



Odour impact assessment

Wardentree Lane Anaerobic Digestion Facility

Report for ET Biogas Ventures Ltd

Customer:

ET Biogas Ventures Ltd

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Contact:

Dr Nigel Gibson
Ricardo-AEA Ltd
Gemini Building, Harwell, Didcot, OX11 0QR, United Kingdom
t: +44 (0) 1235 75 3609
e: nigel.gibson@ricardo-aea.com
Ricardo-AEA is certificated to ISO9001 and ISO14001

Author:

Dr Nigel Gibson

Approved By:

Brian Donovan

Date:

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1 Introduction

1.1 Overview

This assessment considers the odour emissions at the 100,000 tonne per annum AD facility proposed on land off Wardentree Lane.

This facility will supply gas to the gas network and will combust only a portion of the biogas generated by the AD process to generate heat and electricity. The biogas consists predominantly of methane. The CHP engine, rated at 500kW, will discharge combustion gases to atmosphere via a suitably sized stack. Odour generated on site will be contained and treated in an appropriate odour control system. This report presents the assessment of odour around the site.

1.2 The process

The feedstock for the plant consists mainly of energy crops including maize, grass, silage, sugar beet etc., which will be produced from land farmed locally. There is a smaller proportion of feedstock that will be sourced from local businesses also within this area; this will be in respect of waste products from the food preparation industry, mostly vegetable preparation waste. As an approximate guide, the energy crop will amount to in the region of 80%, the waste material 20%.

The grass silage feedstock is harvested in May to July and maize and beet in September/October. Cultivating and harvesting operations will vary depending on the crop but these activities will be complimentary to the existing farming operations.

The maize and beet material will be ensiled in the agricultural storage clamps located on feeder farms. The ensiled material is then transferred by trailer from the feeder farm to the AD site prior to being fed into the digestion system.

From the feed hopper the solid feedstocks are conveyed into the pre-mixing vessel (dissolver), additionally liquids are added and subsequently the mixture is stirred and mascerated, before being pumped into the digester. Through the pre-mixing vessel all feedstocks can be weighed and registered in order to have a precise and accurate feeding mixture.

The digester is an insulated concrete tank, covered by a double membrane roof which captures the biogas. The biogas is produced through the anaerobic digestion of organic matter, contained in the feedstock. This anaerobic digestion process takes place at a temperature of around 37°C. This temperature is required to maintain the activity of the bacteria inside the digester, which convert organic matter into biogas.

Within each digester, 4-5 agitators are installed to be able to completely stir all the digestate which is required to have an efficient and stable digestion process. After digestion a digestate is left-over which will be stored in the gas-tight digestate storage tank (separate end-storage tank).

Before transferring the digestate into the end storage tank it will be pasteurized, in order to make it free of any pathogens remaining after the digestion process. It is then subsequently separated into a solid and liquid phase. The digestate will be applied back to the land as an organic fertilizer, saving mineral fertilizer use and reducing CO₂ emissions caused by the production of chemical fertilizer. There is therefore no residual waste within the whole lifecycle of the plant's operation.

Silage delivery vehicles will remove digestate from the site, transferring the material to the feeder farms, where it will be stored appropriately until applied to land.

Rain falling on site will run along an impermeable surface and enters an underground piped drainage system with all liquid being directed to the liquid feedstock tank. The liquid is then used in the AD process.

The surface water runoff from the site will be collected in a drainage system that will discharge into an attenuation system. The attenuation system will attenuate the flows from the entire site, restricting discharge into the drainage ditch through the use of multi stage pump.

1.3 Emission to air

The principal substances of concern is odour.

Odour emissions arise from:

1. The handling and processing of waste. These odours are either released directly into the process building from where they are directed to the odour control system, or are released directly into the inlet to the biofilter,
2. Peripheral activities associated with the dewatering activities and rain water storage (not digestate storage).

