REPORT

ODOUR ASSESSMENT FOR PRECINCT PLANNING, AREA 20 PRECINCT, NORTH WEST GROWTH CENTRE, BLACKTOWN, NSW

Department of Planning

Job No: **3274**

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ES1 EXECUTIVE SUMMARY

This assessment was conducted to determine the potential for odour impacts on the Area 20 Precinct. The assessment will be a supporting background study for the Area 20 Precinct planning process. Area 20 is a semi-rural area that currently comprises houses on rural properties. Commercial activities are predominantly rural uses such as market gardens and livestock. The proposed development of the study area is for approximately 2,500 residences for about 7,000 people, including higher density residential development.

Potential odour sources surrounding the Area 20 study area include poultry operations, intensive piggeries, a meat rendering operation and sewage treatment plants.

A Level 1 odour impact assessment, consistent with the *Technical framework: assessment and management of odour from stationary sources in NSW* (DECC, 2006a) and its associated *Technical notes* (DECC, 2006b), has been conducted.

The Level 1 study has predicted that a number of poultry operations in the vicinity of the Area 20 study area have potential to individually impact on the proposed development area. When combining the Level 1 areas of influence of these poultry operations, almost all of Area 20 is predicted to be affected by poultry farm odour. These poultry operations were further assessed using a Level 3 odour impact assessment and a more defined area of potential odour influence was determined with a greater confidence than the Level 1 results. Two areas, i.e. a small area to the north and a section of the west of the Area 20 study area are predicted to experience odour impacts greater than 2 odour units, for the scenario that was assessed. Odour nuisance at receptors located within this area may or may not occur in the future if land is developed, however consideration should be given to land use planning decisions relating to sensitive land use, such as residences, schools and hospitals, in these areas.

Separation distances for other potential odour sources, such as intensive piggeries, sewage treatment plants and meat rendering operations have not resulted in encroachment on the Area 20 study area when assessed using the Level 1 assessment methodology, or by using an alternative default buffer distance where Level 1 methods do not exist (i.e. for meat rendering and sewage treatment).

It should be noted that the separation distance for meat rendering plants is a default buffer that does not account for site-specific data such as emission rates and control technologies, meteorology, terrain etc. It is acknowledged that the 1 km buffer is used in Australia as an acceptable default separation distance, however anecdotal evidence also suggests that some meat rendering plants can have odour impacts beyond the default buffer distance.

Options have been provided to control odour impacts from odour generating operations on proposed residential development and associated land uses, for potential inclusion in a development control plan. These recommendations for development control could be substituted by further detailed modelling, whereby site specific emissions details are used in dispersion modelling to support future Development Applications for sensitive land use proposals.

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1 INTRODUCTION

The Department of Planning has requested PAEHolmes to conduct an Odour Impact Assessment relating to the Area 20 Precinct.

This assessment will inform an Indicative Layout Plan as part of Precinct Planning and will be one of the supporting background studies for the Area 20 Precinct planning package, to be prepared as part of the precinct planning process.

1.1 Background

1.1.1 Sydney's North West Growth Centre

Sydney's North West Growth Centre covers approximately 10,000 hectares, within the LGA boundaries of Baulkham Hills, Blacktown and Hawkesbury. It will be supported by a major centre at Rouse Hill and will contain about 70,000 new homes. It is made up of 16 'Precincts', which are areas that will be progressively released over the next 30 years.

1.1.2 Precinct Planning

Precinct Planning is a detailed process which analyses the development potential of each Precinct in the Growth Centres. It will be carried out as a partnership between the NSW Government and the relevant Local Council.

This odour assessment is one of a suite of technical studies that will inform the precinct planning process and the preparation of an Indicative Layout Plan and Development Control Plan for Area 20.

1.2 Project Description

1.2.1 Study Area

The Area 20 Precinct is in the Blacktown Local Government Area. Following a Precinct Boundary Review Process, the planning for Area 20 now encompasses a portion of land from Riverstone East Precinct (in this report the combined area is referred to as the Area 20 study area).

Area 20 is approximately 245 hectares, which will have capacity for about 2,500 dwellings accommodating a population of around 7,000 people. It is bounded by Windsor Road in the east and Schofields Road in the south. The boundary nominally follows the ridgeline to the west, with Second Ponds Creek flowing through the centre. To the east of Area 20 is the Rouse Hill Town Centre.

Area 20 is a semi-rural area that currently comprises houses on rural properties. Commercial activities are predominantly rural uses such as market gardens and livestock. Other commercial interests include a caravan park on Terry Road, landscape supplies on Rouse Road and an earthmoving business and a Council quarry on Schofields Road. Rouse Hill Anglican College is located on the corner of Worcester Road and Rouse Road. The Precinct also takes in part of Rouse Hill Regional Park and Rouse Hill House and Farm.

Figure 1.1 shows the location of the Area 20 study area.

Figure 1.1: Area 20 Study Area

1.2.2 Surrounding Land Use

To the west of the Area 20 study area is the Riverstone East Precinct (yet to be released), which comprises mostly rural industry such as market gardens and livestock. A number of poultry farms and a piggery are located in this area. Further west is the Riverstone Precinct, which contains a mix of urban areas including the suburb of Riverstone and semi-rural residential areas.

To the south west of the Area 20 study area is the Alex Avenue Precinct, which also contains a mix of urban area, semi-rural residential and land uses including poultry farms and a piggery. South of Area 20 is currently rural open area between Schofields Road and the Kellyville Ridge and Stanhope Gardens communities.

Immediately bordering Area 20 to the east across Windsor Road is the Rouse Hill town centre containing urban mixed uses.

Land use north of the Area 20 study area is predominantly rural industry and rural residential, including market gardens and livestock. A J Bush & Son operate a meat rendering plant approximately 1.2 km north northeast of Area 20 and there are a couple of poultry farms close to the study area to the north east. There is also a poultry farm further north on Terry Road, Box Hill.

1.3 Objectives of the Study

The study objectives are to:

- Investigate and identify any source or sources of odour on or in the vicinity of the subject land, including from any ongoing agricultural activities on the subject land;
- Investigate the implications of any existing odours for the staging of the development of the land;
- Recommend management strategies to maximise the development opportunities both under the existing odour situation, and into the future; and
- Make recommendations for controlling impact on proposed residential development and associated land uses from odour generating activities.

1.4 Scope of Work

The study was conducted in two stages. The scope of work required for Stage 1 included:

- Investigation of potential sources of odour that may impact on future development in the Area 20 Precinct, including from sources in neighbouring precincts;
- Developing an understanding of the nature of any odour producing activities identified;
- Conducting a Level 1 Odour Impact Assessment, as outlined in NSW DECC Odour Policy and its Technical Notes, resulting in recommended separation distances;
- Preparing a report outlining the findings of the Level 1 Odour Impact Assessment, including maps outlining where urban development would encroach into the 'separation distances' determined by the study, and making a recommendation for any Stage 2 work if required.

In order to provide this work PAEHolmes conducted an extensive visit to the area and collected relevant data on odour producing activities, the surrounding areas and meteorological conditions for input to the Level 1 Odour Impact Assessment.

As a result of the outcomes from Stage 1 of the study, the Stage 2 work was recommended. The scope of work conducted for Stage 2 included:

- Conducting a Level 3 Odour Impact Assessment, as outlined in NSW DECC Draft Odour Policy and its Technical Notes, using the CALPUFF dispersion model.
- Updating this report to:
    - incorporate the results of the modelling and limitations of the data;
    - review strategies for managing odour impacts;
    - predict odour impacts on the future development of the site, considering management recommendations; and
    - provide recommendations for controlling odour impact from odour generating development on proposed residential development and associated land uses, in the form of development control provisions for inclusion in a development control plan.

Modelling was conducted using the CALPUFF dispersion model and based on a representative 1-year meteorological dataset.

2 ODOUR LEGISLATION AND GUIDELINES

2.1 Legislation

The three most important pieces of legislation for preventing and controlling odour in NSW are the:

- Environmental Planning and Assessment Act 1979 (EP&A Act)
- Protection of the Environment Operations Act 1997 (POEO Act)
- Local Government Act 1993 (LG Act)

The EP&A Act deals with land-use planning, development, assessment and approvals.

The POEO Act requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. The operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act).

The POEO Act includes the concept of 'offensive odour' (section 129) and states it is an offence for scheduled activities to emit 'offensive odour'.

The LG Act gives local councils the power to deal with public nuisance, including odour emissions.

2.2 Guidelines

Odour is probably the most widespread and complex local air pollution problem in Australia. It accounts for the majority of complaints received by environmental authorities and can be a major source of annoyance and stress in affected communities.

In November 2006, NSW Department of Environment and Climate Change (DECC) released two documents, i.e. *Technical framework for the Assessment and Management of Odour from Stationary Sources in NSW* (**DECC, 2006a**) and its associated *Technical notes for the Assessment and Management of Odour from Stationary Sources in NSW* (**DECC, 2006b**). The discussion in this report draws extensively from those documents, which outline the DECC's proposed approach for the assessment of odour emissions, using a three-level system of odour impact assessment of increasing complexity and detail. Depending on the individual characteristics of a new development and its proposed location, a varying degree of investigation into the potential for odour impacts may be required.

- Level 1 is a screening-level technique based on generic parameters for the type of activity and site. It requires minimal data and uses simple equations to provide a broad estimate of the extent of any odour impact. It may be used to identify the potentially affected zone and site suitability for a proposed facility or new neighbouring development or expansion of an existing facility
- Level 2 is a screening-level dispersion modelling technique, using worst-case input data (rather than site-specific data). It is more rigorous and more realistic than a Level 1 assessment. It may be used to assess site suitability and odour mitigation measures for new, modified or existing activities
- Level 3 is a refined-level dispersion modelling technique using site-specific input data. This is the most comprehensive and realistic level of assessment available. It may be used to assess site suitability and odour mitigation measures for new, modified or existing activities

This assessment used a Level 1 odour impact assessment to screen identified odour sources in the vicinity of the Area 20 study area. In general, a Level 1 assessment is sufficient to broadly identify whether a site is suitable or if further assessment of odour impact is necessary or worthwhile.

For a Level 1 assessment, a 'pass' suggests the calculated extent of the odour impact is less than the distance to the nearest (or likely future) receptor. Conversely, a 'fail' suggests the site is probably unsuitable but may warrant further, more detailed investigation. Typically, if a proposal fails Level 1 assessment, the following should be considered:

- adopt better management practices
- increase the level of pollution control
- relocate the activity to an alternative site
- assess the activity using either a Level 2 or 3 assessment, and/or
- redesign the activity or consider other actions as necessary

The predominant potential odour producing activities surrounding the Area 20 study area are 'diffuse sources', for example poultry farms and intensive piggeries. Diffuse sources are generally dominated by odour emissions from area sources, which are difficult to control compared to point source emissions. The odour impacts from these sources are most effectively managed through careful site selection, appropriate project design, site layout and sound management practices.

For poultry farms and piggeries, generic procedures for determining the affected areas have been developed and are useful for assessing the potential for odour impacts or the potentially affected area around existing operations.

The Level 1 odour impact assessment for diffuse sources takes into account the following factors:

- type of operation
- size of operation
- proposed management practices
- density of population likely to be impacted, ranging from a single rural residence to a predominantly urban setting
- local topography (flat, undulating, high relief, low relief or drainage flows)
- surrounding vegetation (none, light or heavy tree cover)
- local meteorology (high, average or low frequency of winds toward sensitive receptor)
- possibility of cumulative impacts.

In summary, the Level 1 odour impact assessment for diffuse sources could be used to determine whether the proposed management practices and distance to the nearest sensitive receptor (and likely future receptors) are sufficient to meet environmental outcomes.

For this study the Level 1 assessment was conducted for poultry operations, piggeries, waste water treatment and meat rendering. Whilst the other odour sources were able to be screened out using a Level 1 approach, the assessment for poultry operations indicated that further assessment would be useful for informing planning decisions for Area 20.

When conducting either a Level 2 or Level 3 odour impact assessment, the dispersion modelling requirements in *Approved methods for the modelling and assessment of air pollutants in New South Wales* (**DECC, 2005**) should be adhered to. The Approved methods document covers:

- ground-level concentration (GLC) criteria for individual odorous and toxic air pollutants
- GLC criteria for hydrogen sulfide
- odour assessment criteria for complex mixtures of odours
- impact assessment methodology based on dispersion modelling
- the procedure for developing site-specific emission limits.

Note that Level 2 and 3 odour impact assessments in the Technical notes document are equivalent to Level 1 and 2 odour impact assessments respectively in the Approved methods document.

A Level 3 assessment was conducted for poultry operations that were identified by the Level 1 assessment to potentially impact on the Area 20 study area. The results of the Level 3 assessment provided useful information about the extent of potential odour impacts on Area 20 from poultry.

2.2.1 Odour Impact Assessment Criteria

Odour impacts are determined by several factors. The most important factors (the so-called **FIDOL** factors) are:

- the **F**requency of the exposure
- the **I**ntensity of the odour
- the **D**uration of the odour episodes
- the **O**ffensiveness of the odour, and
- the **L**ocation of the source

In determining the offensiveness of an odour it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

In summary, whether or not an individual considers an odour to be a nuisance will depend on the FIDOL factors outlined above and although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable.

The DECC framework documents include some recommendations for odour criteria. The criteria have been refined by DECC to take account of population density in the area. **Table 2.1** lists the odour certainty thresholds, to be exceeded not more than 1% of the time, for different population densities.

The difference between odour criteria is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level

there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The criteria assume that 7 odour units at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases there is a chance that sensitive individuals would be exposed. The criterion of 2 odour units at the 99th percentile is considered to be acceptable for the whole population.

Table 2.1: Odour assessment performance criteria

Population of affected community	(OU)
Rural single residence (≤ ~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (~2000) and/or schools and hospitals	2

Source: **DECC, 2006a**, p.21

3 ODOUR IMPACT ASSESSMENT

3.1 Approach

An investigation of the Area 20 study area and the surrounding land was conducted to identify potential sources of odour that may impact future development in the Area 20 study area and to develop an understanding of the nature of any odour producing activities.

Sources of information used to identify potential odour sources included aerial maps, previous assessments for Precinct Planning (**BE, 2008a & 2008b**) and information provided by Blacktown Council. A comprehensive site visit was conducted to gather as much data as possible about the odour sources and other factors required for the assessment (outlined in **Section 3.3** and **Appendix A**).

The data were used to assess areas of potential odour impact around each identified odour source using the Level 1 odour impact assessment methodology provided by *Technical notes for the Assessment and Management of Odour from Stationary Sources in NSW* (**DECC, 2006b**). Where Level 1 odour impact assessment methodologies are not published for particular potentially odorous sources, a recommended buffer distance was applied, based on alternative guidance. It should be noted however that the buffer distance approach is generally more limited than the DECC Level 1 assessment as it usually takes no account of local factors or scale of operation.

Where the area of odour influence of local odour sources was predicted to either encroach on the area or be in proximity of the Area 20 study area when assessed using a Level 1 assessment, it was recommended to further refine the assessment using a Level 3 odour impact assessment. Whereas Level 1 assessment is a screening-level technique based on generic parameters for the type of activity and site, Level 3 assessment is a refined-level dispersion modelling technique using site-specific input data, including terrain and meteorological data. This is the most comprehensive and realistic level of assessment available. The predicted separation distances will vary in different directions around an odour source when based on a Level 3 assessment, as opposed to the uniform circle centred on the source provided by Level 1. The Level 3 assessment may be used to assess site suitability and odour mitigation measures for new, modified or existing activities and would provide a better appreciation for the locations within the Area 20 study area, that are likely to be most affected by odour.

3.2 Odour Sources

Potential odour sources identified as part of the assessment include poultry operations (broiler chickens, layer chickens and ducks), intensive piggeries, a meat rendering plant and wastewater treatment plants.

The following sites were investigated as potential odour sources for this study:

<u>Poultry operations</u>

- 100 Worcester Rd, Rouse Hill (layer farm)
- 21 Terry Rd, Box Hill (broiler farm)
- 181 Cudgegong Rd, Rouse Hill (layer farm)
- 54 Pelican Rd, Schofields (broiler farm)
- 2 Pelican Rd, Schofields (broiler farm)

- 93 Hambledon Rd, Schofields (broiler farm)
- 98 Hambledon Rd, Schofields (broiler farm)
- 96 Hambledon Rd, Schofields (duck farm)
- 50 Schofields Rd, Schofields (broiler farm) – no longer operational
- 94 Hambledon Rd, Schofields (broiler farm) – no longer operational
- 89 Schofields Rd, Rouse Hill (layer farm)
- 25 Schofields Rd, Schofields (broiler farm)
- 26 Schofields Farm Rd, Schofields (broiler farm)
- 34-36 Schofields Rd, Schofields (duck farm)
- 68 Schofields Farm Rd, Schofields (layer farm)
- 73 Boundary Rd, Schofields (layer farm)
- 37-39 Boundary Rd, Schofields (layer farm)
- 47 Argowan Rd, Schofields (broiler farm)
- 95 Tallawong Rd, Schofields (broiler farm)
- 20 Clarke St, Riverstone (broiler farm)
- 16 Clarke St Riverstone (broiler farm)
- 31-33 Boundary Rd, Box Hill (layer farm)
- 22 Withers Rd, Kellyville (broiler farm)
- 28 Foxall Rd, Kellyville (layer farm)
- 372 Windsor Road, Vineyard (broiler farm) – more than 5 km away
- 466 Windsor Road, Vineyard (breeder farm) – more than 5 km away
- 45 Farm Road, Riverstone (duck farm) – more than 5 km away
- 169 Clifton Road, Marsden Park (layer farm) – more than 5 km away
- 138 Clifton Road, Marsden Park (layer farm) – more than 5 km away

Intensive piggeries

- 21 Gordon Rd, Schofields (piggery)
- 101 Hambledon Rd, Schofields (piggery)

Other sources

- A J Bush & Son, Riverstone Meat Rendering Operations (meat rendering)
- Rouse Hill STP (Water Recycling Plant)
- Riverstone STP (Sewage Treatment Plant) – more than 5 km away

Investigations have revealed that some of these sources are no longer operating. In addition, some operating facilities are located at a distance from the Area 20 study area that they are very unlikely to have any impact. Potential odour sources that were found to be non-operational or located more than 5 km from the Area 20 study area have not been included in the assessment.

3.3 Assessment Methodology

3.3.1 Poultry Operations

3.3.1.1 Introduction

Poultry operations in the vicinity of the Area 20 study area were assessed using a Level 1 odour impact assessment. This Level 1 assessment for poultry operations is shown in **Appendix C**. The conservative nature of the Level 1 assessment produced results for poultry operations that indicated an area of influence that almost covered all of Area 20. This information did not provide adequate detail to inform planning decisions about the potentially odour affected areas within Area 20. Therefore, a Level 3 odour impact assessment was conducted.

The Level 3 odour impact assessment, based on an advanced modelling system using the models TAPM and CALMET/CALPUFF, has been used in this study to model the dispersion of odour from the poultry farms that were predicted to have an area of odour influence that either encroaches or is in proximity to the Area 20 study area. The model requires meteorological data (e.g. wind speed, wind direction, atmospheric stability and mixing height) together with emission rates from the sources. The meteorological data that were used are further discussed in **Section 3.4**.

