Appendix 9

Poultry Farm Odour Assessment

RPS

Odour Impact Assessment & Dispersion Modelling Study

Layertech Services

Baldivis W.A.

Final Report

April 2010

THE ODOUR UNIT (WA) PTY LTD

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1 INTRODUCTION

In January 2010, RPS commissioned The Odour Unit WA Pty Limited (TOU) to conduct an Odour Investigation and Dispersion Modelling Study of potential odorous emissions emanating from the Baldivis Layertech Services Poultry (LSP) Farm, with a view to determining the resulting ground level off-site odour impacts by way of both Field Based Ambient Odour Surveys (FAOA's) and Dispersion Modelling.

The investigation was initiated in response to RPS seeking a more definitive description of the currently placed "generic" odour contour that applies to the LSP Farm operation.

RPS represents a land holding at Lot 61 Eighty Road, Baldivis. The land holding is North-West of the LSP Farm **(refer Figure 1).**

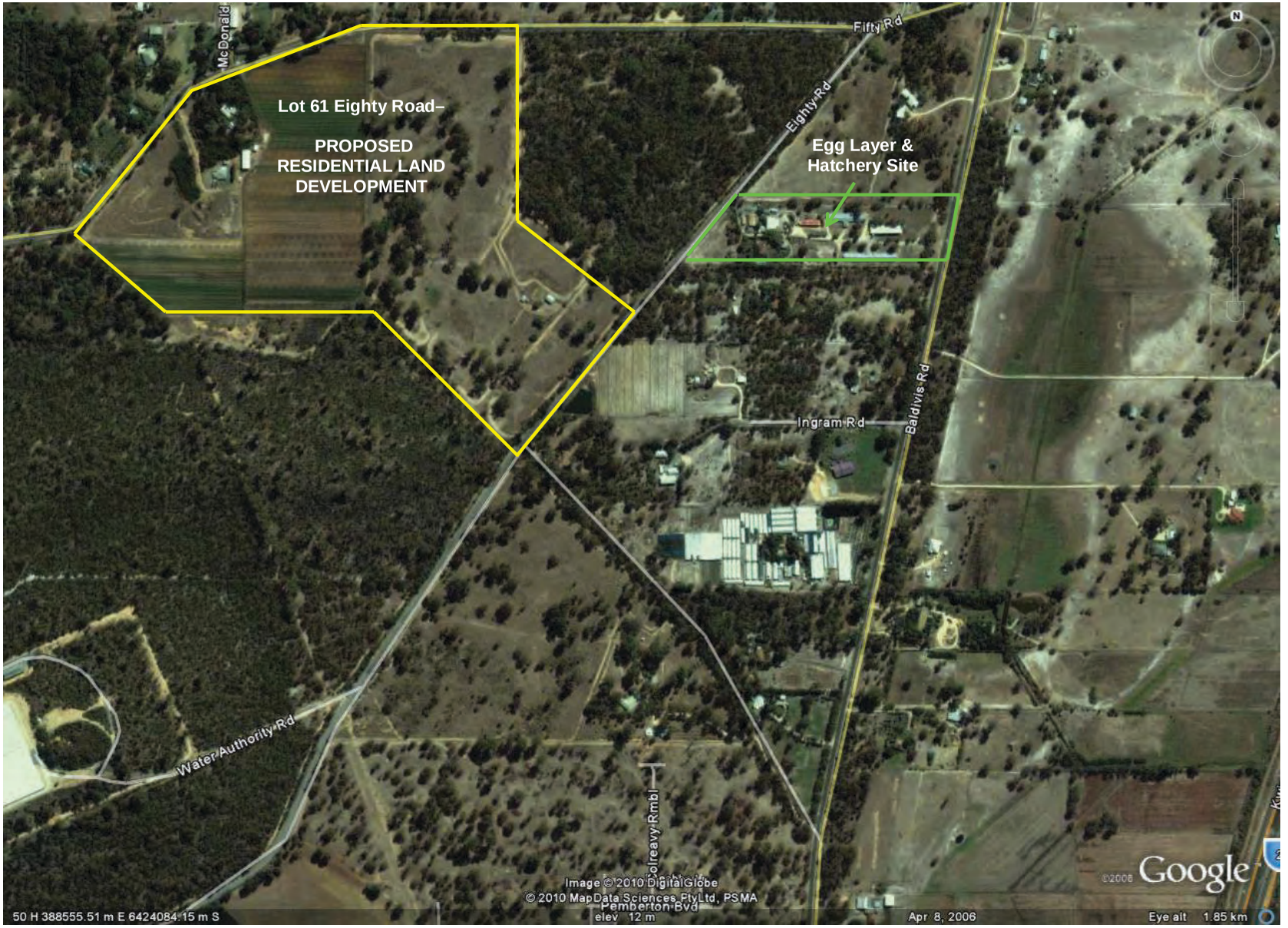


Figure 1: Aerial Plot Illustration of Proposed Residential Land Developments.

The Western Australian generic buffer distance in place for intensive farming in the Poultry Industry is 300m – 1000m depending on size. The size of the LSP Farm suggests that a 300m buffer would apply based on the Western Australian Environmental Protection Agencies document *"Guidance for the Assessment of Environmental Factors: Separation Distances between Industrial and Sensitive Land Uses No.3: June 2005".*

The LSP Farm however may not be perceived as an intensive farming practice as the animals are free-range. Additionally, the LSP Farm is not a meat producer and therefore a basis for a reduction in this 300m buffer range is being investigated herein.

The LSP Farm operation is an egg layer and hatchery facility located in a semi-rural land setting, on an area of approximately 40,000m^2. Multiple sheds are visible at the LSP Farm along with office facilities. Based on TOU's knowledge of shed layouts for poultry farm operations, TOU identified three sheds as potential odorous sources.

The assessment of potential odorous impacts was undertaken utilising two study methodologies. These study methods were Field Based Ambient Odour Assessments according to a modified version of the German VDI Standard 3940, and Dispersion Modelling assessments utilising the Victorian EPA's AUSPLUME modelling software. A total of five (5) field based ambient odour surveys (FAOA's) were conducted by TOU field technicians over the duration of the project. These FAOA's were undertaken over varied conditions and time of day.

The investigation of odorous impacts utilising a dispersion modelling approach requires, at best, site-specific emission data. Given that TOU were unable to gain access to the LSP Farm facility, and with a current lack of industry published data for Poultry Egg Layer and Hatchery Facilities, TOU sought the advise of the WA DEC. TOU was advised by the WA DEC that the LSP Farm facility should be conservatively viewed as a Poultry Broiler operation, although the LSP Farm is clearly not a broiler operation.

This advice essentially elevates the LSP Farm facility into a 'worst case' category for poultry odour emissions, as previous studies by Jiang and Sands (1998) on broiler farms suggest odour emission rate are approximately 2.5 times greater than Layer Shed and Hatchery operations.

TOU utilised odour emission data for input into the dispersion modelling study from the Jiang & Sands (CWWT, 1998) Technical Report entitled "Odour Emissions from Poultry Farms in Western Australia". The broiler (meat birds) odour emission rate, per bird, as reported by Jiang & Sands (1998) is 0.205ou.m^3 sec^{-1} $bird^{-1}$. The reported odour emission rate for layershed farms was 0.079ou.m^3 sec^{-1} $bird^{-1}$.

The results of the TOU field based ambient odour assessments were used to compare to the overly conservative odorous impact predictions of the dispersion modelling. This 'ground truthing' calibration is extremely valuable in validating the predicted odour contour/s from dispersion modelling.

To predict the potential odorous impacts emanating from the LSP Farm operation, TOU adopted the current Queensland Environmental Protection Agency (QEPA) 'Ecoaccess' odour performance criterion (OPC), in lieu of the now defunct WA DEC guidelines (Guidance 47). The QEPA OPC is currently accepted by the WA DEC as an 'interim' guidance whilst the WA DEC prepares a formal OPC.

This report documents the findings of both the field based ambient odour surveys and the plume dispersion modelling study. It describes the method used to undertake these field based ambient odour surveys, details the assumptions for odour emissions data, and presents the relevant WA DEC OPC and results of the odour dispersion modelling study.

2 REVIEW OF POULTRY INDUSTRY EMISSIONS DATA

The Poultry industry in Western Australia is a long-standing economic contributor. However, the extent of reliable peer-reviewed research undertaken into potential emissions from these poultry farms is not yet widespread. As a result of this lack of published information, TOU sought to review those guidelines and known publications that relate specifically to the LSP Farm operation.

2.1 WA DEC RECOMMENDED POULTRY EMISSION RATE

TOU liaises regularly with EPA bodies throughout Australia. At the commencement of this investigation, TOU discussed the requirements of this study with the WA DEC, specifically Mr. Dave Griffith. Mr. Griffith advised TOU that the WA DEC would currently accept published data by Jiang & Sands (1998) entitled 'Odour Emissions from Poultry Farms in Western Australia'.

The findings of the Jiang & Sands (1998) paper reports odour emission rate (OER) data for Poultry Broiler Farms as 0.205 odour units (ou) x m^3 sec^{-1} $bird^{-1}$. This emission rate is based on an average stocking density of 17.4 birds per m^2 of floor area. Given that the LSP Farm is a Layershed and Hatchery facility, the emission data prescribed by the WA DEC is highly conservative. The Jiang & Sands (1998) paper also investigated Layershed and Hatchery emissions reporting a single OER of 0.079ou.m^3 sec^{-1} $bird^{-1}$. The ratio of OER's for Broiler farms is therefore approximately 2.5 times greater than those from Layershed and Hatchery farms.

The 0.079ou's sec^{-1} $bird^{-1}$ is however largely insufficient for use in this study. The reasoning for this is that the Jiang & Sands (1998) study only collected one data point. Since TOU is not aware of other known data published for the Layershed and Hatchery industry relevant to the Western Australian climate, TOU will adopt the WA DEC prescribed 0.205ou.m^3 sec^{-1} $bird^{-1}$ as its basis for this study. The advantage of this however is that the scenario for predictive dispersion modelling will be highly conservative and hence 'worst-case'.

2.2 AUSTRALIAN MODEL CODE OF PRACTICE – POULTRY (4TH ED.)

The Australian Animal Welfare Committee (AWF) prescribes guidelines and ethical conducts for the welfare and husbandry of domestic poultry. Specifically, the AWF has published a report for the welfare of poultry entitled 'The Australian Model Code of Practice for the Welfare of Animals – Domestic Poultry'. The Primary Industries Ministerial Council (PIMC) endorsed this code in May 2002. The report advises that a review of the code will take place in 2010 providing that no new technologies offering significant welfare benefits are available prior to this review date. The 2010 review is yet to be formalised.

This Code of Practice (COP) reports various data for minimal acceptable standards for poultry stocking densities. This data is based on industry changes to 'caged' floor space allocation per bird.

This study has been structured to accommodate for a caged system of poultry housing at the LSP Farm.

To ensure a rigorous assessment of the LSP Farm facility, TOU has reviewed the COP and included the data in its dispersion modelling scenarios. This data differs from the WA DEC prescribed data in that it reports marginally greater stocking densities for facilities operating at best industry practices.

2.1.1 Stocking Densities for Cage Systems – Minimum Acceptable Standards

The following text has been extracted from Appendix 1 of the "Australian Model Code of Practice for the Welfare of Domestic Poultry (4th Edition)".

1. All new cage systems commissioned (i.e. point when the contract to purchase or lease the cages was signed) **from 1 January 2001 (i.e. post 1 Jan 2001 cages) must provide a minimum floor space allowance of 550 cm^2 per layer** for cages with three or more birds per cage where the birds weigh less than 2.4 kg.

