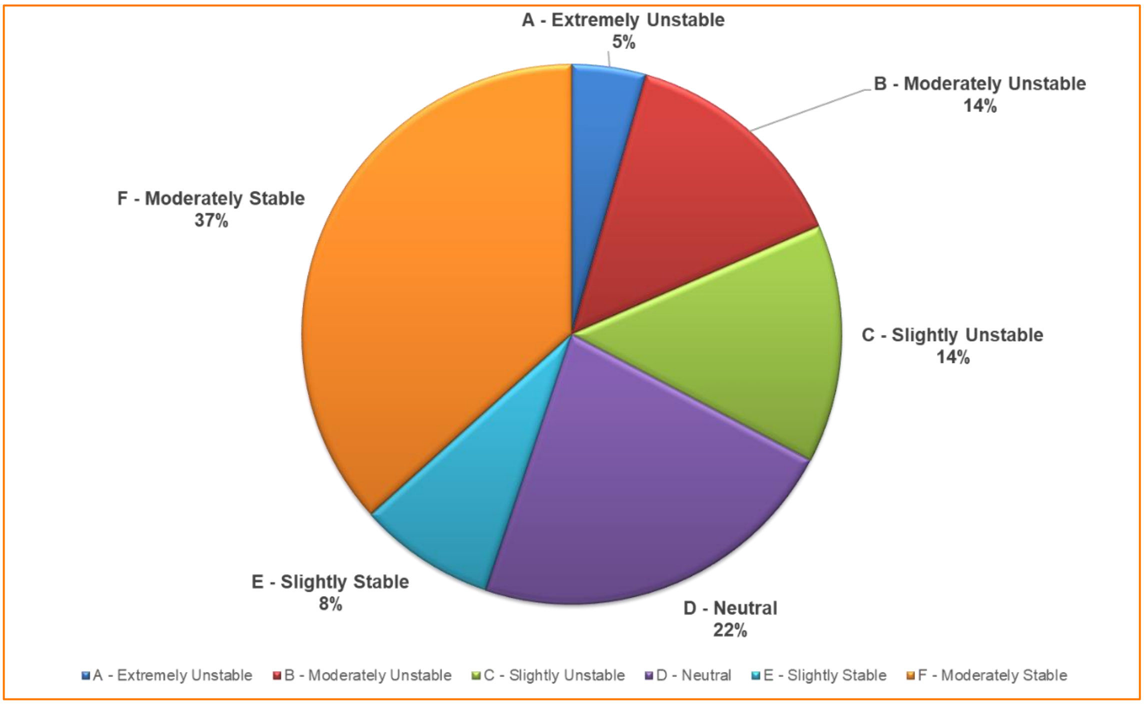


Figure 5-4: Atmospheric Stability

5.1.3 Atmospheric Mixing Height

he mixing height is the height at which vertical mixing of air and suspended gases or particles occurs 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, commonly referred to as an inversion layer, is an important parameter in assessing air emissions, as it defines the vertical mixing of a plume. The air below the layer has restricted vertical dispersion, meaning the higher the mixing height, the greater the potential for dispersion. The estimated variation of mixing height over time predicted at the site by CALMET is shown in Figure 5-5. 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 heights shown below are as expected.

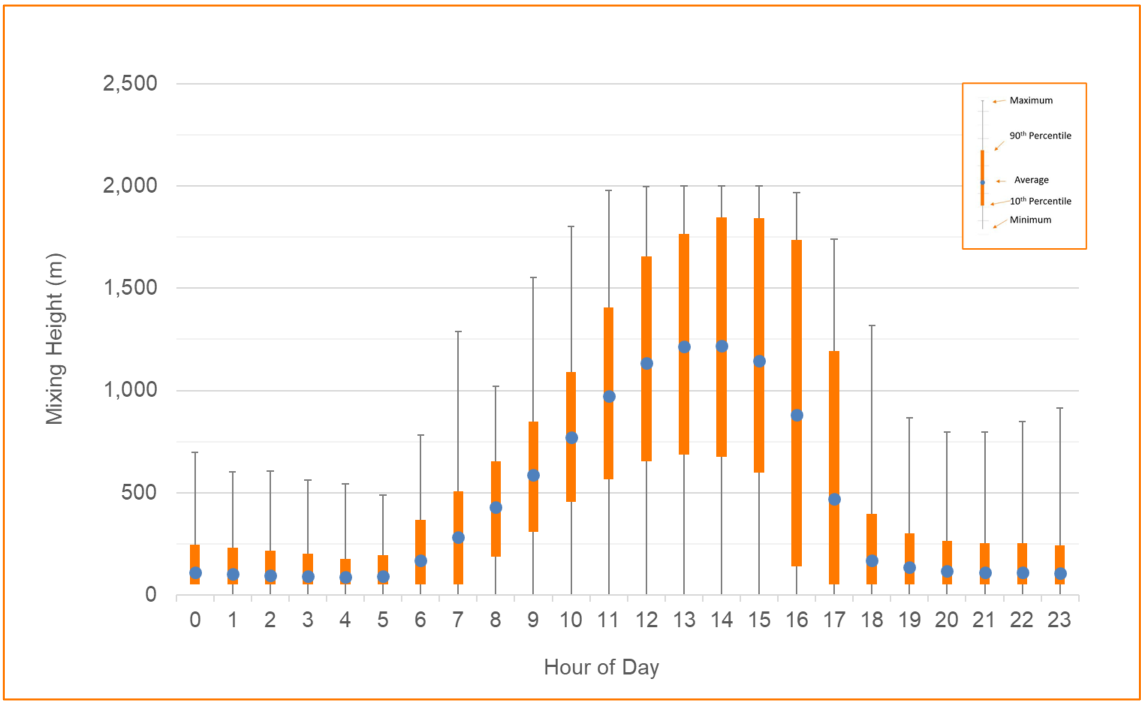


Figure 5-5: CALMET Extract – Predicted Mixing Heights

5.2 Background Air Quality Data

Existing air quality in the region surrounding the Bective farm is influenced by the following sources:

- dust from agricultural activities (ploughing, harvesting, bailing) and the poultry farm itself;
- wind erosion from exposed areas; and
- wheel generated dust from unsealed rural roads.

We are not aware of any air quality monitoring stations with publicly available data in the farm locale however, the Office of Environment and Heritage (OEH) operates several monitoring stations throughout New South Wales.

The Office of Environment and Heritage (OEH) operates several monitoring stations throughout New South Wales. The closest monitoring station is located in Tamworth.

A statistical summary for the 2014 monitoring year (24 hour PM_{10}) is provided in Table 5-1 .Table 5-1 below shows that the average concentration was 15.8 µg/m^3 and the dataset as a whole was dominated by a small number of high values (with the second highest value being 39.2 µg/m^3 once data associated with events such as large bushfires were removed). This means that the use of the maximum background value would produce an unrealistic estimate of the expected maximum dust concentrations in the area around the farm.

Table 5-1: Statistical summary of Tamworth Monitoring Data

Parameter	PM_{10} 24 – hour
Monitoring period	01/01/2014 – 31/12/2014
Averaging period	24 hours
Number of validated measurements	363
Data capture	99.4%
Average	15.8 µg/m^3
Standard deviation	7.0 µg/m^3
Percentiles and Concentrations (µg/m^3)	
25th	11.0
50th	14.9
70th	18.1
90th	24.7
99th	36.2
3rd highest	37.4
2nd highest	39.2
Maximum	**66.6**
Annual Average	**15.8**

Table 5-2: Adopted Background Air Quality Data 2014

Pollutant	Site	Averaging Period	Statistic	Value (µg/m^3)
PM_{10}	Tamworth	24 hours	Maximum	66.6
		Annual	Average	15.8

5.3 Sensitive Receptors

As a large domain was modelled, numerous receptors were identified and included in the modelling. They are shown below as follows:

- Figure 5-6: Receptors adjacent to the site; and
- Figure 5-7: Receptors within the region.