1.4 Design of odour control plant

The air handling system installed on the process building is designed to ensure that a negative pressure is maintained. The air extracted from the building is then directed to a biofilter. The treated air from the biofilter is discharged from the open surface of the biofilter.

Table 1: building volumes used to size the odour control system

Area	Area volume (m ³)	Percent taken up by plant and equipment (%)	Air changes per hour	Air movement
Reception area	15300	0.9	2	Reception area to process area
Process area	6,400	0.9	5	Process area to biofilter

The air handling system is designed to extract air at 5 ACPH from the process area, in turn air at 2 ACPH is drawn through the reception area. In total a volume of approximately 30,000 m³/hr (8.3 m³/s) will be extracted. The extracted air will first pass through a scrubber which will (i) reduce odorants and (ii) humidify the gas flow, and secondly the pre-treated air will pass through a biofilter. The biofilter will be designed to achieve a 45 second residence time. In this study it is assumed that the residual odour concentration from the biofilter will be no more than 1,000 ouE/m³.

The residual air from the biofilter will be discharged through an open biofilter approximately 1.5m above the surface of the process area.

1.5 Scope of Study

Detailed dispersion modelling was carried out to determine the predicted ground level concentrations of odour at nearby sensitive locations due to odour emissions from the odour control system and from peripheral odour emission.

Further details of the modelling methodology and study inputs are provided in Section 2.

2 Assessment Methodology and Study Inputs

2.1 Dispersion Modelling Study

The assessment of impacts to odour due to the proposed operations was undertaken using detailed dispersion modelling to predict ground level concentrations of odour in the vicinity of the site.

Information on emissions from the plant was combined with information on meteorological conditions. A dispersion model was then used to predict the concentrations which would arise in the vicinity of the plant due to these emissions. A current industry standard atmospheric dispersion model (ADMS version 5) was used to carry out the modelling.

A summary of the dispersion modelling procedure is as follows (details of the methodology, study inputs and assumptions used for the modelling assessment are provided in Section 2.3 and following below):

- Information on plant location, plant emission characteristics and building layout was obtained from ET Biogas Ventures Ltd and their contractors.
- Appropriate meteorological data recorded at Wittering weather station.
- Ground level concentrations were calculated on a grid of receptor points. This grid extended 750 metres in each cardinal direction from the site. Concentrations were calculated at 15m intervals on this grid. As well as this, levels of released substances were calculated at specific sensitive locations in the vicinity of the proposed AD facility. These locations are discussed further in Section 3.3, and are shown in Figure 1.
- The above information was entered into the dispersion model, which was run to provide the odour at each grid point and sensitive receptor location.
- The modelled pollutant concentrations were processed using a widely used plotting package (SURFER version 11) to produce contour plots of the model results. These are provided for illustrative purposes only; assessment of the model results was based on the numerical values at relevant sensitive receptor locations as described above.

2.2 Dispersion Model Selection

The dispersion modelling study was carried out using ADMS (Atmospheric Dispersion Modelling System) version 5. ADMS is widely accepted as a current industry standard model for dispersion from point sources such as the biofilter surface.

ADMS is a computer based model of dispersion in the atmosphere of passive, buoyant, or slightly dense, continuous or finite duration releases from single or multiple sources. The development of ADMS was supported by the Environment Agency. A key improvement in ADMS over older models is its use of the most recent scientific understanding of the structure of the atmospheric boundary layer. In the ADMS approach, the boundary layer structure is defined in terms of measurable physical parameters obtained from meteorological readings, which allow for a more realistic representation of the changing characteristics of dispersion with height. The result is a more accurate and soundly-based prediction of the concentrations of pollutants.

The presence of buildings close to the release point can significantly affect the dispersion of material from a source. This influence can be taken into account by the use of an appropriate module in ADMS. The site buildings may influence the dispersion of emissions. It is therefore important that building effects on dispersion are evaluated in detail. This was done using the ADMS buildings module. The effects of terrain on dispersion from the emission points were also evaluated in detail using the ADMS terrain module.