2. Where a producer signed a contract to purchase or lease cages before 1 January 2001, to provide a space allowance of less than 550 cm^2 per bird, installation of these cages must be completed by 30 June 2001, or when legislation is operative after 1 January 2001, within six months of the legislation becoming operative. If these deadlines are not met, the cages will be designated as "post 1 Jan 01 cages" for the purposes of stocking density.

3. Cages other than "post 1 Jan 01" cages are designated as **"pre 1 Jan 01" cages and must provide a minimum floor space allowance of 450 cm^2 per layer** for cages with three or more birds per cage.

4. Minimal acceptable space allowances for caged laying or breeding fowls weighing up to 4.5 kg live weight are presented in the following table:

Pre January 2001 cages	Post 1 January 2001 cages
minimum cage floor area/bird	
3 or more fowls (<2.4 kg) per cage	
450 cm^2	550 cm^2
3 or more fowls (> 2.4 kg) per cage	
600 cm^2	600 cm^2
2 fowls per cage	
675 cm^2	675 cm^2
Single fowl cages	
1000 cm^2	1000 cm^2

*** These figures are recommended for inclusion into statute law of States and Territories as the minimum space allowance for layer hens in cages.**

5. Minimal acceptable space allowances for laying or breeding fowls weighing more than 4.5 kg live weight are presented in the following table:

Birds per Cage	Maximum live weight per unit of floor area from 1 January 1995
3 or more fowls per cage	46 kg / m^2
2 fowls per cage	40 kg / m^2
Single fowl cages	26 kg / m^2

6. Floor area is measured in a horizontal plane and includes the area under the egg/waste baffle and the area under the drinking nipples and vee-trough for water.

7. Maximum acceptable live weight density for rearing layer pullets or layer breeders is 40kg live weight per m2 cage floor area.

The recommendations of the COP relate to the LSP Farm on the basis of stocking densities as either PRE2001 or POST2001.

- The **PRE2001** data for stocking densities recommends a minimum of 450cm^2 (0.045m^2) per bird, which translates into **22.2 birds per m^2 of floor space**, and

- The **POST2001** data for stocking densities recommends a minimum of 550cm^2 (0.055m^2) per bird, which translates into **18.2 birds per m^2 of floor space.**

TOU has utilised both the PRE2001 and POST2001 stocking densities, along with the WA DEC prescribed data to simulate three dispersion modelling scenarios. Each odour source (i.e. layer shed or litter storage/layer shed) was evaluated for maximum surface area available for livestock based on Appendix 1, point 6 of the COP.

3 LAYERTECH SERVICES POULTRY (LSP) FARM

The Layertech Services Poultry (LSP) Farm is located approximately 50kms south west of the Perth Metropolitan CBD. The facility occupies approximately 40,000m^2 and maintains three operational sheds of which TOU has identified as potential odour sources. One of these sheds (Shed 3) may be utilised as a litter storage facility as many operators house their used litter and have it removed at designated intervals annually. **Figure 3.1** below illustrates the layout of the LSP Farm.

Figure 3.1: Layertech Services Poultry (LSP) Farm Layout.

The Storage Warehouse and Hatchery Shed were identified by TOU on the basis of their respective construction and layouts. The Warehouse (white roof) is surrounded by a hardstand and looks to facilitate the throughput of transport vehicles/trucks. The assumed hatchery (brown roof) was identified by TOU as such due to the apparent lack of feeder towers and roof ventilation. Hatcheries must be temperature maintained to ensure welfare and growth of the poultry chicks. TOU's experience with hatcheries would suggest that hatchery odours are largely minimal when compared to egg layer odours. For the purpose of this investigation, TOU has omitted the anticipated hatchery shed as a problematic odour source.

Both Shed 1 and 2 were identified by TOU as the principal Layersheds based largely on their layout and construction. Shed 3 however, although similar in construction to sheds 1 and 2, may be utilised as a storage facility for used Layershed litter to be disposed of at annual intervals. Irrespective of this, TOU has treated Shed 3 as a problematic emission source and modelled it as a functional Layershed. The designated offices/sales building has in part a shed that houses hens/chicks. This is clearly visible from Eighty Road (west side of LSP). TOU's observations downwind of this shed suggest that odours from this source are extremely low. The use of this shed is not clearly understood, however, it is anticipated that hens are held here for sale purposes, or as an intermittent holding shed for hens and chicks.

There are no other known or identified odour sources at the LSP Farm. The LSP Farm land itself is very clean and well managed and is well established for forestry and native shrub, which may serve as effective natural barriers for odour dispersion.

4 ODOUR SAMPLING METHOD

4.1 FIELD BASED AMBIENT ODOUR SURVEYS

The Odour Unit (TOU) uses a method for assessing the ground level impacts of odour emissions from a source that utilizes a modified version of the German standard VDI3940 – "Determination of Odorants in Ambient Air by Field Inspections". TOU's previous experience with ambient odour sampling and subsequent olfactometry analyses indicates that accurate and useful ambient odour concentration data is difficult to obtain using conventional techniques. Therefore, TOU has adopted a more practical approach based on the field measurement of odour intensity.

With this method, calibrated and experienced odour specialists traverses the downwind surrounds of the odour source/s in a strategically mapped pattern, assessing the presence, character and intensity of any odours both from the odour source/s, and those sources impacting on adjacent and adjoining sites, and records these observations along with wind speed and direction.

Five (5) field surveys were conducted over the study period, and were approximately two hours in duration.

Once the assessor/s had determined the wind direction across the locale, he/she would attempt to move around the surrounding areas, downwind of any odorous sources, and covering as much territory as possible. Assessment locations were numbered for each individual survey.

At each assessment location the following data was logged.

- Location reference position
- Time
- Wind direction
- Wind velocity
- Odour present (yes/no)
- Odour character
- Odour Intensity (rating 0-6)
- Comments

Prior to the commencement of each survey, the TOU technician would first survey local meteorological data to determine if the conditions were suitable for conducting a survey of the locale. Once the local weather conditions had been assessed, the assessor would spend up to ten minutes at each assessment location in order to gauge the effects of the odour impact. At each location, wind velocity was measured using a TSI Model Velocicheck hotwire anemometer, while wind direction was determined using a compass. During gusty, highly fluctuating wind conditions, the average velocity and/or a minimum/maximum range was recorded. The average was determined by the technician's observations.

TOU attempted to conduct each field based ambient survey when wind velocity was low to moderate. That is, when wind velocity was less than, or averaging 10.0 – 15.0km/h (2.78m s^{-1} – 4.17m s^{-1}).

If an odour was detected at a location, the trained assessor attempted to characterize it and define its source. Odours that were determined to be clearly unrelated to the LSP Farm were recorded in the comments section of the log sheets. Odours originating from the LSP Farm were rated in accordance with the VDI3882/3940 odour intensity scale.

The general aim was to determine the extent of the impact of odours at the LSP Farm boundary, and off-site of the LSP Farm, and rank their intensity. The ranking scale used by the German standard for Determination of Odour Intensity (VDI3882) and "Determination of Odorants in Ambient Air by Field Inspections" (VDI3940) was used.

The standard's ranking system is based on the following seven-point intensity scale:

TABLE 4.1: GERMAN INTENSITY STANDARD VDI3882/3940 SCALE

Intensity Scale	Description
0	Not detectable
1	Very Weak
2	Weak
3	Distinct
4	Strong
5	Very Strong
6	Extremely Strong

5 FIELD BASED AMBIENT ODOUR SURVEY RESULTS

The results of these surveys are depicted in two principal ways.

Firstly, odour observations from the field logs are statistically processed to derive the frequency of odour observations according to the odour intensity ranking system. The frequency of odour intensity observations is based on a 10-minute assessment interval at a given observation location.

The log sheets completed by the technician contain the unprocessed data for each location on each survey occasion. This data is quite extensive and, while valuable in examining the odour impacts at specific locations, does not enable a general visual assessment of the extent of the odour nuisance.

Secondly, the processed results of the individual field surveys are contained in the following odour impact maps, which are based on the log sheets for each survey. Each map illustrates the locations visited, and the frequency of odour intensity detected from the odour source (represented by a colour coded pie chart). Locations visited that recorded an odour intensity score of '0' (not detectable) were still recorded in order to outline the extent of the plume's limit. The location numbers that correspond to the locations where the survey was concentrated don't necessarily represent the order of locations surveyed for each day of survey. Where duplicate numbers are illustrated on the odour impact maps, the TOU field assessor has assessed that location multiple times to verify suspected odours, or a nil result at that location.

The results are as follows:

Survey #1:

- Tuesday 19th January 2010
- 08:00hrs to 11:00hrs
- Temperature = 30°C to 36°C
- Wind velocity 1m/s - 2.5m/s
- Wind direction SE to ESE

An initial traverse on Eighty Rd was performed to determine the optimal locations for assessors. This showed, with the wind coming from the SE, only slight odours (of intensity ranking 2 and less) were detected directly at the LSP Farm entrance gate on Eighty Rd. The intensity decreased to a ranking of 1 within 70m (from the entrance) in the northern direction along Eighty Rd, and 30m in the southern direction. Past this there were no odours detected (including Fifty Rd).

Survey Location	Intensity Frequencies (%) - Baldivis FAOA 19/01/2010						
	0	1	2	3	4	5	6
1	**74.0**	**20.0**	**6.0**	0	0	0	0
2	**87.0**	**11.0**	**2.0**	0	0	0	0
3	**100**	0	0	0	0	0	0
4	**85.0**	**12.5**	**1.7**	**0.8**	0	0	0
5	**100**	0	0	0	0	0	0
6	**100**	0	0	0	0	0	0
7	**100**	0	0	0	0	0	0
8	**100**	0	0	0	0	0	0

Odour impacts on this survey day were not considered problematic. An illustration of the odour frequencies and location is depicted below. The illustrated size of the frequency pie charts doesn't reflect the 'extent' of the impact. That is, for those frequency pie charts on Eighty Road, the observations are on the road itself and not within the adjoining land to the north-west.