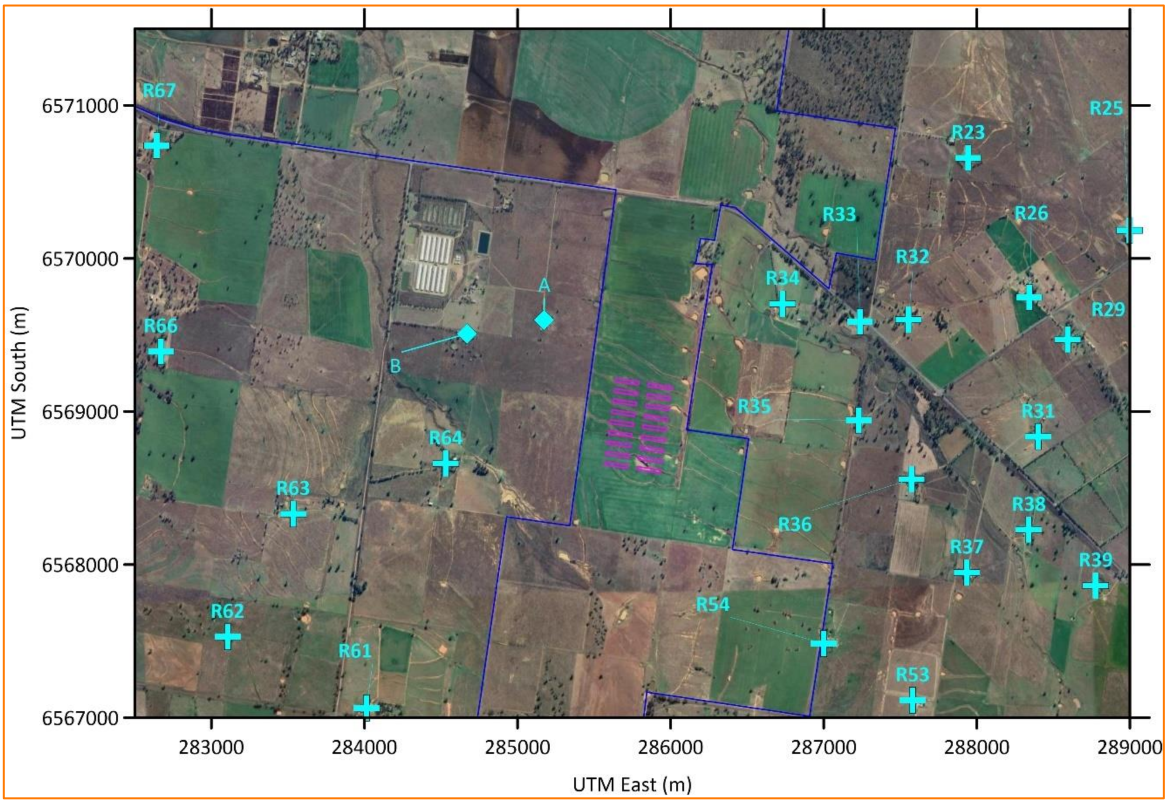


Figure 5-6: Sensitive Receptors – Local

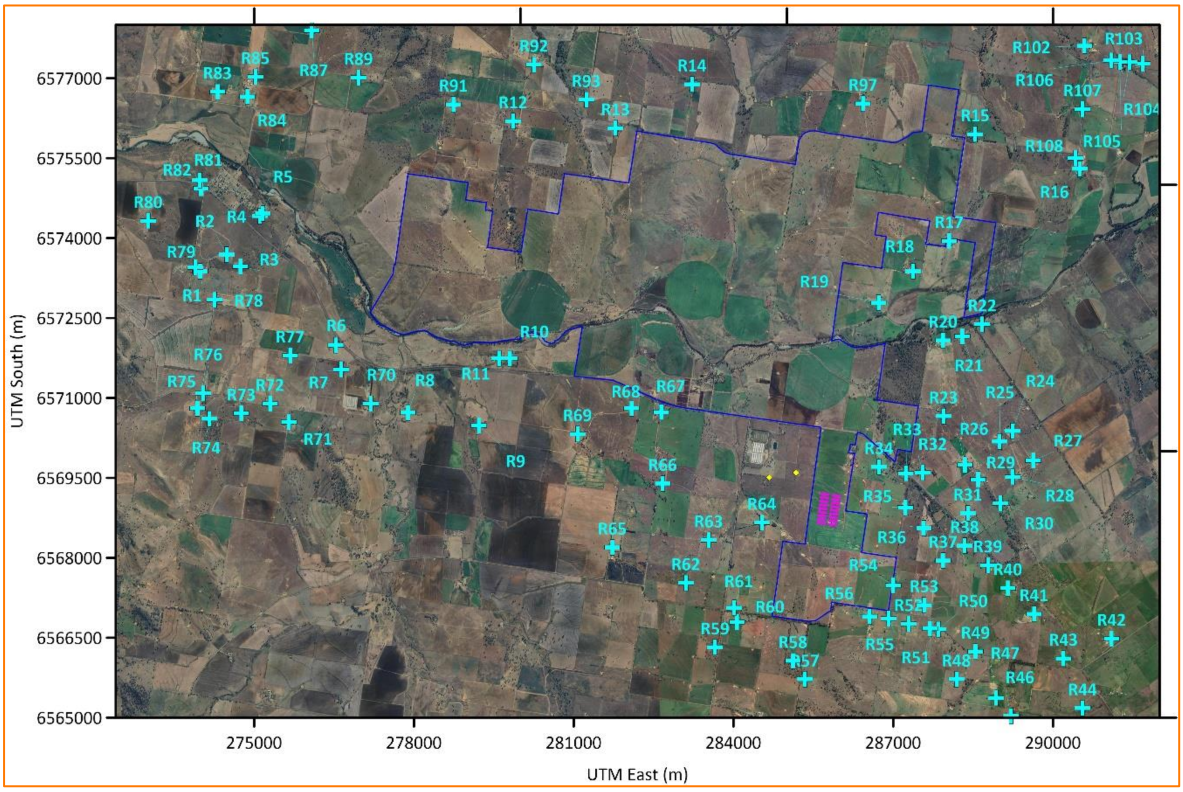


Figure 5-7: Sensitive Receptors – Region

6 RESULTS

6.1 Construction Phase

The *Guidance on the assessment of dust from demolition and construction* (IAQM, 2023)[5] is a document that provides guidance on how to perform a construction dust impact assessment.

The document contains a five step process which is as follows:

- Step 1: Screen the Need for a Detailed Assessment;
- Step 2: Assess the Risk of Dust Impacts Arising;
- Step 3: Site-specific Mitigation;
- Step 4: Determine Significant Effects; and
- Step 5: Dust Assessment Report.

Of the steps above, steps 1 to 4 are relevant to the site. Full details concerning the methodology can be found in IAQM (2023).

6.1.1 Step 1 – Initial Screening

Step 1 uses a deliberately conservative methodology, and as there is a receptor within 250 m of the boundary of the site further assessment is required.

6.1.2 Step 2 – Risk of Dust Impacts

Step 2 involves 3 components:

- 2A – the scale and nature of the works, in terms of a small, medium or large magnitude;
- 2B – the sensitivity of the area to dust impacts, defined as low, medium or high; and
- 2C – a combination of Steps 2A and 2B.

Regarding Step 2A, there are four areas that require assessment, these are defined and described in Table 6-1 below.

It is noted that the closest non project related receptor is approximately 900 m away.

[5] "the document"

Table 6-1: Step 2B Selections

Process	Magnitude Selection	Justification
Demolition	N/A	No demolition
Earthworks	Medium	Area disturbed for Stages 1 and 2 will be ~ 300,000 m^2, which is the approximately area of the pad on which the sheds are built.
Construction	Medium	Each shed building will have a volume of ~12,000 m^3. No on site batching.
Trackout	Medium	Initially during construction unpaved road length will be over 100 m. Possible 20 to 50 vehicles >3.5 t outward per day.

Step 2B involves defining the sensitivity of the receptor as follows:

- For soiling (dust deposition), there are no residential receptors within 900 m of the farm. Therefore, based on Table 2 of IAQM (2023), the risk is low.
- For human health, there are no residential receptors within 90 m of the construction site. Therefore, based on Table 3 of IAQM (2023), the risk is low.

Table 6-2: Outcome of Defining the Sensitivity of the Area

Process	Demolition	Earth Works	Construction	Trackout
Soiling	N/A	Low	Low	Low
Human Health	N/A	Low	Low	Low

Step 2C involves defining the risk based on Table 6-1 and Table 6-2 while assuming no controls are in use. Each of Table 6-3 through Table 6-6 below can be used to define the uncontrolled risk for demolition through trackout.

Table 6-3: Risk of Dust Impacts – Demolition (IAQM, 2023)

Sensitivity of area	Magnitude Potential		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table 6-4: Risk of Dust Impacts – Earth Works (IAQM, 2023)

Sensitivity of area	Magnitude Potential		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 6-5: Risk of Dust Impacts – Construction (IAQM, 2023)

Sensitivity of area	Magnitude Potential		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 6-6: Risk of Dust Impacts – Trackout (IAQM, 2023)

Sensitivity of area	Magnitude Potential		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Negligible
Low	Low Risk	Low Risk	Negligible

The results of the initial risk assessment using the information above is summarised below in Table 6-7. The table shows, that even with a medium emission risk, due to the distances to the receptors, there is a low overall risk. This however does not negate the need for proactive and reactive dust mitigation measures as summarised in Section 8 below.

Table 6-7: Summary Dust Risk Table to Define Site-Specific Mitigation

Process	Demolition Table 6-3	Earth Works Table 6-4	Construction Table 6-5	Trackout Table 6-6
Soiling	N/A	Low Risk	Low Risk	Low Risk
Human Health	N/A	Low Risk	Low Risk	Low Risk

6.1.3 Step 3 – Site specific mitigation

The risk at the site has been found to be low. However, the recommend mitigation measures detailed in Section 8 below should be applied to the site.

6.1.4 Step 4 – Significant Effects

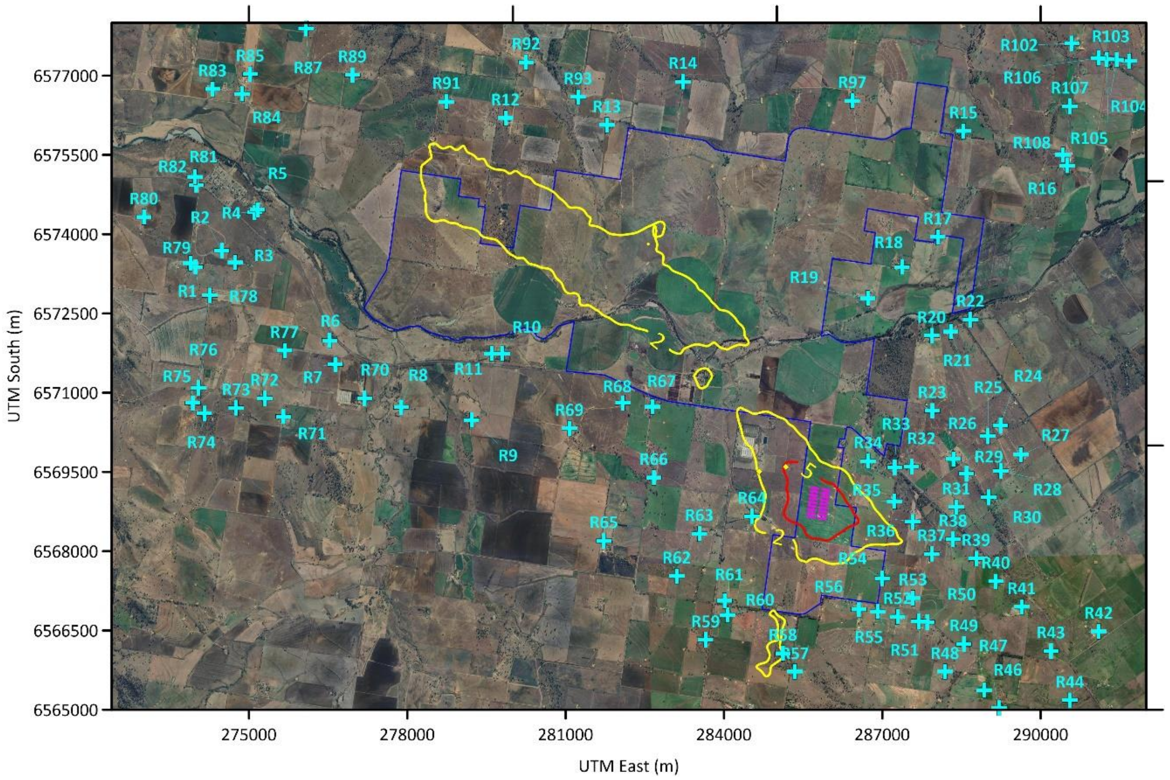
Dust associated with construction is unlikely to lead to nuisance at the nearby receptors if the recommended mitigation measures in Section 8 below are implemented. Therefore, the residual risk for receptors following mitigation will be negligible.