3.3.1.2 Emission rates

Emission rates for dispersion modelling were derived from previously published odour studies for poultry farms. The parameters derived from background studies are further detailed in **Appendix A** and summarised below.

Emission parameters for the poultry farms that were predicted to have the most influential impact on the Area 20 study area are provided in **Table 3.1**.

In June 2003, HLA-Envirosciences Pty Ltd took odour samples from an established Griffith poultry farm (**HLA-Envirosciences, 2003**). Odour samples were collected on Day 35 when there were 32,000 birds in the shed. Samples were taken from one fan stack under varying ventilation rates (20%, 40%, 60%, 80% and 100%).

There were a total of ten fans in the chicken shed, therefore the measured odour strength was multiplied by the number of fans operating when the sample was taken to give the total odour emission.

The odour emission rate (OER) (per 1000 birds) is the product of the volumetric flowrate and the odour strength, divided by the number of birds in the shed, i.e.:

$$\text{OER [ou.m}^3\text{/s/1000 birds]} = \frac{\text{odour strength [ou] x volumetric flowrate [m}^3\text{/s]}}{\text{no. of birds per shed [1000 birds]}}$$

Table A.9 (**Appendix A**) presents a summary of the monitoring data and calculations. Samples were taken on two separate dates, therefore the average of the two sets of sample data were used to produce a plot of OER versus ventilation rate as shown in **Figure A.1**. The data show very good correlation between ventilation and emission rate.

The measurements taken at Griffith did not measure the effect on odour strength of varying the ambient temperatures or the age of chickens. However, studies undertaken for a proposed broiler farm near Tamworth, NSW during May - July 2002 provided information on the typical ventilation rates as a function of external ambient temperature and bird age for tunnel

ventilation sheds (**Mirrabooka Consulting, 2002**). **Table A.10** presents a summary of typical ventilation rate, as a percentage of the total, as it varies with ambient temperature and bird age.

The birds in each farm considered in this report are assumed to be rotated on an approximately 47 day cycle, with approximately 10 days space between each cycle. Although it is likely that each shed will be stocked and depleted at a different time, and hence there would be different ages of birds in each farm at any one time, this assessment uses a worst case assumption that all farms are stocked at the same time (i.e. highest emission rates will coincide from each shed).

For modelling purposes it was assumed that the age of the birds reached 50 days. This takes into account the period after depletion for cleaning of the sheds. The placement sequence was repeated for a whole year. This information was used in conjunction with the emission equation shown in Figure A.1 and the hourly temperature in the meteorological file to provide a variable emission file for use in CALPUFF.

An example calculation is shown in **Appendix A.1**.

3.3.1.3 Dispersion modelling

The Level 3 Odour Impact Assessment used air dispersion modelling based on an advanced modelling system using the models TAPM and CALMET/CALPUFF (see **Figure A.2**, **Appendix A**). This system substantially overcomes the basic limitations of the steady-state Gaussian plume models such as AUSPLUME. These limitations are most severe in very light winds, in coastal environments, and where terrain affects atmospheric flow.

The modelling system works as follows:

- TAPM is a prognostic meteorological model that generates gridded three-dimensional meteorological data for each hour of the model run period.
- CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates fine resolution three-dimensional meteorological data based upon observed ground and upper level meteorological data, as well as observed or modelled upper air data generated for example by TAPM.
- CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

Further details about the TAPM and CALMET/CALPUFF modelling system are provided in **Appendix A**.

3.3.2 Intensive piggeries

The Level 1 odour impact assessment methodology for intensive piggeries, as outlined in the Technical notes (DECC, 2006b), is summarised below and provided in detail in **Appendix A**.

Recommended separation distances for intensive piggeries are calculated using the following equation:

$$D = \sqrt{N} \times 50 \times S$$

Where: N = Number of standard pig units (SPU). A standard pig unit is defined as a grower pig of 26–60 kilograms live weight. **Table A.6** (**Appendix A**) shows factors for converting other types and weights of pig to SPU.

D = Separation distance in metres between the closest points of the piggery and the most sensitive receptor or impact location.

S = Composite site factor = S1 x S2 x S3 x S4 x S5. Site factors S1, S2, S3, S4 and S5 are determined according to site-specific information relating to shed design, maintenance schedule, receptor, terrain, vegetation and wind factor.

STANDARD PIG UNITS (SPUS)

Piggeries either have a range of pigs, from farrowing to finisher, or only one type of pig (e.g. growers). Larger pigs usually produce more manure and hence have a greater potential for odour production. For a piggery growing from farrowing to finishers, the number of standard pig units (SPU) can be estimated by multiplying the total number of sows by ten. **Table A.6** (**Appendix A**) can be used for more refined calculations.

Final pig numbers are calculated from **Table A.7** (**Appendix A**) using the approximate live weight and type. Total standard pig numbers are calculated by multiplying the number of pigs in each class by the above conversion factors and then adding the totals.

The value of S to apply in the equation depends on site-specific information pertaining to the proposed shed design, maintenance schedule, receptor, terrain, vegetation and wind frequency.

ODOUR POTENTIAL FACTOR (S1)

The odour potential factor (S1) for each class of piggery, varies with the shed design and maintenance schedule. It can be determined from **Table A.7** (**Appendix A**) by multiplying the factors together ie. A x B x C x D x E. The S1 factor can be no lower than 0.5.

The reduction factor could be adjusted if there is a new technology that can be demonstrated and quantified to reduce the odour.

The odour potential factor S1 for this assessment is based on the data collected by Benbow Environmental (**BE, 2008a**). That study found that piggeries at 21 Gordon Rd and 101 Hambledon Rd each held lactating sows, gestating sows, and suckers. One farm also had growers. Both farms had slatted floors with deep pits, limited ventilation by ridge and side-ventilator, anaerobic lagoons, and used conventional feeding.

RECEPTOR FACTOR (S2)

The receptor factor (S2) varies depending on the likely impact area. The receptor factor for intensive piggeries is determined in the same way as for broiler farms and outlined above in **Section 6C.1**, although the factors are different as shown in **Table A.8** (**Appendix A**).

The proposed development of Area 20 is for more than 2000 people and therefore a factor of 1.6 has been used for S2 for piggeries in this assessment.

TERRAIN FACTOR (S3)

The terrain factor (S3) varies according to topography and its ability to disperse odours and is determined as shown in **Table A.3** (**Appendix A**).

The intensive piggeries under investigation as part of this study were located on the other side of a low level ridge line from the Area 20 study area, and were therefore assigned a terrain factor of 0.9 for undulating terrain.

VEGETATION FACTOR (S4)

The vegetation factor (S4) varies according to vegetation density, as shown in **Table A.4** (**Appendix A**). The vegetation density is assessed by the effectiveness with which the vegetation stand will reduce odour by dispersion. Tree cover should be maintained, as far as practicable, for the life of intensive piggeries operation.

The intensive piggeries considered in this study were assigned a factor of 0.9, since the piggeries were located with a few trees between them and the proposed development area. .

WIND FREQUENCY FACTOR (S5)

The wind frequency factor (S5) is determined from **Table A.5** (**Appendix A**).

Wind speed and direction varies annually and diurnally (that is by the season and by the hour of the day). Although there is generally one direction that is the most frequently observed (prevailing wind), the wind direction usually blows from all directions at some time.

Local meteorology has been assessed (see **Section 3.4**) and winds are considered to be normal, i.e. the piggeries were assigned a wind frequency factor of 1.0.

3.3.3 Two odour sources in close proximity

Where two similar operations, for example two broiler farms or two piggeries, are near each other, the area of influence may need to be modified.

Where the operations are considered as separate entities, a 20% increase in separation distance may apply to the area that is predicted to be influenced by both. The two sources are assessed by adding 20% to the required separation distance of each operation and determining whether the two zones overlap. If the zones overlap, the added 20% applies to the separation distance. If the zones don't overlap, the normal separation distance applies.

3.3.4 A J Bush & Son, Riverstone meat rendering operations

There is no Level 1 odour impact assessment methodology for meat rending operations outlined by the Technical notes (**DECC, 2006b**). However, DECC has published recommended separation distances for these operations, as outlined below.

A minimum buffer distance to the nearest residence or residential area of 1000 m is recommended downwind of a rendering plant. This depends on the prevailing winds and may need to be increased if effective and reliable odour control equipment is not installed (**DECC, 2008**).

For the Level 1 odour impact assessment, a buffer zone of 1000 m has been applied to the A J Bush & Son meat rendering operations.

3.3.5 Sewage Treatment Plants

There is no Level 1 odour impact assessment methodology for sewage treatment plants outlined by the Technical notes (**DECC, 2006b**). However, Sydney Water and the Department of Urban Affairs and Planning (DUAP, now the Department of Planning) have published guidance on recommended separation distances for these operations, as outlined below.

DUAP has issued Circular No E3 (**DUAP, 1989**) which outlines a guideline for buffer areas about sewage treatment plants. This guideline states that:

Ideally, buffer areas should be created through local environment plans, and be at least 400 metres wide, but this may vary to suit local conditions. Meteorological advice should be obtained to work out the most likely movement of air flows so that the widest buffer areas can be established in that direction.

To obtain the most efficient use of land possible, buffer zone areas should also be used for compatible purposes. Possibilities include: flora and fauna reserves; grazing; agricultural use; forestry; commercial plant nurseries; recreation; effluent disposal; or public road reserves.

The Water Directorate has released further guidance in relation to separation distances from Sewage Treatment Plants, i.e. the STP Buffer Zone Land Use Planning Guidelines (**Water Directorate, 2006**). These guidelines maintain that the DUAP guidance of 400 m buffer remains relevant for NSW, however the Water Directorate guidelines provide a risk assessment methodology that may indicate where a land use may be appropriate within the 400 m zone. It also notes that during development of STP infrastructure projects, the appropriate assessments should be undertaken to determine an appropriate buffer distance. In some cases this distance may be more than 400 m.

Sydney Water has prepared a Sewage Treatment Plant Buffer Zone Policy (**Sydney Water, 1997**) that is intended to assist Sydney Water personnel as well as Councils and developers in assessing the suitability of land for different types of developments. Within this policy document the following discussion is made on the subject of the width of buffer zones:

It is generally agreed that the buffer width should be measured from the existing plant boundary. However, in many cases, adjoining development already encroaches on the 400 metre zone, if measured from the plant boundary. Several STPs have residential development, which was permitted prior to current policy standards, within 400 metres of their boundaries. The Corporation needs to avoid further encroachment into STP buffer zones to the extent possible.

The buffer zone is an area defined by DUAP and Sydney Water in which development is subject to additional controls. The logic behind this is that this area has the potential to be exposed to the additional risks of exposure to releases of chlorine from chlorination facilities, odour, noise and light from the normal and abnormal operation of the facility and dust from the handling of solids on the site. This potential for exposure to any or all of the noted agents makes 24 hour per day use of this area by the public for, for example, residential or entertainment uses unsuitable.

The 400 m buffer zone has been applied to the local sewage treatment plants in this Level 1 odour assessment to indicate whether there is any conflict between the proposed development land and the separation distance as recommended above.

Table 3.1: Emissions parameters for most influential poultry farms on Area 20 study area (Level 3 Assessment)

Address	Bird Type	Sheds	Est. Total Birds	Shed	Birds (per/shed)	Easting (mE)	Northing (mS)	Length (m)	Width (m)	Area (m^2)
100 Worcester Rd	Layer	4	32,000	1	8,000	305776	6271825	92	13.5	1242
				2	8,000	305789	6271803	92	13.5	1242
				3	8,000	305802	6271782	92	13.5	1242
				4	8,000	305815	6271760	92	13.5	1242
21 Terry Rd, Box Hill	Broiler	3	61,050	1	20,350	305082	6273857	92	13	1196
				2	20,350	305088	6273880	92	13	1196
				3	20,350	305094	6273907	92	13	1196
181 Cudgegong Rd	Layer	1	10,000	1	10,000	305143	6271310	52.5	25	1312.5
93 Hambledon Rd	Broiler	3	53,000	1	18,338	304659	6268716	91	13.5	1228.5
				2	18,338	304655	6268683	91	13.5	1228.5
				3	16,323	304560	6268697	81	13.5	1093.5
98 Hambledon Rd	Broiler	5	73,000	1	17,447	305033	6268678	47.5	24	1140
				2	13,888	305129	6268658	55	16.5	907.5
				3	13,888	305102	6268658	55	16.5	907.5
				4	13,888	304984	6268658	55	16.5	907.5
				5	13,888	304954	6268658	55	16.5	907.5
25 Schofields Rd	Broiler	3	75,000	1	24,240	303636	6269457	90	15	1350
				2	30,219	303652	6269431	93.5	18	1683
				3	20,541	303663	6269408	88	13	1144
95 Tallawong Rd	Broiler	5	92,000	1	18,981	305020	6270402	91.5	14	1281
				2	18,981	305020	6270402	91.5	14	1281
				3	22,818	304987	6270410	110	14	1540
				4	15,039	304925	6270344	72.5	14	1015
				5	16,180	304943	6270326	84	13	1092

Address	Bird Type	Sheds	Est. Total Birds	Shed	Birds (per/shed)	Easting (mE)	Northing (mS)	Length (m)	Width (m)	Area (m^2)
20 Clarke St	Broiler	6	70,000	1	11,667	304005	6271576	52	17	884
				2	11,667	304030	6271593	52	17	884
				3	11,667	304054	6271609	52	17	884
				4	11,667	304077	6271625	52	17	884
				5	11,667	304100	6271640	52	17	884
				6	11,667	304125	6271657	52	17	884
22 Withers Road	Broiler	5	130,000	1	36,748	309906	6270580	102.5	20	2050
				2	19,324	309888	6270559	77	14	1078
				3	36,748	309870	6270538	102.5	20	2050
				4	18,589	309914	6270486	61	17	1037
				5	18,589	309926	6270460	61	17	1037

a. This S1 value is a combination of the standard 690 and 980 S1 values, with the values weighted based on the number of birds in the tunnel ventilated and naturally ventilated sheds (BE, 2008a).

3.4 Meteorology

Odour impacts on the Area 20 study area will be influenced by local meteorology. Meteorological conditions, such as wind speed, wind direction and atmospheric turbulence, affect how often receptors are likely to be downwind of an odour source as well as how well the odour disperses in the atmosphere.

The annual and seasonal windroses based on a CALMET extract are shown in **Figure B.1** (**Appendix B**) for data collected for Vineyard in 1998/99.

On an annual basis winds from the southwest region are predominant. In autumn winds blow predominantly from the southwest. In summer winds from the sector covering the south-southwest to the east northeast are common and in winter winds from southwest and west-southwest are most common. In spring winds from the north and west are predominant.

The frequency distribution of hourly averaged wind speed values is shown in **Figure B.2** (**Appendix B**). Light wind speeds (up to 2 m/s) are relatively frequent and occur approximately 53% of the time. Strong winds (greater than 6 m/s) occur approximately 3.5% of the time.

In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. The most well-known stability classification is the Pasquill-Gifford scheme[a], which denotes stability classes from A to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions. Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

The frequency distribution of estimated stability classes in the meteorological file is presented in **Figure B.3** (**Appendix B**). The data show a total of 49% of hours with either E or F stability class.

3.5 Assessment Results

3.5.1.1 Poultry farms

The results of the dispersion modelling are shown in **Figure 3.1** for the predicted 99th percentile odour concentrations for the nine most influential poultry operations in proximity of the Area 20 study area. In **Figure 3.1**, the red line indicates the DECC guideline value of 2 OU, which is applicable for urban areas (i.e. exposure greater than 2000 people (see **Table 2.1**)).

These results show a significantly reduced area of influence on the Area 20 study area when compared with the Level 1 Assessment results. It should be noted that this Level 3 assessment is still considered to be conservative since without further information from each poultry farm operator about their farming cycles, we have made a conservative assumption for the assessment scenario that all chicken sheds are operating on the same cycle, i.e. the highest odour emission rates are being released from all of the sheds at the same time. In reality this scenario would be very unlikely. Regardless, these results indicate which part of the Area 20

[a] A more accurate turbulence scheme within CALPUFF, based on micrometeorological parameters, was used for modelling.

land has the highest likelihood of potential odour impacts and therefore the results can be used to inform planning decisions about preferred locations for sensitive land uses.

Two areas, i.e. a small area to the north and a section of the west of the Area 20 study area are predicted to experience odour impacts greater than 2 OU, for the scenario that was assessed.

Potential receivers of odour impacts in the northern part of the Area 20 study area are limited to the Rouse Hill House Estate and Rouse Hill Regional Park. The source of the odour is predominantly from the poultry operation at 100 Worcester Rd. This is an existing situation and it is unlikely that any specific planning considerations are required to mitigate this circumstance as the surrounding land uses are not planned to change with the release of the Area 20 land.

The western section of the proposed land for release, that is predicted to exceed the 2 OU guideline, can be considered to have the highest likelihood of future receptors experiencing odour impacts. The main influencing poultry operation is the farm at 95 Tallawong Rd. Odour nuisance at receptors located within this area may or may not occur in the future if land is developed, however consideration should be given to land use planning decisions relating to sensitive land uses, such as residences, schools or hospitals, in this area. Non-sensitive land uses in this area include Cudgegong Reserve, SW Reservoir and an electricity easement. More detailed modelling and assessment could be undertaken at the Development Application stage in relation to the area shown to potentially exceed the 2 OU limit,in conjunction with the poultry farm operators.

3.5.1.2 Intensive piggeries

The operational piggeries in the surrounding region are not predicted to influence the Area 20 study area. **Table 3.2** provides the Level 1 assessment calculations and **Figure 3.2** shows the recommended separation distances for the intensive piggeries that were assessed in this study using the Level 1 methodology.

No further assessment was considered necessary for the piggeries.

Table 3.2: Recommended Separation Distances from Intensive Piggeries

Address	Sheds	SPU[a]	S1[a]	S2	S3	S4	S5	Separation distance (m)	Separation distance +20% (m)	Distance from Area 20 (m)
21 Gordon Rd	3	182	0.87	1.6	0.9	0.9	1	760	912	1200
101 Hambledon Rd	4	403	0.60	1.6	0.9	0.9	1	781	937	1200

a. Based on BE, 2008a.

3.5.1.3 A J Bush & Son, Riverstone meat rendering operations

The recommended 1 km separation distance (**DECC, 2008**) has been applied to the AJ Bush & Son, Riverstone meat rendering operation, as shown in **Table 3.3** and **Figure 3.3**. The suggested separation distance indicates that odour from the meat rendering operations will not adversely influence the Area 20 study area.

It should be noted that the recommended 1 km separation distance for meat rendering plants is a default buffer that does not account for site-specific data such as emission rates and control technologies, meteorology, terrain etc. It is acknowledged that the 1 km buffer is used in Australia as an acceptable default separation distance, however anecdotal evidence also suggests that some meat rendering plants can have odour impacts beyond the default buffer distance.

The closest receptor within Area 20 is approximately 1.7 km from the rendering operations. In addition, as shown by the results of the Level 3 assessment for poultry operations, the ridgeline running across the northern part and along the western area of Area 20, influences wind drainage flows from the direction of the rendering operations and provides some buffer to the areas to the south and east of the ridge.

In the absence of more detailed data for the meat rendering operations, a Level 3 assessment cannot be conducted at this stage, however it is recommended that a Level 3 assessment be conducted for more proximate land releases.

