# Bioaerosol Risk Assessment

## Malaby Biogas, Warminster

**Client: Malaby Biogas**

**Reference: 5141r4**

**Date: 15th September 2022**

## Report Issue

Report Title: Bioaerosol Risk Assessment - Malaby Biogas, Warminster

Report Reference: 5141

| Field | Report Version | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
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| Position | Director | Director | Director | Director |
| Date of Issue | 12th January 2022 | 18th January 2022 | 19th January 2022 | 15th September 2022 |
| Comments | Draft for comment | Updated following client comment | Updated following client comment | - |

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# 1.0 INTRODUCTION

## 1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by Malaby Biogas to undertake a Bioaerosol Risk Assessment in support of an Environmental Permit Application for the anaerobic digestion (AD) plant operated by the company at Bore Hill Farm Biodigester, Deverill Road, Warminster, BA12 8FB.

1.1.2 During the operation of the facility there is the potential for bioaerosol emissions and associated impacts at sensitive receptor locations in the vicinity of the site. A Risk Assessment has therefore been undertaken to identify potential emission sources and evaluate effects in the local area.

1.1.3 The purpose of this Bioaerosol Risk Assessment is to:

- Establish the likely sources of bioaerosols arising from operations at the site;
- Assess the potential for significant risk of impact at sensitive locations due to emissions from the identified sources; and,
- Identify any additional mitigation required to control potential effects.

## 1.2 Site Location and Context

1.2.1 The Malaby Biogas AD plant is located at Bore Hill Farm Biodigester, Deverill Road, Warminster, Wiltshire, BA12 8FB, at National Grid Reference (NGR): 386685, 143646. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 The site operates as a biological treatment facility under an Environmental Permit (No. EPR/AB3036RT) issued by the Environment Agency (EA). The following types of input materials are accepted and processed at the plant:

- Solid food and process wastes;
- Sludges; and,
- Pre-processed liquid wastes.

1.2.3 An Environmental Variation Permit Application is currently being made in order to authorise a number of changes to operations. These include an increase to the annual tonnage of waste which is permitted to be received at the site from 28,000 tonnes per annum (tpa) to 40,000tpa, as well as the potential installation of a biogas upgrade plant.

1.2.4 The application will also result in a change in the permit type from a 'waste operation' to an 'installation' in order to reflect the higher proposed treatment capacity. As an installation, there will be a requirement for the site to operate in accordance with Best Available Techniques (BAT).

1.2.5 The proposals have the potential to result in changes in bioaerosol emissions from operations at the plant and associated exposure at existing sensitive locations and a proposed residential development to the north of the facility. As such, a Bioaerosol Risk Assessment has been undertaken in order to identify potential emission sources and evaluate effects in the local area. This is detailed in the following report.

# 2.0 PROCESS DESCRIPTION

## 2.1 Introduction

2.1.1 A brief summary of the AD process is provided in the following Sections. It should be noted that the description incorporates all activities which will be undertaken at the site following implementation of the proposed changes.

## 2.2 Management

2.2.1 The overall management responsibility for the plant lies with Malaby Biogas. The day to day facility management is undertaken by a suitable trained appointed Manager and a team of trained operators and support staff who deal specifically with the operation of the plant.

2.2.2 Regular checks and maintenance of all plant and equipment are undertaken by the Management Team or appropriately trained staff in accordance with a planned preventive maintenance schedule. A range of spare parts is kept on site. If additional items are required these are generally available within a 24-hour period. In addition, there is certain amount of redundancy factored into the plant operation which allows for some items to be out of action temporarily but for the remainder of the facility to continue operating normally.

## 2.3 Feedstock Delivery and Storage

2.3.1 A summary of the feedstock delivery and storage procedures is provided in the following Sections.

**Solid Waste**

2.3.2 Unpackaged and packaged solid wastes are transferred to the facility in enclosed Heavy Goods Vehicles (HGVs). Following arrival, these drive directly into the reception building on the western section of the site and deposit loads within dedicated storage areas.

2.3.3 A fast-acting roller shutter door is used to allow delivery vehicle entry and exit to/from the building. This remains closed at all times except for when access is required in order to

maintain a sealed environment as far as practicable and limit the potential for fugitive bioaerosol emissions to the external atmosphere.

2.3.4 In accordance with EA guidance 'How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion'[1] and the European Commission (EC) 'Best Available Techniques (BAT) Reference Document for Waste Treatment'[2], air is extracted from the building and transferred to an existing LECA media wet scrubbing biofilter system for treatment prior to discharge to atmosphere via a dedicated dispersion stack. This terminates at a height of approximately 6m above ground level at the point of release and 16m above the overall yard level.

2.3.5 The biofilter has been designed to provide a minimum air residence time in excess of 45s in order to promote effective capture and treatment of emissions. In addition, the biofilter is maintained in accordance with EA guidance[3] to ensure optimum performance.