6.2 Odour

6.2.1 Isolation

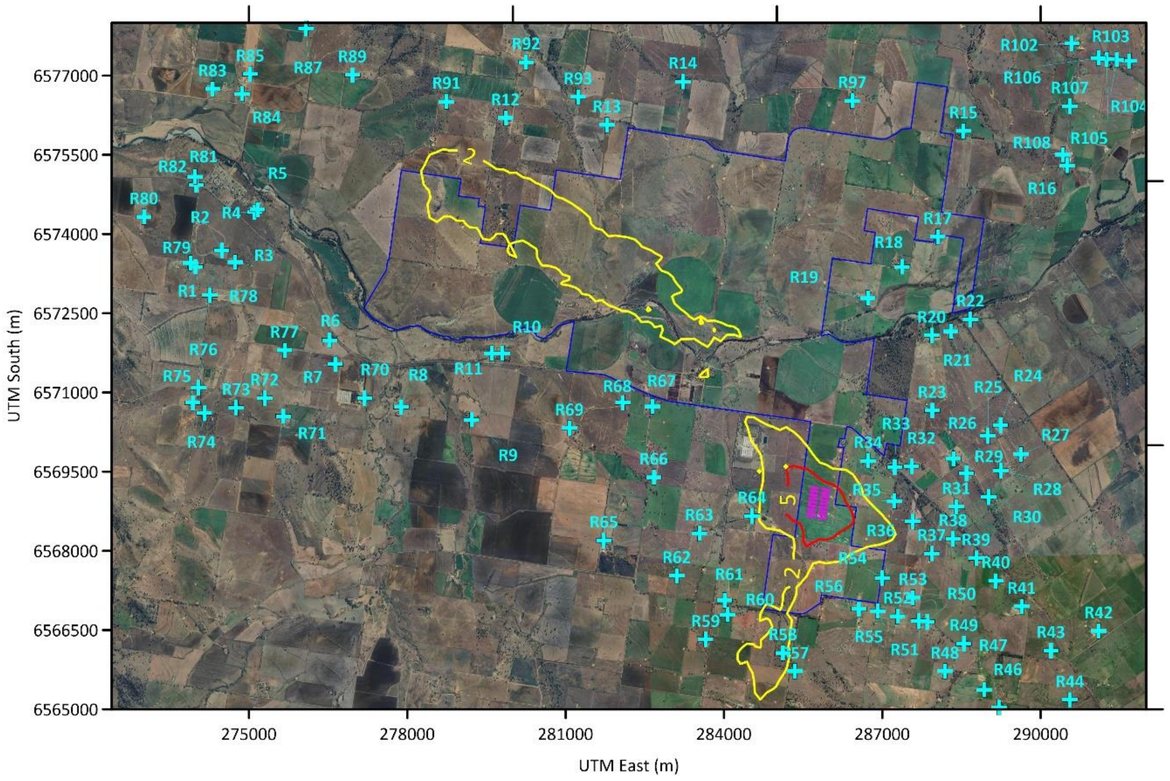
The results for the farm in isolation are shown in Figure 6-1 to Figure 6-3 below for Day 1 to Day 28 placements.

The top 20 receptor concentrations for each scenario are shown in Table 6-8 below. All results are at a K actor of 1.9.



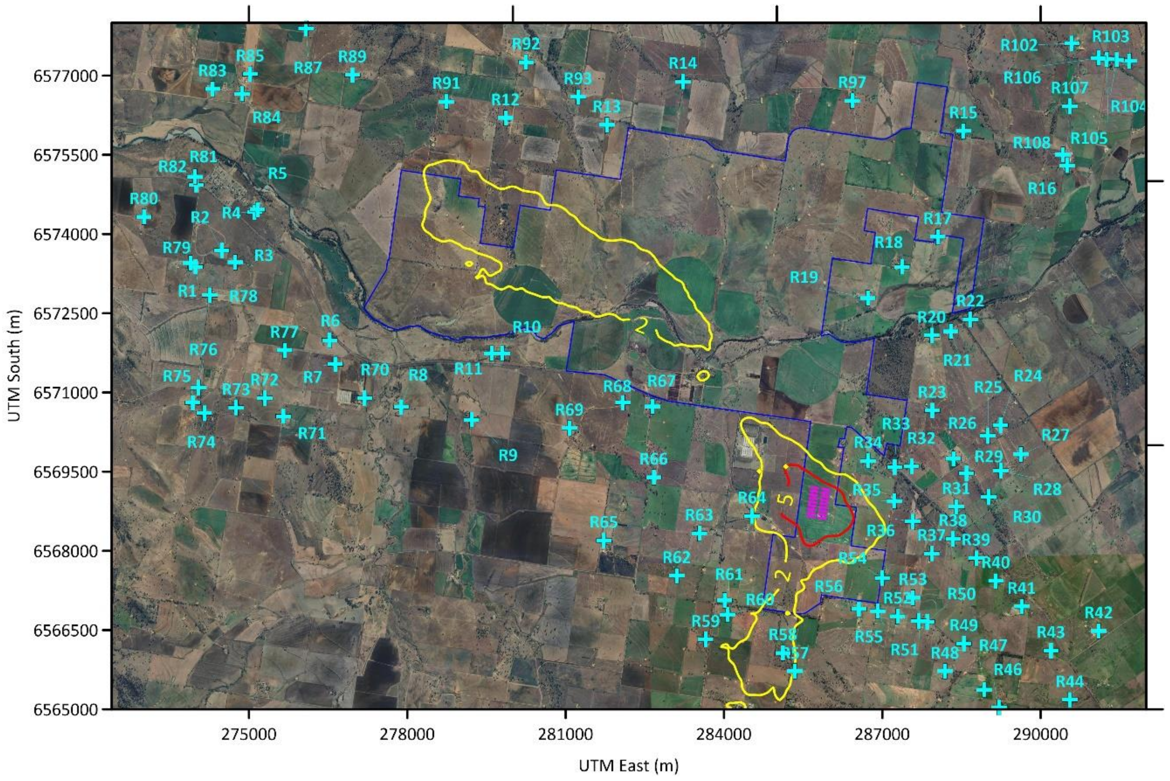
Species: Odour	Site: Bective South	Scenario: Day 1 K=1.9	Averaging Period: 1 sec	Percentile: 99th
Criterion: 5 ou	Units: ou	Meteorology: 2014	Model: CALPUFF v 6.42	Author: G. Galvin

Figure 6-1: Contours - Farm in Isolation Day 1



Species: Odour	**Site:** Bective South	**Scenario:** Day 14 K=1.9	**Averaging Period:** 1 sec	**Percentile:** 99th
Criterion: 5 ou	**Units:** ou	**Meteorology:** 2014	**Model:** CALPUFF v 6.42	**Author:** G. Galvin

Figure 6-2: Contours - Farm in Isolation Day 14



Species: Odour	Site: Bective South	Scenario: Day 28 K=1.9	Averaging Period: 1 sec	Percentile: 99th
Criterion: 5 ou	Units: ou	Meteorology: 2014	Model: CALPUFF v 6.42	Author: G. Galvin

Figure 6-3: Contours - Farm in Isolation Day 28

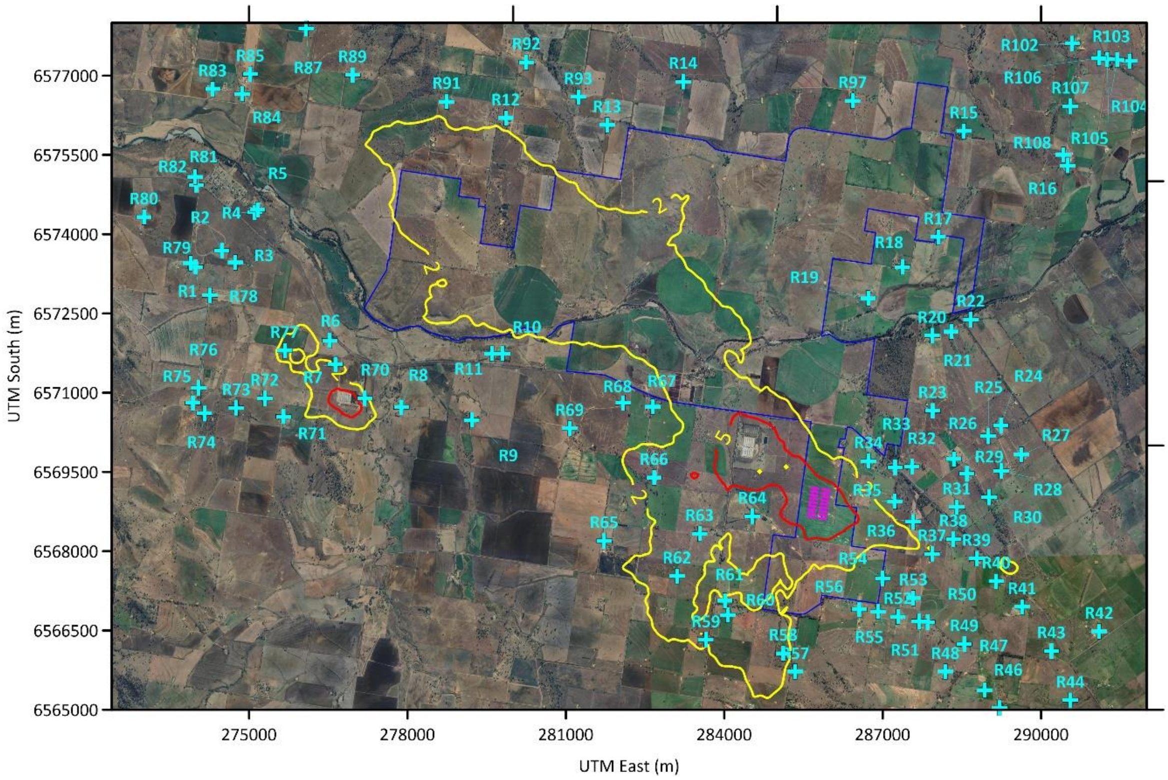
Table 6-8: Top 20 Predicted Receptor Concentrations (99th 1 sec)

