21 October 2019

Muscat Developments
Westbrook Road
Cawdor, NSW
cm43@bigpond.com

Astute Environmental Consulting

Dear Cathy and James

Re: Air Quality Impact Assessment – Goolgowi New South Wales – Summary of Updated Modelling

As requested, we have performed odour modelling of your proposed meat chicken farm located on Lot 1 and 2 DP 749831 McRaes Road, Goolgowi, New South Wales ("the site").

The modelling we have performed makes use of best practice modelling methodology and is consistent with the methods used to assess other farms in the area. The modelling has been performed based on a maximum of sixty sheds and has taken into account the comments in the letter from NSW EPA to the Department of Planning and Environment dated 28 June 2019 ("the letter") specifically the comment relating to the likely exit velocity of the ventilation stacks.

The work we have performed is to build on the previous work of Advitech and to ensure comments provided by EPA are addressed.

The modelling switches and settings were based on OEH (2011).

Meteorology

The meteorological modelling used a combination of prognostic data and data from weather stations within the area (Griffith BOM and RFM data for 2007). The year 2007 was previously shown to be consistent with long term averages for the area.

The use of observed weather data from a region combined with prognostic data to generate site specific data is consistent with the Generic Guidance and Optimum Model Settings for the CALPUFF modelling system for inclusion into the 'Approved methods for the Modeling and Assessment of Air Pollutants in NSW, Australia' (OEH, 2011).

This methodology was successfully applied to the expansion of the Tabbita Poultry Complex approximately 20km to the south east.

TAPM v4 was run for the year, and the outputs were used to drive CALMET as the Step 1 Windfield.

CALMET was modelled using the nested approach, where the final results from a coarse-grid run with the observed data were used as the initial guess to a fine inner grid. With this methodology terrain features including slope flows, blocking effect can be allowed to take effect and the larger –scale wind flow provides a better start in the fine-grid run.

The outer domain (72.8 km × 60.0 km) was modelled with a resolution of 0.4 km. TAPM-generated three-dimensional meteorological data was used as the initial guess wind field (3km) and the local topography and available surface weather observations in the area were used to refine the wind field defined by the TAPM data.

Hourly surface meteorological data from Bureau of Meteorology (BoM) station located at Griffith Airport AWS and also from the RFM poultry farm were incorporated. The output from the outer domain CALMET modelling was then used as the initial guess field for the inner domain CALMET modelling. The inner domain encompasses an area of 30 km × 30 km.

A terrain and land use resolution of 30m was used throughout the domain. The terrain data was derived based on the SRTM dataset and the Landuse was initially based on the Australia Pacific Global Land Cover Characterization (GLCC) dataset at 1km resolution. The land use was then manually edited at 100m resolution based on a recent aerial photograph of the area.

Key inputs used in TAPM and CALMET are summarised below in Table 1.

Table 1: TAPM and CALMET Setup

Model	Parameter	Value
TAPM (v 4.0.5)	Number of grids (spacing)	30km, 10km, 3km
	Number of grid points	41 x 41 x 25 (vertical)
	Year of analysis	2007
	Centre of analysis	34° 9.30' South (latitude), 146° 2.3' East (longitude)
	Meteorological data assimilation	N/A
	Radius of influence	N/A
CALMET (v 6.334) – outer grid	Meteorological grid domain	72.8km x 60.0km
	Meteorological grid resolution	0.4km
	South-west corner of domain	X = 375.000 km, Y = 6190.000 km
	Surface meteorological stations	Griffith Airport AWS RFM Poultry Farm TAPM (to fill in blanks)
	Upper air meteorological data	Model generated.
	3D Windfield	m3D from TAPM (3.0km) input as in initial guess in CALMET
	Year of analysis	2007
	Terrad	7.0 km
	R1/R2	2.5/2.5
	Rmax1/Rmax2/Rmax3	5/5/5
CALMET (v 6.334) – inner grid	Meteorological grid domain	30km x 30km
	Meteorological grid resolution	0.15km
	South-west corner of domain	X = 352.500 km, Y = 6218.500 km
	Surface meteorological stations	N/A
	3D Windfield	3D output from outer domain model run
	Year of analysis	2007
	Terrad	6.0 km

Ventilation Setup (Stacks)

The ventilation configuration of the proposed sheds was based on a drawing prepared by SKOV (with air baffles, Broiler house with Chimneys fans 07.03.19 ver 1). This assumes that when in tunnel ventilation mode each shed uses a number of SKOV DCT 920-4E fans. These fans are capable of 40,100 m^3/hr (11.1 m^3/s) at 50 Pa[1] and generate an outlet velocity of 8.5 m/s out of a 1.295m diameter duct at 50 Pa. The sources in the model for the tunnel ventilation mode were set to a velocity of 8 m/s with an exit height of 8 metres. The SKOV drawing is shown below as Figure 1.