Models of atmospheric dispersion processes are generally more reliable for long period means than short period means. Models are usually more reliable over intermediate distances (100m to 1000m) than very close to the source, or more distant from the source. This reflects the range of data that

have been used to compile the models. Where emissions data are less reliable, or averaging periods are shorter, the results are likely to be less accurate.

To acknowledge this potential for variability in dispersion model results, a conservative approach has been adopted throughout the study, as described throughout this section. This means that modelled results are likely to be overestimates rather than under-estimates of the ground level concentrations that will arise in practice.

In summary, ADMS was considered to be the most suitable model for this application for the following reasons:

- Industry standard model for atmospheric dispersion modelling;
- Advanced understanding of boundary layer meteorology; and
- Ability to model the influence of buildings and terrain on dispersion.

2.3 Study inputs

2.3.1 Assessment Criteria

There are no mandatory or statutory numeric standards for determining whether the level of odour perceived at a specific location is acceptable or not. The Environment Agency has published guideline criteria for Agency permitted / regulated sites at 1.5, 3 and 6 ouE/m³ as 98thile 1 hour averages for the most, moderate and least offensive process emissions. In presenting this information the Environment Agency provides example processes which fall within each offensiveness category as shown in Table 2.

Table 2: Odour benchmark published by the Environment Agency

Offensiveness	Processes	Criterion
Most offensive	• decaying animal or fish remains • involving septic effluent or sludge • biological landfill odours	1.5 ouE/m ³ 98 th ile 1 hr
Moderately offensive	• intensive livestock rearing • fat frying (food processing) • sugar beet processing • well aerated green waste composting	3 ouE/m ³ 98 th ile 1 hr
Less offensive ¹	• brewery • confectionary • coffee roasting • bakery	6 ouE/m ³ 98 th ile 1 hr

At sensitive location (e.g. residential properties, pub gardens, amenity etc) the odour from the AD plant should be assessed on this basis of a benchmark 1.5 ouE/m³ as a 98thile 1 hour average, while at less sensitive locations (factories, offices etc) the odour should be assessed on this basis of a benchmark of 3 ouE/m³ as a 98thile 1 hour average

The prediction that a particular property lies above the guideline concentration does not necessarily imply that unreasonable annoyance will follow. However, it is suggested that the probability of such an occurrence is increased in proportion to the exceedence of the guideline.

¹ The 2002 and 2009 draft H4 guidance notes included "Fragrance and Flavourings" within the less offensive category. This was omitted from the 2011

2.3.2 Emissions Data

The provisional emissions data and characteristics for the odour control unit are set out in Table 3. Table 4 lists the odour emission rate of the peripheral odour sources

Table 3: Emissions data for the biofilter

Aspect		Unit	Value
Biofilter location		-	525055, 325250
Biofilter height		M	0.5m above surrounding ground level
Biofilter area		M	100
Volumetric flow		Am ³ /hr	30,000
Efflux velocity		m/s	0
Efflux temperature		°C	15
Concentration	odour	OU _E /m ³	1,000
Mass emission	odour	OU _E /s	8,333

Table 4: Odour emission rates for peripheral odour sources

Emission source	Exposed area (m ²)	Worst case odour emission factor (OU _E /m ² /s)	Odour emission rate (OU _E /s)
Surface water lagoons	1,400	0.31	465
Digestate separator	10	3.1	31
Total			496