Scenario	Isolation – Day 1		Isolation – Day 14		Isolation – Day 14	
Rank	Receptor	Concentration	Receptor	Concentration	Receptor	Concentration
1	SR58	2.0	SR58	2.8	SR58	3.2
2	SR64	1.7	SR64	1.7	SR64	2.0
3	SR37	1.5	SR60	1.4	SR57	2.0
4	SR60	1.4	SR37	1.3	SR60	1.6
5	SR41	1.3	SR41	1.2	SR54	1.1
6	SR40	1.2	SR57	1.2	SR36	1.1
7	SR35	1.1	SR36	1.2	SR56	1.0
8	SR59	1.1	SR39	1.1	SR35	1.0
9	SR61	1.1	SR34	1.1	SR59	1.0
10	SR39	1.1	SR35	1.1	SR37	1.0
11	SR36	1.0	SR40	1.0	SR34	0.9
12	SR56	1.0	SR59	0.9	SR41	0.9
13	SR42	1.0	SR38	0.9	SR61	0.9
14	SR57	1.0	SR84	0.9	SR62	0.9
15	SR91	1.0	SR91	0.9	SR85	0.8
16	SR85	0.9	SR85	0.9	SR63	0.8
17	SR34	0.9	SR54	0.9	SR84	0.8
18	SR54	0.9	SR56	0.9	SR40	0.8
19	SR84	0.9	SR42	0.9	SR55	0.8
20	SR12	0.9	SR83	0.8	SR33	0.8

6.2.2 Cumulative

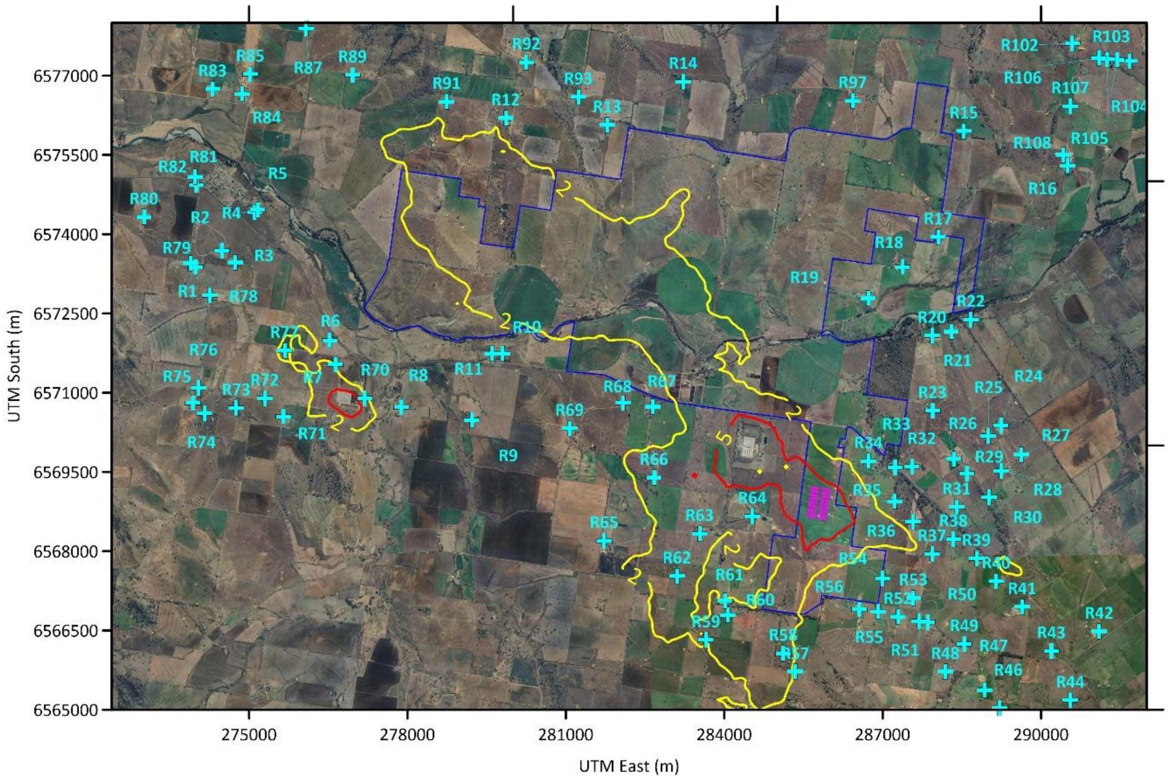
The results for the farm shown cumulatively with other poultry farms in the area are shown in Figure 6-4 to Figure 6-6 below for Day 1 to Day 28 placements (other farms at day 1). All results are at a K actor of 1.9.

The top 15 receptor concentrations for each scenario are shown in Table 6-9 below. In total, 10 receptors were predicted to be at or above 2.0 ou. Based on a population density for Bective of 2.4 people per dwelling from the 2021 Census, this gives a potentially affected population of 25 people, and an odour criterion of $C_{99\ 1sec}$ = 5 ou.



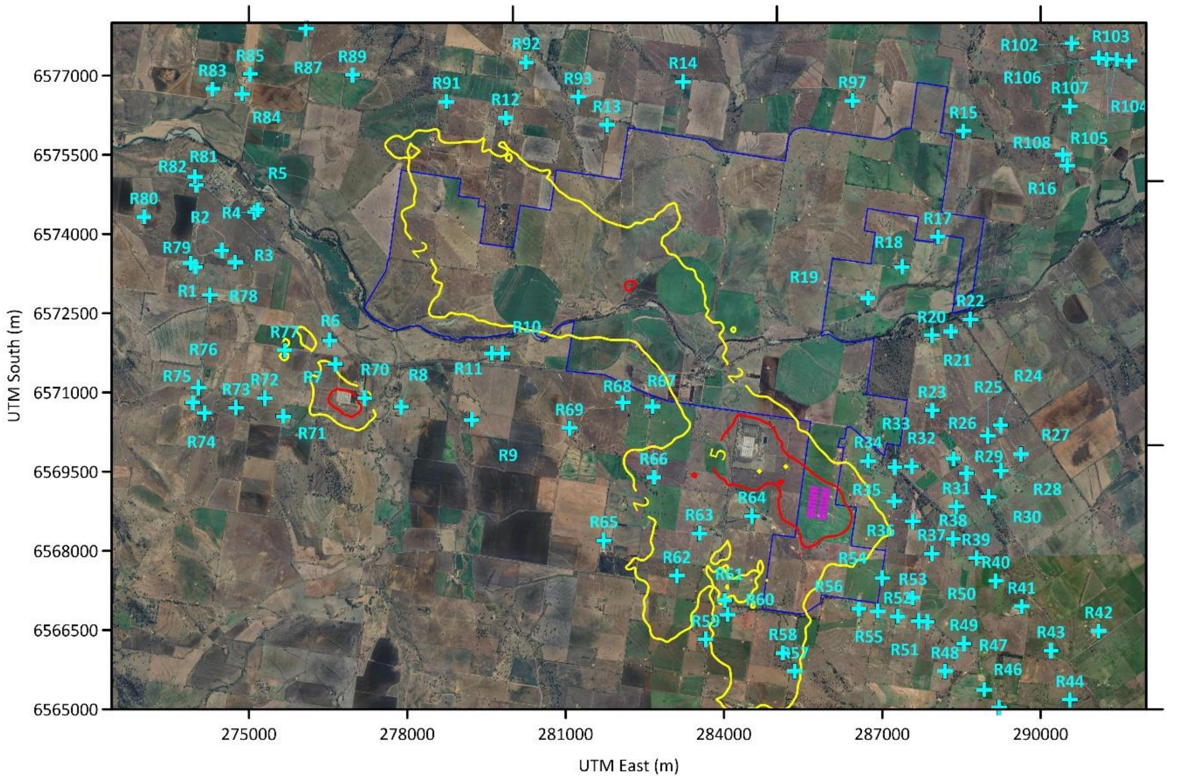
Species: Odour	**Site:** Bective South	**Scenario:** Day 1	**Averaging Period:** 1 sec	**Percentile:** 99th
Criterion: 5 ou	**Units:** ou	**Meteorology:** 2014	**Model:** CALPUFF v 6.42	**Author:** G. Galvin

Figure 6-4: Contours - Cumulative Day 1



Species:	Site:	Scenario:	Averaging Period:	Percentile:
Odour	Bective South	Day 14	1 sec	99th
Criterion:	**Units:**	**Meteorology:**	**Model:**	**Author:**
5 ou	ou	2014	CALPUFF v 6.42	G. Galvin

Figure 6-5: Contours - Cumulative Day 14



Species: Odour	Site: Bective South	Scenario: Day 28	Averaging Period: 1 sec	Percentile: 99th
Criterion: 5 ou	**Units:** ou	**Meteorology:** 2014	**Model:** CALPUFF v 6.42	**Author:** G. Galvin

Figure 6-6: Contours - Cumulative Day 28

Table 6-9: Top 20 Predicted Cumulative Receptor Concentrations (99th 1 sec)

Scenario	Cumulative – Day 1		Cumulative – Day 14		Cumulative – Day 28	
Rank	Receptor	Concentration	Receptor	Concentration	Receptor	Concentration
1	4.3	SR66	4.0	SR66	4.2	SR66
2	3.5	SR62	3.1	SR62	3.5	SR62
3	3.0	SR60	3.0	SR58	3.4	SR58
4	2.9	SR63	2.8	SR60	2.9	SR63
5	2.5	SR58	2.7	SR63	2.7	SR64
6	2.5	SR64	2.5	SR64	2.5	SR57
7	2.4	SR70	2.4	SR70	2.5	SR60
8	2.2	SR61	2.2	SR77	2.4	SR70
9	2.2	SR77	2.1	SR59	2.0	SR61
10	2.1	SR59	2.1	SR61	2.0	SR77
11	1.9	SR37	1.9	SR57	1.8	SR59
12	1.9	SR71	1.8	SR37	1.8	SR71
13	1.9	SR7	1.8	SR71	1.8	SR65
14	1.8	SR65	1.8	SR65	1.6	SR7
15	1.7	SR40	1.7	SR29	1.5	SR30
16	1.7	SR67	1.7	SR7	1.5	SR68
17	1.7	SR12	1.7	SR41	1.5	SR28
18	1.6	SR30	1.7	SR39	1.4	SR67
19	1.6	SR57	1.6	SR40	1.4	SR3
20	1.6	SR39	1.6	SR67	1.4	SR41

6.3 Particulate Matter

The predicted ground level concentrations of PM_{10} for both the maximum 24-hour and annual average are presented below. Note that the background concentration for the 24 hour average concentration is higher than the 50 µg/m^3 limit at 66.6 µg/m^3 and the predicted increments are small.