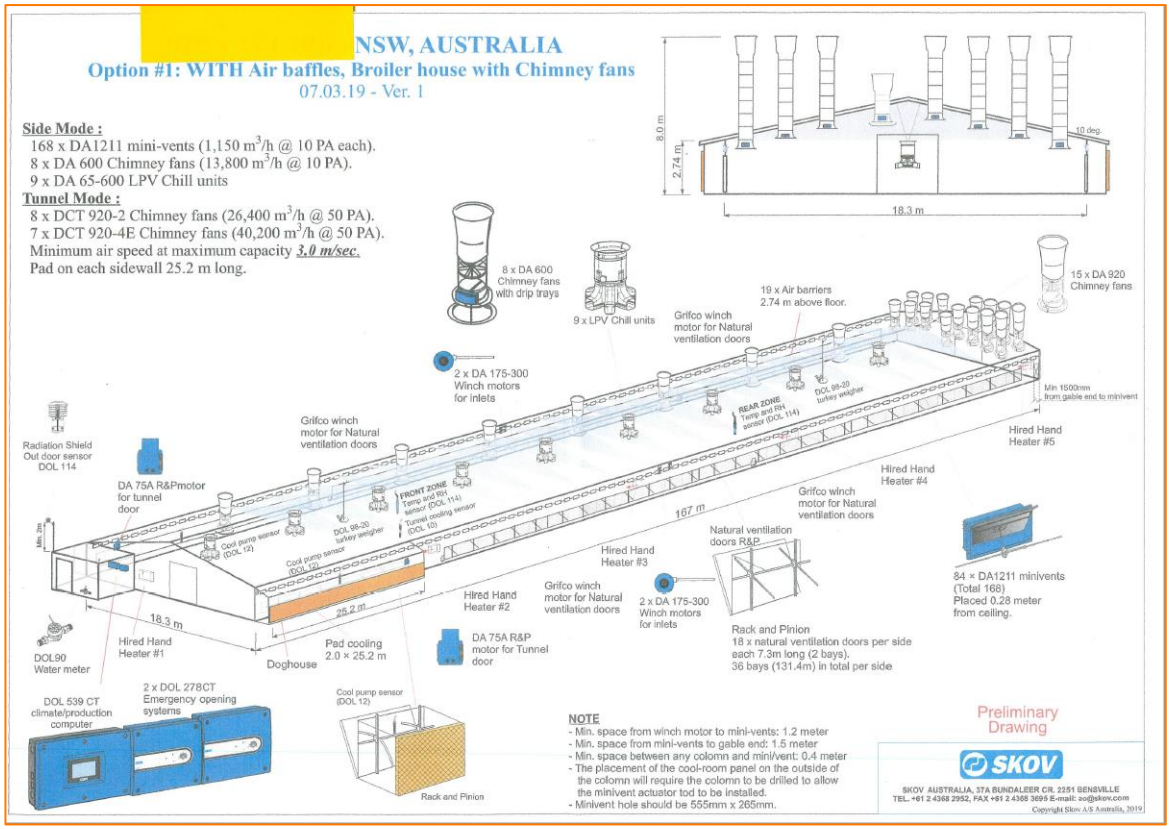


Figure 1: SKOV Drawing (Source Client)

When in minimum vent mode, the shed was set up assuming a number of SKOV DA600 or similar fans which are capable of achieving above a minimum exit velocity of 4 m/s at a height of 6 meters (the exit velocity was limited to this).

Information in the SKOV drawing indicated that a DA600 fan can achieve 13,800 m^3/hr @ 10 Pa. Through an outlet cone with a diameter of 1.02m an exit velocity of 5.5 m/s at 10 Pa could be achieved. At 50 Pa, the fan could achieve an outlet velocity of approximately 4.5 m/s.

Consisent with previous assessments for the site, we assumed that the sheds would remain in minimum ventilation up to 18% of total capacity (30 m^3/s). That is, if all roof fans were operating, they

[1] No back pressure on the fan would be 0 Pa, at this pressure the fan could achieve 8.8 m^3/s.

could achieve 30 m^3/s. This is conservative; if the shed went into tunnel earlier than this, the exit velocity and discharge height would be faster and higher.

Emissions

Emissions were estimated for the following sites using the K factor method of Ormerod and Holmes (2005):

- Jeanella South (based on bird numbers detailed in the Jeanella reports);
- Jeanella (based on bird numbers detailed in the Jeanella reports);
- The site (sixty sheds with stacks).

Key assumptions used in the emission estimation include:

- Maximum ventilation rate of 10 m3/hr/bird at maximum;
- 60,000 birds per shed;
- 50 day batch, with 17 day cleanout;
- Thinning
    - 15% of birds placed removed at day 32;
    - 25% of birds placed removed at day 38;
    - 15% of birds placed removed at day 42; and
    - All gone by end of day 50.
- Standard target temperatures;
- K factor for all sheds of 2.2;
- Placement/offset (to be consistent with Advitech assessment[2]):
    - Jeanella and Jeanella South – all in day 1; and
    - Muscat site, all birds across 60 sheds placed on the same day (unrealistic) and then varied by 14, 28 and 42 days.

An example emission profile generated for the work is shown below in Figure 2.

[2] Advitech assessment showed minimal variation in predicted concentrations.

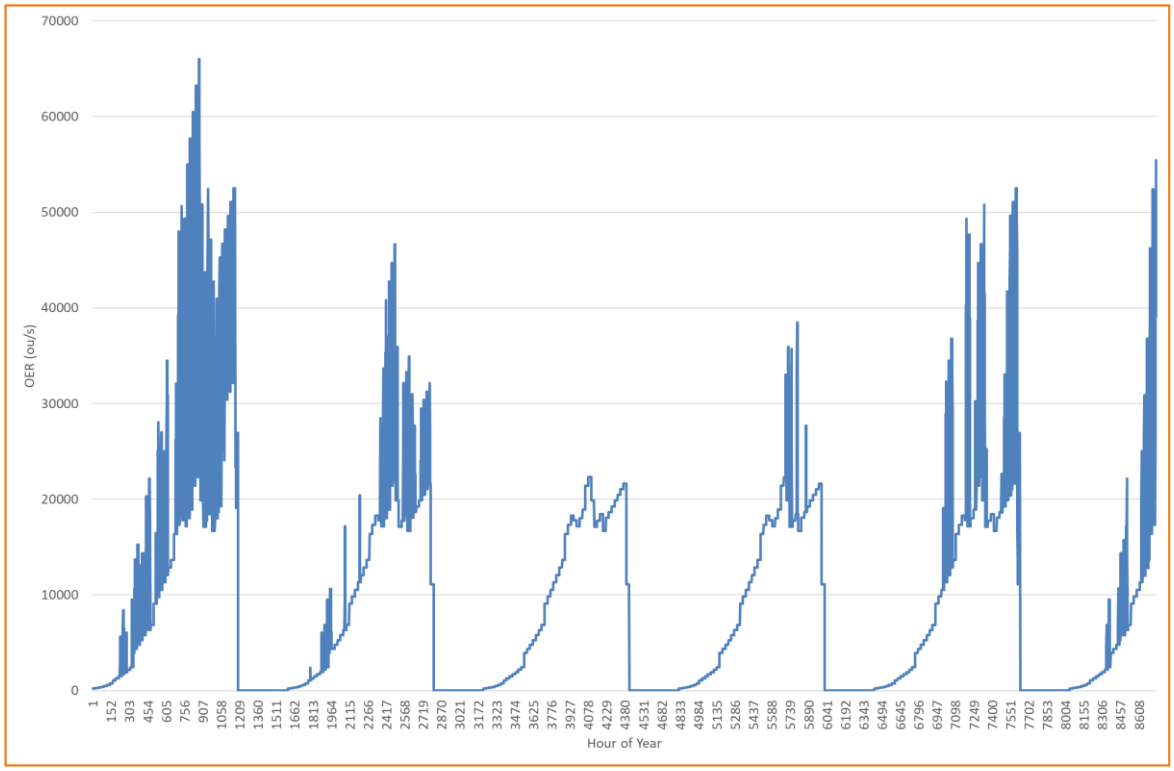


Figure 2: Example Emission Profile – Day 1 Placement – 60,000 birds

CALPUFF

Key inputs we used in CALPUFF are summarised below in Table 2. The duty fans were modelled as a series of point sources at one end of the sheds, and the tunnel fans were modelled as a series of points sources at the fan end of the shed. Diameters were varied by ventilation stage to ensure that the minimum velocity was achieved in the modelling.