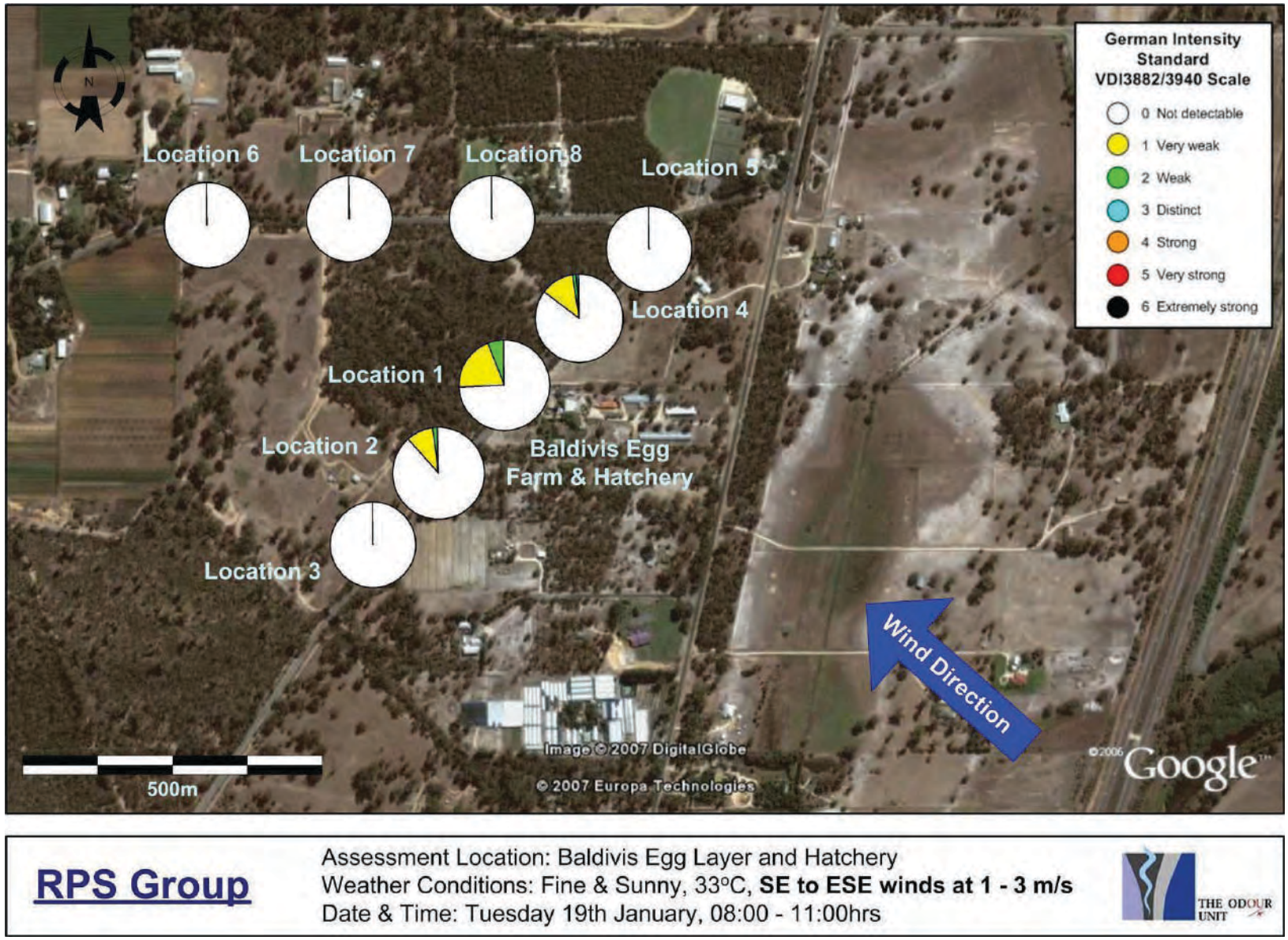


Figure 5.1: Field Based Ambient Odour Survey Result (19th January, 2010).

Survey #2:

- Wednesday 20th January 2010
- 13:00hrs to 16:00hrs
- Temperature = 26°C
- Wind velocity 2.5m/s - 5m/s
- Wind direction S to E

The assessors were set in the same initial locations as the first survey, as the wind conditions were similar. On Eighty Rd the highest intensity rank was 2, with greater frequency than the first survey. The highest frequency of 2's was located, again, directly at the Eighty Rd entrance gate. North on Eighty Rd, the plume was just detectable approximately 100m from the entrance at intermittent odour intensity of less than 2. Odour observations south of the Eighty road entrance were intermittently detectable up to 40m. No odours were detected on Fifty Rd.

Survey Location	Intensity Frequencies (%) - Baldivis FAOA 20/01/2010						
	0	1	2	3	4	5	6
1	**60.0**	**25.0**	**15.0**	0	0	0	0
2	**66.0**	**30.0**	**4.0**	0	0	0	0
3	**100**	0	0	0	0	0	0
4	**74.0**	**24.0**	**2.0**	0	0	0	0
5	**100**	0	0	0	0	0	0
6	**100**	0	0	0	0	0	0
7	**100**	0	0	0	0	0	0
8	**100**	0	0	0	0	0	0

Odour impacts on this survey day were not considered problematic. An illustration of the odour frequencies and location is depicted below. The illustrated size of the frequency pie charts doesn't reflect the 'extent' of the impact. That is, for those frequency pie charts on Eighty Road, the observations are on the road itself and not within the adjoining land to the north-west.

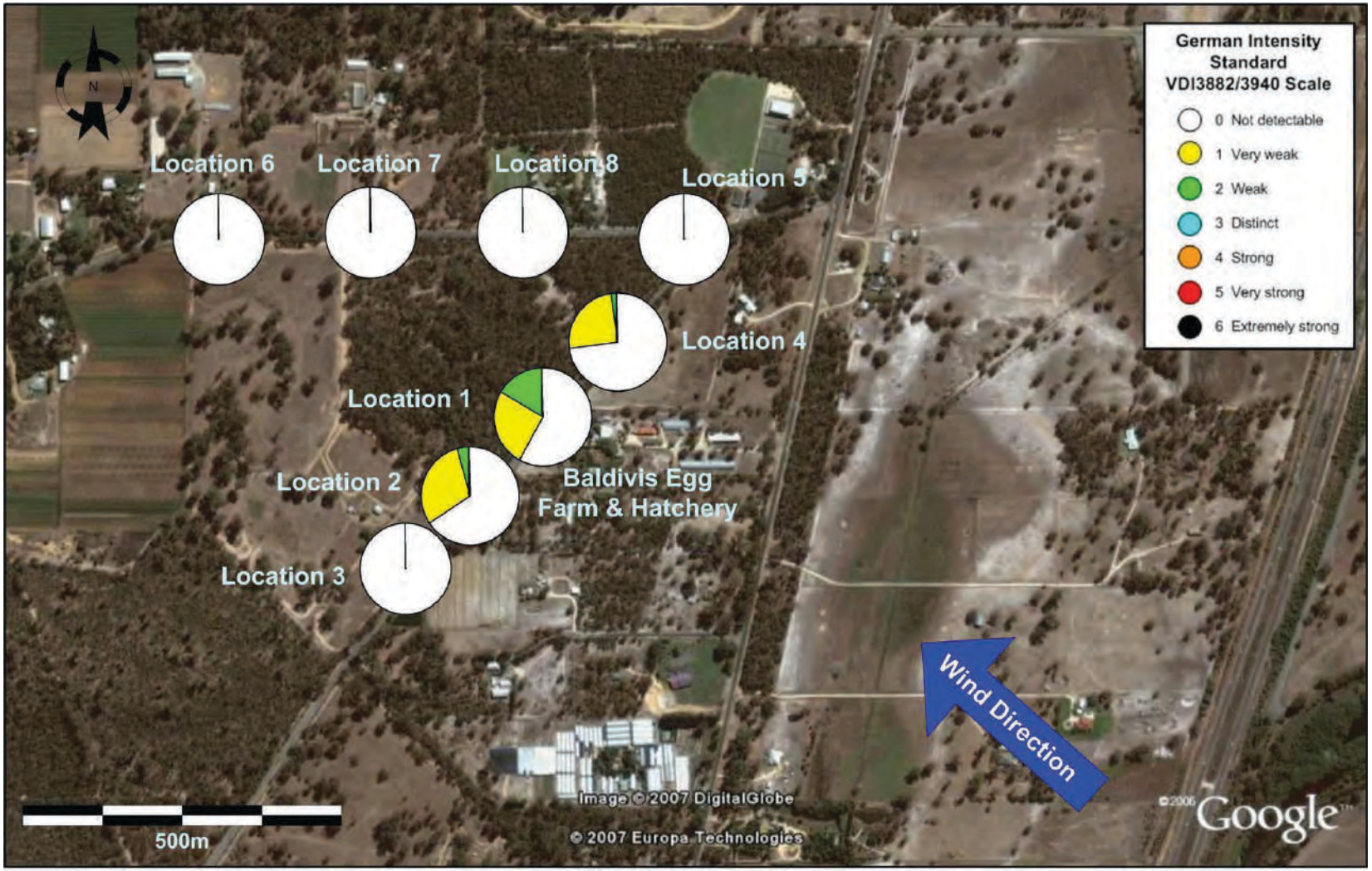


Figure 5.2: Field Based Ambient Odour Survey Result (20th January, 2010).

Survey #3:

- Thursday 21st January 2010
- 09:00hrs to 12:00hrs
- Temperature = 20°C to 26°C
- Wind velocity 2.5m/s - 4.5 m/s
- Wind direction S

With the wind coming from the south no odours were detected at the Eighty Rd entrance location. Approximately 70m north (still on Eighty Rd) intensity rankings of 1 and infrequent 2's were recorded. Assessors were located at various positions north of the facility on Fifty Rd and east on Baldivis Rd. No odours were detected at these locations.

Survey Location	Intensity Frequencies (%) - Baldivis FAOA 21/01/2010						
	0	1	2	3	4	5	6
1	**0.0**	0	0	0	0	0	0
2	**74.0**	**24.0**	**2.0**	0	0	0	0
3	**100**	0	0	0	0	0	0
4	**100.0**	0	0	0	0	0	0
5	**100**	0	0	0	0	0	0
6	**100**	0	0	0	0	0	0
7	**100**	0	0	0	0	0	0
8	**100**	0	0	0	0	0	0

Odour impacts on this survey day were not considered problematic. An illustration of the odour frequencies and location is depicted below. The illustrated size of the frequency pie charts doesn't reflect the 'extent' of the impact. That is, for those frequency pie charts on Eighty Road, the observations are on the road itself and not within the adjoining land to the north-west.

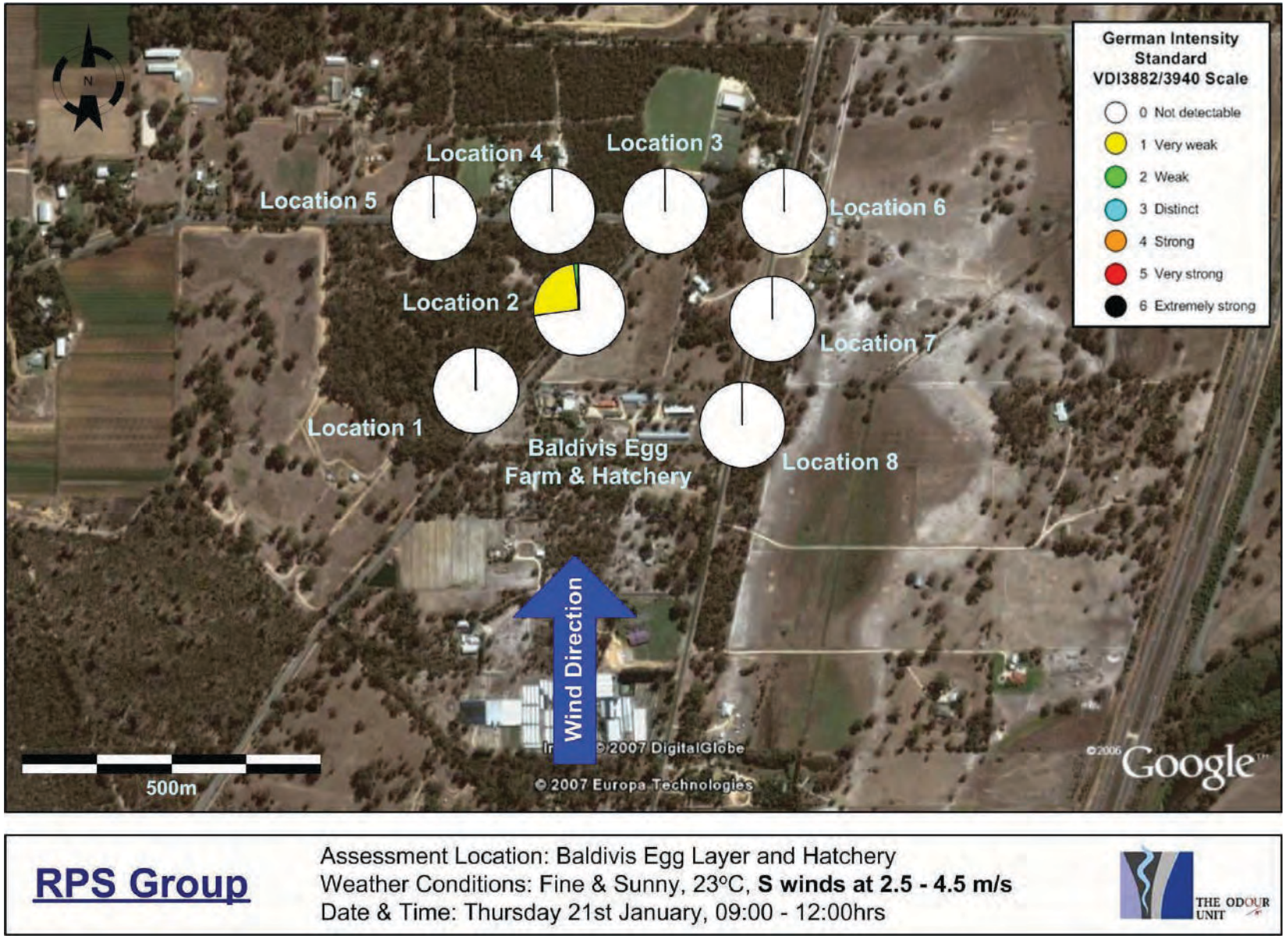


Figure 5.3: Field Based Ambient Odour Survey Result (21st January, 2010).