The results show:

- The maximum predicted 24-hour concentration in isolation for all sensitive receptors was 6.1 µg/m^3 at SR 41;
- The cumulative 24-hour PM_{10} assessment which includes the particulate emissions from the sheds, predicted no additional days above the 50 µg/m^3 criterion;
- Cumulative annual average predictions including background and particulate emissions from the shed are predicted to be in compliance with the impact assessment criteria for the majority of sensitive receptors; and
- For the annual average, no receptors are above the criterion.

Table 6-10: Top 20 Predicted Isolation Receptor Concentrations 24 Hour PM_{10}

Scenario	Cumulative – Day 1		Cumulative – Day 14		Cumulative – Day 28	
Rank	Concentration (μ/m³)	Receptor	Concentration (μ/m³)	Receptor	Concentration (μ/m³)	Receptor
1	4.6	SR62	6.1	SR41	3.7	SR64
2	4.4	SR35	3.8	SR37	3.3	SR41
3	4.3	SR56	3.7	SR35	3.3	SR37
4	4.3	SR61	3.5	SR60	3.2	SR58
5	3.7	SR54	3.5	SR40	3.1	SR40
6	3.7	SR36	3.5	SR56	3.1	SR56
7	3.7	SR40	3.4	SR31	3.1	SR62
8	3.6	SR60	3.4	SR64	2.9	SR43
9	3.4	SR39	3.2	SR58	2.7	SR54
10	3.2	SR26	3.2	SR42	2.7	SR57
11	3.2	SR32	3.1	SR32	2.6	SR30
12	3.2	SR37	2.9	SR39	2.5	SR42
13	3.1	SR30	2.9	SR59	2.4	SR55
14	3.1	SR25	2.8	SR29	2.2	SR48
15	3.0	SR31	2.6	SR26	2.2	SR60
16	3.0	SR59	2.6	SR54	2.1	SR61
17	2.9	SR42	2.4	SR25	1.9	SR34
18	2.9	SR66	2.4	SR62	1.9	SR66
19	2.8	SR24	2.4	SR36	1.8	SR39
20	2.8	SR52	2.2	SR43	1.8	SR59

Table 6-11: Top 20 Predicted Cumulative Receptor Concentrations 24 Hour PM_{10}

Scenario	Cumulative – Day 1		Cumulative – Day 14		Cumulative – Day 28	
Rank	Concentration (μ/m^3)	Receptor	Concentration (μ/m^3)	Receptor	Concentration (μ/m^3)	Receptor
1	71.2	SR62	72.7	SR41	70.3	SR64
2	71.0	SR35	70.4	SR37	69.9	SR41
3	70.9	SR56	70.3	SR35	69.9	SR37
4	70.9	SR61	70.1	SR60	69.8	SR58
5	70.3	SR54	70.1	SR40	69.7	SR40
6	70.3	SR36	70.1	SR56	69.7	SR56
7	70.3	SR40	70.0	SR31	69.7	SR62
8	70.2	SR60	70.0	SR64	69.5	SR43
9	70.0	SR39	69.8	SR58	69.3	SR54
10	69.8	SR26	69.8	SR42	69.3	SR57
11	69.8	SR32	69.7	SR32	69.2	SR30
12	69.8	SR37	69.5	SR39	69.1	SR42
13	69.7	SR30	69.5	SR59	69.0	SR55
14	69.7	SR25	69.4	SR29	68.8	SR48
15	69.6	SR31	69.2	SR26	68.8	SR60
16	69.6	SR59	69.2	SR54	68.7	SR61
17	69.5	SR42	69.0	SR25	68.5	SR34
18	69.5	SR66	69.0	SR62	68.5	SR66
19	69.4	SR24	69.0	SR36	68.4	SR39
20	69.4	SR52	68.8	SR43	68.4	SR59

Table 6-12: Top 20 Predicted Isolation Receptor Concentrations Annual PM_{10}

Scenario	Cumulative – Day 1		Cumulative – Day 14		Cumulative – Day 28	
Rank	Concentration (μ/m³)	Receptor	Concentration (μ/m³)	Receptor	Concentration (μ/m³)	Receptor
1	0.2	SR58	0.2	SR58	0.2	SR58
2	0.2	SR60	0.1	SR64	0.1	SR57
3	0.1	SR59	0.1	SR60	0.1	SR64
4	0.1	SR64	0.1	SR37	0.1	SR60
5	0.1	SR61	0.1	SR56	0.1	SR56
6	0.1	SR56	0.1	SR36	0.1	SR54
7	0.1	SR57	0.1	SR41	0.1	SR37
8	0.1	SR62	0.1	SR57	0.1	SR41
9	0.1	SR37	0.1	SR40	0.1	SR61
10	0.1	SR36	0.1	SR59	0.1	SR62
11	0.1	SR35	0.1	SR39	0.1	SR59
12	0.1	SR41	0.1	SR61	0.1	SR40
13	0.1	SR54	0.1	SR35	0.1	SR36
14	0.1	SR40	0.1	SR38	0.1	SR55
15	0.1	SR39	0.1	SR54	0.1	SR39
16	0.1	SR63	0.1	SR63	0.1	SR42
17	0.1	SR38	0.1	SR42	0.1	SR35
18	0.1	SR66	0.1	SR62	0.1	SR51
19	0.1	SR30	0.1	SR55	0.1	SR34
20	0.1	SR55	0.1	SR30	0.1	SR52

Table 6-13: Top 20 Predicted Cumulative Receptor Concentrations Annual PM_{10}

Scenario	Cumulative – Day 1		Cumulative – Day 14		Cumulative – Day 28	
Rank	Concentration (μ/m^3)	Receptor	Concentration (μ/m^3)	Receptor	Concentration (μ/m^3)	Receptor
1						
2	16.0	SR60	15.9	SR64	15.9	SR57
3	15.9	SR59	15.9	SR60	15.9	SR64
4	15.9	SR64	15.9	SR37	15.9	SR60
5	15.9	SR61	15.9	SR56	15.9	SR56
6	15.9	SR56	15.9	SR36	15.9	SR54
7	15.9	SR57	15.9	SR41	15.9	SR37
8	15.9	SR62	15.9	SR57	15.9	SR41
9	15.9	SR37	15.9	SR40	15.9	SR61
10	15.9	SR36	15.9	SR59	15.9	SR62
11	15.9	SR35	15.9	SR39	15.9	SR59
12	15.9	SR41	15.9	SR61	15.9	SR40
13	15.9	SR54	15.9	SR35	15.9	SR36
14	15.9	SR40	15.9	SR38	15.9	SR55
15	15.9	SR39	15.9	SR54	15.9	SR39
16	15.9	SR63	15.9	SR63	15.9	SR42
17	15.9	SR38	15.9	SR42	15.9	SR35
18	15.9	SR66	15.9	SR62	15.9	SR51
19	15.9	SR30	15.9	SR55	15.9	SR34
20	15.9	SR55	15.9	SR30	15.9	SR52

7 MONITORING PROGRAM

At this point in time, no ambient monitoring is proposed for the new site

If nuisance is alleged during construction or while operational, any monitoring performed should be in accordance with the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (NSW EPA, 2022b).

8 MITIGATION MEASURES

8.1 Construction

To ensure continual compliance and reduce the risk of dust nuisance, we recommend ongoing management which should consist of:

- minimising disturbed areas;
- treating any long term stockpiles to minimise dust emissions;
- road management:
    - treatment of the external road surface used by heavy vehicles to stabilise the roads; and/or
    - watering of the roads and/or open areas to reduce dust emissions as required;
- limiting vehicle speeds during conditions where dust emissions have the potential to be higher than normal due to dry or windy conditions;
- revegetating disturbed areas around the site which are not required for vehicle traffic or operations.

With regard to the timing of water truck use during construction, the primary dust management trigger should be visible dust with the potential to leave the site. If dust from the site is observed which has the potential to leave the site, watering should immediately occur. Other measures such as rehabilitation of exposed areas and minimising the area of the site exposed should also be included as part of site management.

8.2 Operational Phase

Good management practices play a significant role in reducing the potential for offensive odour and the emissions particulate matter. We note that this farm has proposed to use vertically mounted fans to enhance dispersion.

The proposed poultry sheds will be similar in design and scale to those used throughout the area with the exception of vertically mounted fans. As the farm will grow for Baiada, the sheds will have near identical operational and management procedures to the existing farms. Therefore, the design features, best management practices and mitigation measures used in the region are appropriate and will be implemented here:

Odour

- Vegetation buffers should be planted and maintained around the sheds as soon as practicable following construction. Vegetation buffers reduce the magnitude and frequency of any adverse air quality impacts by effectively slowing and filtering air movement from the ground level fans, which reduces dust impacts via dust deposition and also assists in odour dispersion.

- The poultry sheds will be tunnel-ventilated which allow good control over internal moisture levels and also promote optimum growing conditions and bird health. The increased airflow and improved feed conversion in modern tunnel-vented sheds assists in the maintenance of the bedding material within the optimal moisture range.

- The poultry sheds will be fully enclosed, have wide eaves, and be surrounded by concrete bund walls to prevent rainwater from entering the sheds and to allow for the controlled discharge of washdown water during cleaning. These measures will reduce the moisture level within the poultry sheds associated with rainfall, helping to keep litter moisture low and subsequently reducing the risk of abnormal odour emissions.