Table 2: CALPUFF Setup

Model	Parameter	Value
CALPUFF (v 6.40)	Meteorological grid domain	30 km x 30 km
	Meteorological grid resolution	0.15 km
	South-west corner of domain	X = 352.500 km, Y = 6218.500 km
	Method used to compute dispersion coefficients	2 - dispersion coefficients using micrometeorological variables
	Minimum turbulence velocity (Svmin)	0.2 m/s
	Building downwash included	Yes
	Method used to simulate building downwash	ISC
	Default settings	All other relevant CALPUFF defaults have been used

Results

The results of the modelling for the rectors shown in Figure 3 are shown below.

Figure 3: Sensitive Receptor Locations

Farm in Isolation

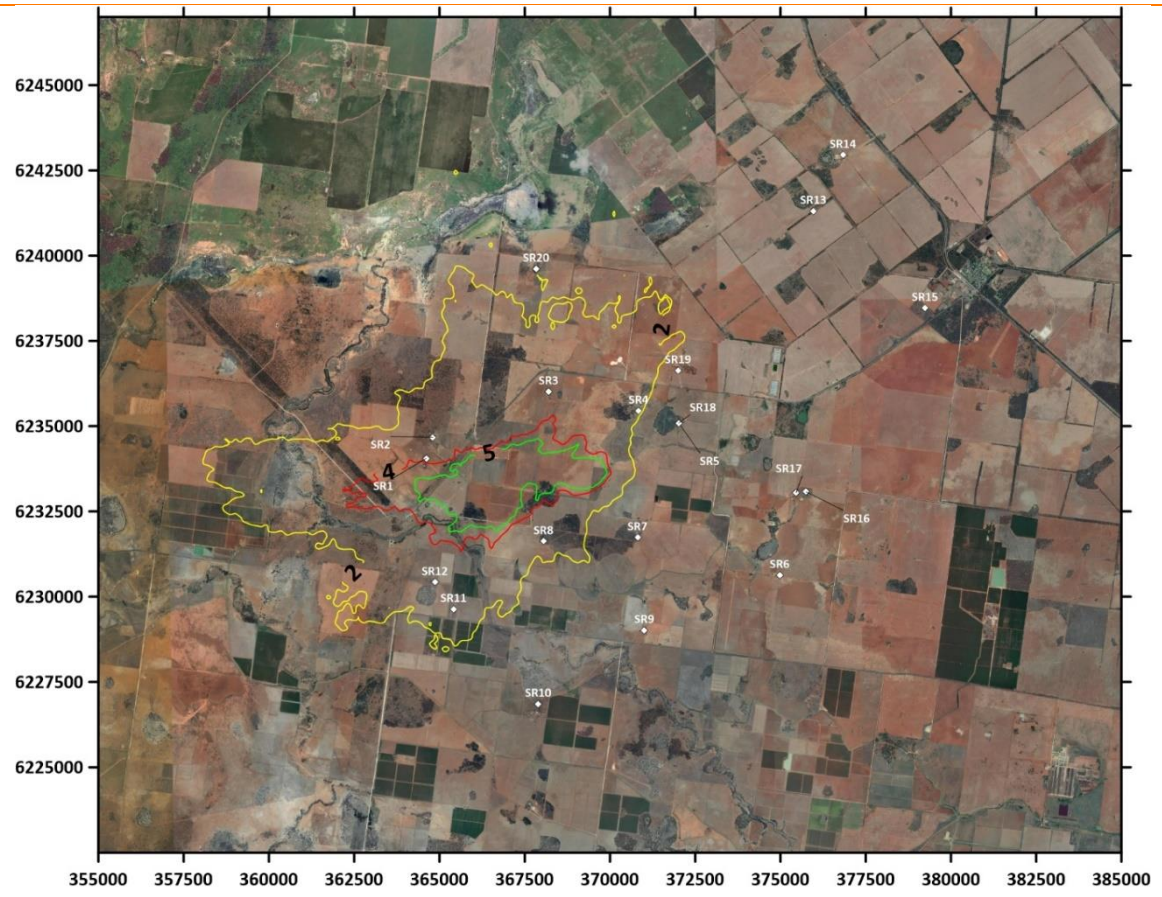
The results for the staging runs as previously performed by Advitech are shown below in Table 1 and also in Figure 4 to Figure 7 . The results show compliance with the $C_{99\ 1sec}$ = 5 ou criterion.

It is our experience with farms elsewhere that batch staging typically doesn't result in significant changes. It is relevant to consider that batch staging in effect looks at multiple runs. For example, the profiles shown in Table 1 represent ~35,000 hours of modelling. It is therefore not appropriate to assess multiple years and only consider the worst year.

This is critical as chicken farms operate on a moving cycle with start dates changing over time. When the percentile across the four cycles is considered (i.e. the 350th hour of four years, rather than the 88th highest each year for four years), the results highlight that the variation over time is not significant.