3.5.1.4 Sewage Treatment Plants

The two local Sewage Treatment Plants, i.e. Riverstone Sewage Treatment Plant and the Rouse Hill Recycled Water Plant, are not predicted to influence the Area 20 study area. **Table 3.3** and **Figure 3.4** show the default buffer distances of 400 m surrounding each site. Riverstone STP is located approximately 6 km northwest of the study area and the Rouse Hill Recycled Water Plant is approximately 1.25 km to the east.

No further assessment was considered necessary for the sewage treatment plants.

Table 3.3: Recommended Separation Distances from Other sources

Address	Operation	Separation distance (m)	+20% (m)	Distance from Area 20 (m)
1106 Windsor Rd, Riverstone	Meat Rendering Plant	1000	1200	1200
Mile End Road, Rouse Hill	Rouse Hill STP (Recycled Water Plant)	400	480	1250
Bandon Road, Vineyard	Riverstone STP	400	480	6000

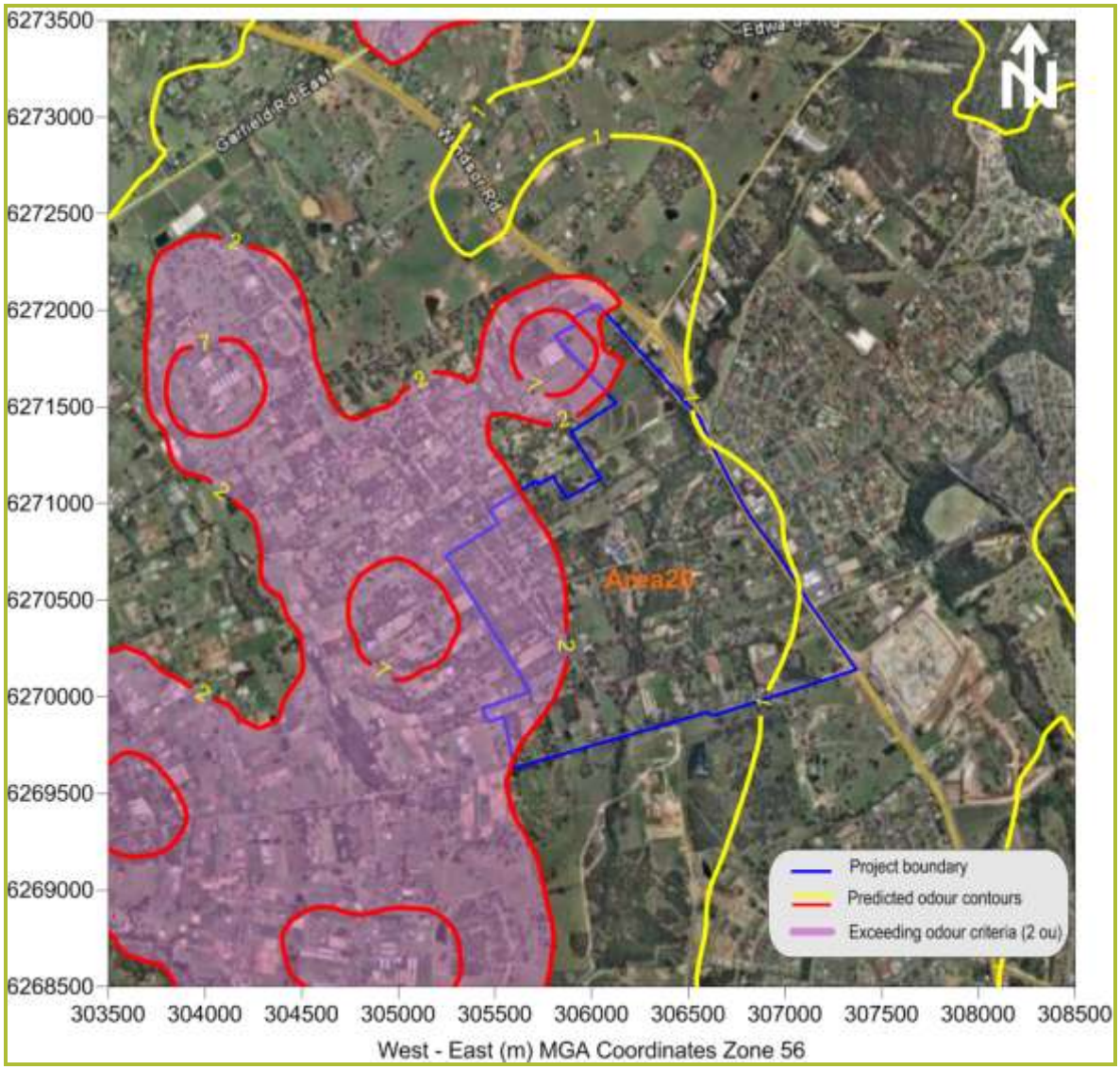

Figure 3.1: Predicted 99th percentile, Odour Concentrations for the nine most influential poultry operations in proximity of the Area 20 study area

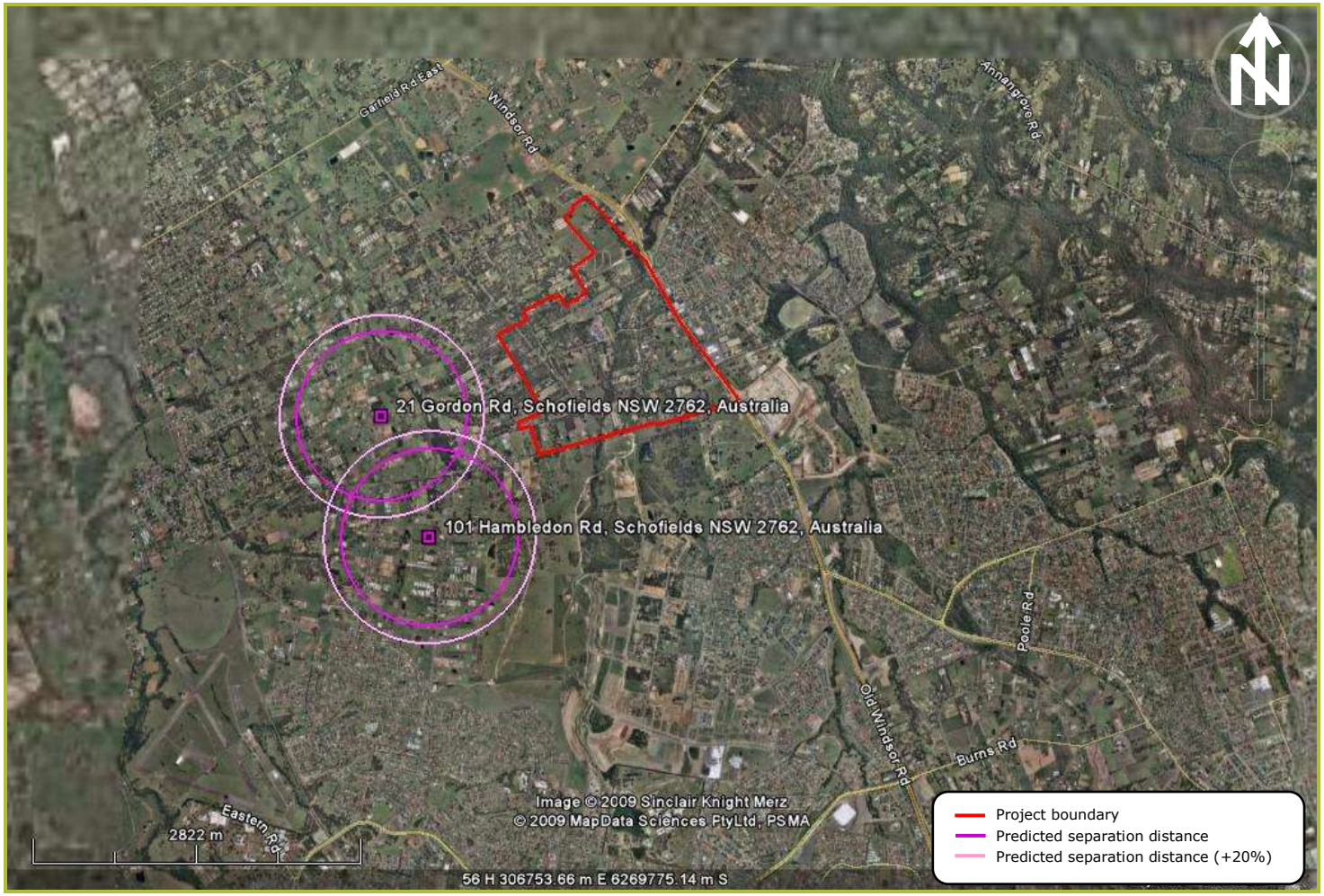

Figure 3.2: Level 1 separation distances for intensive piggeries in proximity of Area 20 study area

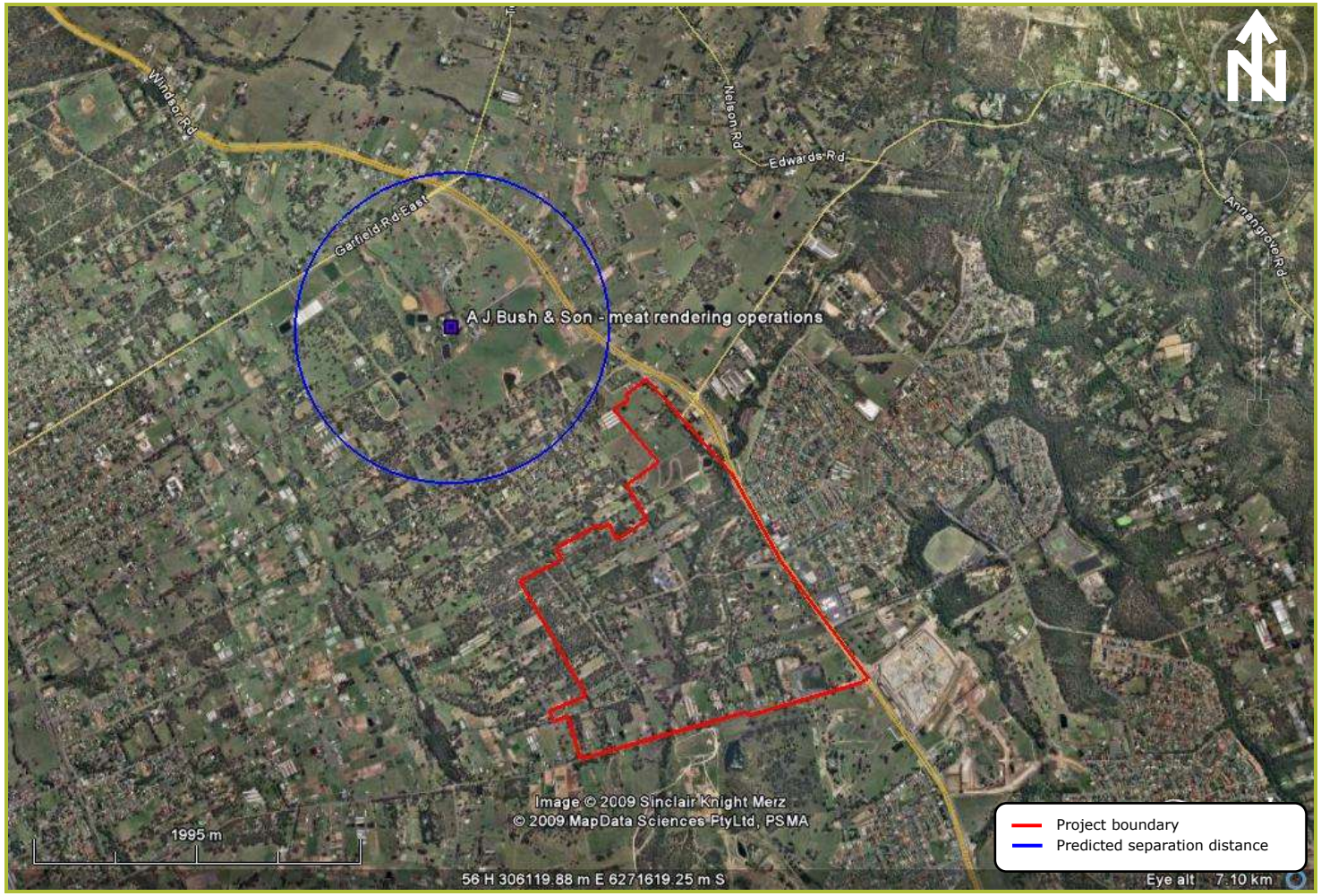

Figure 3.3: Recommended buffer distance for meat rendering operations in proximity of Area 20 study area

Figure 3.4: Recommended buffer distances for sewage treatment plants in proximity of Area 20 study area

4 RECOMMENDATIONS

4.1 Potential Development Control Provisions

It is recommended that development controls be implemented to manage odour impacts in future development of the study area. Potential provisions are listed below:

- Plan a transition of land use zones that locates sensitive uses, such as residences, schools and hospitals, in areas that are not adjacent to odour generating activities, where this is possible. Non-sensitive uses such as reserves, reservoirs and utilities easements may be more acceptable in these areas.
- Consider introducing specific zoning categories for odour-generating activities, e.g. agriculture, intensive agriculture, minerals/metal processing, waste industries.
- Ensure that sensitive uses, such as residences, schools and hospitals are located outside the 2 odour unit buffer or where possible, for example residential use, that appropriate agreements are in place (see S149 Part 5 certificates, below).
- Reduce density of the residences that are planned within the 2 OU buffer to decrease the number of potential receptors in that area. This may also allow the amount of shrubs and trees to be maximised which can assist dour dispersion by increasing turbulence of winds flowing across them.
- Plan compatible land uses in areas closest to odour sources, e.g. car parks, commercial areas. Residential areas should be away from odour sources.
- Orientate buildings to provide adequate air flow, i.e. no dead end courtyards, long narrow spaces, or areas where air may stagnate. Design buildings to encourage air flow.
- Ensure that air intake to buildings is not from the direction of odour sources.
- Consider ventilation and air conditioning and design buildings so that people do not live or work in areas of buildings facing odorous sources.
- Build continuous dense landscaping around local odour sources or Precinct boundaries to assist in reducing odour by increasing dispersion.
- Consider erasing a separation distance and removing development restrictions if an odour source ceases operation and has no prospect of reviving. Delayed development in the predicted 2 OU buffer zone, until such a time as more detailed assessment is undertaken, or the operations cease may allow more flexibility of planning in future.
- Implement new buffer zones where shorter separation distances can be determined or more confidence is desired in predicted buffer distances for some odour sources, either with or without changing the operation of the source, for example, through further study. More detailed odour modelling, including site specific emissions in conjunction with the operators of nearby odour generating operations, could be considered at Development Application stage for those properties planned within the 2 OU buffer zone.
- Evaluate whether the nature of a development is compatible with odour affected lands and if odour nuisance will be detrimental to the successful long-term function of the completed development
- Purchase or long-term lease neighbouring properties to provide a secure buffer zone around a facility and increase the separation distance between the site of the odour emissions and existing or potentially sensitive use.

When odour assessment criteria are being exceeded at receptors despite avoidance and mitigation measures at the source or in the pathway, consideration could be given to measures that would manage the reaction of the receptors and increase their willingness to accept the odour levels.

These types of approaches may also be appropriate before an activity begins operation if there is some degree of uncertainty about whether the proposed odour avoidance and mitigation strategies will achieve the required odour levels at receptors.

- Establish a communication strategy so that affected neighbours are kept informed about the operation of odour generating facilities and are consulted about aspects of these operations likely to result in odour.
- Investigate the feasibility of facilities entering into an agreement with neighbours regarding their acceptance of the odour impacts. Negotiated outcomes would need to be documented in licence conditions, particularly in relation to the 'offensive odour' provisions of the POEO Act. However, negotiated outcomes would not normally flow to any new neighbours (should properties be sold) or apply in relation to any new land uses. As a result, such an arrangement would not provide a secure long-term mitigation strategy.
- Use of S149 Part 5 certificates attached to the title of properties within the 2 odour unit contour. This option makes it clear to prospective purchasers that the land may be subject to offensive odour from the chicken farms from time to time. It is noted that this option is supported by NSW Government odour policy. Essentially the prospective purchasers should not have a basis of odour complaint provided the poultry farm does not cause more odour than anticipated. Thus, a clear and concise description of the nature of the odour impact should be included on any S149 certificates. Generally the information shown on the S149 certificate should include **Figure 3.1** and state that (for example); "*potentially offensive odour may occur from time to time within the 2 OU contour shown on Figure 3.5. The odour is chicken farm odour emanating from the operation of <name and address of the farm(s)> as predicted for their 2009 operation*."
- Investigate the practicality of providing the most affected receptors with air-conditioning or other measures to reduce the impacts of emissions. This option would normally only be considered in exceptional circumstances.

Council should also consider new odour sources in the future development of the Precinct. Commercial businesses that produce odour will need to be controlled if they have potential to affect sensitive zones or nearby businesses and residences.

5 CONCLUSIONS

An investigation has been conducted to identify and develop an understanding of potential sources of odour that may impact the future development of the Area 20 Precinct. A Level 1 odour impact assessment, consistent with the *Technical framework: assessment and management of odour from stationary sources in NSW* (DECC, 2006a) and its associated *Technical notes* (DECC, 2006b), has indicated potential sources of odour that may impact on future development in the study area. The impact assessment has resulted in recommended separation distances for nearby odour sources.

The Level 1 assessment has predicted that a number of poultry operations in the vicinity of the Area 20 study area have potential to individually impact on the proposed development area. However, when combining the Level 1 recommended areas of influence of poultry operations with greatest influence, almost all of Area 20 is predicted to be affected by poultry farm odour. These operations were further assessed using a level 3 odour impact assessment.

The Level 3 assessment of poultry farms is based on an advanced modelling system using the models TAPM and CALMET/CALPUFF. This assessment requires meteorological data (eg. wind speed, wind direction, atmospheric stability and mixing height) together with emission rates from the sources. The Level 3 results have shown a significantly reduced area of influence from poultry operations on the Area 20 study area when compared with the Level 1 Assessment results. However, a small area to the north and to the west of the proposed Area 20 land to be released is predicted to exceed the DECC guideline for odour in urban areas. Consideration should be given to land use planning decisions relating to sensitive land use in these areas.

Separation distances for other potential odour sources, such as intensive piggeries, sewage treatment plants and meat rendering operations have not resulted in encroachment on the Area 20 study area when assessed using the Level 1 assessment methodology, or an alternative default buffer distance where Level 1 methods do not exist (i.e. for meat rendering and sewage treatment).

It should be noted that the separation distance for meat rendering plants is a default buffer that does not account for site-specific data such as emission rates and control technologies, meteorology, terrain etc. It is acknowledged that the 1 km buffer is used in Australia as an acceptable default separation distance, however anecdotal evidence also suggests that some meat rendering plants can have odour impacts beyond the default buffer distance.

This report has provided options to control odour impacts from odour generating development on proposed residential development and associated land uses, for potential inclusion in a development control plan. These recommendations for development control could be substituted by further detailed assessment, whereby site specific emissions details are used in dispersion modelling to support future Development Applications for sensitive land use proposals.