Survey #4:

- Friday 22nd January 2010
- 09:00hrs to 12:00hrs
- Temperature = 22°C to 28°C
- Wind velocity 1m/s - 3 m/s
- Wind direction E to S

Intensity rankings of 1 and 2 were recorded at the Eighty Rd entrance and also approximately 70m north of the entrance. No odours were detected south of the entrance. Assessors were spaced approximately 200m apart along Fifty Rd, no odours were detected. As with all surveys the direct surrounds, including Baldivis and Ingram Rd, were traversed to detect any possible effects of swinging winds. No odours observed.

Survey Location	Intensity Frequencies (%) - Baldivis FAOA 22/01/2010						
	0	1	2	3	4	5	6
1	**49.0**	**35.0**	**16.0**	0	0	0	0
2	**100.0**	0	0	0	0	0	0
3	**63.0**	**33.0**	**4.0**	0	0	0	0
4	**100.0**	0	0	0	0	0	0
5	**100**	0	0	0	0	0	0
6	**100**	0	0	0	0	0	0
7	**100**	0	0	0	0	0	0
8	**100**	0	0	0	0	0	0

Odour impacts on this survey day were not considered problematic. An illustration of the odour frequencies and location is depicted below. The illustrated size of the frequency pie charts doesn't reflect the 'extent' of the impact. That is, for those frequency pie charts on Eighty Road, the observations are on the road itself and not within the adjoining land to the north-west.

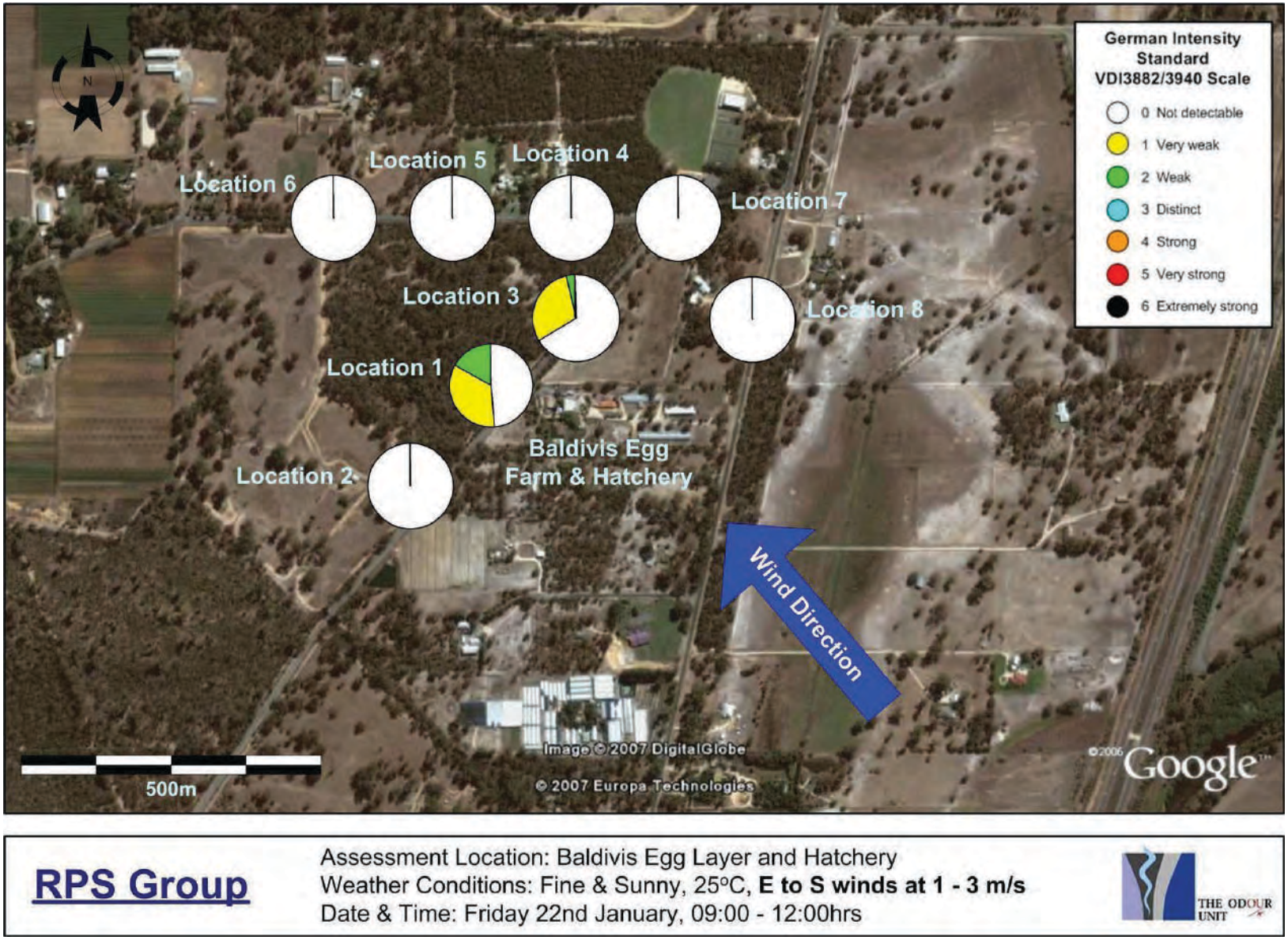


Figure 5.4: Field Based Ambient Odour Survey Result (22nd January, 2010).

Survey #5:

- Monday 25th January 2010
- 09:00 to 12:00hrs
- Temperature = 25°C to 28°C
- Wind velocity 1m/s - 3 m/s
- Wind direction SE to ENE

As the wind was initially coming from the SE direction, the assessors were positioned at the Eighty Rd entrance gate. The LSP poultry odours detected were given rankings of 1 with a small number of 2 rankings. Approximately 50m to the north, intensity rankings of 1 and a small number of 2's were recorded. When assessors were positioned along Fifty Rd, approximately 200m apart, no odours could be detected. Baldivis and Ingram roads were traversed, which showed no upwind odour sources.

Survey Location	Intensity Frequencies (%) - Baldivis FAOA 25/01/2010						
	0	1	2	3	4	5	6
1	**60.0**	**34.0**	**6.0**	0	0	0	0
2	**100.0**	0	0	0	0	0	0
3	**63.0**	**33.0**	**4.0**	0	0	0	0
4	**100.0**	0	0	0	0	0	0
5	**100**	0	0	0	0	0	0
6	**100**	0	0	0	0	0	0
7	**100**	0	0	0	0	0	0
8	**100**	0	0	0	0	0	0

Odour impacts on this survey day were not considered problematic. An illustration of the odour frequencies and location is depicted below. The illustrated size of the frequency pie charts doesn't reflect the 'extent' of the impact. That is, for those frequency pie charts on Eighty Road, the observations are on the road itself and not within the adjoining land to the north-west.

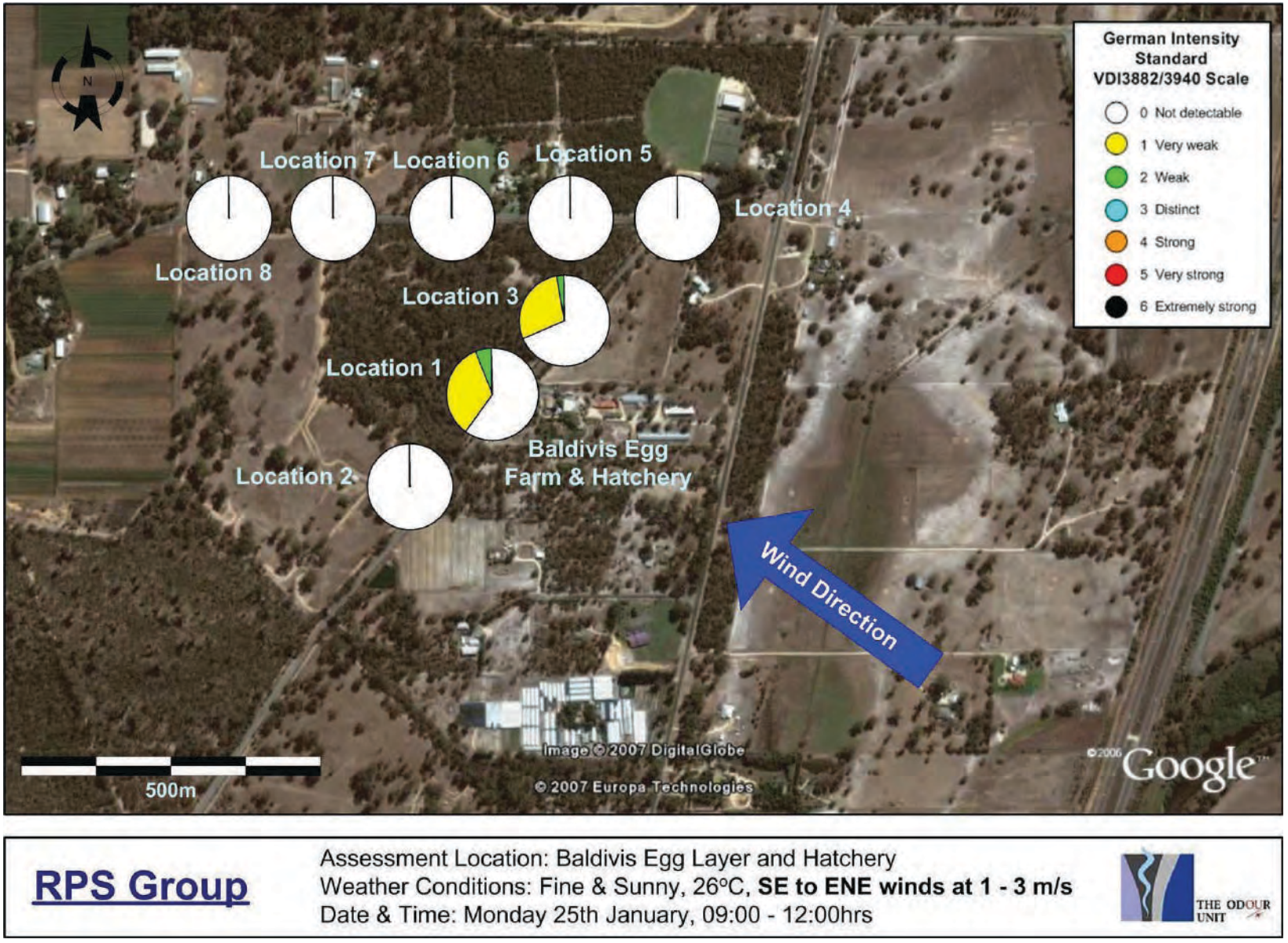


Figure 5.5: Field Based Ambient Odour Survey Result (25th January, 2010).