2.3.3 Hours of Operation

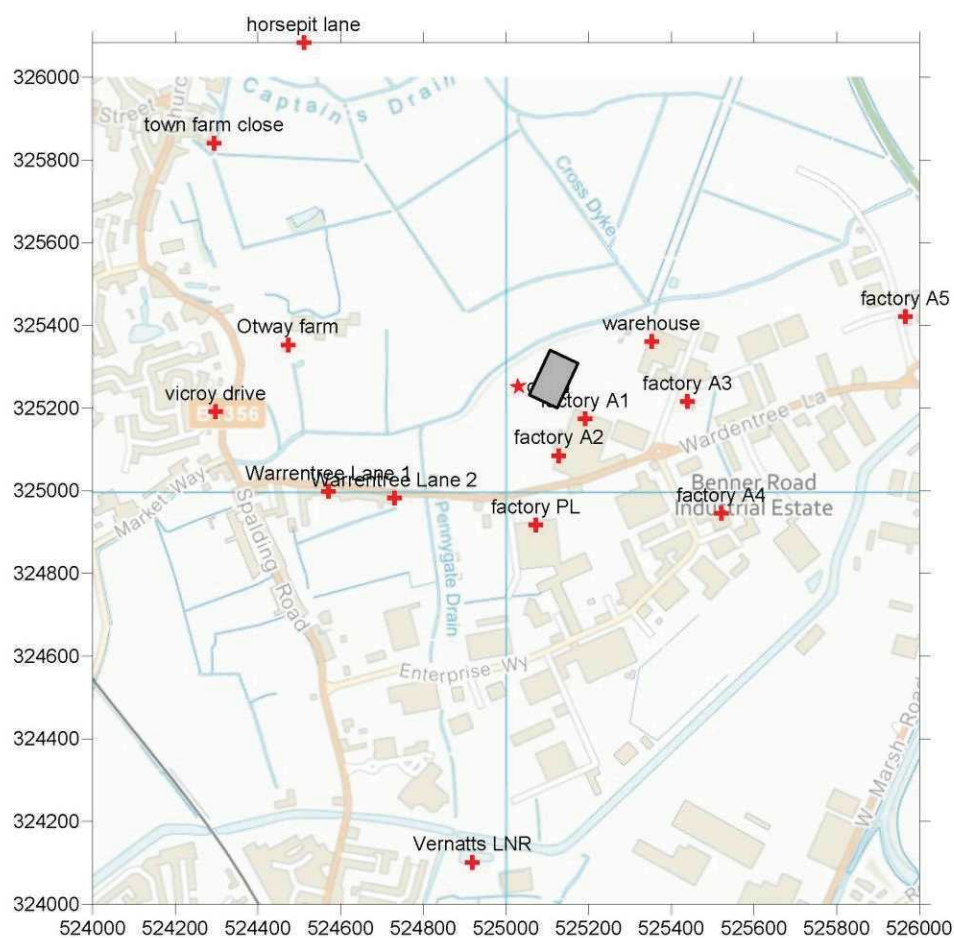
For the purposes of the modelling study it was assumed that the odour control system operates at 100% load continuously for the entire year.

2.3.4 Sensitive Receptors

Sensitive receptors include members of the public who may be exposed to releases arising from the operation of the proposed facility. Exposure is normally considered at locations such as domestic dwellings, hospitals and schools. A number of potentially sensitive receptors have been identified in close proximity to the plant and concentrations of odour were predicted at these locations. The sensitive receptors are shown in Table 5.

Table 5: Sensitive receptor locations considered in this study

Location	Easting	Northing
horsepit lane	524511	326084
town farm close	524294	325841
Otway farm	524473	325353
vicroy drive	524298	325191
Warrentree Lane 1	524571	324998
Warrentree Lane 2	524730	324982
warehouse	525352	325361
factory A1	525192	325174
factory A2	525128	325085
factory PL	525072	324917
Vernatts LNR	524919	324101
factory A3	525439	325216
factory A4	525521	324945
factory A5	525966	325421