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APPENDIX A

Assessment Methodology

A.1 ASSESSMENT METHODOLOGY

A.1.1 Level 1 Assessment – Separation Distance Calculations

A.1.1.1 Poultry Farms

The Level 1 odour impact assessment methodology for broiler chicken farms, as outlined in the Technical notes (**DECC, 2006b**), is provided below.

Recommended separation distances for broiler farms are calculated using the following equation:

$$D = (N)^{0.71} \times S$$

Where: N = Number of standard broiler chicken shed units (SBCSU) (1 SBCSU is equivalent to 22,000 broiler chickens);

D = Separation distance in metres between the closest points of the broiler chicken sheds and the most sensitive receptor or impact location;

S = Composite site factor = S1 x S2 x S3 x S4 x S5. Site factors S1, S2, S3, S4 and S5 relate to shed design, receptor, terrain, vegetation and wind frequency. The value of S depends on site-specific information pertaining to S1 to S5.

SHED FACTOR (S1)

The shed factor (S1) depends on how the shed is ventilated. Factors for S1 are shown in **Table A.1**.

Table A.1: Shed factor (S1)

Shed type	Value
Controlled fan ventilation without barriers [a]	980
Controlled fan ventilation with barriers	690
Natural ventilation	690

a. Barriers defined as walls, berms and other structures designed to mitigate emissions from controlled fan ventilated sheds.
b. Source: DECC 2006b, p.21

RECEPTOR FACTOR (S2)

The receptor factor (S2) varies depending on the likely impact area. It is determined based on criteria shown in **Table A.2**.

Table A.2: Receptor factor (S2)

Receptor type	Value
Large towns, greater than 2000 persons	1.05
Medium towns, 500–2000 persons	0.75
Medium towns, 125–500 persons	0.55
Small towns, 30–125 persons	0.45
Small towns, 10–30 persons	0.35
Single rural residence	0.30
Public area (occasional use)	0.05 [a]

a. The value for public areas would apply to areas subject to occasional use. Higher values may be appropriate for public areas used frequently or sensitive in nature, such as frequently used halls and recreation areas. These should be assessed individually.
b. Source: DECC 2006b, p.21

The impact area being considered may be a neighbour's house, small town or large town that may be affected by odour generated at the broiler chicken sheds. Any likely future receptor locations should also be considered.

For a town, the distance is measured from the closest point of the town boundary. For a rural farm residence, the distance is the closest part of the residence itself, excluding any yards.

TERRAIN FACTOR (S3)

The terrain factor (S3) varies according to topography and its ability to disperse odours and is determined from **Table A.3**.

Table A.3: Terrain factor (S3)

Receptor	Value
Valley drainage zone	2.0
Low relief	1.2
Flat	1.0
Undulating country between broiler chicken farm and receptor	0.9
High relief or significant hills and valleys between broiler chicken farm and receptor	0.7

Source: DECC 2006b, p.22

Flat is regarded as less than 10% upslope, 2% downslope and not in a valley drainage zone.

High relief is regarded as upslope terrain or a hill that projects above the 10% rising slope from the broiler chicken sheds. Thus the receptor location will be either uphill from the broiler chicken sheds, behind a significant obstruction or have significant hills and valleys between the sheds and the receptor.

Low relief is regarded as terrain which is generally below the 2% falling slope from the broiler chicken sheds. Thus the receptor will be downhill from the broiler chicken sheds.

Undulating hills is regarded as terrain where the topography consists of continuous rolling, generally low level hills and valleys with minimal vegetation cover, but without sharply defined ranges, ridges or escarpments.

A valley drainage zone has topography at low relief with significant confining sidewalls.

Topographical features at the selected site may adversely affect the odour impact under certain circumstances. During the early evening or night time, under low wind speed conditions, population centres located in a valley at a lower elevation than a broiler chicken farm may be

subject to higher odour concentrations as a result of down-valley wind or the occurrence of low-level inversions. Unless site-specific information has been gathered under conditions dominated by low wind speeds, the value for the factor S3 should apply.

VEGETATION FACTOR (S4)

The vegetation factor (S4) varies according to vegetation density, as shown in Table A.4. The vegetation density is assessed by the effectiveness with which the vegetation stand will reduce odour by dispersion. Tree cover should be maintained, as far as practicable, for the life of broiler chicken sheds.

Table A.4: Vegetation factor (S4)

Vegetation	Value
Crops only, no tree cover	1.0
Few trees, long grass	0.9
Wooded country	0.7
Heavy timber	0.6
Heavy forest (both upper and lower storey)	0.5

Source: DECC 2006b, p.23

Few trees, long grass is regarded as open country with a permanent covering of grass or pasture of around 1 m or more in height and with a light scattering of timber which is distributed continuously across the buffer area. Topography would be predominantly flat to slightly undulating. Isolated clumps of trees would not be sufficient to attract this concession. Land being actively cropped would not attract this concession because of the extended periods when it is bare or carrying only very low ground cover.

Wooded country is regarded as open forest country with tree density not sufficient to provide a continuous canopy, but sufficiently dense to influence air movement. There would be little or no lower storey vegetation. The density needs to be such that the vegetation can be considered as a contiguous belt and isolated clumps would not attract this concession. The minimum tree height is 4 m and the minimum extent in the direction of the receptor is 400 m.

Heavy timber is regarded as tall forest areas with dense timber stands providing a continuous canopy.

There is limited understorey vegetation, mainly associated with regrowth. The minimum tree height is 4 m and the minimum extent in the direction of the receptor is 400 m.

Heavy forest, upper and lower storey is regarded as dense layers of taller timber with an interlocking canopy and with extensive amounts of lower storey vegetation of various species resulting in almost complete ground cover and a dense upper canopy. Examples are uncleared brigalow areas and dense eucalypt forests where little or no clearing or harvesting have occurred. The minimum tree height is 4 m and the minimum extent in the direction of the receptor is 400 m.

The values suggested for S4 should be used with care. No concession should be given for an intention to plant a barrier.

To improve visual amenity and odour dispersion, premises should be encouraged to plant and maintain upper- and lower-storey vegetation that would not cast shadows on the broiler chicken sheds.

WIND FREQUENCY FACTOR (S5)

The wind frequency factor (S5) is determined from **Table A.5**.

Table A.5: Wind frequency factor (S5)

Wind frequency	Value
High frequency towards receptor (greater than 60%)	1.5
Normal wind conditions	1.0
Low frequency towards receptor (less than 5%)	0.7

Source: DECC 2006b, p.23

Wind speed and direction varies annually and diurnally (that is by the season and by the hour of the day). Although there is generally one direction that is the most frequently observed (prevailing wind), the wind direction usually blows from all directions at some time.

The wind can be classed as high frequency towards the receptor if the wind is blowing towards the receptor (± 40 degrees) with a frequency of at least 60 % of the time for all hours over a whole year.

The wind can be classed as low frequency towards the receptor if the wind is blowing towards the receptor (± 40 degrees) with a frequency of less than 5 % of the time for all hours over a whole year.

A.1.1.2 Intensive piggeries

The Level 1 odour impact assessment methodology for intensive piggeries, as outlined in the Technical notes (**DECC, 2006b**), is provided below.

Recommended separation distances for intensive piggeries are calculated using the following equation:

$$D = \sqrt{N} \times 50 \times S$$

Where: N = Number of standard pig units (SPU). A standard pig unit is defined as a grower pig of 26–60 kilograms live weight. **Table A.6** shows factors for converting other types and weights of pig to SPU.

D = Separation distance in metres between the closest points of the piggery and the most sensitive receptor or impact location.

S = Composite site factor = S1 x S2 x S3 x S4 x S5. Site factors S1, S2, S3, S4 and S5 are determined according to site-specific information relating to shed design, maintenance schedule, receptor, terrain, vegetation and wind factor.

STANDARD PIG UNITS (SPUS)

Piggeries either have a range of pigs, from farrowing to finisher, or only one type of pig (e.g. growers). Larger pigs usually produce more manure and hence have a greater potential for odour production. For a piggery growing from farrowing to finishers, the number of standard pig units (SPU) can be estimated by multiplying the total number of sows by ten. **Table A.6** can be used for more refined calculations.

Table A.6: Standard pig units conversion table

Type of pig Approximate weight range (kg)	Number of standard pig units (SPU)
Lactating sows 160–250	2.5
Gestating sow 160–250	1.8
Gilt 100–160	1.8
Heavy finisher 100-125	1.8
Boar 100–250	1.6
Finisher 61–100 (75)	1.6
Grower 26–60 (40)	1.0
Weaners 8–25 (16)	0.5
Suckers/early weaners 1.4–8	0.1

Source: DECC 2006b, p.30

Final pig numbers are calculated from **Table A.7** using the approximate live weight and type. Total standard pig numbers are calculated by multiplying the number of pigs in each class by the above conversion factors and then adding the totals.

The value of S to apply in the equation depends on site-specific information pertaining to the proposed shed design, maintenance schedule, receptor, terrain, vegetation and wind frequency.

ODOUR POTENTIAL FACTOR (S1)

The odour potential factor (S1) for each class of piggery, varies with the shed design and maintenance schedule. It can be determined from **Table A.7** by multiplying the factors together i.e. A x B x C x D x E. The S1 factor can be no lower than 0.5.

The reduction factor could be adjusted if there is a new technology that can be demonstrated and quantified to reduce the odour.

Table A.7: Odour potential factor (S1)

	Odour potential factors	Value
A	**Type of building**	
	1 Slatted floor and deep pit	1.0
	2 Partly slatted floor and shallow pit or open drain with regular flushing	0.9
	3 Partly slatted floor and sloping floor and regular flushing	0.8
	4 Partly slatted floor and 'pull plug' and recharge system	0.6
B	**Ventilation of buildings**	
	1 Limited ridge and side-ventilators (or side only) or limited forced (fan) ventilation	1.0
	2 Ridge ventilators which are at least 90% of the roof length and are at least 10% of the roof width and side ventilators are at least 90% of the length of the two long sides of the building and at least 30% of the side wall height, with roof and walls insulated	0.9
	3 Fan forced ventilated shed with well designed uniform ventilation throughout shed	0.9
C	**Effluent collection frequency within all pig buildings**	
	1 Faeces, urine and other biological material removed from the confines of the buildings every 24 hours or less often	1.0
	2 Faeces, urine and other biological material removed from the confines of the buildings while essentially aerobic but in no case less often than 24 hours	0.9
D	**Effluent treatment system (within the piggery compound)**	
	1 Anaerobic lagoon(s) (including all inlet pipes/channels)	1.0
	2 Series lagoons anaerobic/aerobic (or facultative) and evaporation lagoons	1.0
	3 Facultative lagoon(s) (including all inlet pipes/channels)	0.95
	4 Aerated lagoon(s) (aerobic surface layer over entire lagoon)	0.75
	5 Aerobic lagoon(s)	0.6
	6 No effluent storage within at least 500 m of the piggery	0.6
E	**Feeding**	
	1 Conventional feeding	1.0
	2 Phase feeding	0.9
	3 Phase feeding with optimal protein	0.8

Source: DECC 2006b, p.31

RECEPTOR FACTOR (S2)

The receptor factor (S2) varies depending on the likely impact area. The receptor factor for intensive piggeries is determined in the same way as for broiler farms and outlined above, although the factors are different as shown in **Table A.8**.

Table A.8: Receptor factor (S2)

Receptor type	Value
Large towns, greater than 2000 persons	1.6
Medium towns, 500–2000 persons	1.2
Medium towns, 125–500 persons	1.1
Small towns, 30–125 persons	1.0
Small towns, 10–30 persons	0.6
Single rural residence	0.3
Public area (occasional use)	0.05 [a]

a. The value for public areas would apply to areas subject to occasional use. Higher values may be appropriate for public areas used frequently or sensitive in nature, such as frequently used halls and recreation areas. These should be assessed individually.

b. Source: DECC 2006b, p.33

OTHER SITE FACTORS (S3, S4 AND S5)

The other site factors, i.e. terrain factor (S3), vegetation factor (S4) and wind frequency factor (S5), are assessed in the same way for intensive piggeries as for broiler chicken sheds (see above).

A.1.1.3 Two odour sources in close proximity

Where two similar operations, for example two broiler farms or two piggeries, are near each other, the area of influence may need to be modified.

Where the operations are considered as separate entities, a 20% increase in separation distance may apply to the area that is predicted to be influenced by both. The two sources are assessed by adding 20% to the required separation distance of each operation and determining whether the two zones overlap. If the zones overlap, the added 20% applies to the separation distance. If the zones don't overlap, the normal separation distance applies.

A.1.2 Level 3 Assessment

A.1.2.1 Emission rates

Emission rates for dispersion modelling were derived from previous odour studies that have been published for poultry farms.

In June 2003, HLA-Envirosciences Pty Ltd took odour samples from an established Griffith poultry farm (**HLA-Envirosciences, 2003**). Odour samples were collected on Day 35 when there were 32,000 birds in the shed. Samples were taken from one fan stack under varying ventilation rates (20%, 40%, 60%, 80% and 100%).

There were a total of ten fans in the chicken shed, therefore the measured odour strength was multiplied by the number of fans operating when the sample was taken to give the total odour emission.

The odour emission rate (OER) (per 1000 birds) is the product of the volumetric flowrate and the odour strength, divided by the number of birds in the shed, that is:

$$\text{OER } [\text{ou.m}^3/\text{s}/1000 \text{ birds}] = \frac{\text{odour strength [ou] x volumetric flowrate } [\text{m}^3/\text{s}]}{\text{no. of birds per shed [1000 birds]}}$$

Table A.9 presents a summary of the monitoring data and calculations. Samples were taken on two separate dates, therefore the average of the two sets of sample data were used to produce a plot of OER versus ventilation rate as shown in **Figure A.1**. The data show very good correlation between ventilation and emission rate.

Table A.9: Odour monitoring data and emission calculations

Ventilation rate (%)	Average volumetric flowrate (m^3/s)	Measured odour strength (ou)	No. of fans operating	Odour emission rate (OER) ($ou.m^3/s/1000$ birds)
Testing 9-Jun-03				
20	6.0	724	2	271
40	5.3	430	4	286
60	5.7	430	6	458
80	4.8	446	8	540
100	5.5	512	10	882
Testing 19-Jun-03				
20	4.6	558	2	160
40	4.3	558	4	297
60	3.9	832	6	609
80	4.3	776	8	829
100	4.5	630	10	885
Average odour emission rate				
20	-	-	-	216
40	-	-	-	292
60	-	-	-	533
80	-	-	-	685
100	-	-	-	883

The measurements taken at Griffith did not measure the effect on odour strength of varying the ambient temperatures or the age of chickens. However, studies undertaken for a proposed broiler farm near Tamworth, NSW during May - July 2002 provided information on the typical ventilation rates as a function of external ambient temperature and bird age for tunnel ventilation sheds (**Mirrabooka Consulting, 2002**). **Table A.10** presents a summary of typical ventilation rate, as a percentage of the total, as it varies with ambient temperature and bird age.

Table A.10: Ventilation rate as a function of ambient temperature and bird age

Ambient temperature (°C)	Age of birds (days)					
	7	14	21	28	35	42+
	Ventilation rate (%)					
35+	33	33	50	100	100	100
30 to 34.9	23	33	50	100	100	100
25 to 29.9	1.3	11.5	33.3	66.7	100	100
20 to 24.9	1.3	2.9	11.5	39.6	66.7	66.7
15 to 19.9	1.3	2.9	6.2	10.4	14	12.4
10 to 14.9	1.3	2.9	6.2	10.4	14	12.4
5 to 9.9	1.3	2.9	6.2	10.4	14	12.4
0 to 4.9	1.3	2.9	6.2	10.4	14	12.4

The birds in each farm considered in this report are assumed to be rotated on an approximately 47 day cycle, with approximately 10 days space between each cycle. Although it is likely that each shed will be stocked and depleted at a different time, and therefore there would be different aged birds in each farm at any one time, this assessment uses a worst case

assumption that all farms are stocked at the same time (i.e. highest emission rates will coincide from each shed).

For modelling purposes it was assumed that the age of the birds reached 50 days. This takes into account the period after depletion for cleaning of the sheds. The placement sequence was repeated for a whole year. This information was used in conjunction with the emission equation shown in **Figure A.1** and the hourly temperature in the meteorological file to provide a variable emission file for use in CALPUFF.

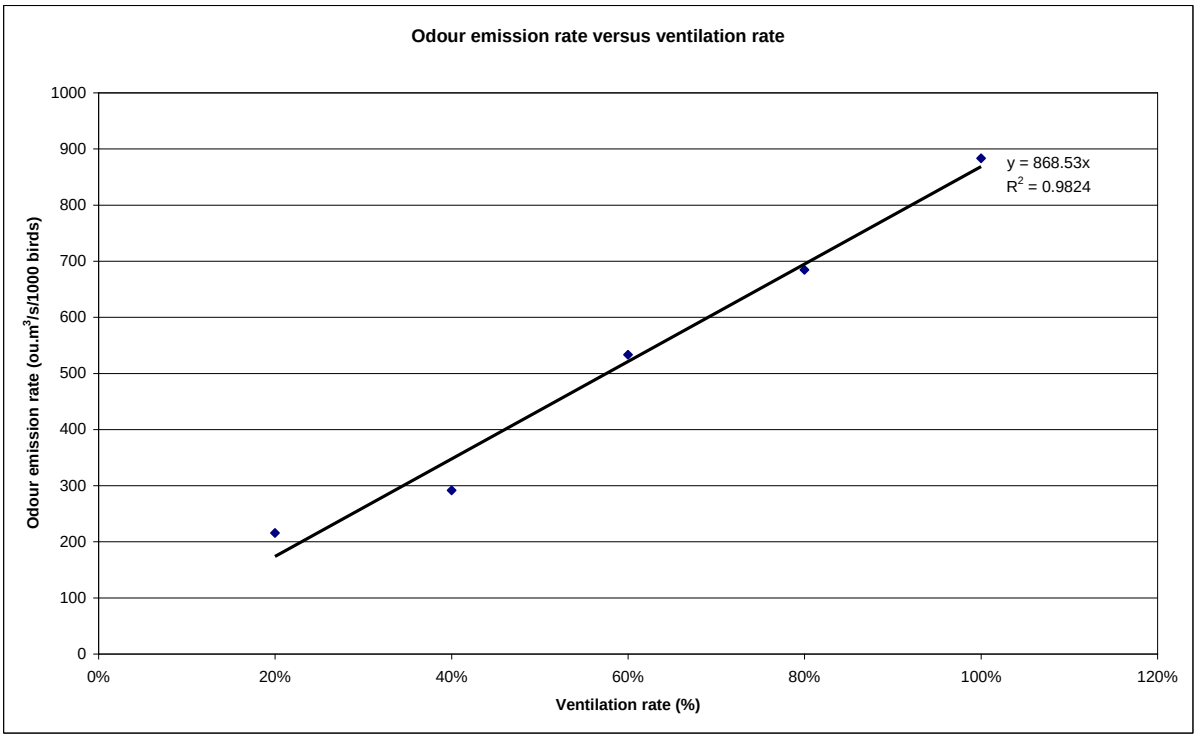

Figure A.1: Odour emission rate versus ventilation rate

An example calculation is shown below:

From **Figure A.1,** the maximum emission rate at 100% ventilation is 869 ou.m^3/s/1000 birds. It should be noted that this is higher than other published odour emission rates for well run tunnel-ventilated sheds.