6 ODOUR CRITERIA AND DISPERSION MODEL GUIDELINES

Regulatory authority guidelines for odorous impacts of gaseous process emissions are not designed to satisfy a 'zero odour impact criteria', but rather to minimise the nuisance effect to acceptable levels of these emissions to a large range of odour sensitive receptors within the local community.

In Australia, each state and territory's environmental protection agency has developed its own unique odour performance criteria (OPC) for new and existing odour emitting facilities. In Western Australia, the DEC has withdrawn their OPC guideline document *No. 47: Guidance for the Assessment of Environmental Factors – Assessment of Odour Impacts from New Proposals (2002)*, but has yet to replace it. A suitable new OPC is currently being discussed.

In the absence of a current OPC guideline, the DEC notified TOU that the Queensland EPA's *Ecoaccess – Guideline: Odour Impact Assessment from Developments (2004)* is currently acceptable as an 'interim' OPC. The detail of the relevant QEPA OPC is as follows;

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

    - Where a facility does not operate continuously, the 99.5th percentile must be applied to the actual hours of operation.

The WA DEC have also indicated an additional criterion for use in dispersion modelling of ground level volume and area sources. The additional criterion is:

2. 8ou, 1-hour average, 99.9th percentile.

Both criteria will be investigated in this study.

7 ODOUR DISPERSION MODELLING METHOD

The odour dispersion modelling study for the LSP Farm was carried out using AUSPLUME Version 6.0, a Gaussian, steady-state, plume dispersion model developed by the Victorian Environmental Protection Authority (EPA Victoria). Ausplume is the approved dispersion model recommended by all of the EPAs in Australia.

The AUSPLUME V6.0 atmospheric dispersion model is used to project downwind ground level concentrations of air contaminants by taking into consideration various factors including:

- Odour emissions data - odour emission rate and source dimensions;
- Site specific meteorology;
- Geophysical impact (topography); and
- Building wake effects.

For this study, the air contaminant was odour and ground level concentrations in odour units (ou) have been projected. It should be noted that terrain effects are incorporated within the model for point sources such as stacks and vents only, but not for area and volume sources. All of the sources input into this model were ground-level area sources.

7.1 METEOROLOGICAL DATASET

Available meteorological data in the area is not readily obtainable, nor do current meteorological weather stations exist in the area with suitable data. Previously, the Hope Valley station was an acceptable dataset, however, the WA DEC has withdrawn its support of this Hope Valley data. The DEC does however endorse the Caversham dataset (ca94-b) for metropolitan assessments west of the Darling Scarp. This dataset was developed from the WA DEC approved Caversham weather station which is situated approximately 21 kilometres inland from the coast and approximately 7

kilometres from the base of the Darling Scarp. The modelling results from ca94-b dataset can be considered to be representative of a “poor dispersion” year.

The Caversham site is approximately 50 kilometres north-north west of the LSP Farm. Additionally, the LSP Farm is approximately 10 kilometres inland from the coast, whereas the Caversham site is approximately 21 kilometres inland. The Caversham site represents meteorological observations near the Darling Scarp. Prevailing problematic winds are typically easterly, compounded by winds drainage flows from the escarpment. As such, the dataset is conservative in the westerly direction (i.e. from easterly winds).

Given the location of the LSP Farm it may not be affected by these strong easterly wind drainage flows and hence problematic easterlies may be less prevalent at this location. Summer prevailing winds at the LSP Farm are easterlies in the morning and south-westerlies in the early afternoon. The south-westerlies are generally strong and represent favourable conditions for dispersion. The early morning easterlies generally exist in stable conditions and therefore may represent poor dispersion.

Adverse odour impacts are likely to be more prevalent during warmer months, as elevated temperatures tend to result in higher odour emissions. It is also important to note that, while calm to light wind conditions are the most problematical in terms of poor dispersion and odour nuisance, the standard Gaussian dispersion formulation intrinsic to the Ausplume model fails to adequately cope with wind velocities below 0.5 m s^{-1}. As a result, all winds < 0.5 m s^{-1} are treated as 0.5 m s^{-1} by the model.

In addition to wind direction and speed, atmospheric stability is an important factor in odour transport and dispersion. Stability refers to the vertical movement of the atmosphere and subsequently the dispersion of pollutants vertically within the atmospheric boundary layer. Atmospheric stability is classified under the Pasquill-Gifford scheme where seven stability classes have been defined as: A – very unstable; B – unstable; C – slightly unstable; D – neutral; E – slightly stable; F – stable; and G – very stable. F and G tend to be grouped together as F in dispersion models. When the atmosphere is stable, vertical movement is suppressed and

dispersion is poor. This is the case for classes E and F, which are apparent during temperature inversions. Neutral conditions also result in poor vertical dispersion for ambient temperature or cool plumes.

Table 7.1 below represents meteorological observations from the Hope Valley dataset. Although the dataset is not used in the dispersion model, it is useful to 'interrogate' the data to understand the local conditions. Table 7.1 shows that the atmosphere in the Baldivis region is stable for 15.87% over the 1995 – 1997 yearly dataset and neutral for a further 27.08% over this three-year dataset.

Table 7.1: Distribution of PG stability classes vs. wind speed (Hope Valley data).

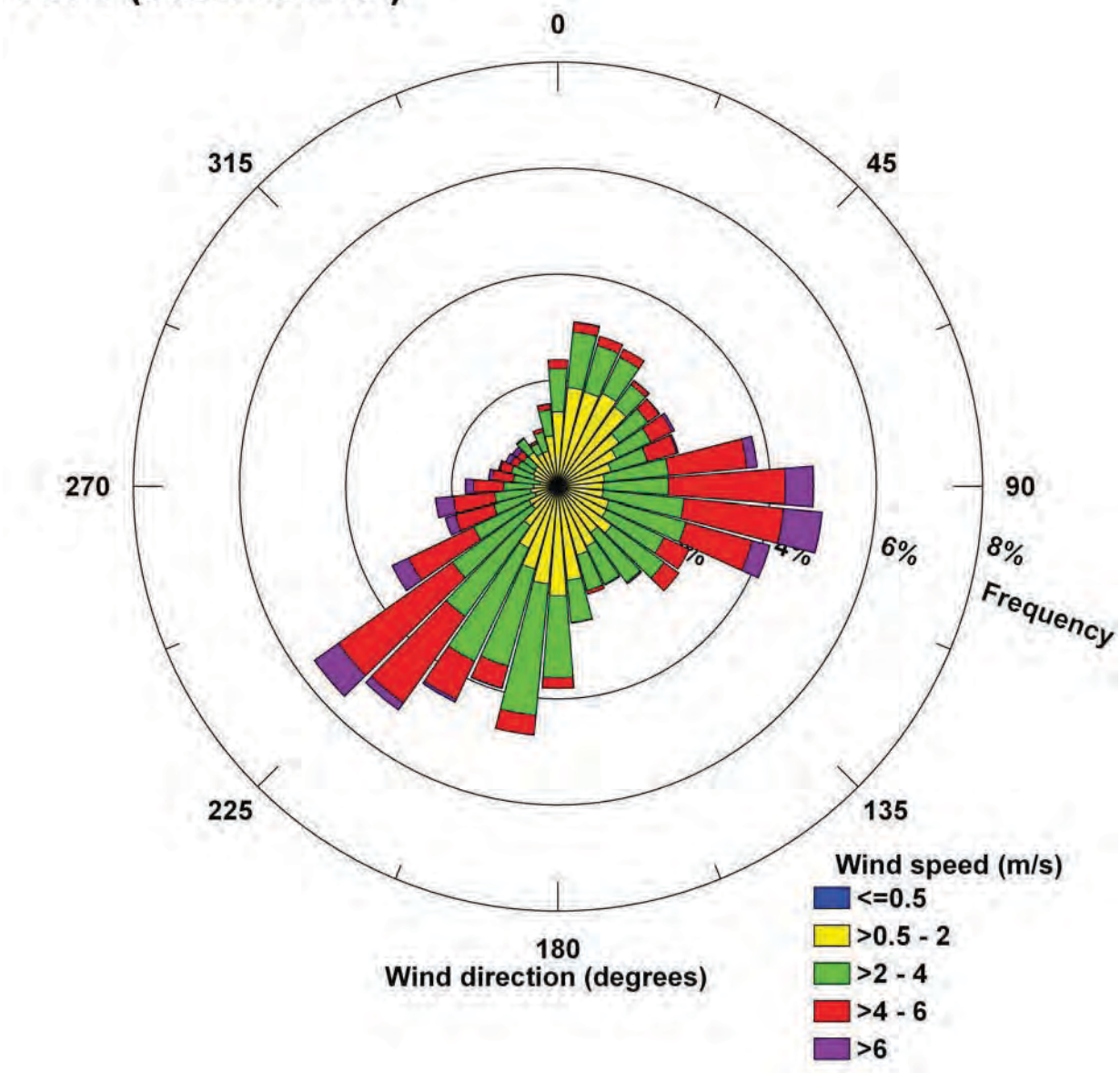
Pasquill Gifford Stability Class	Wind speed (m/s)						
	≤ 2	≤ 4	≤ 8	≤ 12	> 12	Total	%
A	450	533	-	-	-	983	3.74%
B	253	1785	490	-	-	2528	9.61%
C	149	1542	4417	179	-	6287	23.90%
D	168	1312	5419	224	-	7123	27.08%
E	224	4053	932	-	-	5209	19.80%
F	1401	2771	2	-	-	4174	15.87%

Table 7.2 below represents dispersion stability classes and time of day. Stable conditions (stability F) exist between 6pm to 8am for the three-year '95-'97 meteorological dataset, with the greatest stability occurring between the hours of 9pm through until 5am.

Table 7.2: Distribution of PG stability classes vs. time of day (Hope Valley data).									
Pasquill Gifford Stability Class	Time of day (hrs)								
	2400 - 0259	0300 - 0559	0600 - 0859	0900 - 1159	1200 - 1459	1500 - 1759	1800 - 2059	2100 - 2359	Total
A	-	-	17	393	408	150	15	-	983
B	-	1	96	785	999	573	74	-	2528
C	6	8	417	1501	1581	2083	689	2	6287
D	852	862	1469	602	300	482	1692	864	7123
E	1228	1284	803	5	-	-	539	1350	5209
F	1202	1133	486	2	-	-	279	1072	4174

The observations in **Table 7.2** represent local meteorological observations from the Hope Valley station in the Baldivis region approximately ten years ago. Local weather has changed over the last decade and has seen a shift in patterns where easterlies tend to remain for longer periods in the summer months. Typically, the period of December – March represents longer easterly conditions in the early morning with winds moving southerly and south-westerly in the early afternoon. Generally speaking, these easterly conditions can be considered the most problematic in the Perth region with respect to air dispersion. Moreover, under very calm conditions, odour plumes tend to elevate due to buoyancy, and increase in concentration, and are 'pushed, or moved' away from the source under low intermittent wind conditions. This often creates intermittent impacts off-site from a given odour source which under more constant wind conditions may have little odour impact due to the continual 'stripping' of the odour plume.