Figure 1: Sensitive receptor locations considered in this study

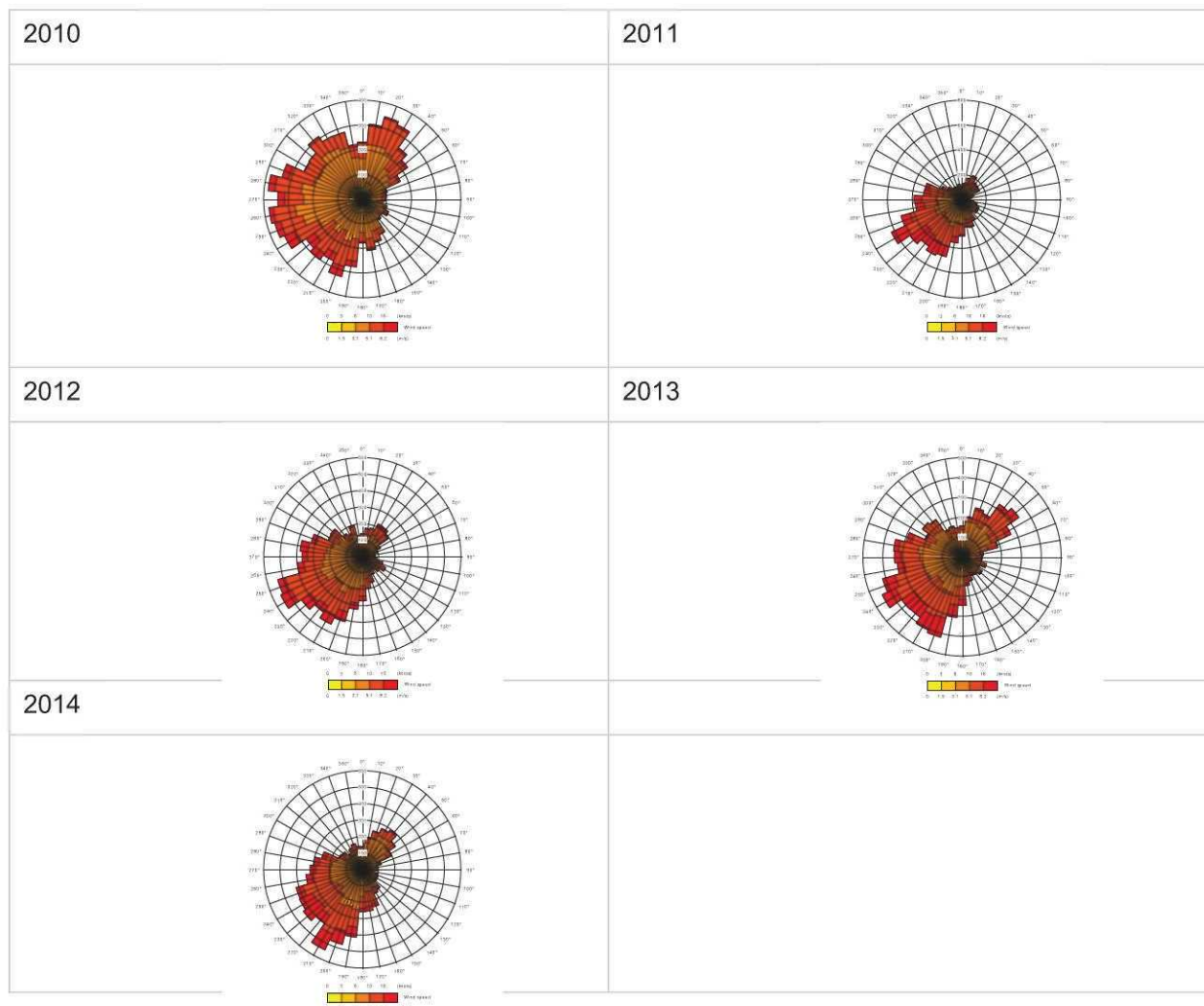
A receptor grid with dimensions 1.5km x 1.5km was also set up to cover the area surrounding the proposed site. The grid spacing was 15m.

2.3.5 Meteorological Data

The most appropriate meteorological station is the RAF Wittering weather station. This station is approximately 18km to the north west of the site. Five years of hourly sequential data recorded from 2010 – 2014 were used for the study. It has been assumed that the data are representative of conditions at the site. The wind roses for each year of meteorological data utilised in the assessment are shown in Figure 2.