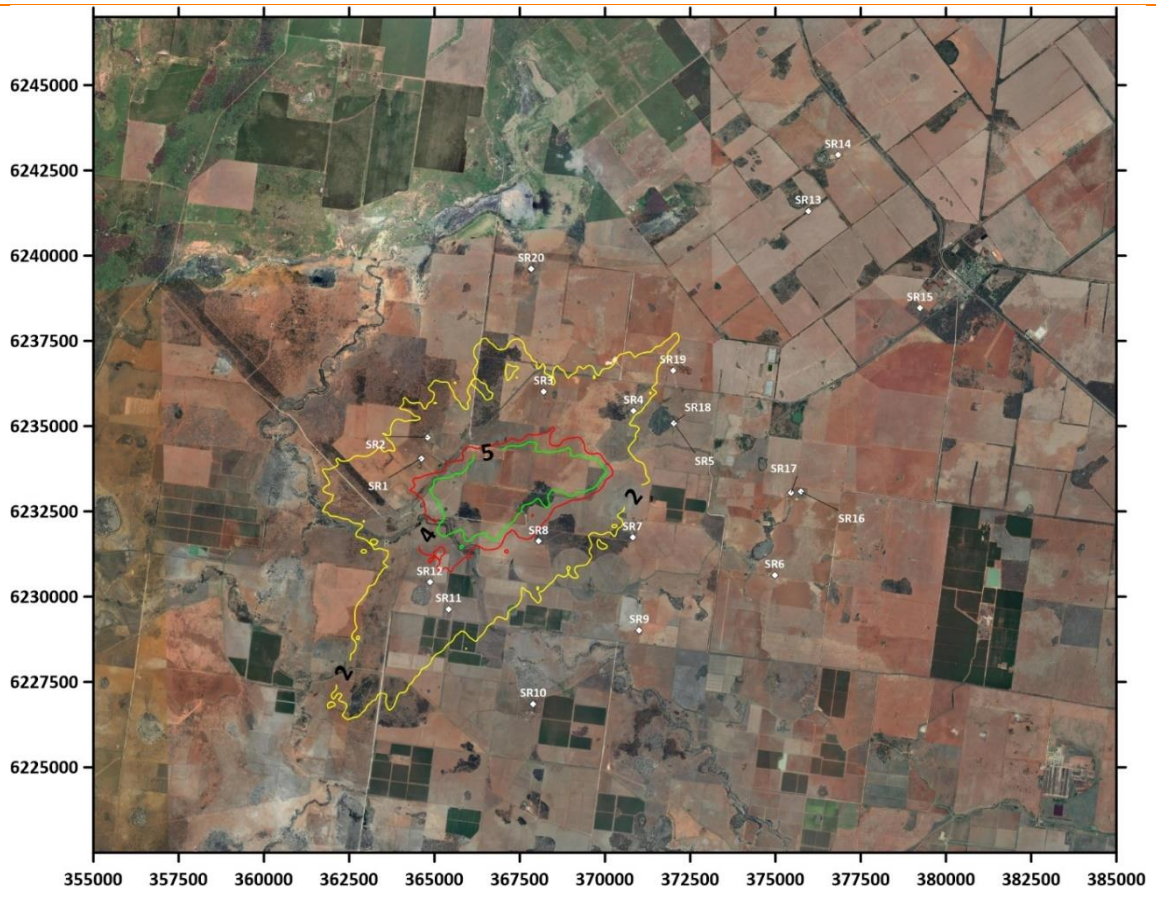
Table 3: Sensitive Receptor Results – Farm in isolation 60 sheds

Receptor	Day 1 – all in	Day 14 staging	Day 28 staging	Day 42 staging
SR1	3.5	2.6	2.0	1.6
SR2	2.8	2.5	2.0	1.6
SR3	3.2	2.7	3.0	2.8
SR4	2.2	2.3	2.3	1.9
SR5	0.9	1.1	1.3	0.9
SR6	0.4	0.5	0.7	0.9
SR7	1.1	1.6	1.7	2.5
SR8	2.6	3.4	3.0	3.5
SR9	0.6	1.2	1.1	1.5
SR10	1.2	1.5	1.3	1.5
SR11	2.3	2.7	3.0	3.1
SR12	2.8	3.7	4.1	3.5
SR13	0.7	0.7	0.8	0.7
SR14	0.6	0.5	0.5	0.6
SR15	0.2	0.3	0.3	0.2
SR16	0.3	0.5	0.5	0.6
SR17	0.4	0.6	0.5	0.6
SR18	0.8	1.1	1.3	0.9
SR19	1.7	1.9	1.5	1.4
SR20	1.7	1.1	1.5	1.8



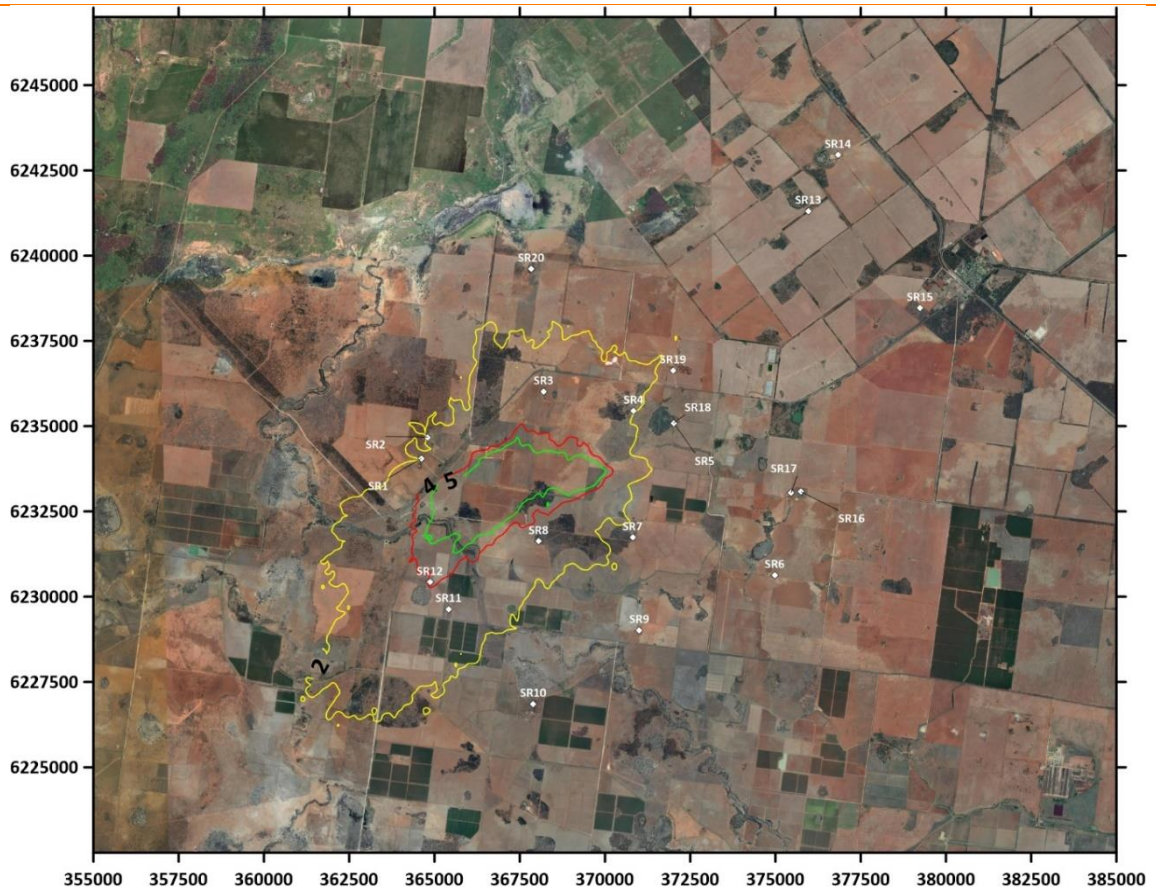
Species: Odour	**Site:** Goolgowi	**Scenario:** Isolation Day 1	**Averaging Period:** 1 second	**Percentile:** 99 th
Criterion: 5	**Units:** ou	**Meteorology:** 2007	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 4: Goolgowi Farm in Isolation Day 1 – 60 sheds