- The poultry sheds will be fitted with nipple drinkers with drip cups to minimise water spillage and prevent elevated moisture levels in the litter.
- The feed silos will be fully enclosed to prevent rainwater entry, as wet feed can be a potential odour source.
- The maximum stocking density will not exceed RSPCA specifications.
- Regular monitoring and maintenance of the tunnel ventilation systems and bird drinkers will be performed to avoid spillage, leaks, lowering of efficiency of fans and uneven distribution.
- Stocking densities and bird health within each of the poultry sheds will be regularly checked and, if necessary, appropriate corrective measures will be implemented.
- Daily monitoring and maintenance of the litter will occur to identify, remove and replace any caked material beneath drinking lines and/or areas with excessive moisture content.
- Spent litter will be promptly removed from the sheds and transported off-site in covered trucks at the end of each production cycle during the clean-out phase. Handling of the material will be avoided during adverse climatic conditions, such as cold air drainage in the early morning or at night and during strong winds, wherever possible.
- Poultry litter will not be stockpiled or spread within the site.
- Dead birds will be collected from the sheds on a daily basis and stored in the enclosed on-site dead bird facility before removal from site.
- The insides of the poultry sheds and the surrounds will be maintained at all times to ensure a clean and sanitary environment.
- Shed access points will remain closed at all times other than for allowing access to the sheds.
- Where possible, activities that may increase odour emissions (for example, bedding material replacement) will be undertaken during daytime hours.

Particulate Matter

- Vegetation buffers should be planted be planted and maintained around the new farm as soon as practicable following construction. Vegetative buffers reduce the magnitude and frequency of any adverse air quality impacts from emissions near ground level by effectively slowing and filtering air movement, which enhances dust deposition which reduces the movement of dust offsite.
- The feed silos will be fully enclosed to minimise emissions of particulate matter when loading/unloading.
- Vehicles will not exceed a general speed limit of 40 km/hr within the site and should be confined, where possible, to the internal access roads.
- Internal access roads will be appropriately constructed and maintained to minimise dust emissions.
- The poultry sheds will be thoroughly cleaned between batches, with a focus on the fan end of the sheds.
- The generators are mounted appropriately with a vertical air discharge
- Where possible, the handling of bedding material and litter will be avoided during adverse climatic conditions.

- Poultry litter will be promptly transported off-site in covered trucks at the end of each production cycle.

A standard assessment has been performed and documented in this report. Poultry farm management and profitability are directly related, in that a well run farm has good bird health and growth and low emissions. The K factor measurements detailed above indicate that a K factor of 1.5 is achievable and a lower value is expected. On this basis, based on the modelling using the vertical discharges, additional odour control options are not warranted at this point in time.

9 DISCUSSION

9.1 Use of Vertical Fans

The results shown both in isolation and cumulatively above were as expected, in that the footprint of the farm was relatively small. This is due to the use of vertically mounted fans, which emit like a stack, rather than ground level. Research including (Bottcher, et al., 2001) have highlighted the benefits of such arrangements. Bottcher et al. noted that the use of taller stacks, rather than simply elbows directing air vertically was the preferred options for a dispersion perspective. Here, we have shown that with a 7 m release height and a velocity of 6 m/s, the footprint of the farm is relatively small.

Cumulatively, all receptors were at or below 4 ou.

However, it is critical that the farm operate as modelled, and that the fans are able to achieve the release height and velocity modelled. If variable speeds fans are used, these should be set to operate at a flow not less than that required to achieve the 6 m /s velocity.

9.2 Weather stations

Two new weather stations were installed on Bective Station, one near the feedlot (station 2) and another to the west further down the river (station 1) in late November 2023. Both stations were Environdata stations, and met relevant requirements and made use of Vaisala WXT530 Windcap ultrasonic sensors.

The first station failed on 11 January 2024 at around 7 pm after birds destroyed the wind speed and direction sensor. The second station failed on 4 February 2024 at around 7 am, after birds destroyed the wind speed and direction sensor.

This was not discovered until early to mid June 2023 as it is unusual for sensors with Vaisala bird spikes to be damaged so quickly, if at all. During a site visit on 21 June 2024, both stations were brought back on line with cup and vane sensors and the Vaisala sensors were removed. Due to no sensors being available in Australia, these were not replaced until late August 2023. On around 7 August 2024, station 2 started reporting a high frequency of no winds, which was inconsistent with the period leading up to this. On 4 September 2024, the data quality improved and the station started reporting winds again. This issue only occurred with Station 2 which is at the feedlot. For station 1, the difference in measured winds before and after the cup and vane system was replaced was minimal as shown in Figure 9-1 where:

- Blue box shows day where sensor was replaced;
- Dots show hourly averaged wind speeds; and
- Red arrow shows a data gap (no data for that hour).

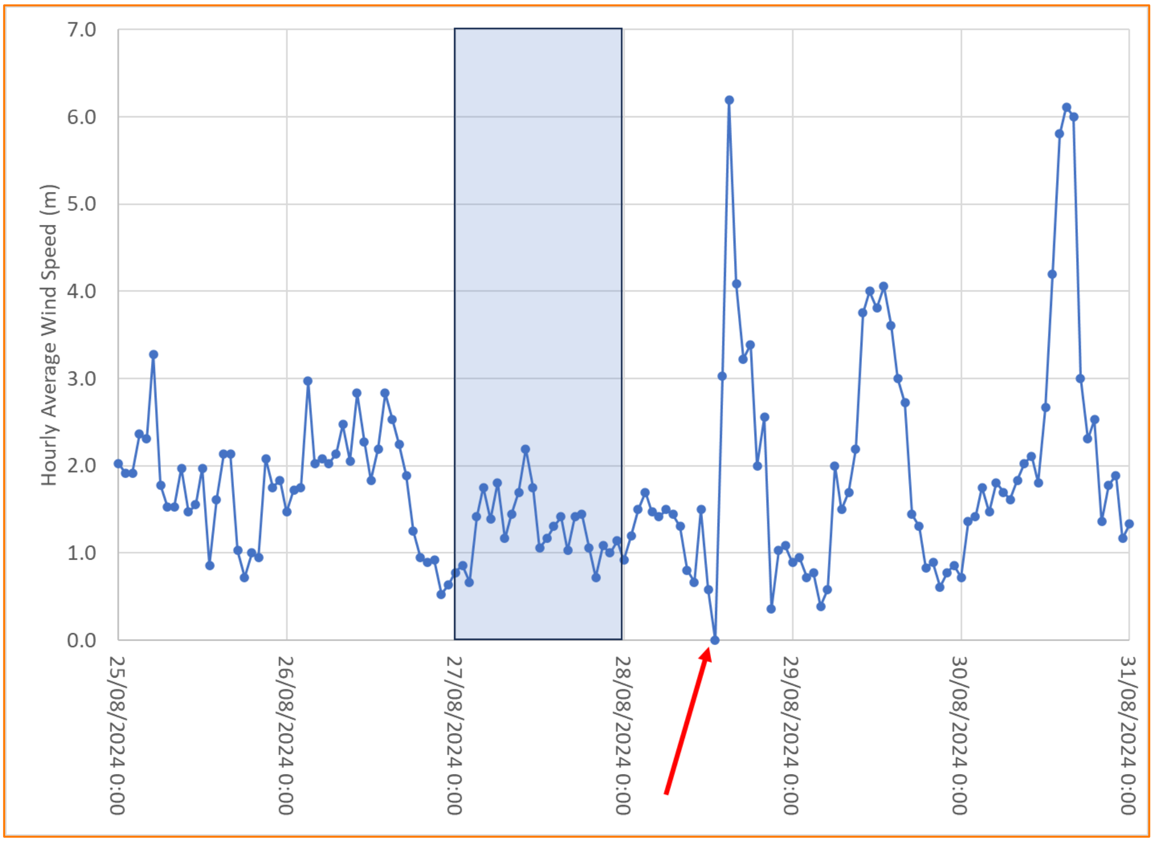


Figure 9-1: Station 2 - Before and After Replacement of Sensor – August 2024

Unfortunately, as the TAPM synoptic hasn't been updated since September, TAPM cannot be run and compared to the most recent data for the weather station, as no on site data was available, we validated the use of TAPM against a cup and vane station at the Moana farm (now known as Karinya). It is understood that the station there recently upgraded to an ultrasonic sensor. The validation involved running TAPM at that site, and comparing the TAPM predictions to the observed data using the benchmarks in USEPA (2020) and having regard to Johnson (2019). It is noted that the site is classified as complex terrain per AMS (2012).

Two years were selected at random, 2017 and 2022 and the results are shown for wind speed and direction as follows:

- Table 9-1: Wind Speed Statistics – TAPM 300 m v Observed - 2017;
- Table 9-2: Wind Direction Statistics – TAPM 300 m v Observed - 2017;
- Table 9-3: Wind Speed Statistics – TAPM 300 m v Observed - 2022; and
- Table 9-4: Wind Direction Statistics – TAPM 300 m v Observed – 2022.

Table 9-1: Wind Speed Statistics – TAPM 300 m v Observed - 2017

Variable	Calculated Value	Criteria	Meets Criteria?
Bias	0.2	±0.5 ±2.5 (complex)	Yes
RMSE	1.5	<2	Yes
IOA	0.8	>0.6	Yes
SkillE	0.9	<1	Yes
SkillR	0.8	<1	Yes
SkillV	1.0	<1	Yes

Table 9-2: Wind Direction Statistics – TAPM 300 m v Observed - 2017

Variable	Calculated Value	Criteria	Meets Criteria?
Bias (hourly)	2.2°	±10° ±20° (complex)	Yes
Gross Error (hourly)	57.0°	≤30° ≤55° (complex)	No Yes complex
Bias (daily)	7.1°	±10 ±20° (complex)	Yes
Gross Error (daily)	50.2°	≤30° ≤55° (complex)	No Yes complex

Table 9-3: Wind Speed Statistics – TAPM 300 m v Observed - 2022

Variable	Calculated Value	Criteria	Meets Criteria?
Bias	0.0	±0.5 ±2.5 (complex)	No Yes complex
RMSE	1.2	<2	Yes
IOA	0.9	>0.6	Yes
SkillE	0.7	<1	Yes
SkillR	0.6	<1	Yes
SkillV	1.0	<1	Yes

Table 9-4: Wind Direction Statistics – TAPM 300 m v Observed – 2022

Variable	Calculated Value	Criteria	Meets Criteria?
Bias (hourly)	-7.2°	±10° ±20° (complex)	Yes
Gross Error (hourly)	24.7°	≤30° ≤55° (complex)	No Yes complex
Bias (daily)	-1.6°	±10 ±20° (complex)	Yes
Gross Error (daily)	36.6°	≤30° ≤55° (complex)	Yes

Quantile Quantile (QQ) plots were prepared for wind speed. A QQ plot is a scatterplot created by plotting two sets of data against one another. If both datasets have a similar distribution, the points should form a straight line.