If the ambient temperature is equal to 24 ^{o}C and the age of birds in shed is 21 days, **Table A.10** shows that the ventilation rate is equal to 11.5%. The odour emission rate per 1000 birds is therefore equal to:

$$\text{OER (ou.m}^3\text{/s/1000 birds)} = 11.5/100 * 869 = 99.94$$

If the number of birds per shed is equal to 41,000, the shed odour emission rate to model is equal to:

$$\text{OER (ou.m}^3\text{/s)} = 99.94 * 41 = 4097.54$$

This procedure was applied to each hour of the year to create a variable emission file for use in CALPUFF.

A.1.2.2 Dispersion modelling

The air dispersion modelling conducted for this assessment has been based on an advanced modelling system using the models TAPM and CALMET/CALPUFF (see **Figure A.2**). This system substantially overcomes the basic limitations of the steady-state Gaussian plume models such as AUSPLUME. These limitations are most severe in very light winds, in coastal environments, and where terrain affects atmospheric flow.

The modelling system works as follows:

- TAPM is a prognostic meteorological model that generates gridded three-dimensional meteorological data for each hour of the model run period.
- CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates fine resolution three-dimensional meteorological data based upon observed ground and upper level meteorological data, as well as observed or modelled upper air data generated for example by TAPM.
- CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

TAPM

The Air Pollution Model, or TAPM, is a three dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research. Detailed description of the TAPM model and its performance is provided elsewhere. The Technical Paper by Hurley (2005) describes technical details of the model equations, parameterisations, and numerical methods. A summary of some verification studies using TAPM is also given in Hurley *et al*. (2005).

TAPM solves the fundamental fluid dynamics and scalar transport equations to predict meteorology and (optionally) pollutant concentrations. It consists of coupled prognostic meteorological and air pollution concentration components. The model predicts airflow important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses.

Upper air data were generated over the study region using TAPM. The TAPM-generated data and observed surface meteorological data were then entered into the CALMET diagnostic meteorological model, which is discussed below.

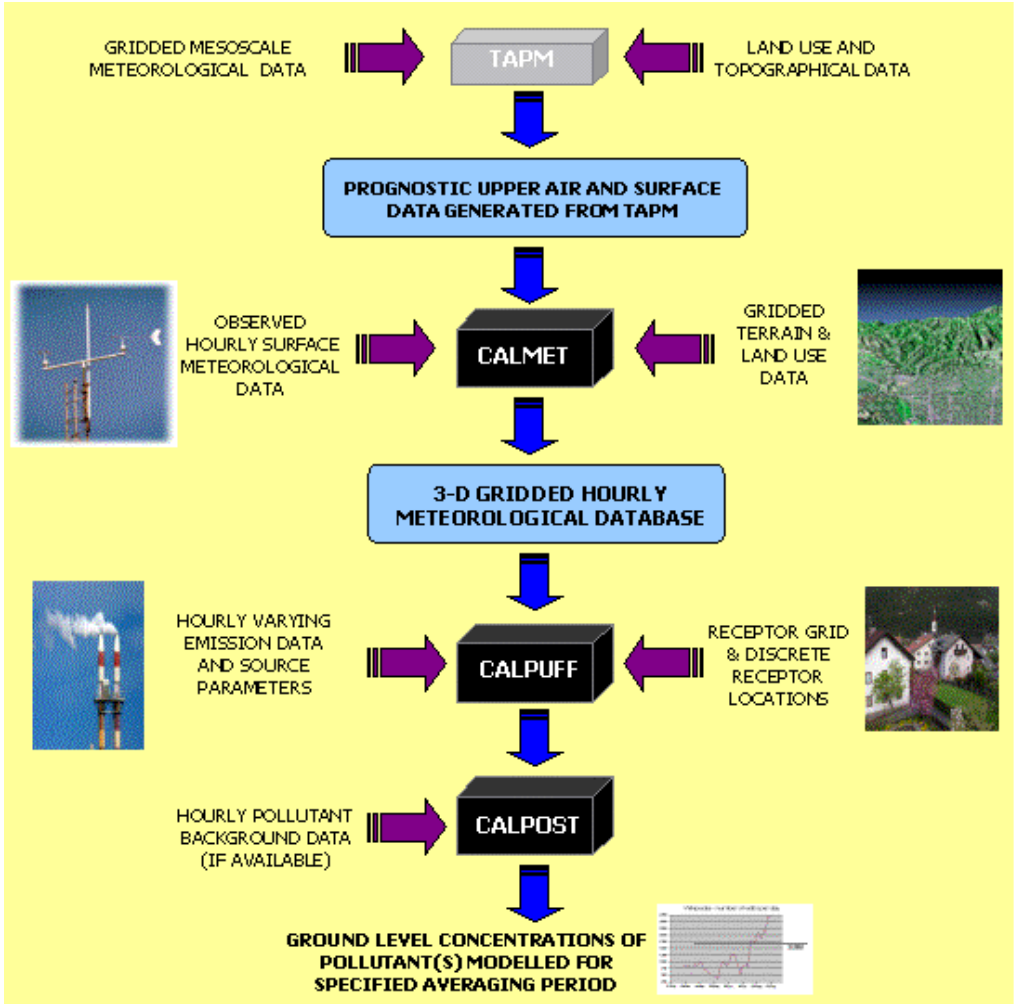

Figure A.2: Modelling Methodology Used in this Study

CALMET

CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are used in the CALPUFF dispersion model.

The hourly TAPM-generated data and observed data for the period of analysis were used as input to the CALMET pre-processor to create a fine resolution, three-dimensional meteorological field for input into the dispersion model. CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict girded meteorological fields for the region.

Terrain data has been sourced from the Shuttle Terrain Mission dataset. The spatial resolution of this data is 100 m.

Hourly surface meteorological data for Vineyard were used for the modelling year. The data were supplemented with upper air data derived from TAPM simulations.

CALPUFF

CALPUFF (**Scire *et al.,* 2000a**) is a multi-layer, multi-species, non-steady state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across the puff and takes into account the complex arrangement of emissions from point, area, volume, and line sources.

As with any air dispersion model, CALPUFF requires inputs in three major areas:

- Emission rates and source details.
- Meteorology.
- Terrain and surface details, as well as specification of specific receptor locations.

CALPUFF is endorsed by the US EPA, and has been used in many studies in New South Wales and other parts of Australia.

APPENDIX B

Meteorology

B.1 METEOROLOGY

B.1.1 Wind

Windroses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points – N, NNE, NE, etc. The bar at the top of each windrose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus it is possible to visualize how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day.

The diurnal windroses based on a CALMET extract are shown in **Figure B.1**. On an annual basis winds from the southwest region are predominant. In autumn winds blows predominantly from the southwest. In summer winds from the sector covering the south-southwest to the east northeast are common and in winter winds from southwest and west-southwest are most common. In spring winds from the north and west are predominant.

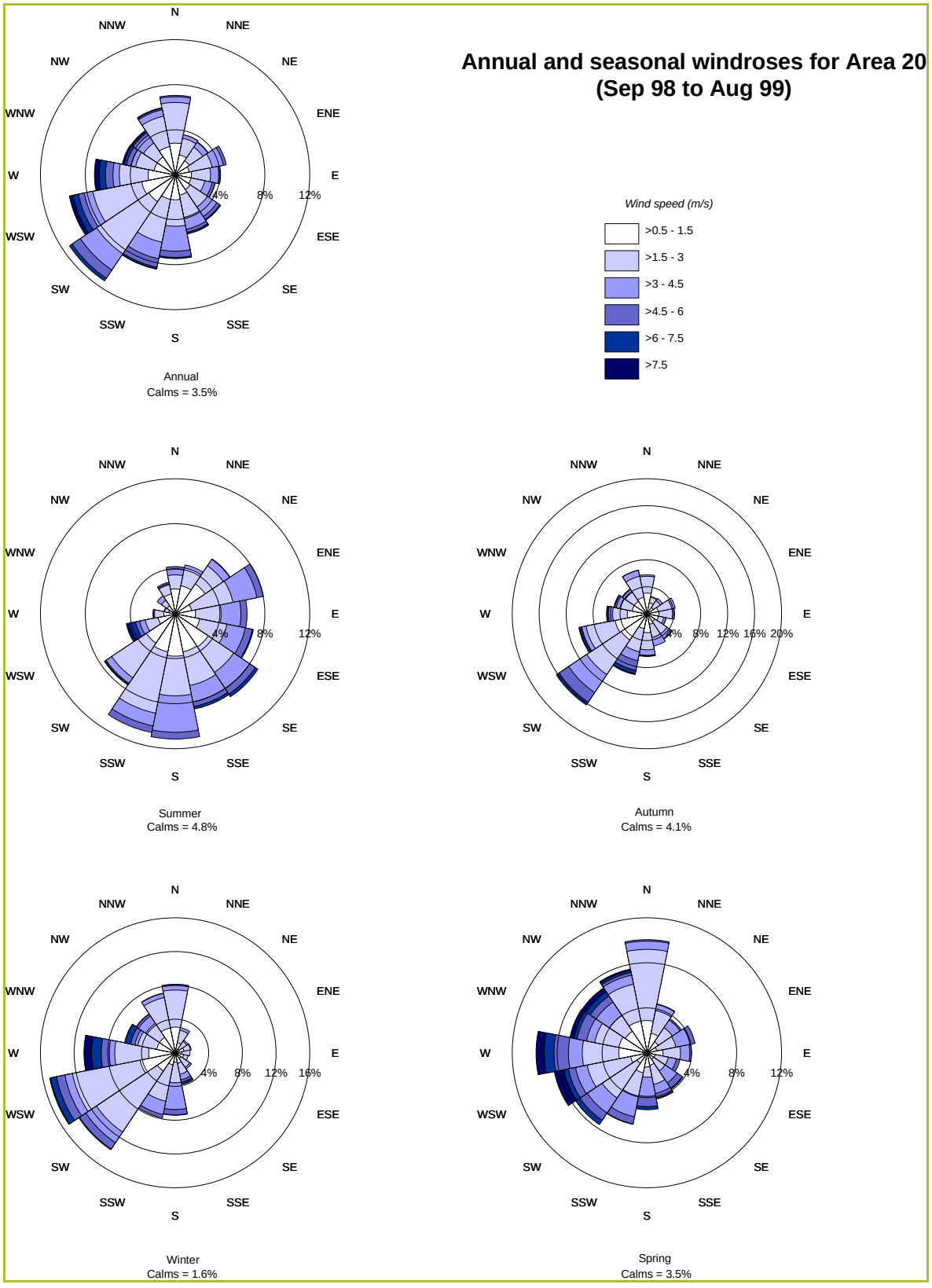

Figure B.1: Annual and seasonal windroses

The frequency distribution of hourly averaged wind speed values is shown in **Figure B.2**. Light wind speeds (up to 2 m/s) are relatively frequent and occur approximately 53% of the time. Strong winds (greater than 6 m/s) occur approximately 3.5% of the time.

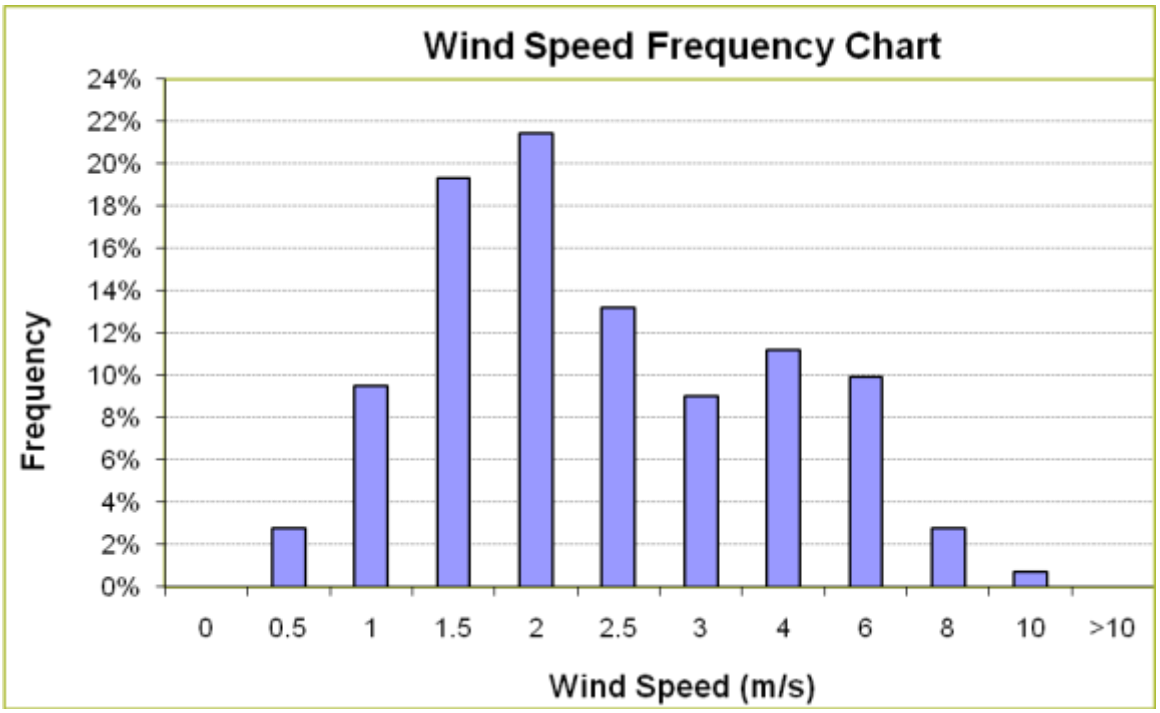

Figure B.2: Wind Speed Distribution for 2005

B.1.2 Stability

Atmospheric turbulence is an important factor in plume dispersion. Turbulence acts to increase the cross-sectional area of the plume due to random motions, thus diluting or diffusing a plume. As turbulence increases, the rate of plume dilution or diffusion increases. Weak turbulence limits plume diffusion and is a critical factor in causing high plume concentrations downwind of a source, particularly when combined with very low wind speeds.

Turbulence is related to the vertical temperature gradient, the condition of which determines what is known as stability, or thermal stability. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe atmospheric conditions and thus dispersion.

The most well-known stability classification is the Pasquill-Gifford scheme[b], which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution.

At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early

[b] A more accurate turbulence scheme within CALPUFF, based on micrometeorological parameters, was used for modelling.

morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind.

Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

The frequency distribution of estimated stability classes in the meteorological file is presented in Figure B.3. The data show a total of 49% of hours with either E or F stability class.

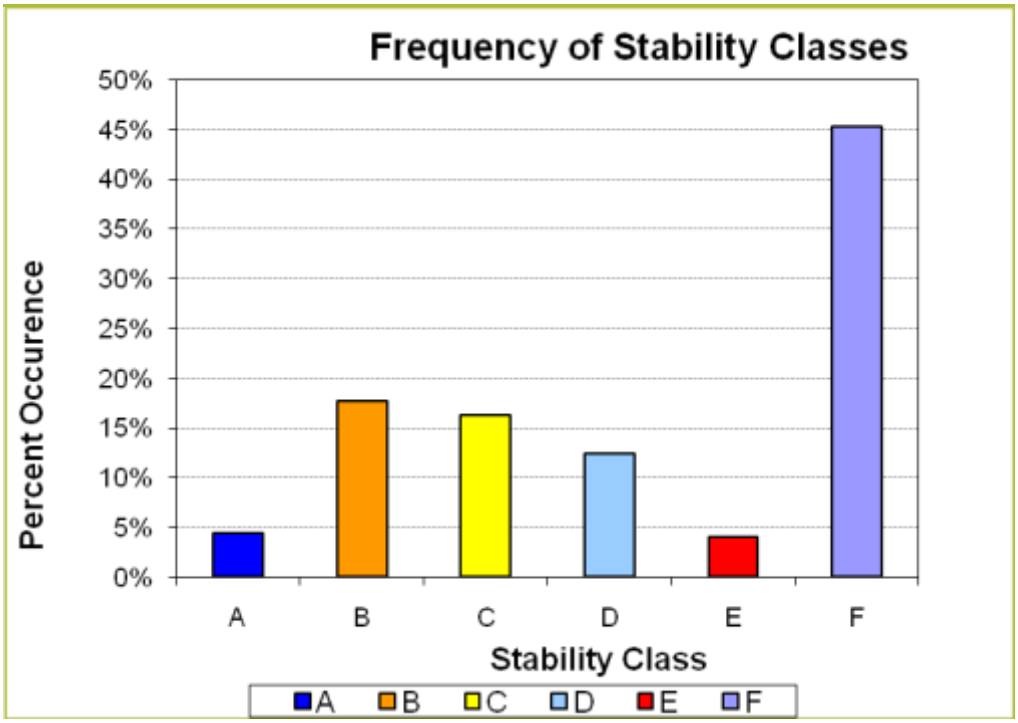

Figure B.3: Frequency Distribution of Estimated Stability Classes

APPENDIX C

Level 1 Assessment for Poultry Operations

C.1 LEVEL 1 ASSESSMENT FOR POULTRY FARMS

C.1.1 Methodology

The Level 1 odour impact assessment methodology for broiler chicken farms, as outlined in the Technical notes (DECC, 2006b), is summarised below and provided in detail in **Appendix A**.

All poultry farms that are included in this assessment have been assessed using the broiler farm Level 1 odour assessment methodology (**DECC, 2006b**). There is no variation to account for layer farms or duck farming operations, although it is generally accepted that broiler farms have higher potential odour impact than layers or ducks and therefore this approach is likely to provide a conservative separation distance for these sources.

Recommended separation distances for broiler farms are calculated using the following equation:

$$D = (N)^{0.71} \times S$$

Where: N = Number of standard broiler chicken shed units (SBCSU) (1 SBCSU is equivalent to 22,000 broiler chickens);

D = Separation distance in metres between the closest points of the broiler chicken sheds and the most sensitive receptor or impact location;

S = Composite site factor = S1 x S2 x S3 x S4 x S5. Site factors S1, S2, S3, S4 and S5 relate to shed design, receptor, terrain, vegetation and wind frequency. The value of S depends on site-specific information pertaining to S1 to S5.

SHED FACTOR (S1)

The shed factor (S1) depends on how the shed is ventilated. Factors for S1 are shown in **Table A.1** (**Appendix A**).

The majority of poultry sheds investigated in this study operate under natural ventilation. The two exceptions are the broiler chicken farms at 25 Schofields Road, which consists of a combination of tunnel ventilated and natural ventilated sheds and the farm at 20 Clarke St, which is a tunnel ventilated operation.

The shed factor used for this assessment is 690 for the majority of farms however the factor for the Schofields Rd site is factored proportionally to the number of chickens kept under tunnel ventilation compared to natural ventilation. The shed factor for 20 Clarke St is 980 for tunnel ventilated operations.

RECEPTOR FACTOR (S2)

The receptor factor (S2) varies depending on the likely impact area. It is determined based on criteria shown in **Table A.2** (**Appendix A**).

Proposals for the future development of Area 20 are to consider capacity for about 2,500 dwellings accommodating a population of around 7,000 people. The receptor factor for this assessment is set to 1.05.

TERRAIN FACTOR (S3)

The terrain factor (S3) varies according to topography and its ability to disperse odours and is determined from **Table A.3** (**Appendix A**).