**Liquid Waste**

2.3.6 Liquid wastes are delivered to the site in vacuum tankers. Following arrival, the feedstocks are transferred into the existing buffer storage tank on the southern section of the facility using a mechanical pumping system. This is a closed arrangement and therefore feedstocks are not exposed to atmosphere during transfer.

2.3.7 A collection system at the offload point is utilised to capture any air displaced from the tankers during liquid waste delivery and transfer it to the biofilter for treatment prior to discharge to atmosphere via the dispersion stack.

2.3.8 Gas displaced from the storage tank during filling is vented directly to the gas line via sealed pipework. As such, there is no bioaerosol release to atmosphere as a result of liquid waste delivery.

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1 How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion, EA, 2013.

2 Best Available Techniques (BAT) Reference Document for Waste Treatment, EC, 2018.

3 How to comply with your environmental permit. Additional technical guidance for: composting and aerobic treatment sector, EA, 2013.

## 2.4 Preliminary Processing of Feedstocks

2.4.1 Solid waste is removed from the storage areas and deposited into a feed hopper located within the building using a front-end loading shovel. This removes any packaging and macerates the material prior to transfer via sealed pipework to the buffer tank. The pumping arrangement is a closed system and therefore the feedstocks are not exposed to atmosphere during transfer.

## 2.5 AD Plant Operation

2.5.1 The feedstocks are digested within two sealed AD tanks. These include all necessary non-return valves and pumps to ensure there are no losses from any part of the process. The facility is fully automated to maintain maximum efficiency at all times.

2.5.2 The biogas produced within the digestion process (a mixture of methane ($CH_4$), carbon dioxide ($CO_2$) and trace gases) is combusted within two existing Combined Heat and Power (CHP) units in order to generate electricity and heat. Exhaust gases from the CHP units are dispersed to atmosphere via two dedicated stacks.

2.5.3 The site also includes two boilers which are used for the combustion of biogas in the event that both CHP units are not operational, or if the plant has a unusually high heat demand. Based on review of historical data for the facility, the total operational period for the boilers is not anticipated to exceed 500-hours per annum during any given year.

2.5.4 A proportion of the biogas produced from the AD process will potentially be upgraded for use as road fuel. This will involve stripping out impurities, including $CO_2$, specific Volatile Organic Compounds (VOCs) and hydrogen sulphide ($H_2S$). $CO_2$ generated by the upgrading process will be discharged to atmosphere via a dedicated stack.

2.5.5 The site has an automatic back-up flare that burns gas in a controlled manner if the CHP units or proposed upgrade system stops temporarily, or if plant maintenance is required. Should the flare fail for any reason, the tanks are fitted with automatic emergency release valves to avoid over pressure. These are a necessary safety feature and only function as a last resort during abnormal operating conditions. A record of their use is kept and the reason for utilisation fully documented.

## 2.6 Digestate Production and Separation

2.6.1 The plant produces digestate as a by-product of the process which can be used as a biofertiliser. Many types of AD feedstocks are rich in nutrients. These remain within the material throughout the process, making digestate a valuable biofertiliser. By making the best possible use of digestate as a biofertiliser, nutrients are returned to the land through natural cycles to replace the input of inorganic fertiliser. Recycling in this way closes a loop to create more sustainable agricultural production systems.

2.6.2 The digestate is separated into grit and liquid fractions using an existing vibrating screen table which is housed within an enclosed unit. Air is extracted from the structure during operational periods and transferred to the biofilter abatement system for treatment prior to discharge to atmosphere via the dispersion stack. This arrangement helps to promote negative pressure and reduce the potential for fugitive bioaerosol emissions from the unit when access is required.

2.6.3 Grit is discharged from the separator into an Intermediate Bulk Container (IBC) for storage prior to removal from the site. The liquid fraction is transferred to a pasteurisation unit for heat treatment prior to storage within an existing tank and subsequent transfer off-site.

## 2.7 Pasteurisation

2.7.1 The liquid digestate fraction is subject to heat treatment in an existing pasteurisation unit. Gas displaced from the pasteuriser during filling is vented directly to the gas line via sealed pipework. As such, there is no bioaerosol release to atmosphere from this source during normal operation.

2.7.2 Pasteurised digestate is transferred to an existing storage tank located on the southern section of the facility. Gas displaced from the tank during filling is vented directly to the gas line via sealed pipework. As such, there is no bioaerosol release to atmosphere from this source during normal operation.

## 2.8 Liquid Digestate Transfer Off-site

2.8.1 Liquid digestate is transported off site in vacuum tankers. These couple to the outlet point using a hose before the material is transferred from the storage tank using a mechanical

pumping system. The pumping arrangement is a closed system and therefore the digestate is not exposed to atmosphere during removal. Air displaced from the tankers during filling is transferred to an existing condensate trap prior to introduction to the biofilter inlet feed for abatement before discharge to atmosphere via the dispersion stack.