The plots for 2017 and 2022 are shown below as Figure 9-2 and Figure 9-3 respectively. The lines are relatively straight, as shown by the similarity between the blue points, and theoretical 1:1 line. There is however some divergence below 2 m/s indicating that the model may slightly underpredict light (under 3 m/s) winds.

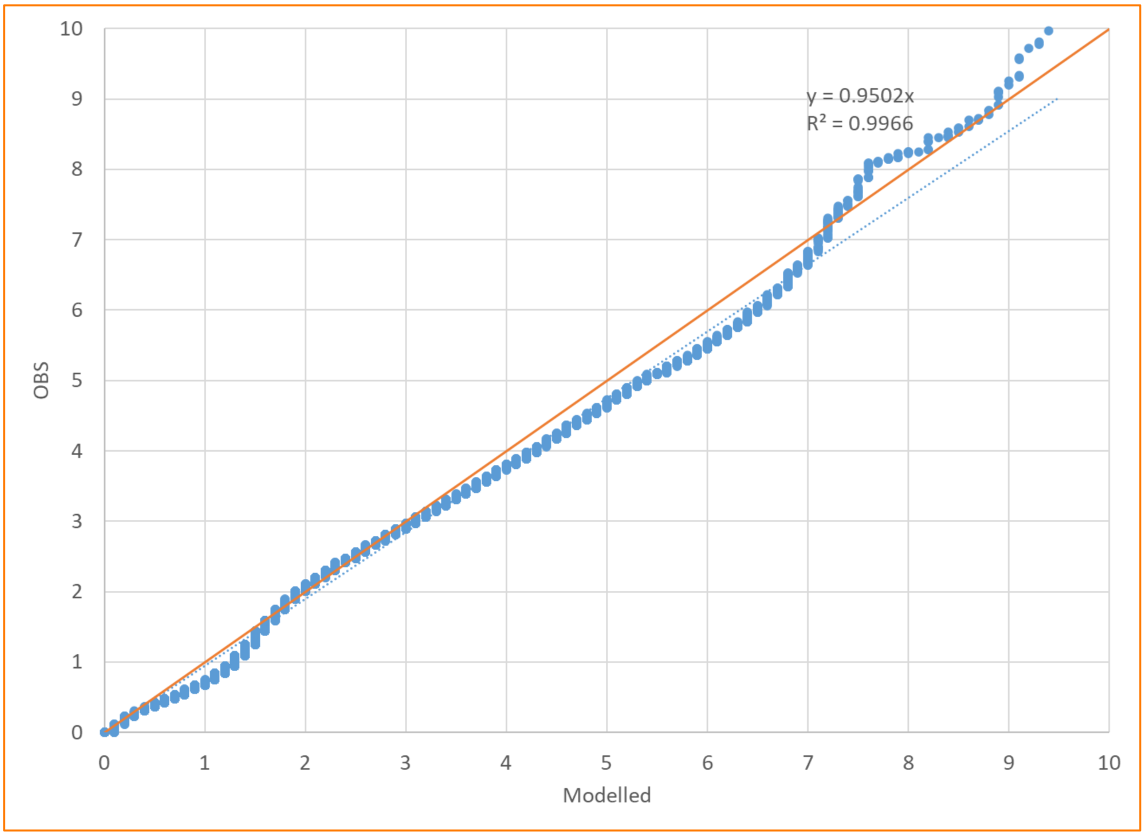


Figure 9-2: QQ Plot Wind Speed 2017 (m/s)

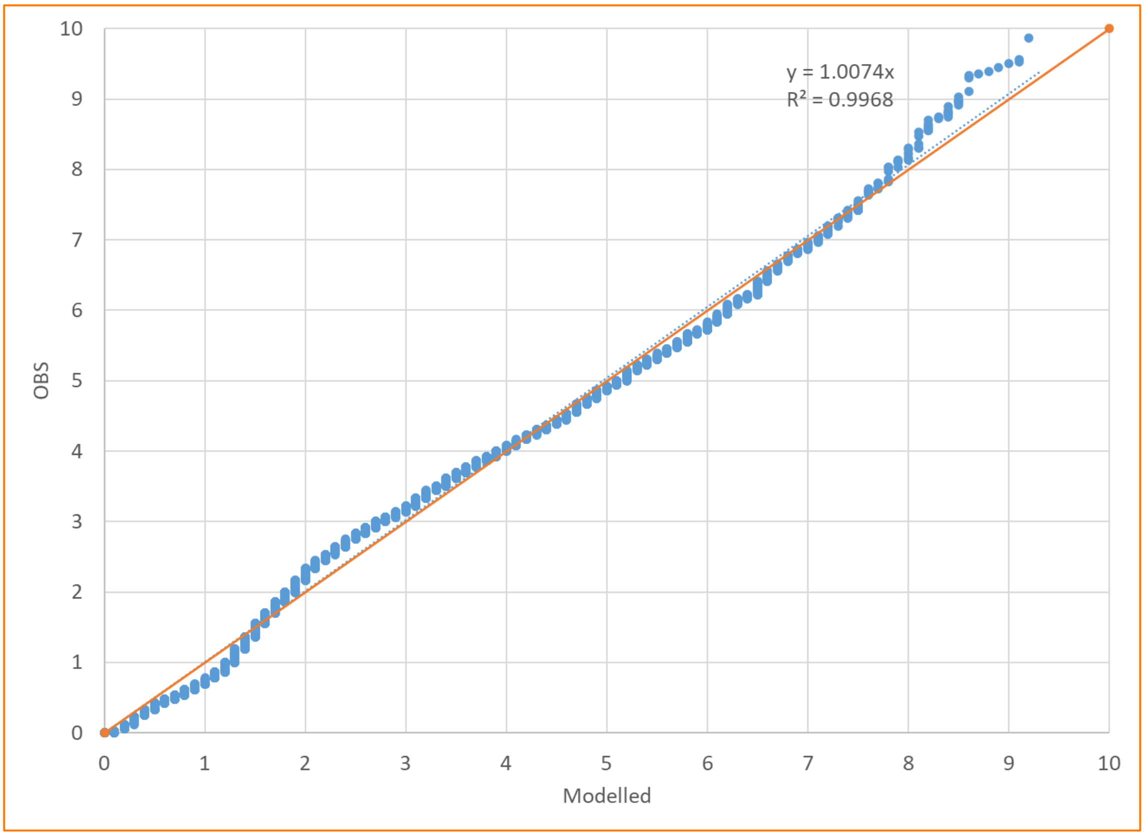


Figure 9-3: QQ Plot Wind Speed 2022 (m/s)

Overall, the analysis shows that TAPM performs relatively well in the area.

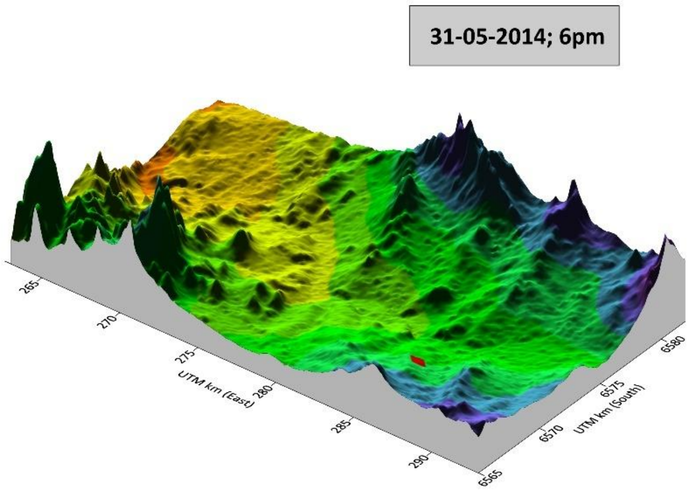
9.3 Cold air drainage

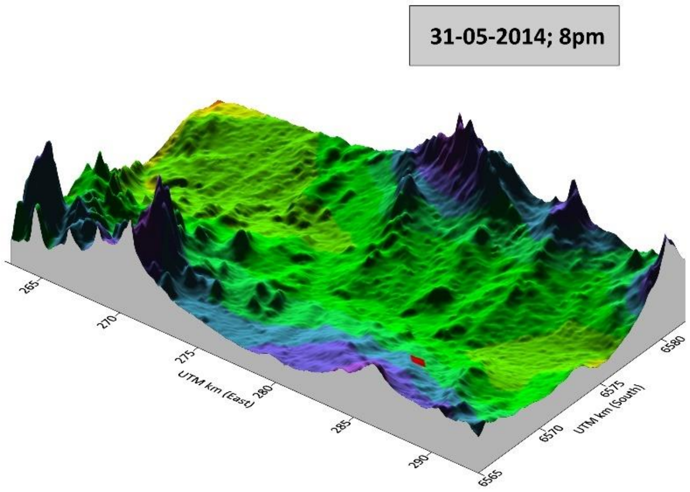
The EPA required in their response and investigation and assessment of odour impacts likely to be associated with cold air drainage.