The poultry farms under investigation as part of this study were either located on the other side of a low level ridge line from the Area 20 study area, and were therefore assigned a terrain factor of 0.9 for undulating terrain, or otherwise the assigned factor was 1.0 representing flat terrain.

VEGETATION FACTOR (S4)

The vegetation factor (S4) varies according to vegetation density, as shown in **Table A.4** (**Appendix A**). The vegetation density is assessed by the effectiveness with which the vegetation stand will reduce odour by dispersion. Tree cover should be maintained, as far as practicable, for the life of broiler chicken sheds.

The poultry operations considered in this study were assigned a factor of 1.0, representing no tree cover. There is some tree cover in the area, although this assumption provides a conservative approach.

WIND FREQUENCY FACTOR (S5)

The wind frequency factor (S5) is determined from **Table A.5** (**Appendix A**).

Wind speed and direction varies annually and diurnally (that is by the season and by the hour of the day). Although there is generally one direction that is the most frequently observed (prevailing wind), the wind direction usually blows from all directions at some time.

Local meteorology has been assessed (see **Section 3.4**) and winds are considered to be normal. All sites were assigned a wind frequency factor of 1.0.

C.1.2 Assessment Results

Twenty nine poultry farms were identified in the region of the Area 20 study area. A list of poultry operations that were identified for review, are outlined in **Section 3.2**. During the study some of these sites were confirmed to have ceased operation (as noted in **Section 3.2**). Other sites were identified as being at a distance from the study area to have an insignificant impact. Any operations that were determined to have ceased or were more than 5 km from the study area, were not included in the Level 1 assessment calculations.

Table C.1 provides the Level 1 assessment calculations for poultry farms that were included in the study. The distance of each farm from the study area is also provided in the table. Recommended separation distances for a number of poultry farms are predicted to encroach on the Area 20 study area according to the Level 1 assessment methodology.

The poultry farms with the greatest predicted area of influence on the Area 20 study area are:

- 95 Tallawong Rd, Rouse Hill
- 100 Worcester Rd, Rouse Hill
- 20 Clarke St, Riverstone

Other farms that encroach slightly or whose area of influence is in proximity to the boundary of the Area 20 study area under the Level 1 assessment method are:

- 25 Schofields Rd, Scholfields
- 98 Hambledon Rd, Schofields
- 93 Hambledon Rd, Scholfields
- 21 Terry Rd, Box Hill
- 181 Cudgegong Rd, Rouse Hill
- 22 Withers Rd, Kellyville

The small layer chicken farm at 89 Schofields Rd is located within the Area 20 Precinct, however its area of influence is small and within its property boundary.

The recommended individual separation distances for these poultry farms, that have the greatest potential influence on the Area 20 study area, are shown in **Figure D.1** to **Figure D.10** (**Appendix D**). The yellow circles indicate the recommended buffer distances for individual farms and the orange circles are the buffer distances plus 20%, for use when two farms create an influence over the same area.

Error! Reference source not found. provides a prediction for the combined area of influence of the nine most influencing poultry farms in the region of the Area 20 study area, based on the Level 1 assessment methodology. It can be seen from Error! Reference source not found. that all of the Area 20 study area is predicted to be influenced by odour from a poultry operation or combination of the most influential farms.

Error! Reference source not found. does not provide Level 1 separation distances of the other poultry operations outlined in Error! Reference source not found. since these sources do not encroach on the Area 20 study area.

It is likely that the Level 1 assessment has produced overly conservative results, particularly for the cumulative area of influence due to poultry farms. This approach does not provide very useful information for planning future development of the Area 20 study area, since all of the area proposed for release is predicted to be affected by odour from poultry operations.

It was considered to be likely that the predicted separation distances for all odour sources would be less, as well as providing results with greater confidence, if assessed using a Level 3 odour assessment, as outlined by the Technical notes (**DECC, 2006b**).

Therefore further assessment has been conducted using the Level 3 assessment method for the odour sources that are predicted to encroach on the Area 20 study area or are in proximity to its boundary using the Level 1 method (see **Section** Error! Reference source not found.). The CALPUFF dispersion model was used to predict odour concentrations, incorporating terrain, meteorology and further refined data about emissions as available

Table C.1: Recommended Separation Distances from Poultry Farms (Level 1 Assessment method)

Address	Bird Type	Sheds	Est. Total Birds	SBCSU	S1	S2	S3	S4	S5	Separation distance (m)	Separation distance +20% (m)	Distance from Area 20 (m)
100 Worcester Rd, Rouse Hill	Layer	4	32,000	1.45	690	1.05	1	1	1	945	1134	10
21 Terry Rd, Box Hill	Broiler	3	61,000	2.78	690	1.05	1	1	1	1495	1794	1900
181 Cudgegong Rd, Rouse Hill	Layer	1	10,000	0.45	690	1.05	1	1	1	414	497	470
54 Pelican Rd, Schofields	Broiler	4	49,500	2.26	690	1.05	0.9	1	1	1163	1395	2460
2 Pelican Rd, Schofields	Broiler	2	39,500	1.79	690	1.05	0.9	1	1	987	1184	2730
93 Hambledon Rd, Schofields	Broiler	3	53,000	2.41	690	1.05	0.9	1	1	1217	1461	1400
98 Hambledon Rd, Schofields	Broiler	5	73,000	3.32	690	1.05	0.9	1	1	1528	1834	1260
96 Hambledon Rd, Schofields	Duck	5	7,000	0.32	690	1.05	0.9	1	1	289	347	1300
89 Schofields Rd, Schofields	Layer	1	350	0.02	690	1.05	1	1	1	38	46	Within Area 20
25 Schofields Rd, Schofields	Broiler	3	75,000	3.41	796[a]	1.05	0.9	1	1	1797	2156	1850
26 Schofields Farm Rd, Schofields	Broiler	4	42,750	1.95	690	1.05	0.9	1	1	1047	1256	1650
34-36 Schofields Rd, Schofields	Duck	2	15,900	0.72	690	1.05	0.9	1	1	518	622	1680
68 Schofields Farm Rd, Schofields	Layer	3	50,000	2.27	690	1.05	0.9	1	1	1165	1398	1800
73 Boundary Rd, Schofields	Layer	1	40,000	1.81	690	1.05	0.9	1	1	993	1192	1600
37-39 Boundary Rd, Schofields	Layer	1	22,750	1.03	690	1.05	0.9	1	1	668	801	1480
47 Argowan Rd, Schofields	Broiler	3	63,250	2.87	690	1.05	0.9	1	1	1380	1656	3400
95 Tallawong Rd, Rouse Hill	Broiler	5	92,000	4.18	690	1.05	1	1	1	2001	2401	400
20 Clarke St, Riverstone	Broiler	6	70,000	3.18	980	1.05	0.9	1	1	2106	2528	1450
16 Clarke St, Riverstone	Broiler	2	31,000	1.41	690	1.05	0.9	1	1	830	996	1600
31-33 Boundary Rd, Box Hill	Layer	4	87,500	3.98	690	1.05	0.9	1	1	1740	2088	3400
22 Withers Rd, Kellyville	Broiler	5	130,000	5.91	690	1.05	1	1	1	2558	3069	2500
28 Foxall Rd, Kellyville	Layer	3	61,850	2.81	690	1.05	1	1	1	1509	1811	3340

a. This S1 value is a combination of the standard 690 and 980 S1 values, with the values weighted based on the number of birds in the tunnel ventilated and naturally ventilated sheds (BE, 2008a).