The windrow figure below illustrates the Caversham metrological dataset used in the dispersion modelling assessments.


Caversham Site Specific
1994 (ca94-b.met)
0
45
90
135
180
225
270
315
6%
8%
Frequency
Wind direction (degrees)
Wind speed (m/s)
<=0.5
>0.5 - 2
>2 - 4
>4 - 6
>6

7.2 LOCAL LAND USE AND TOPOGRAPHY

The Baldivis LSP locale can be considered a 'flat to rolling rural' landscape southwest of the Perth Metropolitan CBD, where many properties are large hectare lots. The current trend of 'urban-sprawl' within the Perth Metropolitan area has seen a significant increase in residential developments encroaching into rural landscapes. The Baldivis LSP Farm is situated within a currently developing residential area and is largely surrounded by natural vegetation and large well-established forestry.

The topography in the immediate vicinity of the LSP Farm is both flat and rolling rural. The land elevation at the LSP Farm is approximately 15m Australian Height Datum (AHD).

The surface roughness category (Z_o) chosen for this dispersion model was 0.3, to reflect the surface friction created by the rolling rural landscape and the established flora on the adjoining and surrounding properties.

7.3 GRIDDED RECEPTOR FILE

The Receptor file used in the model was a Cartesian grid with receptors spaced at 50m by 50m intervals. The grid extended approximately 1,000m to the west of the LSP Farm, approximately 900m to the east, and both 700m and 500m to the north and south of the LSP Farm respectively. As Ausplume does not incorporate terrain elevation into the calculation for volume sources, terrain effects were ignored.

7.4 DISPERSION MODEL SOURCE AND EMISSION RATE CONFIGURATIONS

The dispersion model configuration for odour sources was developed from data estimated by TOU during the field based ambient surveys, and from aerial imagery data. Three odour sources were identified by TOU as follows:

Shed 1 – Layershed
Shed 2 – Layershed
Shed 3 – Layershed /or/ Litter Storage Shed

As discussed in **Section 2**, preferred odour emissions data was advised by the WA DEC and applied to the LSP Farm. In addition, TOU reviewed the "Australian Model Code of Practice for the Welfare of Animals - Domestic Poultry" (4th Edition), to ascertain the recommended stocking densities of poultry prescribed in the code. The estimated areas of each of the odour sources are presented in **Table 7.3.** The derived odour emission rates (OER's) are presented in **Tables 7.4; 7.5 & 7.6** with each table representing differing odour emissions data that reflects the individual emission scenarios discussed in Section 2.

Table 7.3: LSP Farm Estimated Individual Odour Source Dimensions.

Odour Source	Length (m)	Width (m)	Height (m)	Surface Area (m^2)
Shed 1 - Layershed	88	15	5	**1,320**
Shed 2 - Layershed	58	15	5	**870**
Shed 3 – Layershed/Litter Storage	50	18	5	**900**

Table 7.4: LSP Farm derived OER's based on "Poultry Code of Practice" **PRE2001**.			
Odour Source	# Birds[A]	**PRE2001** Stocking Density[B] (Birds / m^2)	Odour Emission Rate[C] ($ou.m^3\ sec^{-1}$)
Shed 1 - Layershed	**29,304**	22.2	**6,007**
Shed 2 - Layershed	**19,314**	22.2	**3,959**
Shed 3 – Layershed/Litter Storage	**19,980**	22.2	**4,096**

[A]Bird Numbers derived from source surface areas x Stocking Densities. [B]The "Code of Practice for the Welfare of Animals - Domestic Poultry" (4th Ed.) prescribes a minimal stocking Density, **PRE2001**, of 450cm^2 per bird (22.2 birds /m^2). [C]Odour Emission Rate (OER) derived from multiplying the bird numbers x 0.205$ou.m^3\ sec^{-1}$.

Table 7.5: LSP Farm derived OER's based on "Poultry Code of Practice" **POST2001**.			
Odour Source	# Birds[A]	**POST2001** Stocking Density[B] (Birds / m^2)	Odour Emission Rate[C] ($ou.m^3\ sec^{-1}$)
Shed 1 - Layershed	**24,024**	18.2	**4,925**
Shed 2 - Layershed	**15,834**	18.2	**3,246**
Shed 3 – Layershed/Litter Storage	**16,380**	18.2	**3,358**

[A]Bird Numbers derived from source surface areas x Stocking Densities. [B]The "Code of Practice for the Welfare of Animals - Domestic Poultry" (4th Ed.) prescribes a minimal stocking Density, **POST2001**, of 550cm^2 per bird (18.2 birds /m^2). [C]Odour Emission Rate (OER) derived from multiplying the bird numbers x 0.205$ou.m^3\ sec^{-1}$.

Table 7.6: LSP Farm derived OER's based on WA DEC advice of 0.205ou.m^3 sec^{-1}.

Odour Source	# Birds[A]	**WA DEC** Stocking Density[B] (Birds / m^2)	Odour Emission Rate[C] (ou.m^3 sec^{-1})
Shed 1 - Layershed	**22,968**	17.4	**4,708**
Shed 2 - Layershed	**15,138**	17.4	**3,103**
Shed 3 – Layershed/Litter Storage	**15,660**	17.4	**3,210**

[A]Bird Numbers derived from source surface areas x Stocking Densities. [B]The WA DEC advised TOU on using the Jiang & Sands (1998) study for Broiler Farm emissions, which prescribes a stocking density of 17.4 birds per m^2. [C]Odour Emission Rate (OER) derived from multiplying the bird numbers x 0.205ou's sec^{-1}.

7.5 ODOUR DISPERSION MODELLING SCENARIOS

Three scenarios were modelled for this impact assessment study, with each scenario having differing emissions data according to either the WA DEC recommended, or the Code of Practice for Domestic Poultry **(refer Tables 7.4; 7.5 & 7.6 above).**

All three scenarios were modelled according to the QEPA OPC "Ecoaccess" criteria of 2.5ou, 1-hour averaging times at the 99.5th percentile.

In addition, each modelled scenario was further assessed at criteria of 8ou, 1-hour averaging times at the 99.9th percentile, which illustrates a predicted odour impact concentration 'near field' to the LSP Farm property boundary.

Importantly, all odour emission rates have been modelled as constant. It is highly unlikely that odours are constant from the LSP Farm given that the sheds are closed in the evening, and the life cycles of the birds would vary, and therefore odour emissions would vary. A constant emission rate represents the most conservative approach for dispersion modelling.

8 ODOUR DISPERSION MODELLING STUDY RESULTS

Figures 8.1; **8.2 and 8.3** present the results of the odour dispersion modelling study, presenting the odour contours relating to each emission rate scenario outlined in Tables 7.4; 7.5 and 7.6 of section 7.

All dispersion modelling was predicted with constant emission rates, and with emission rates exempt from temperature dependency.

Figure 8.1 illustrates modelled emissions based on the WA DEC recommended stocking density of 17.4 birds per m^2 of floor space. The emission rate applied to this stocking density was 0.205ou.m^3 sec^{-1} $bird^{-1}$ and was recommended by the WA DEC, and taken from Jiang & Sands (1998).

Figure 8.2 illustrates modelled emissions based on the Australian Model COP (POST2001) recommended stocking density of 18.2 birds per m^2 of floor space. The emission rate applied to this stocking density was 0.205ou.m^3 sec^{-1} $bird^{-1}$ and was recommended by the WA DEC, and taken from Jiang & Sands (1998).

Figure 8.3 illustrates modelled emissions based on the Australian Model COP (PRE2001) recommended stocking density of 22.2 birds per m^2 of floor space. The emission rate applied to this stocking density was 0.205ou.m^3 sec^{-1} $bird^{-1}$ and was recommended by the WA DEC, and taken from Jiang & Sands (1998).

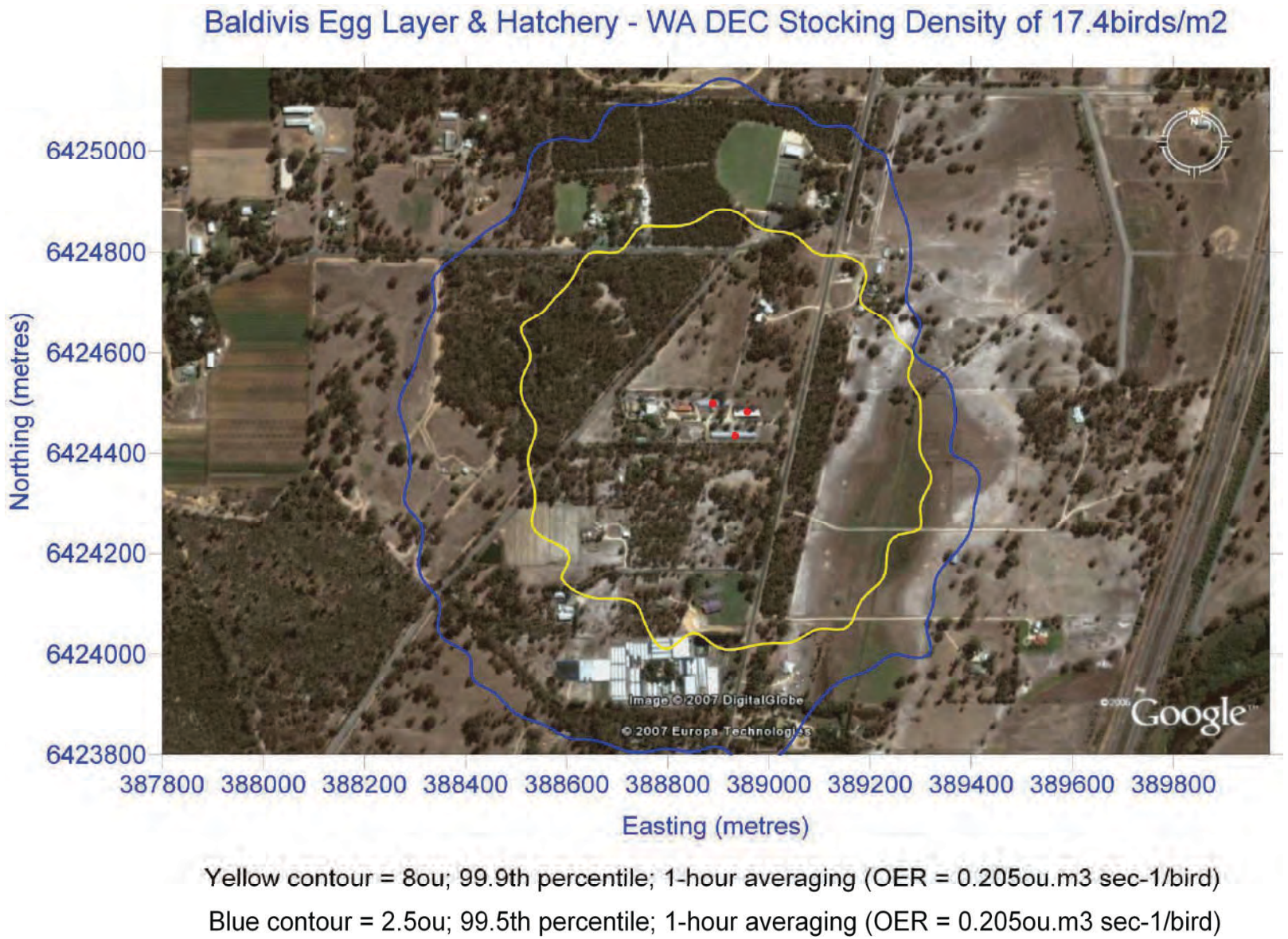


Figure 8.1: Modelling result contours for the WA DEC recommended Emission Rates (refer Section 2.1).