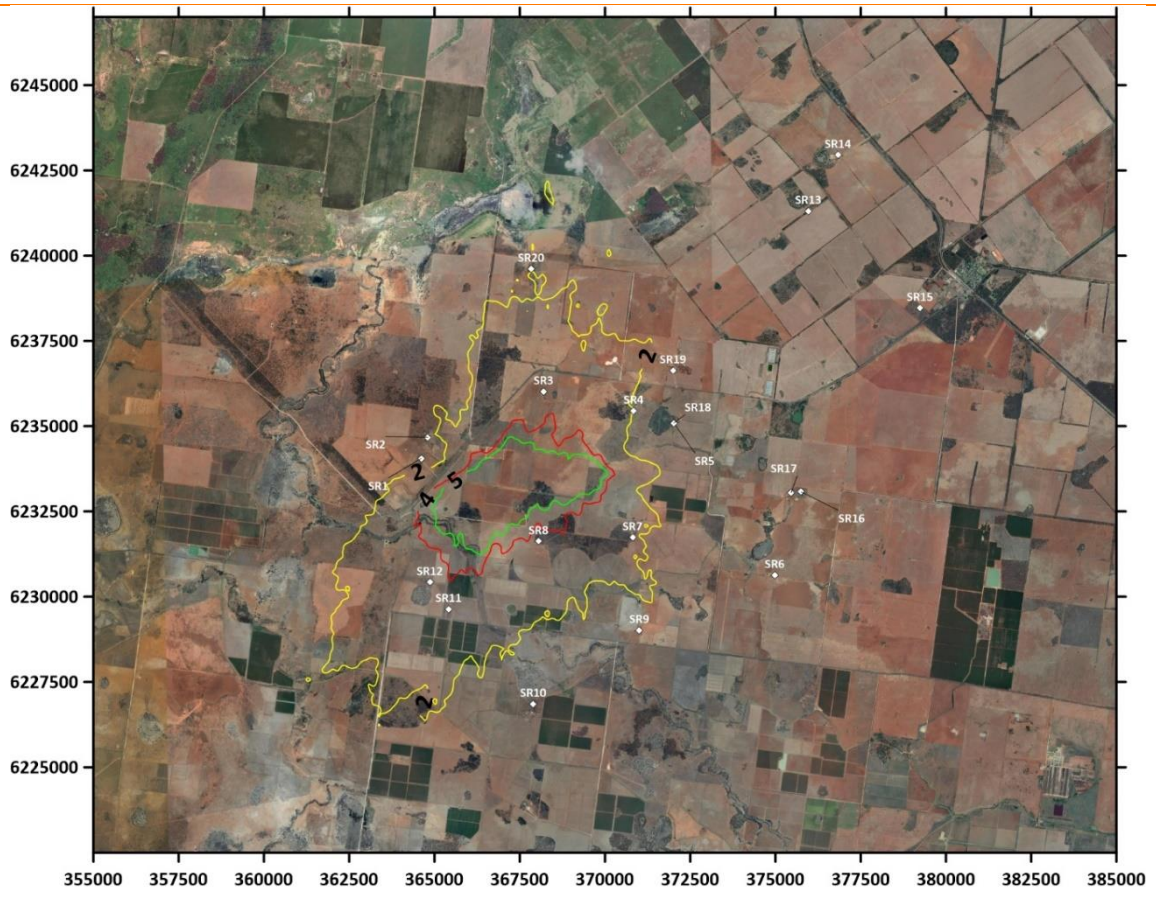
Species:	Site:	Scenario:	Averaging Period:	Percentile:
Odour	Goolgowi	Isolation Day 14	1 second	99 th
Criterion:	**Units:**	**Meteorology:**	**Model:**	**Author:**
5	ou	2007	CALPUFF v 6.42	W. Shillito

Figure 5: Goolgowi Farm in Isolation Day 14 – 60 sheds



Species: Odour	**Site:** Goolgowi	**Scenario:** Isolation Day 28	**Averaging Period:** 1 second	**Percentile:** 99 th
Criterion: 5	**Units:** ou	**Meteorology:** 2007	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 6: Goolgowi Farm in Isolation Day 28 – 60 sheds



Species: Odour	**Site:** Goolgowi	**Scenario:** Isolation Day 42	**Averaging Period:** 1 second	**Percentile:** 99 th
Criterion: 5	**Units:** ou	**Meteorology:** 2007	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 7: Goolgowi Farm in Isolation Day 42 – 60 sheds

Cumulative

The results of the staging with the Jeanella and Jeanella South Farms are shown in Table 4 and Table 5 (rounded) and Figure 8 and Figure 11.