APPENDIX D

Predicted Separation Distances

D.1 PREDICTED SEPARATION DISTANCES

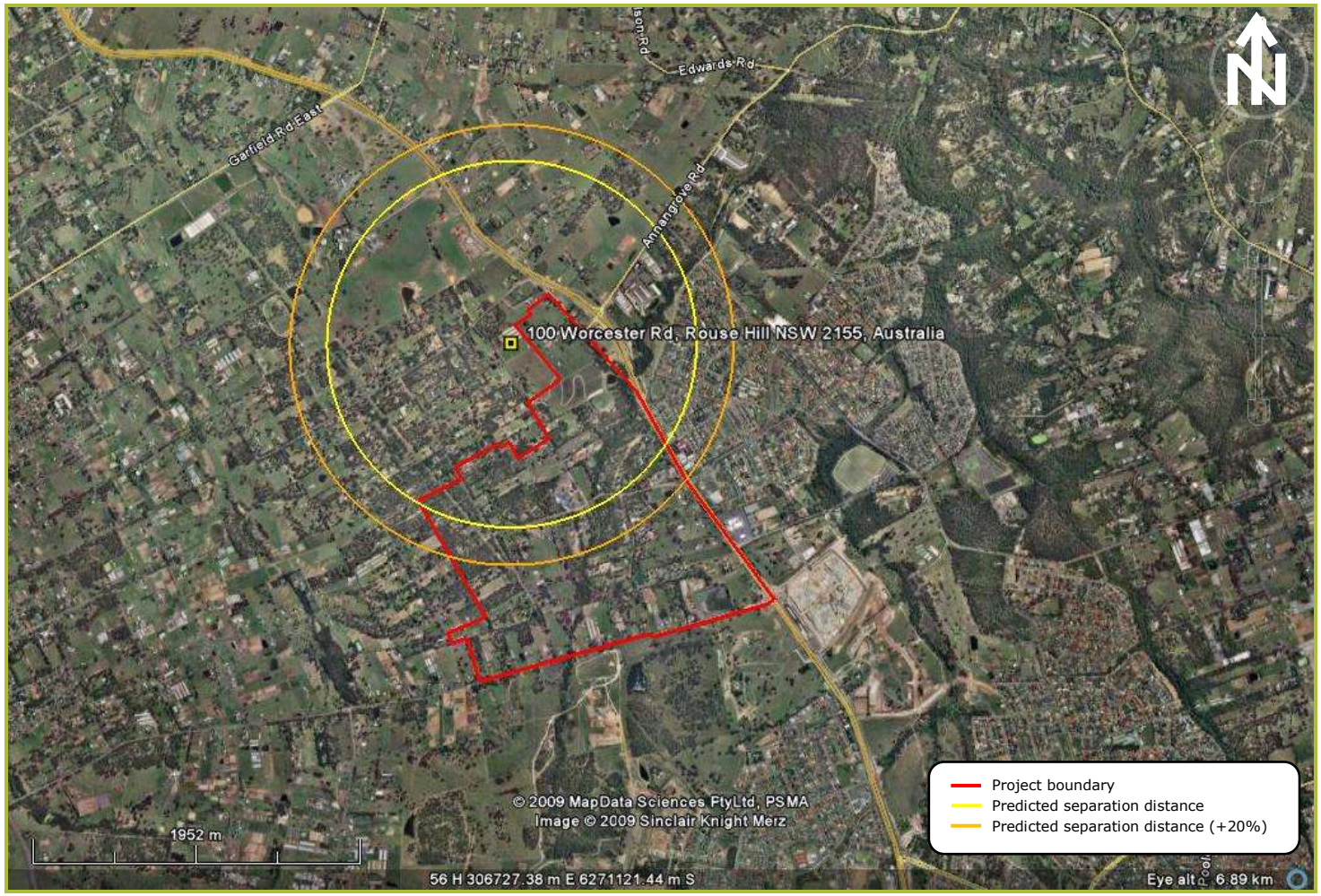

Figure D 1: Level 1 separation distance for layer farm at 100 Worcester Road

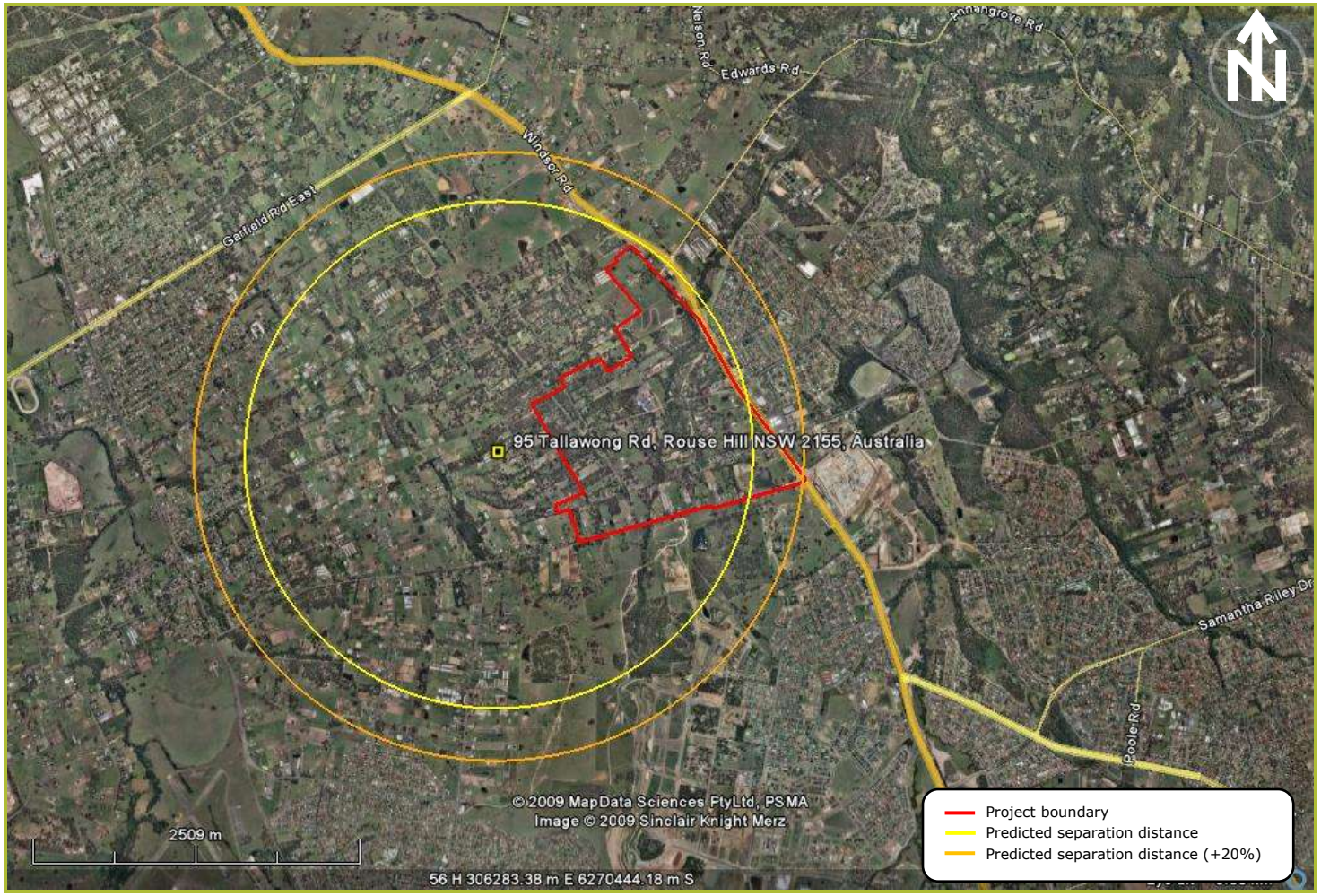

Figure D.2: Level 1 separation distance for broiler farm at 95 Tallawong Rd

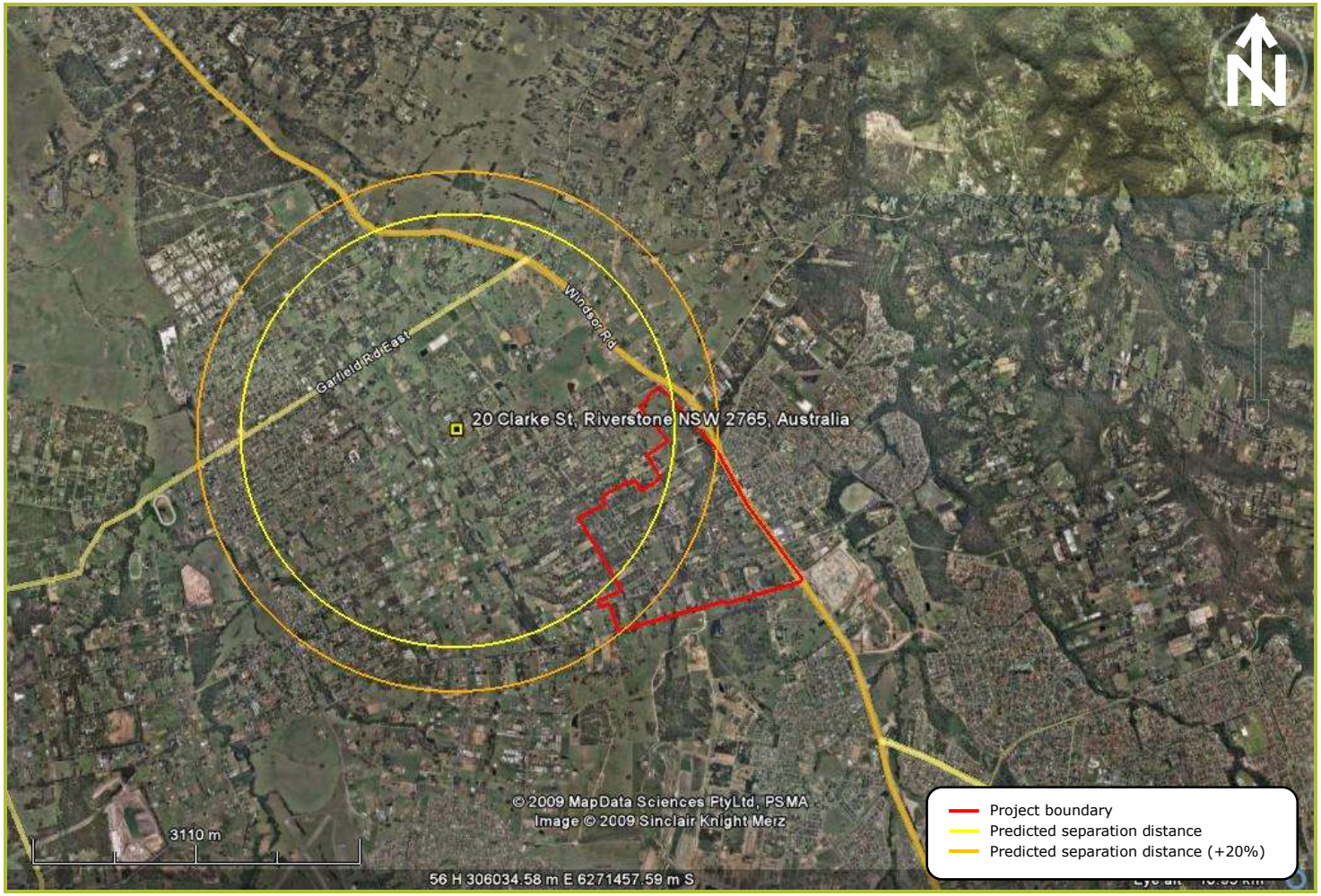

Figure D.3: Level 1 separation distance for broiler farm at 20 Clarke St

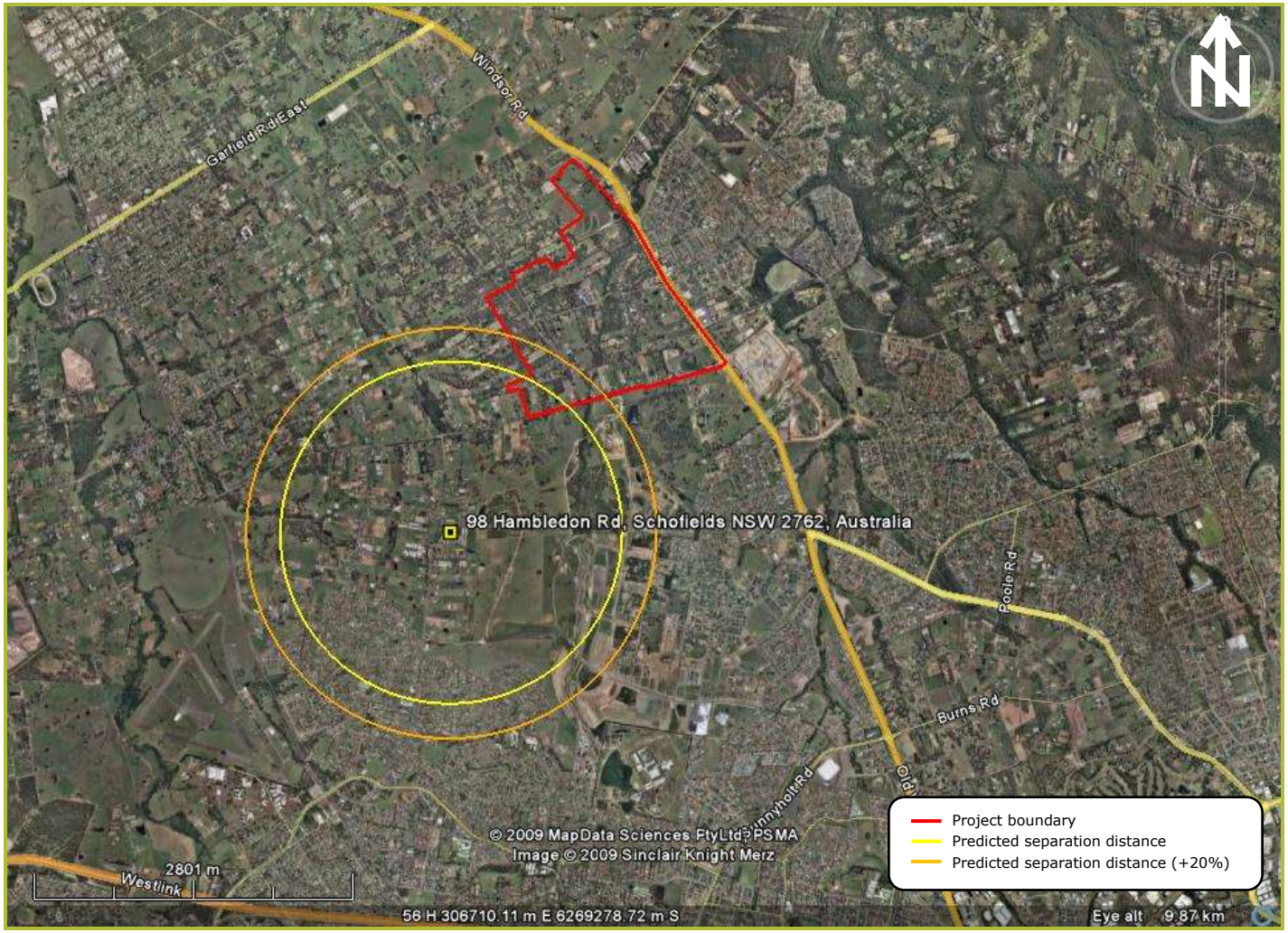

Figure D.4: Level 1 separation distance for broiler farm at 98 Hambledon Rd

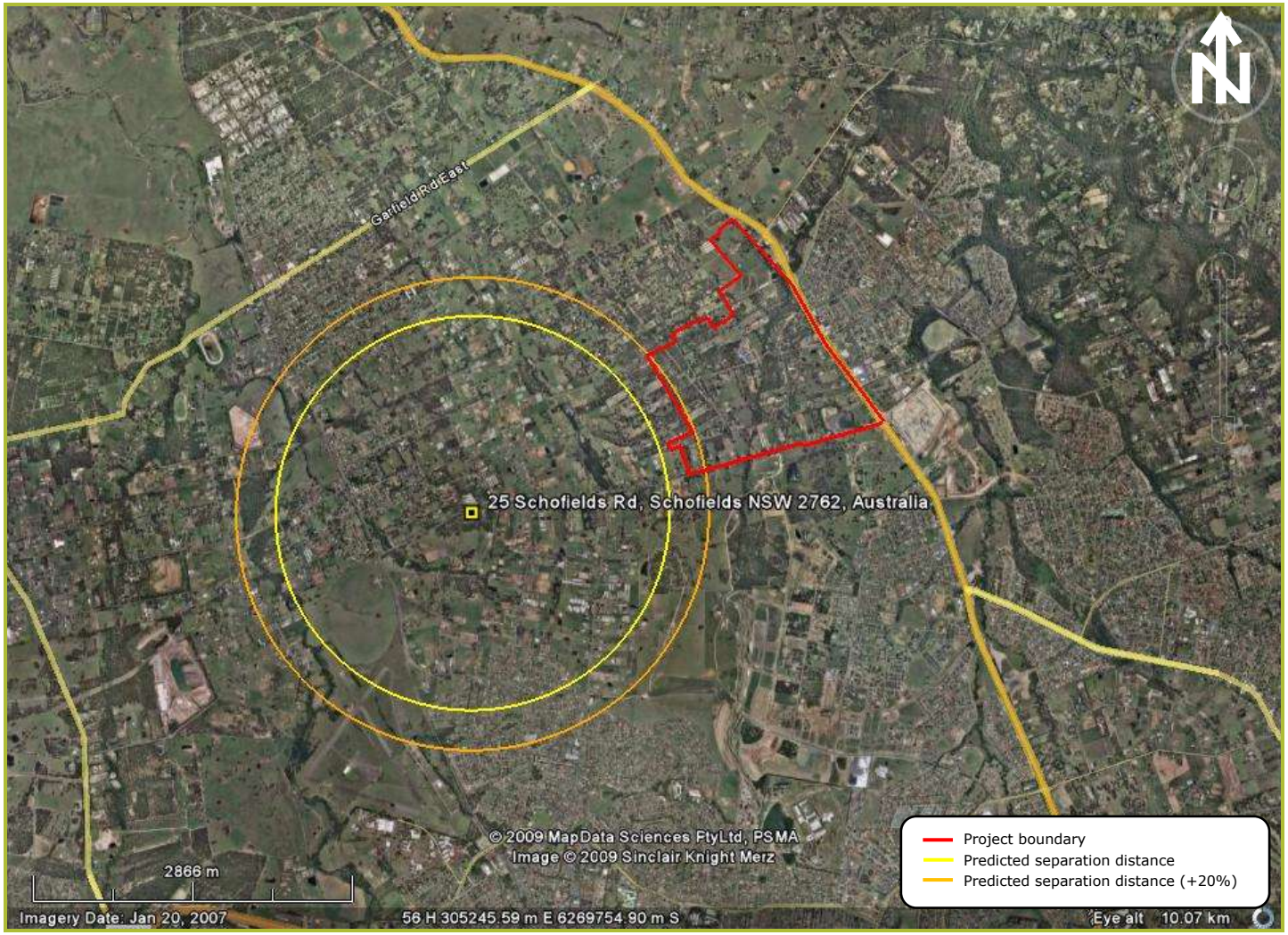

Figure D.5: Level 1 separation distance for broiler farm at 25 Schofields Rd

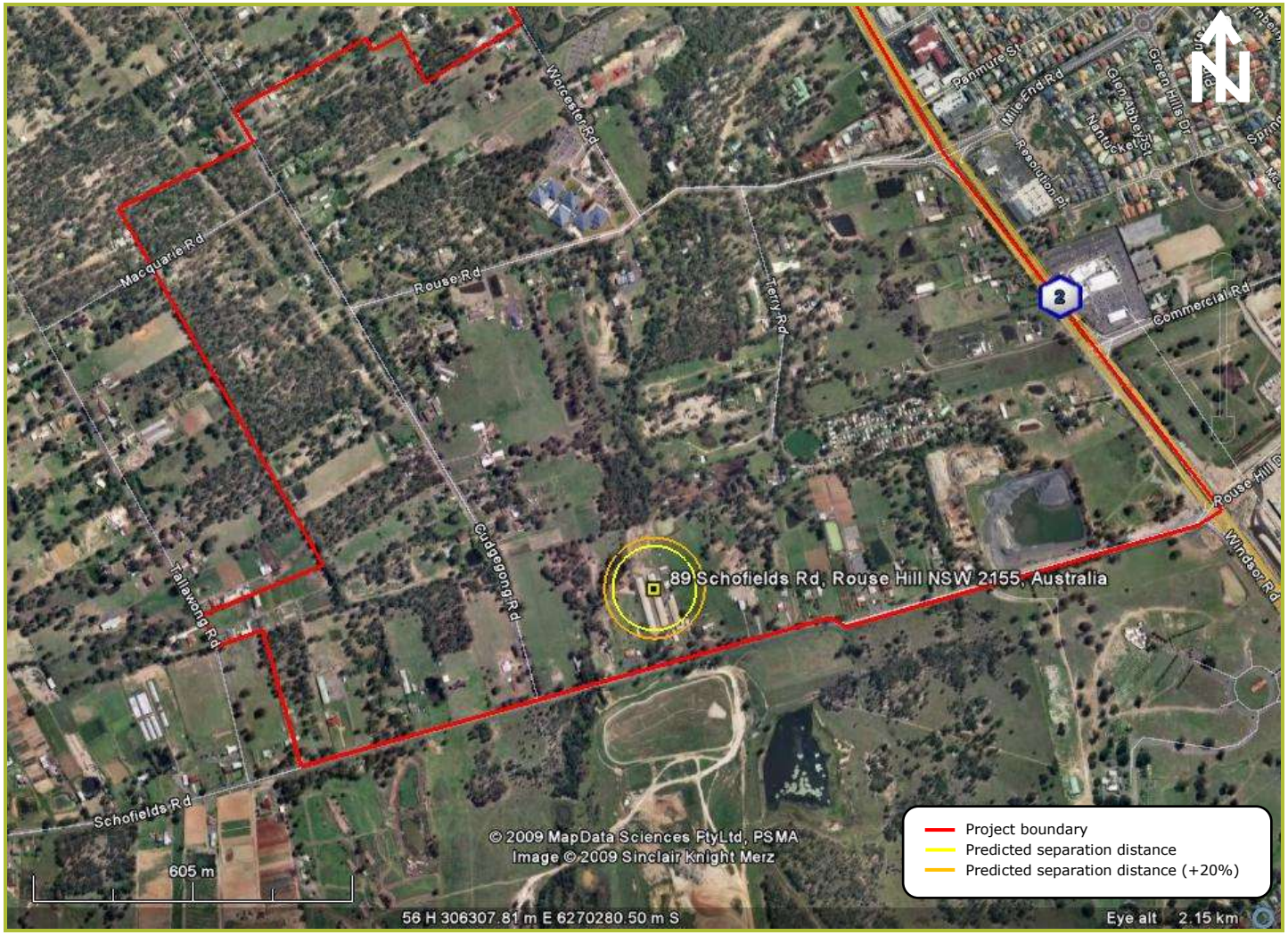

Figure D.6: Level 1 separation distance for layer farm at 89 Schofields Road

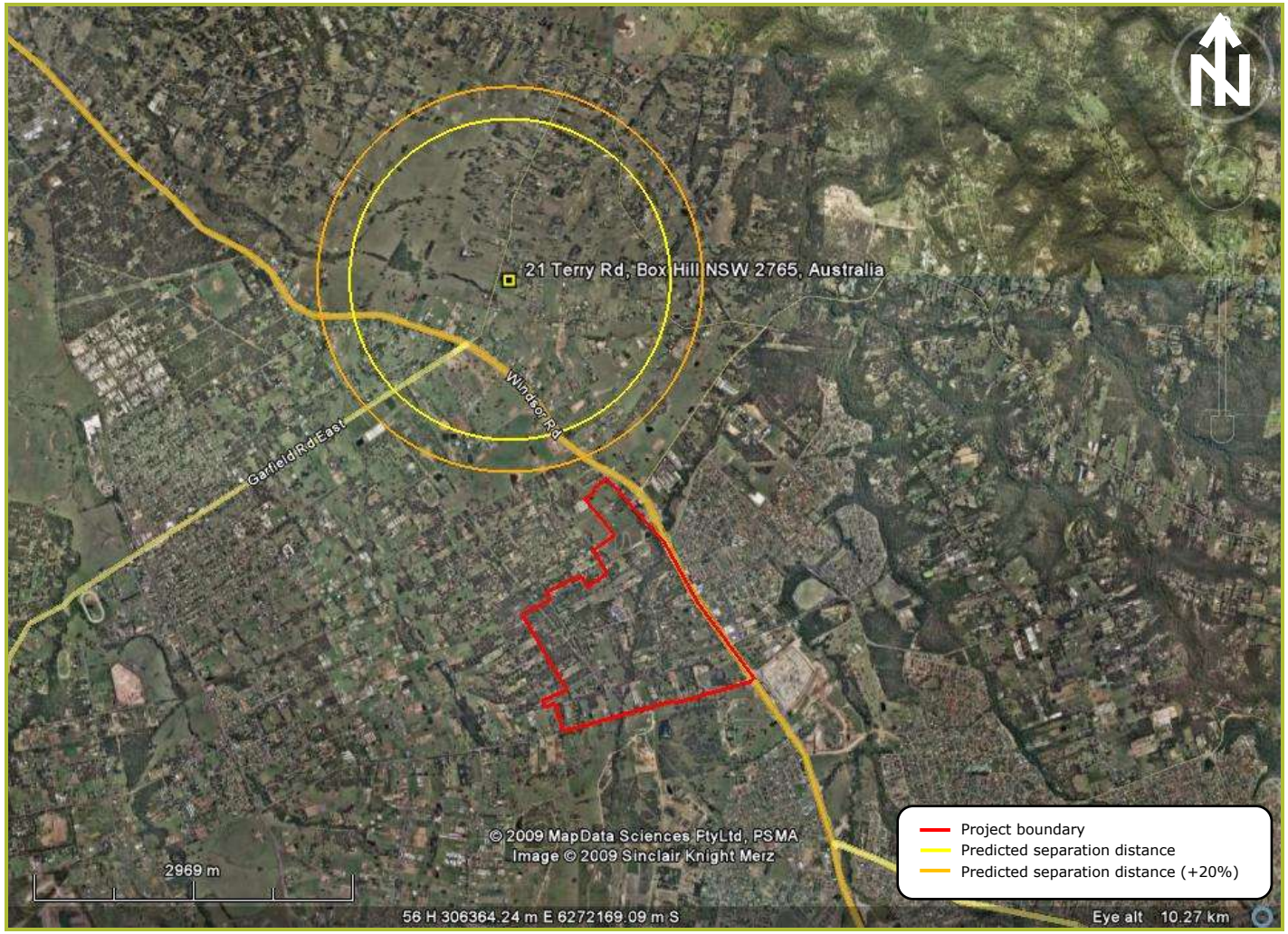

Figure D.7: Level 1 separation distance for broiler farm at 21 Terry Rd