Meteorological data was sourced from the NOAA surface observations archive and processed into hourly sequential ADMS format. Data filling was carried out where necessary according to the methodology provided by the USEPA in their “Meteorological Monitoring Guidance for Regulatory Modeling Applications” guidance document. The recommended filling procedure is based on the persistence method- this is where a missing value is replaced by the use of data from the previous hour(s). Missing cloud cover data is quite common in meteorological data sets though on this occasion after filling the data capture is good, i.e. >90%DC for all meteorological parameters.

Figure 2: Windrose for RAF Wittering 2010-2014



2.3.6 Terrain

Changes in topography in the vicinity of the site could potentially have an effect upon dispersion of pollutants. This is only likely to be significant in areas where large-scale slopes exceed a gradient of 1:10. A review of Ordnance Survey mapping of the local area indicates that the terrain is relatively flat. Therefore, the main modelling assessment was carried out without using the terrain module in ADMS.

2.3.7 Surface Roughness

The surface roughness is a length scale used to represent the turbulent effect of obstructions in the surrounding area. As the land surrounding the site is a mix of suburban and open land, a single surface roughness value for the assessment location of 0.3m was used.

3 Impact assessment and results

The results of the dispersion modelling from the biofilter and peripheral sources are set out in Table 7. The results are based on the maximum concentrations at the specific receptor for any of the five years of meteorological data used in the study. Throughout the study, these and other conservative assumptions have been used to ensure that any impacts are more likely to be over-estimated than under-estimated. These assumptions and the other main study inputs are detailed in Section 3 of this report.

Table 7 also presents the maximum concentration at the location of greatest impact. The results are presented for the open biofilter and for the peripheral source. .

Plots have been prepared to illustrate the location at which the maximum impact is likely to occur. Figure 3 shows the forecast contribution of odour for the biofilter.

Figure 3: Predicted odour concentration for the open biofilter (ouE/m^3 as 98thile 1 hour)