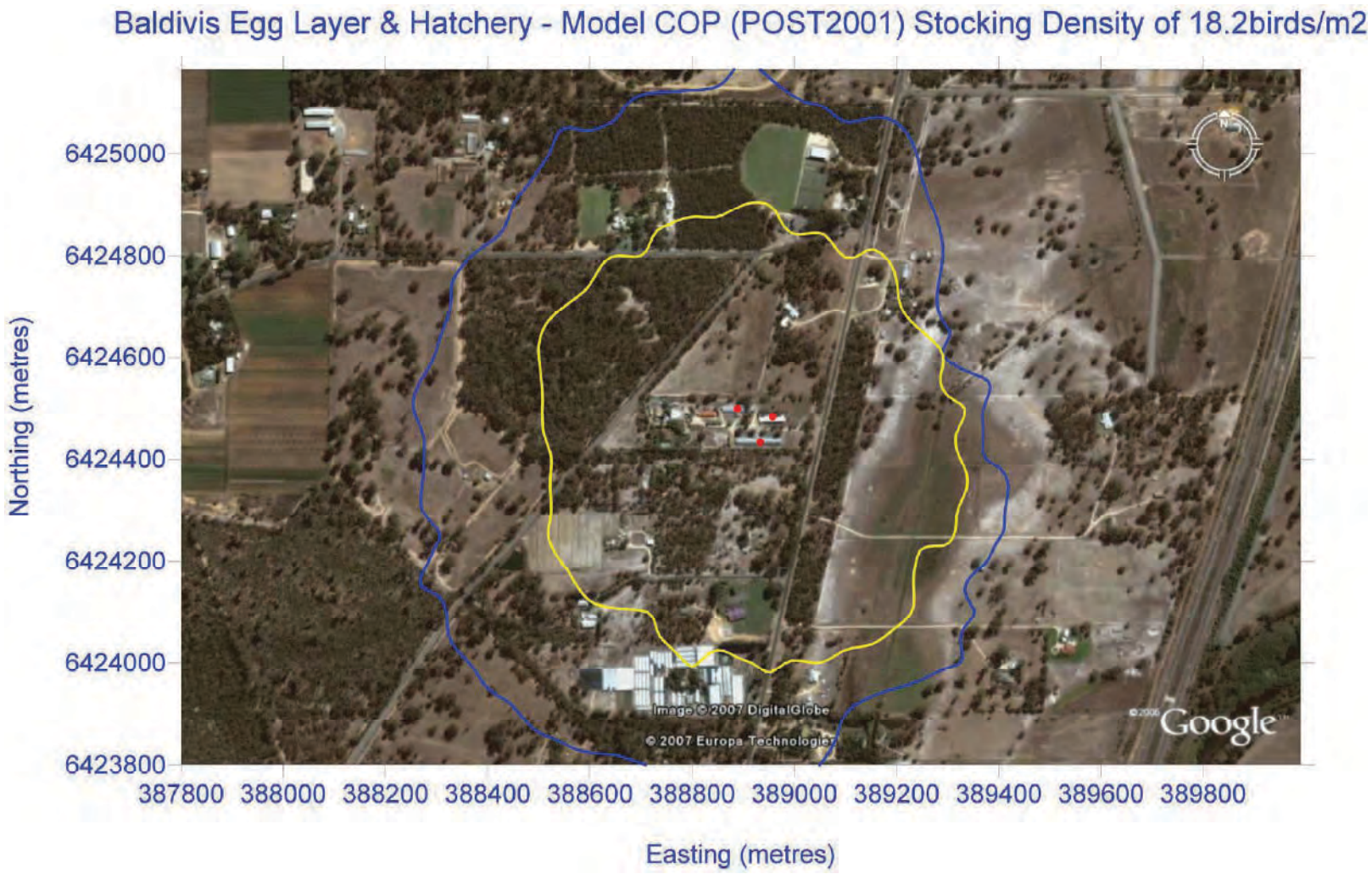


Figure 8.2: Modelling result contours for Emission Rates based on the "Australian Model Code of Practice for the Welfare of Animals – Domestic Poultry (4th Ed.) POST2001 Guidance. (Refer Section 2.2.1).

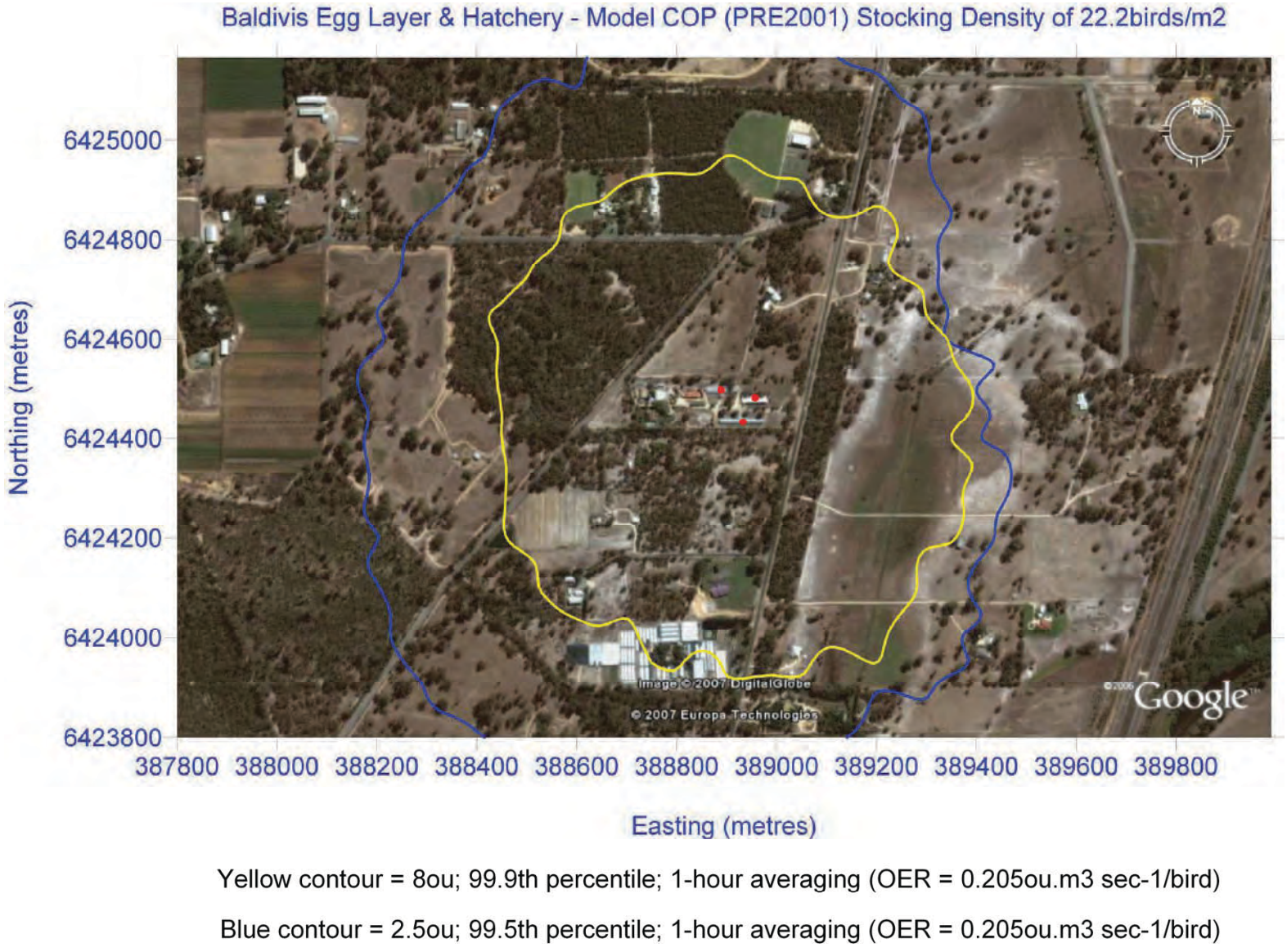


Figure 8.3: Modelling result contours for Emission Rates based on the "Australian Model Code of Practice for the Welfare of Animals – Domestic Poultry (4th Ed.) PRE2001 Guidance. (Refer Section 2.2.1).

9 DISCUSSION OF RESULTS

The Odour Unit Pty Ltd (TOU) conducted an Odour Dispersion Modelling & Field Based Ambient Odour Survey Study of the Layertech Services Poultry (LSP) Facility in Baldivis Western Australia throughout the period of January 2010. The structure for this Odour Impact Study was to assess the potential problematic impacts from the LSP Farm on the adjacent land holding at Lot 61 Eighty Road, Baldivis that has been proposed for redevelopment. Whilst undertaking a 'desktop' Odour Dispersion Modelling Study, TOU also conducted five 'Field Based Ambient Odour Assessments' (FAOA's) to evaluate ground level odorous impacts emanating from the LSP Farm.

The results of the FAOA surveys have concluded that TOU field assessors did not observe problematic odours beyond the boundary of the LSP Farm.

The German VDI 3882 intensity scale is used in FAOA surveys to 'rank' observations of odours. TOU's observations did not exceed an intensity rank of 3, which can be considered problematic. Moreover, TOU field technicians had to 'actively' seek out odour and attempt to define its character during the survey periods. Observations such as this indicate strongly that odours are not problematic, in particular beyond the boundary of the LSP Farm. This result was expected when accounting for the Free Range configuration of the LSP Farm.

TOU is of the belief that these odours observed during the FAOA surveys are non-problematic with respect to Lot 61 Eighty Road, Baldivis. In addition, odour observations were transient and the plume was considered to be narrow. TOU also observed many rural odours that often 'masked' those small intensity odours experienced from/at the LSP Farm boundary. These odours were customary of a typical rural landscape such as grass, fruit and flowering trees.

The Odour Dispersion Modelling 'desktop' study results **(refer section 8)** indicates odour impacts well beyond those observations made during the FAOA's. Again, this result was expected, particularly since the odour emission rate used represents a

poultry broiler (meat) farm. Jiang and Sands suggest that odour emission from free range farms may be at least 2.5 times less than broiler odours. This finding is highly supported by TOU, however, TOU believes that odours from poultry free range farms, in particular egg layer and hatchery configurations such as the LSP Farm, may have odour emission rates much less than indicated by Jiang and Sands.

For comparison, TOU has modelled the Jiang and Sands reported odour emission rate of 0.079ou.m^3 sec^{-1} $bird^{-1}$ for free range configurations and investigated a near-field ground level odour concentration of 5 odour units. TOU modelled the 0.079 OER against an odour criterion of 5ou, 99.5th percentile and 1 hour averaging times. The result of this sensitivity model is illustrated in **Figure 9.1** below.