Figure D.8: Level 1 separation distance for layer farm at 181 Cudgegong Rd

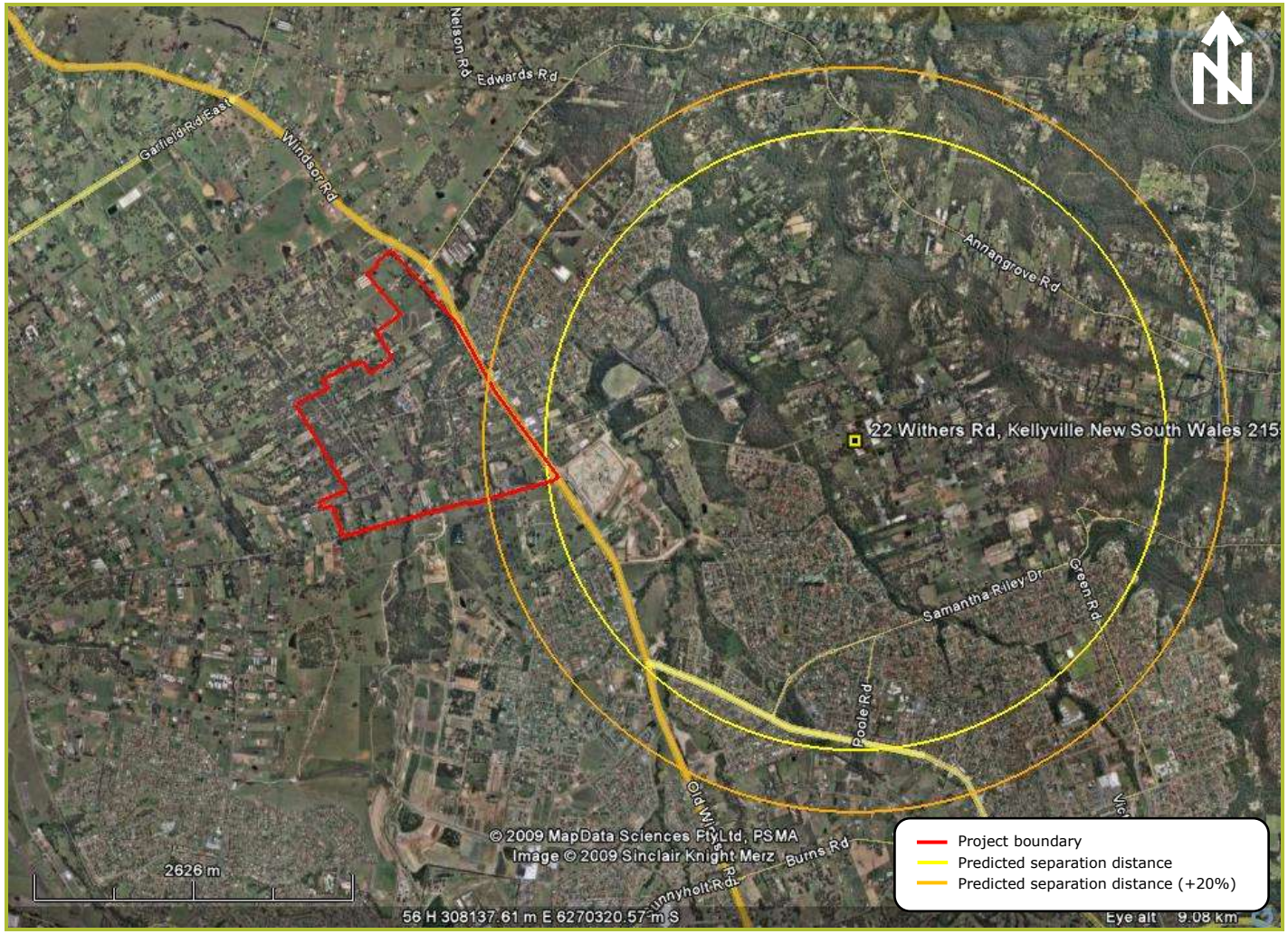

Figure D.9: Level 1 separation distance for broiler farm at 22 Withers Rd

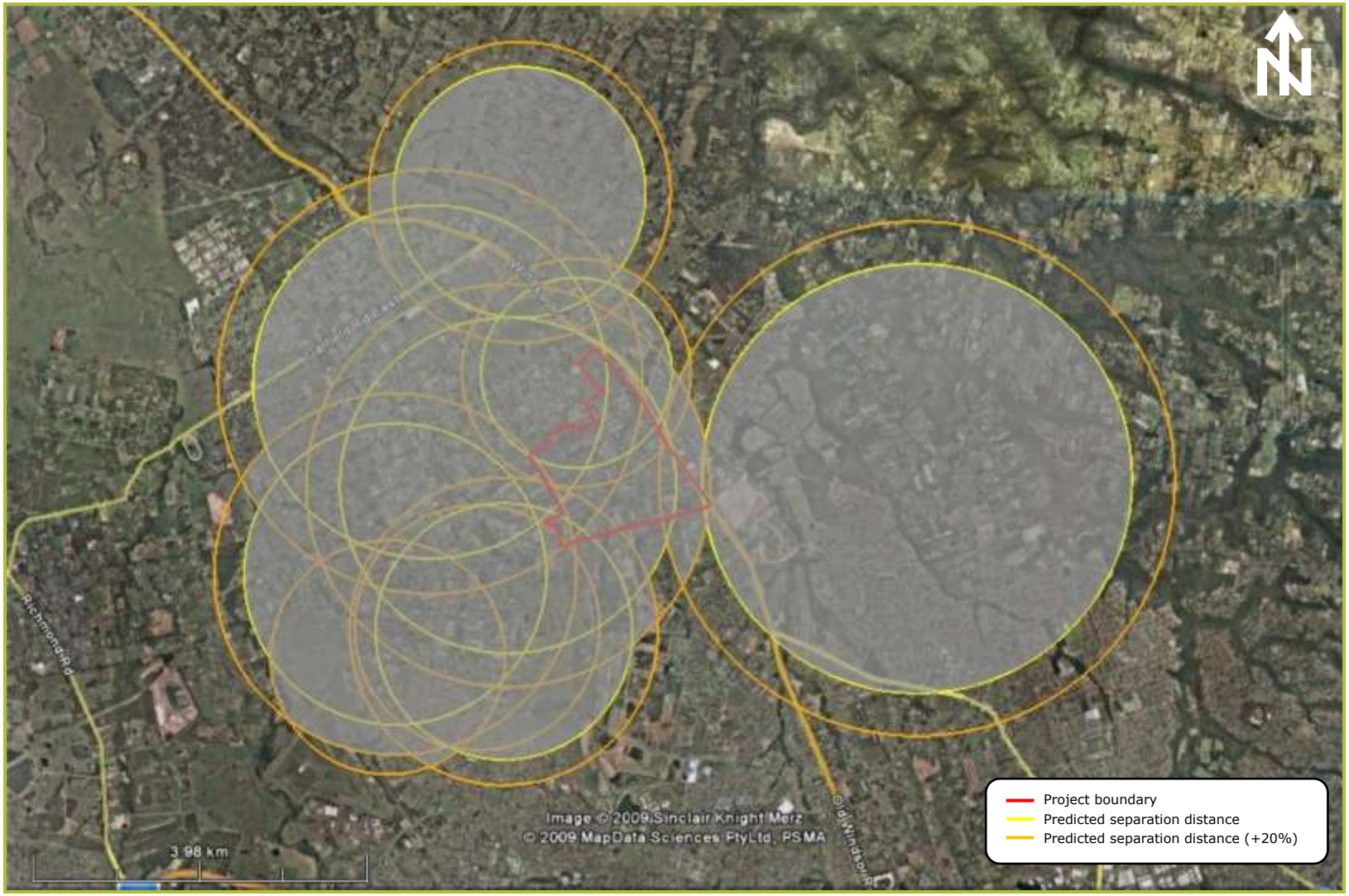

Figure D.10: Combined Level 1 separation area for poultry farms around Area 20 study area

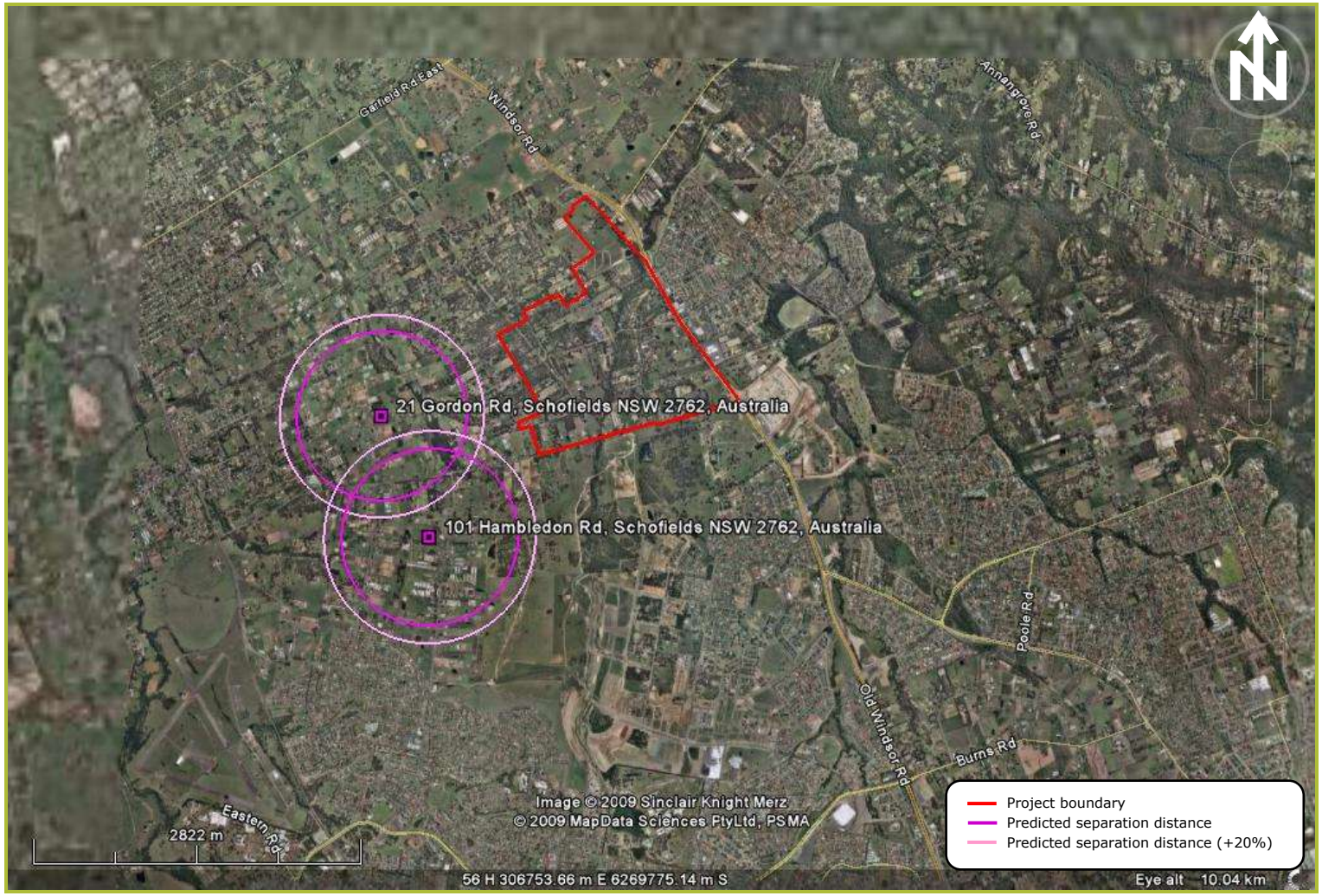

Figure D.11: Level 1 separation distances for intensive piggeries in proximity of Area 20 study area

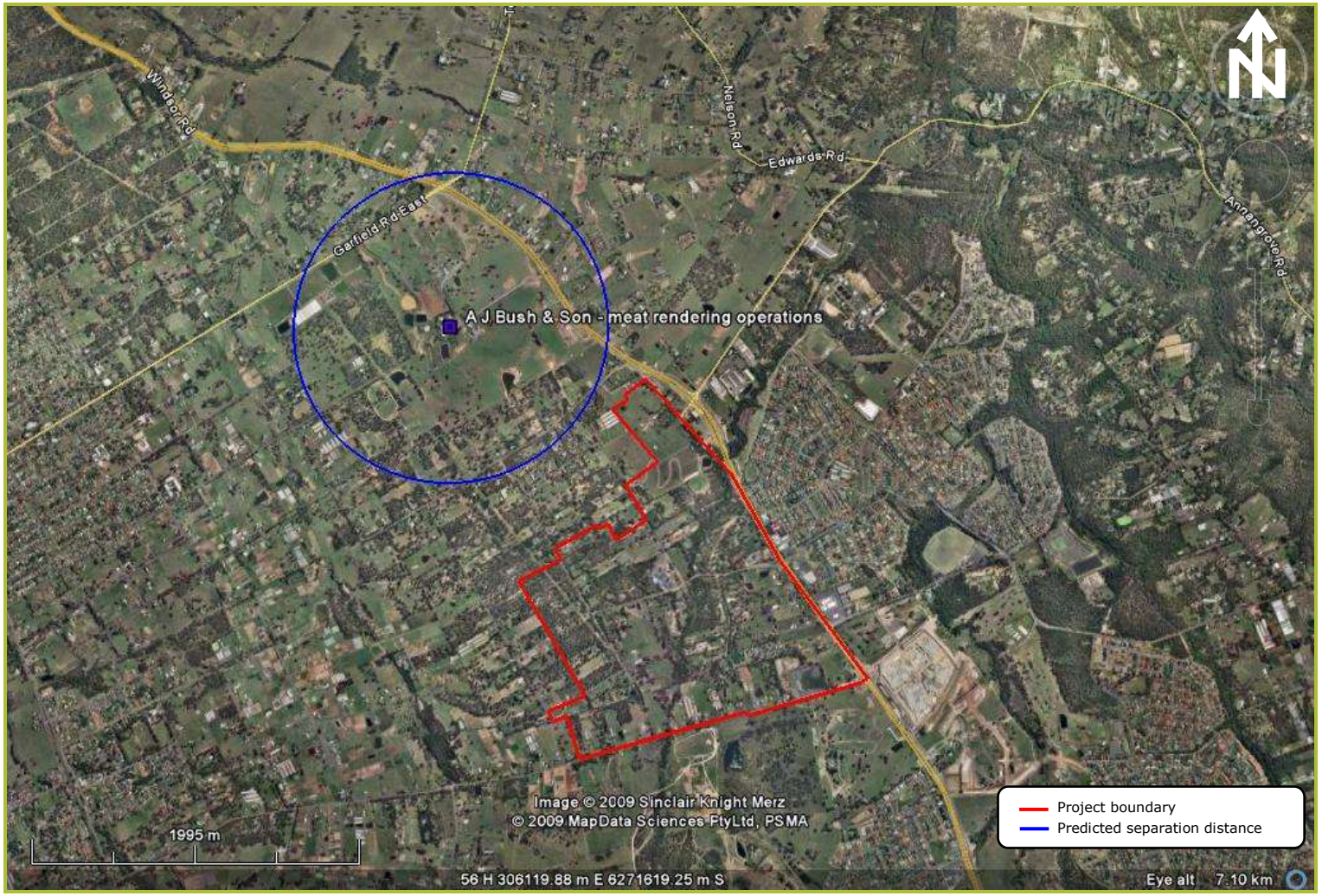

Figure D.12: Recommended buffer distance for meat rendering operations in proximity of Area 20 study area

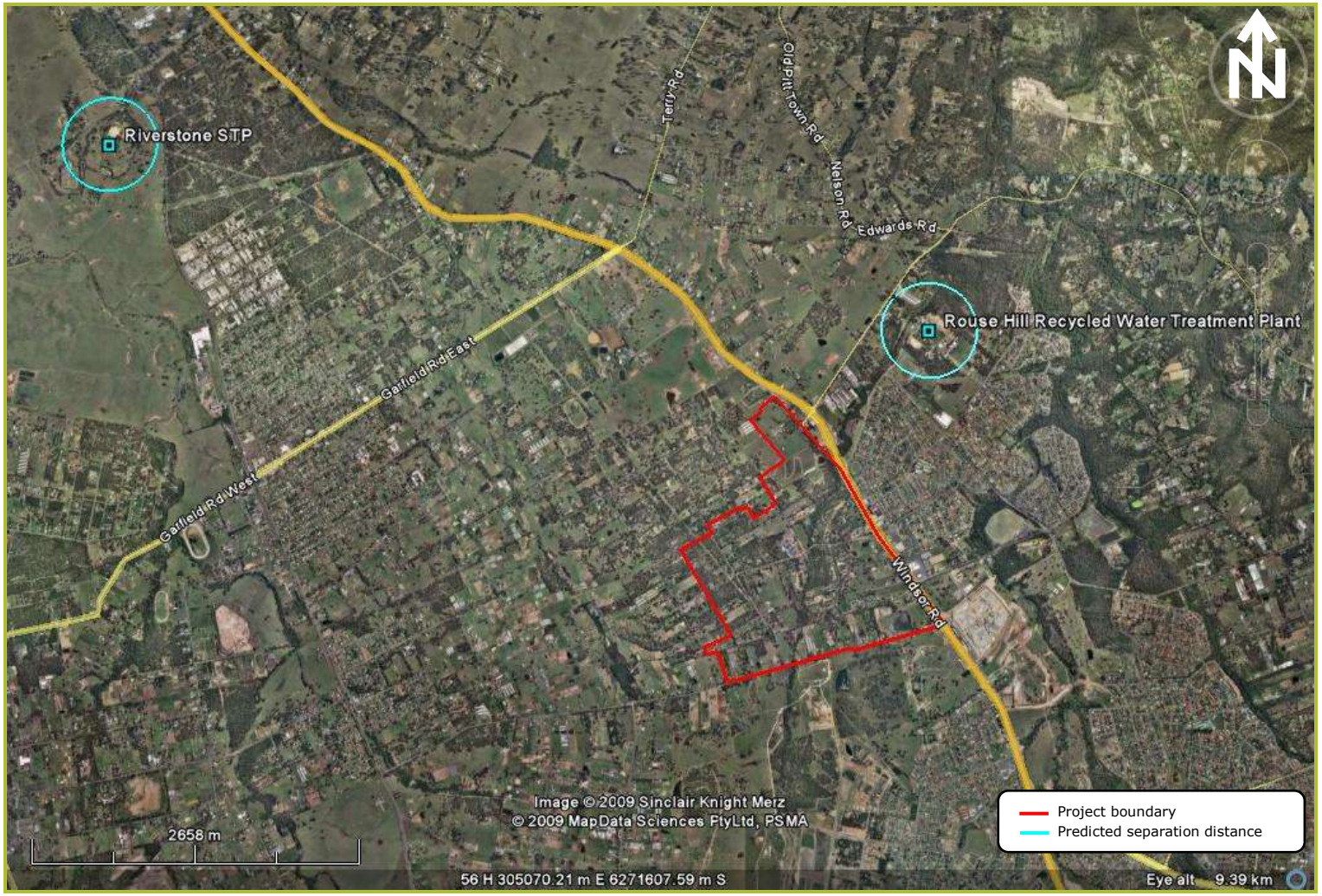

Figure D.13: Recommended buffer distances for sewage treatment plants in proximity of Area 20 study area

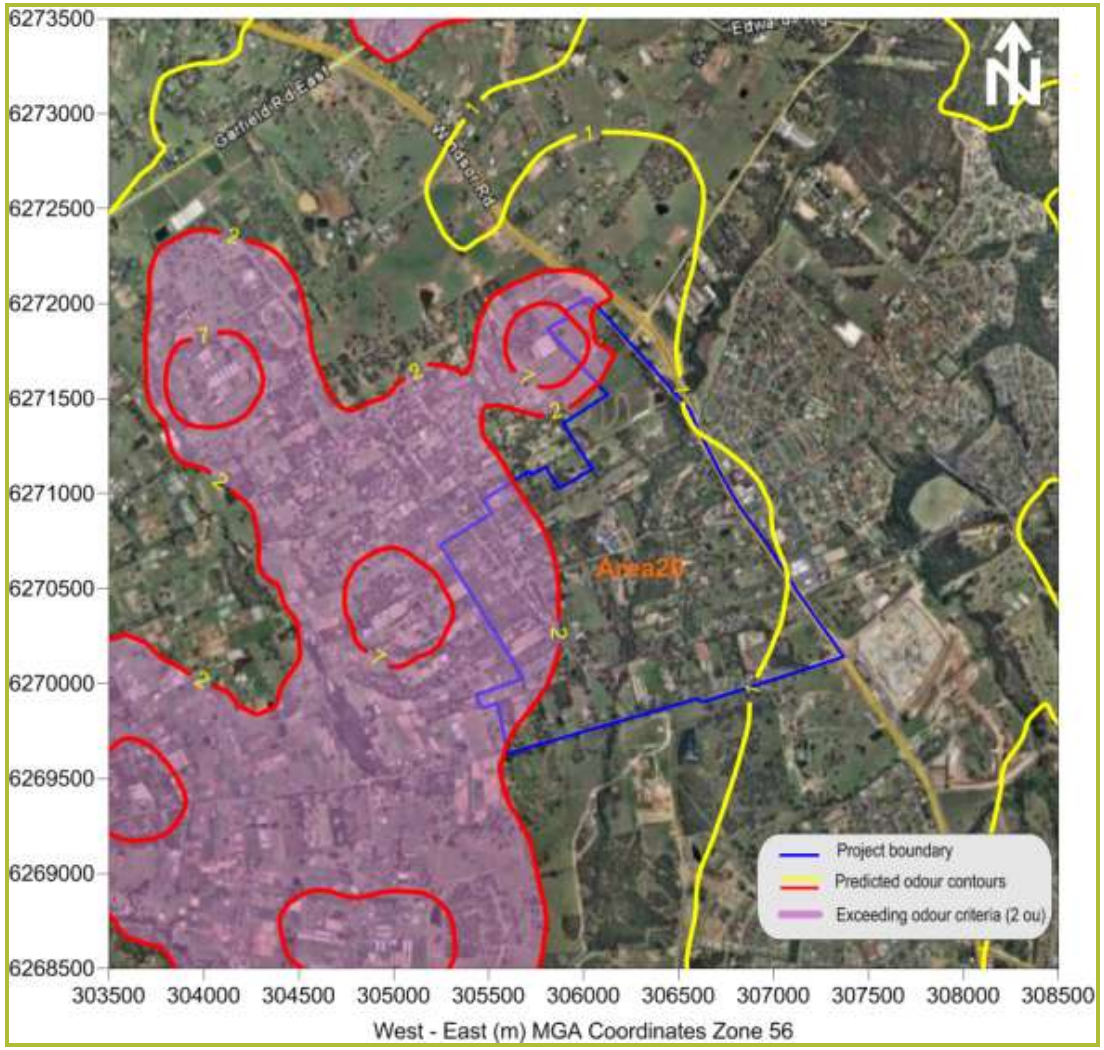

Figure D.14: Predicted 99th percentile, Odour Concentrations for the nine most influential poultry operations in proximity of the Area 20 study area