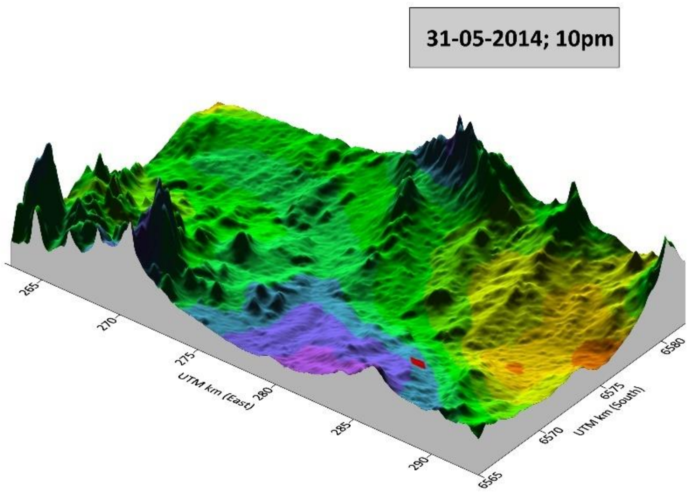
Cold air drainage can occur under light to calm wind conditions, where cold air on higher terrain, drains downward towards lower terrain in some cases pooling cold air at the lowest point. In the case of a valley with a river system, the cold air would be expected to flow downward along the river.

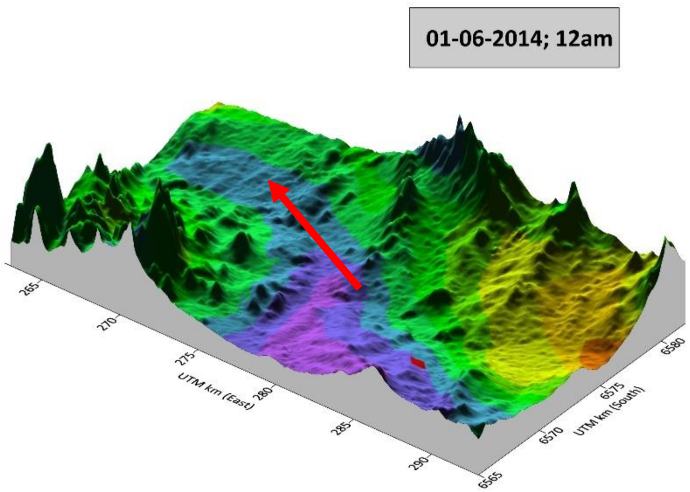
By default, the equations underpinning CALMET and CALPUFF take into account cold air drainage. Critically, research including Levenson & Matthiae (1975) has shown that the temperate change on a site as air moves downhill can be a good indicator of cold air drainage.

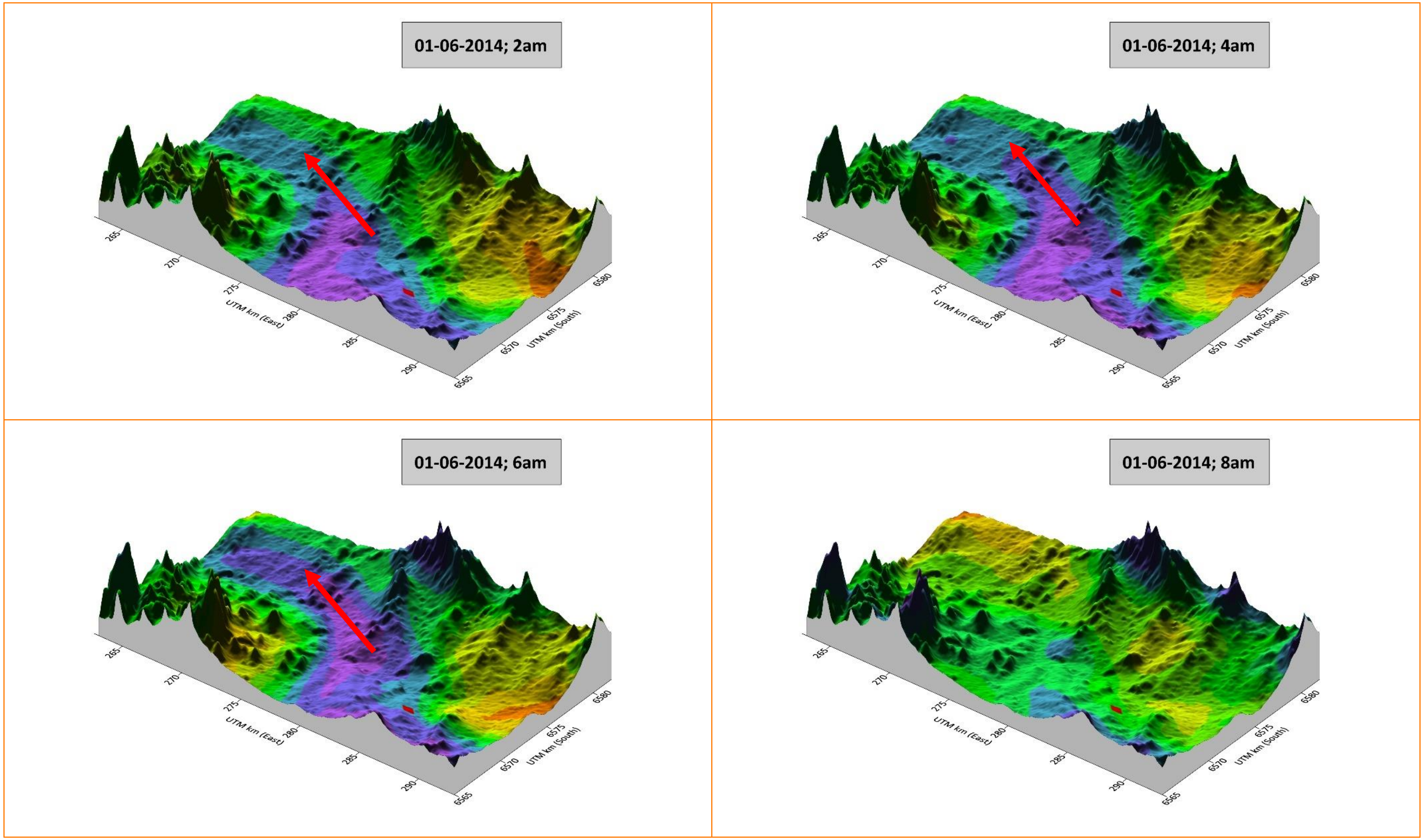
A series of temperature extracts have been taken from CALMET for a single period during May/June 2014. These have been overlaid on an exaggerated terrain base and shown below over time. The red dot shows the farm site. The colour range indicates temperature and unfortunately varies slightly between images. For reference the temperature range is ~18-15°C (orange to light purple) in the 31/5/2014 6 pm image, ~15-12° (orange to light purple) in the 1/6/2024 midnight figure, and ~15-12° in the 6 am figure (orange to light purple). Unfortunately, they cannot be seen at this scale, but the wind vectors often moved from points of high temperature to low temperature in the figures.


31-05-2014; 6pm
265
270
275
UTM km (East)
280
285
290
6565
6570
6575
6580
UTM km (South)


31-05-2014; 8pm
265
270
275
UTM km (East)
280
285
290
6565
6570
6575
6580
UTM km (South)


31-05-2014; 10pm
265
270
275
UTM km (East)
280
285
290
6565
6570
6575
6580
UTM km (South)


01-06-2014; 12am
265
270
275
UTM km (East)
280
285
290
6565
6570
6575
6580
UTM km (South)


01-06-2014; 2am
01-06-2014; 4am
01-06-2014; 6am
01-06-2014; 8am
UTM km (East)
UTM km (South)
265
270
275
280
285
290
6565
6570
6575
6580

The use of SVMIN at 0.2 here, as opposed to not using the default value of 0.5 as per McGahan et al. typically overstates cold air drainage. The figures above clearly show that cold air drainage is predicted in the model, as demonstrated in the period from 6 pm through 8 am the following day, where the cold air drainage is shown to be predicted, and then stop as the day warmed up.

9.4 Peak emissions

EPA requested that the report include a consideration of 'worst case' emission scenarios, and sensitivity analysis around the timing of peak emissions.

For poultry farms, as noted in McGahan et al., a K factor of 1.9 is considered an upper K factor for new farms. As such this has become the default standard, from the earlier K factor of 2.2. The change from 2.2 to 1.9 reflects the decrease in emissions over time, which is most often attributed to the introduction of the RSPCA shed management methods. As such, K=1.9 is often considered worst case.

A K factor of 2.2 would see emissions 16% higher than modelled here. Based on the results above, if this were to occur, compliance would still be predicted.

Regarding the time of peak emissions, we have modelled Day 1 placement, Day 14 placement and Day 28 placement. In effect covering three different years of production across 2014. The results shown in Table 6-9 above showed that the results were not overly sensitive to placement.

Based on the above, both worst case and batch staging have been assessed and not considered to be significant here.

9.5 Compliance with Legislation

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in the State (NSW EPA, 2022a).

Here, we have modelled the poultry farms per the SEARs, as they have a similar odour character. The Approved Methods in Section 7.7, notes that if the criteria are exceeded, then control strategies should be included until compliance is achieved. Here the control strategies are related to the use of the vertical discharge of emissions.

The compliance with the criterion from the Approved Methods, and having regard to the *Technical Framework - Assessment and management of odour from stationary sources in NSW* (DEC NSW, 2006), means that the risk of harm or unreasonable interference is low, compared to a site that doesn't comply. In particular, the use of the methods detailed in Sections 7 and 8 as well as following best practice, including that detailed in the *Planning and environment guideline for establishing meat chicken farms – Guide 1 Assessment Guide* (McGahan, et al., 2021) will assist in this regard.

10 CONCLUSION

The modelling presented in this report considers the proposed operation and has been performed in accordance with the Approved Methods. The modelling indicates that the proposed development would not lead to any exceedances of the odour criterion (5 ou) at the nearest sensitive locations if a K factor of 1.9 was achieved.

The modelling has also demonstrated that the risk associated with particulate matter is low.

Based on our assessment we recommend the proposed farm be operated and managed in line with *Best Practice Management for Meat Chicken Production in New South Wales - Manual 2 – Meat Chicken Growing Management* (DPI, 2012) and any other relevant standards published from time to time.

We recommend that vegetative buffers be planted at the fan end of the sheds to assist with reducing potential odour and dust risks, in particular to address potential dust risks identified in the modelling. A buffer of at least 10 metres wide, and planted in line with the recommendations in the literature.

Care should be taken to ensure the sheds are built and operated in line with the assumptions used in this report, in particular being able to exhaust air vertically via fans placed 7 m above the ground, achieving an exit velocity of at least 6 m/s.

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