Table 4: Sensitive Receptor Results – Cumulative Results with Jeanella and Jeanella South

Receptor	Day 1 – all in	Day 14 staging	Day 28 staging	Day 42 staging
SR1	5.0	3.8	3.2	3.0
SR2	4.0	3.7	3.2	3.0
SR3	4.2	3.9	3.9	4.0
SR4	4.1	4.1	4.2	3.7
SR5	4.0	3.6	3.8	3.7
SR6	1.9	2.2	2.2	2.7
SR7	4.1	4.2	3.9	4.6
SR8	3.8	4.3	3.7	4.1
SR9	2.2	2.3	2.2	2.4
SR10	2.2	2.3	2.3	2.5
SR11	2.8	3.5	3.5	3.7
SR12	4.0	4.5	4.8	4.0
SR13	2.7	2.5	2.7	2.6
SR14	2.6	2.2	2.4	2.7
SR15	2.0	2.1	2.0	2.0
SR16	2.2	2.8	2.5	2.9
SR17	2.6	2.9	2.9	3.2
SR18	3.9	3.6	3.8	3.7
SR19	4.8	4.7	4.8	4.5
SR20	2.1	1.7	2.1	2.5

Table 5 shows the rounded results from Table 4. Any concentrations at or above 5 ou (no values above 5) are highlighted grey. The receptors with higlighted cells are 1, 7, 12 and 19.

Receptor 1 is to the west of the site, and is the closest to the farm. Day 1 cumulative run shows 5 ou, with the other values being 4 or less.

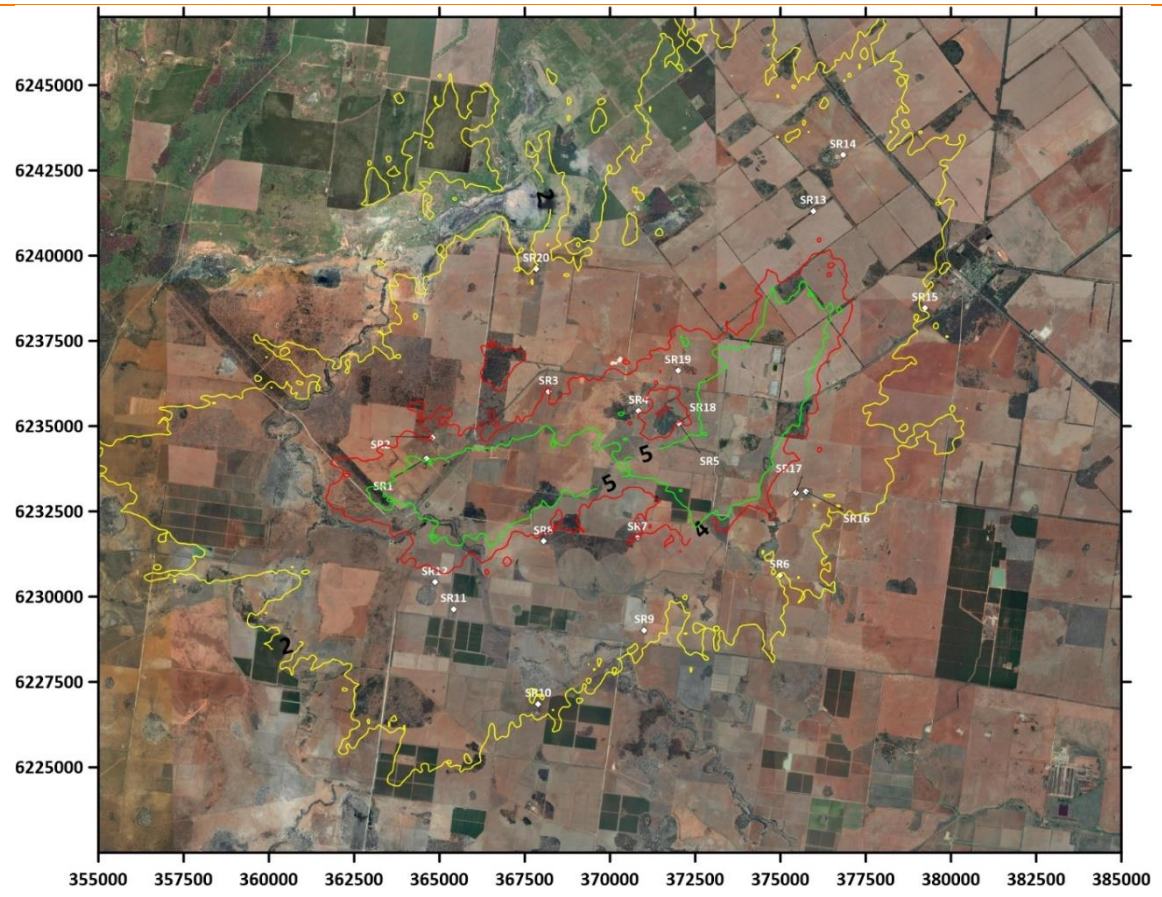
Receptor 7 is the south of the site, with the day 42 run showing 5 ou, with the other runs being 4 ou. This receptor had concentrations around up to 2.5 ou in the isolation run.

Receptor 12 is to the south west of the site with two runs showing 4 ou and two runs showing 5 ou. This receptor also had a concentration of 4.1 ou in the isolation run for day 28.

The final receptor is 19, which is located to the west of Jeanella, and the north east of the site. The impacts at this receptor are predicted to be dominated by the existing Jeanella operations with 5 ou being cumulatilvely predicted at this location for all runs. .