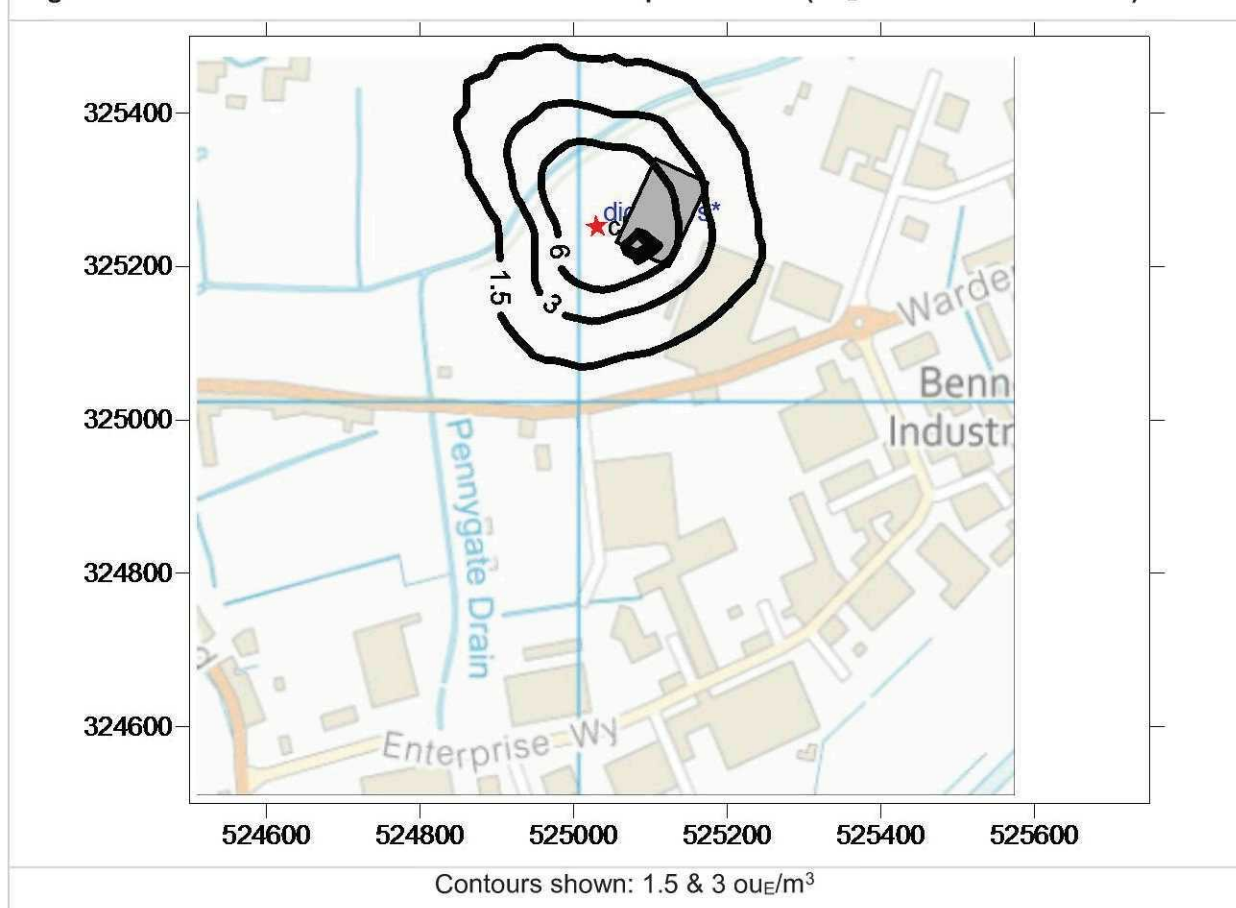


Table 7 Process contributions at specific receptor locations considered in this study

Location	Contribution from biofilter	Contribution from peripheral sources	Total contribution	% benchmark
horsepit lane	0.14	0.01	0.15	10%
town farm close	0.14	0.01	0.14	10%
Otway farm	0.15	0.01	0.16	10%
vicroy drive	0.06	0.00	0.06	4%
Warrentree Lane 1	0.16	0.01	0.17	11%
Warrentree Lane 2	0.25	0.02	0.28	18%
warehouse	0.56	0.03	0.59	20%
factory A1	2.03	0.09	2.12	71%
factory A2	1.30	0.06	1.37	46%
factory PL	0.45	0.02	0.47	16%
Vernatts LNR	0.06	0.00	0.06	2%
factory A3	0.43	0.02	0.45	15%
factory A4	0.19	0.01	0.20	7%
factory A5	0.10	0.01	0.11	4%

The impact assessment shown in Table 7 presents the analysis of odour concentrations at the receptor locations considered in this study. The combined impact of odour from the biofilter and the peripheral sources is predicted to represent only a small fraction of the odour benchmark of 1.5 ouE/m³ as a 98thile at residential locations. The analysis shows that the combined impact at the neighbouring industrial premises is predicted to meet the odour benchmark of 3 ouE/m³ as a 98thile for less sensitive locations.

The illustration presented in Figure 3show1 that the point of maximum odour impact lies in close proximity to the site, well away from residential properties. This location is either within or close to the site boundary where no members of the public are likely to have access.

4 Conclusion

This study sets out an analysis of predicted odour emissions from the AD operation.

The assessment shows that:

- Assuming that the odour emission rate from the biofilter is limited to 8,333 ou_E/s discharging from the biofilter surface, then the predicted odour level will be considerably less than 1.5ou_E/m³ as a 98thile at residential properties and less than 3 ou_E/m³ as a 98thile at less sensitive factor locations
- Assuming that the odour emission rate from the peripheral sources (dewatering plant, lagoons) are consistent with those found elsewhere then the predicted odour level will be considerably less than 1.5ou_E/m³ as a 98thile at all receptor locations.

RICARDO-AEA

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom

t: +44 (0)1235 753000

e: enquiry@ricardo-aea.com

www.ricardo-aea.com