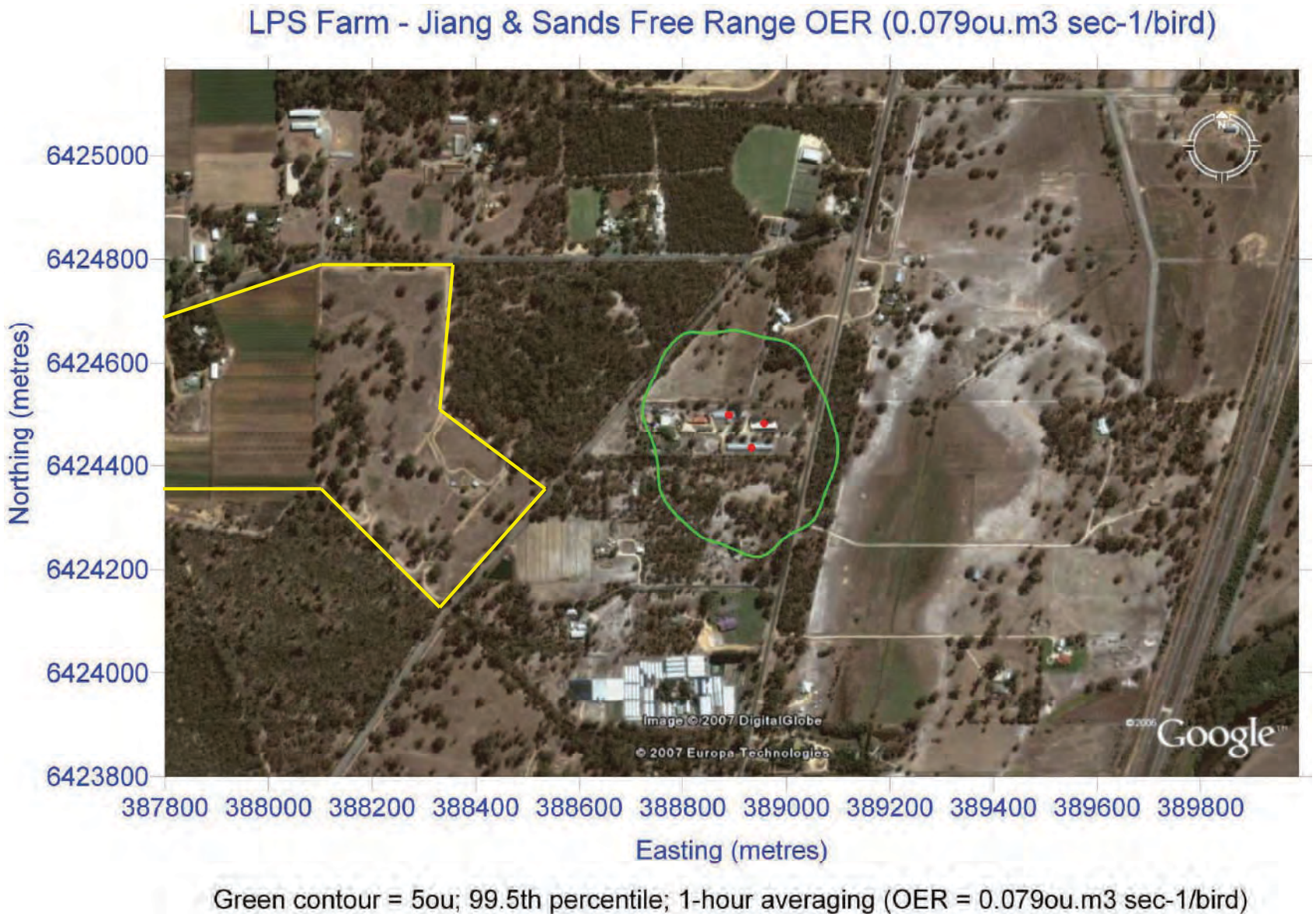


Figure 9.1: Sensitivity Modelling result for an OER of 0.079 at 5ou, 99.5th percentile and 1 hour averaging.

TOU investigated three dispersion modelling scenarios for the LSP Farm based on an Australian Poultry industry literature review, and recommendations from the WA DEC.

TOU has undertaken an odour sensitivity modelling **(Figure 9.1)** exercise to derive what emission rate and odour criteria is relevant to the LSP Farm. The model projection compares well with the FAOA findings. The model projection shows a distance of off-site odour impacts up to approximately 100 metres in any direction from the shed locations at the LSP Farm. This distance is supported by TOU's field observations.

The sensitivity model projection represents a ground level odour impact of 5 odour units at the 99.5th percentile. The stocking density determines the overall odour emission rate and therefore it is likely that the stocking densities at the LSP Farm are less than the 17.4 birds per m^2 investigated. TOU's field observations may represent ground level odours of possibly 1 or 2 odour units at or near the LSP Farm boundary and therefore may support a reduction in the stocking density. These odours were not considered problematic.

The modelling outcomes from the Australian Model Code of Practice and those from the Jiang and Sands data represent highly conservative and overstated emissions for the LSP Farm. The emissions data used represented poultry broiler operations. The LSP Farm is not a broiler producer and has been found to be non-problematic beyond the boundary with respect to odour observations. The model projections in this study also represent constant odour emissions of which the LSP Farm would not produce.

It is the strong viewpoint of TOU that odours from the LSP Egg Layer and Hatchery Farm would not be problematic beyond the Farm boundaries under the current operating conditions.

However, since Lot 61 Eighty Road, Baldivis is in close proximity to the western boundary of the LSP Farm, TOU recommends that the proposed residential land development at Lot 61 Eighty Road, Baldivis retain some public land and/or

recreational areas that border Eighty Road, Baldivis. This recommendation is based on the close proximity of the proposed land development at Lot 61 Eighty Road, Baldivis and the western boundary of the LSP Farm, and therefore it cannot be assumed that transient odour impacts would not occur under the worst conditions for dispersion.

10 REFERENCES

1. Animal Welfare Committee (AWF). 'Australian Model Code of Practice for the Welfare of Animals – Domestic Poultry, 4th Ed. Endorsed by Primary Industries Ministerial Council (PIMC) May 2002.

2. Jiang, J & Sands, J. 'Odour Emissions from Poultry Farms in Western Australia'. Centre for Waste Water Technology NSW, 1998.

3. Queensland Environment Protection Agency. 'Ecoaccess – Guideline: Odour Impact Assessment from Developments', 2004.

4. Western Australian Department of Environmental Protection: 'Guidance for the Assessment of Environmental Factors – Assessment of Odour Impacts from New Proposals' Document No. 47, 2002.

5. Western Australian Department of Environmental Protection. 'Odour Methodology Guideline', March 2002.

Appendix A

Example of the AUSPLUME Model Output File

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.300m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	Huber-Snyder method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

2.5ou_99.5th_1hr_Jiang&Sands
SOURCE CHARACTERISTICS

VOLUME SOURCE: SHED1

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388933	6424434	0m	3m	4m	1m

(Constant) emission rate = 4.71E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: SHED2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388889	6424499	0m	3m	4m	1m

(Constant) emission rate = 3.10E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: SHED3

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388957	6424483	0m	3m	5m	1m

(Constant) emission rate = 3.21E+03 OUV/second
No gravitational settling or scavenging.

1

Layertech_Baldivis_0.205OER_2.5ou's_99.5&ile_1hr_ca94-b

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
387800.m 387850.m 387900.m 387950.m 388000.m 388050.m 388100.m
388150.m 388200.m 388250.m 388300.m 388350.m 388400.m 388450.m
388500.m 388550.m 388600.m 388650.m 388700.m 388750.m 388800.m
388850.m 388900.m 388950.m 389000.m 389050.m 389100.m 389150.m
389200.m 389250.m 389300.m 389350.m 389400.m 389450.m 389500.m
389550.m 389600.m 389650.m 389700.m 389750.m 389800.m 389850.m
389900.m 389950.m

and these y-values (or northings):
6423800.m 6423850.m 6423900.m 6423950.m 6424000.m 6424050.m 6424100.m
6424150.m 6424200.m 6424250.m 6424300.m 6424350.m 6424400.m 6424450.m
6424500.m 6424550.m 6424600.m 6424650.m 6424700.m 6424750.m 6424800.m
6424850.m 6424900.m 6424950.m 6425000.m 6425050.m 6425100.m 6425150.m
6425200.m 6425250.m 6425300.m 6425350.m 6425400.m 6425450.m 6425500.m
6425550.m 6425600.m 6425650.m 6425700.m 6425750.m

METEOROLOGICAL DATA : Caversham 1994 Blockley 271200. Read ca94aus.rea for

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.300m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	Huber-Snyder method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

8ou_99.9th_1hr_Jiang&Sands
SOURCE CHARACTERISTICS

VOLUME SOURCE: SHED1

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388933	6424434	0m	3m	4m	1m

(Constant) emission rate = 4.71E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: SHED2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388889	6424499	0m	3m	4m	1m

(Constant) emission rate = 3.10E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: SHED3

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388957	6424483	0m	3m	5m	1m

(Constant) emission rate = 3.21E+03 OUV/second
No gravitational settling or scavenging.

1

Layertech_Baldivis_0.205OER_8ou's_99.9&ile_1hr_ca94-b

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
387800.m 387850.m 387900.m 387950.m 388000.m 388050.m 388100.m
388150.m 388200.m 388250.m 388300.m 388350.m 388400.m 388450.m
388500.m 388550.m 388600.m 388650.m 388700.m 388750.m 388800.m
388850.m 388900.m 388950.m 389000.m 389050.m 389100.m 389150.m
389200.m 389250.m 389300.m 389350.m 389400.m 389450.m 389500.m
389550.m 389600.m 389650.m 389700.m 389750.m 389800.m 389850.m
389900.m 389950.m

and these y-values (or northings):
6423800.m 6423850.m 6423900.m 6423950.m 6424000.m 6424050.m 6424100.m
6424150.m 6424200.m 6424250.m 6424300.m 6424350.m 6424400.m 6424450.m
6424500.m 6424550.m 6424600.m 6424650.m 6424700.m 6424750.m 6424800.m
6424850.m 6424900.m 6424950.m 6425000.m 6425050.m 6425100.m 6425150.m
6425200.m 6425250.m 6425300.m 6425350.m 6425400.m 6425450.m 6425500.m
6425550.m 6425600.m 6425650.m 6425700.m 6425750.m

METEOROLOGICAL DATA : Caversham 1994 Blockley 271200. Read ca94aus.rea for

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.300m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	Huber-Snyder method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

5ou_99.5th_1hr_Jiang&Sands_0.079
SOURCE CHARACTERISTICS

VOLUME SOURCE: SHED1

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388933	6424434	0m	3m	4m	1m

(Constant) emission rate = 1.82E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: SHED2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388889	6424499	0m	3m	4m	1m

(Constant) emission rate = 1.20E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: SHED3

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
388957	6424483	0m	3m	5m	1m

(Constant) emission rate = 1.24E+03 OUV/second
No gravitational settling or scavenging.

1

Layertech_Baldivis_0.079OER_5ou's_99.5&ile_1hr_ca94-b

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
387800.m 387850.m 387900.m 387950.m 388000.m 388050.m 388100.m
388150.m 388200.m 388250.m 388300.m 388350.m 388400.m 388450.m
388500.m 388550.m 388600.m 388650.m 388700.m 388750.m 388800.m
388850.m 388900.m 388950.m 389000.m 389050.m 389100.m 389150.m
389200.m 389250.m 389300.m 389350.m 389400.m 389450.m 389500.m
389550.m 389600.m 389650.m 389700.m 389750.m 389800.m 389850.m
389900.m 389950.m

and these y-values (or northings):
6423800.m 6423850.m 6423900.m 6423950.m 6424000.m 6424050.m 6424100.m
6424150.m 6424200.m 6424250.m 6424300.m 6424350.m 6424400.m 6424450.m
6424500.m 6424550.m 6424600.m 6424650.m 6424700.m 6424750.m 6424800.m
6424850.m 6424900.m 6424950.m 6425000.m 6425050.m 6425100.m 6425150.m
6425200.m 6425250.m 6425300.m 6425350.m 6425400.m 6425450.m 6425500.m
6425550.m 6425600.m 6425650.m 6425700.m 6425750.m

METEOROLOGICAL DATA : Caversham 1994 Blockley 271200. Read ca94aus.rea for