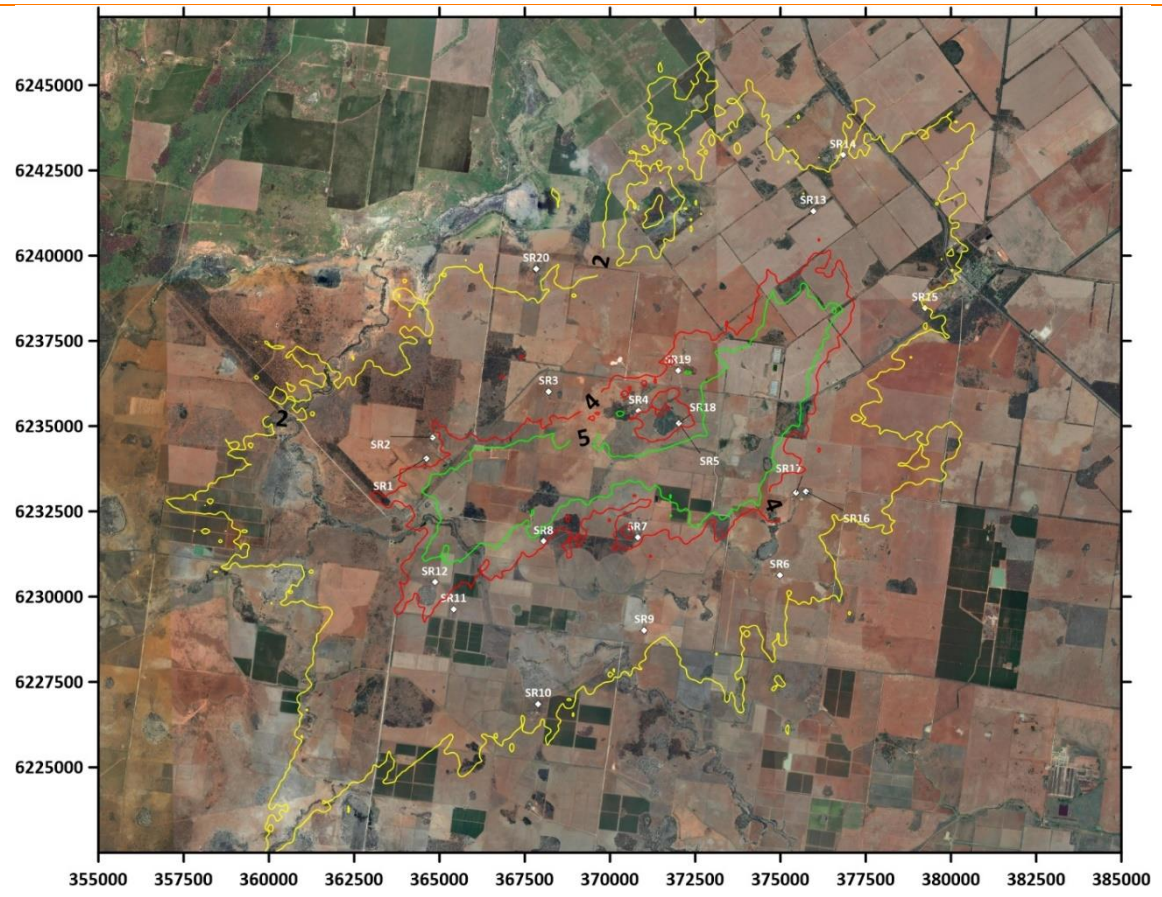
Table 5: Sensitive Receptor Results – Cumulative Results with Jeanella and Jeanella South (Rounded)

Receptor	Day 1 – all in	Day 14 staging	Day 28 staging	Day 42 staging
SR1	5	4	3	3
SR2	4	4	3	3
SR3	4	4	4	4
SR4	4	4	4	4
SR5	4	4	4	4
SR6	2	2	2	3
SR7	4	4	4	5
SR8	4	4	4	4
SR9	2	2	2	2
SR10	2	2	2	3
SR11	3	4	4	4
SR12	4	5	5	4
SR13	3	3	3	3
SR14	3	2	2	3
SR15	2	2	2	2
SR16	2	3	3	3
SR17	3	3	3	3
SR18	4	4	4	4
SR19	5	5	5	5
SR20	2	2	2	3



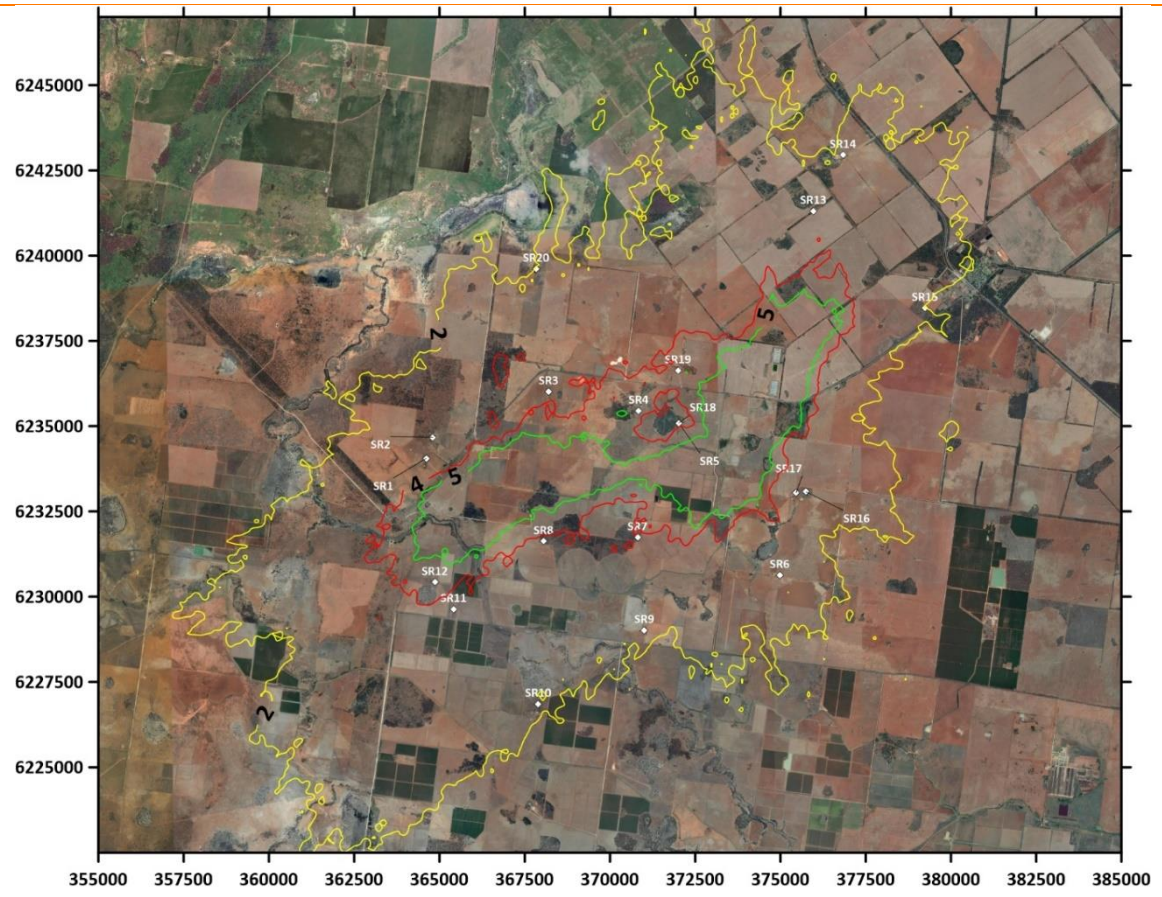
Species: Odour	**Site:** Goolgowi	**Scenario:** Cumulative Day 1	**Averaging Period:** 1 second	**Percentile:** 99 th
Criterion: 5	**Units:** ou	**Meteorology:** 2007	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 8: Goolgowi Farm Cumulative Farms Day 1 – 60 sheds



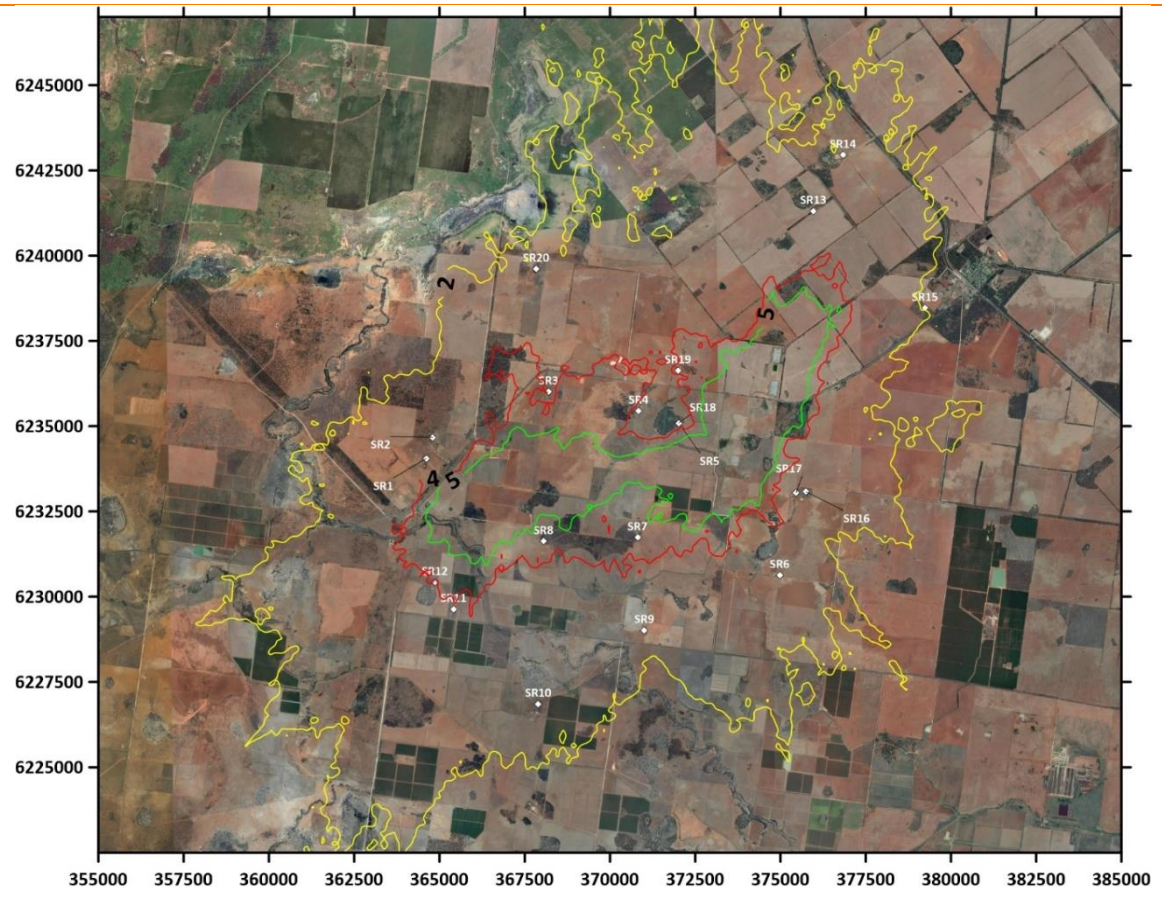
Species:	Site:	Scenario:	Averaging Period:	Percentile:
Odour	Goolgowi	Cumulative Day 14	1 second	99 th
Criterion:	**Units:**	**Meteorology:**	**Model:**	**Author:**
5	ou	2007	CALPUFF v 6.42	W. Shillito

Figure 9: Goolgowi Farm Cumulative Farms Day 14 – 60 sheds



Species:	Site:	Scenario:	Averaging Period:	Percentile:
Odour	Goolgowi	Cumulative Day 28	1 second	99 th
Criterion:	**Units:**	**Meteorology:**	**Model:**	**Author:**
5	ou	2007	CALPUFF v 6.42	W. Shillito

Figure 10: Goolgowi Farm Cumulative Farms Day 28 – 60 sheds



Species: Odour	**Site:** Goolgowi	**Scenario:** Cumulative Day 42	**Averaging Period:** 1 second	**Percentile:** 99 th
Criterion: 5	**Units:** ou	**Meteorology:** 2007	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 11: Goolgowi Farm Cumulative Farms Day 42 – 60 sheds

Conclusion

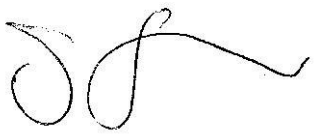
We have remodelled the Goolgowi as in line with the methodology detailed above. A K factor of 2.2 has been used for all runs for all sites.

The effect of staging is relatively small however when considered cumulatively, there are a number of receptor runs predicted to be at or below $C_{99\ 1\ sec}$ = 5 ou.

As four separate runs have been performed, it would be appropriate to consider the 99th percentile for all hours (i.e. four years of data) for the staging. When analysed, it was found that the $C_{99\ 1sec}$ concentrations for 35,040 hours of run time was similar to the average of four placement scenarios highlighting that the worst-case placement in isolation isn't indicative of long-term farm operation.

Recent test data for the region has highlighted that farms in the area can operate at a K factor of less than 2.2. If the existing farms or the proposed farm were to operate at a lower K factor, the results would be lower.

Sincerely



Geordie Galvin
B.Eng (Env Eng) M.Eng (Env) MIEAust A.AirQual
Principal Environmental Engineer

References

OEH, 2011. *Generic Guidance and Optimum Model Settings for the CALPUFF modelling system for inclusion into the 'Approved methods for the Modeling and Assessment of Air Pollutants in NSW, Australia',* Sydney: Offices of Environment and Heritage, New South Wales.

Ormerod, R. & Holmes, G., 2005. *Description of PAE Meat Chicken Farm Odour Emissions Model,* Brisbane: Pacific Air & Environment.