# 3.0 BIOAEROSOL BACKGROUND

## 3.1 Bioaerosol Definition

3.1.1 Bioaerosol is a general term for microorganisms suspended in the air. These microorganisms include fungi and bacteria, as well as their components such as mycotoxins, endotoxins and glucans. Bioaerosols are generally less than 100µm in size and are not filtered out by hairs and specialised cells that line the nose. Due to their airborne nature and small size, many bioaerosols can penetrate the human respiratory system, resulting in inflammatory and allergic responses.

3.1.2 Although bioaerosols are ubiquitous, operations involving organic materials provide environments that are conducive to their growth. Bioaerosols are therefore likely to be associated with AD feedstocks and products, and in particular, handling activities, which release the microorganisms into the air.

## 3.2 Health Risks from Bioaerosols

3.2.1 Exposure to bioaerosols has been associated with human health effects, symptoms can include inflammation of the respiratory system, coughs and fever. Inhalation of bioaerosols may also cause or exacerbate respiratory diseases[4]. They have been known to cause gastrointestinal illness, eye irritation and dermatitis.

3.2.2 Possible links have also been made between exposure to bioaerosols and organic dust toxic syndrome. This is an acute disease that causes symptoms resembling those of influenza, such as shivering, an increase in body temperature, dry cough and muscle and joint pains. Of particular relevance to waste management facilities are infections caused by Aspergillus fumigatus. Invasive aspergillosis is a particularly severe infection, which may be fatal and is primarily a concern with at risk and immuno-suppressed patients.

3.2.3 Although some data is available, one of the major knowledge gaps for bioaerosols is their associated dose-response relationships. It is not currently possible to state with any certainty that a given concentration will result in a particular health impact. This is due to

[4] Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.

the number of bioaerosols that are naturally present within the environment as well as the complexities associated with human responses to different microorganisms.

### 3.3 Bioaerosol Emissions from Waste Management Operations

3.3.1 Most scientific research on bioaerosol emissions from waste management operations focusses on open windrow and In-Vessel Composting (IVC) systems. Although it is recognised that there are fundamental differences between composting and AD processes, there are similarities between the types of feedstocks, handling activities and infrastructure utilised. As such, a review of relevant research has been undertaken in order to inform the assessment. The findings are detailed in the following Section.

3.3.2 The EA document 'Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data'[5] summarises the findings of emissions measurement work undertaken at three composting facilities, including two open air turned windrow sites and one IVC plant. The results from the work indicated a well-defined decline in concentrations of bioaerosols with increased distance from source. In most cases, measured concentrations were at or below background levels within 250m of the sources assessed.

3.3.3 The ADAS report 'Bioaerosol Monitoring and Dispersal from Composting Sites'[6] provides a summary of the findings from measurement work undertaken at three composting sites. Sampling for bioaerosols was undertaken downwind of a wide range of composting activities including shredding, turning, loading, unloading and screening. The results indicated that 91% of all micro-organisms sampled across all three sites were below 1,000cfu/$m^3$ at a downwind distance of 125m.

3.3.4 The Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) report 'Measurement and Modelling of Emissions from Three Composting Sites'[7] provides a summary of the findings from monitoring work undertaken at three composting sites, which included two IVC facilities and one open windrow system. The findings indicated that there is the potential for seasonal variation in ambient concentrations of the mould of Aspergillus fumigatus, with concentrations being the highest in the autumn. In most

5 Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data, EA, 2001.

6 Bioaerosol Monitoring and Dispersal from Composting Sites, ADAS, 2005.

7 Measurement and Modelling of Emissions from Three Composting Sites, SNIFFER, 2007.

cases, levels of all bioaerosols assessed were at or below background equivalent concentrations within 250m of the sources assessed.

3.3.5 The Department for Environment Food and Rural Affairs (DEFRA) research report 'Bioaerosols and odour emissions from composting facilities'[8] focusses on the comparability of different sampling methodologies and the influence of spatial and temporal variation on ambient bioaerosol concentrations. Measurements were undertaken at four different composting facilities in England, which represent a range of system types. The results of the study corroborate existing research and suggest that concentrations of bioaerosols generally return to background levels within 250m of the source.

3.3.6 The findings of the review have been considered as appropriate throughout the assessment.

## 3.4 Legislative Control

3.4.1 Atmospheric emissions from industry are controlled in the UK through the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. The operation of an AD plant is included within the Regulations and as such the facility is required to operate in accordance with an Environmental Permit issued by the EA.

## 3.5 Environment Agency Policy

3.5.1 The EA Regulatory Position Statement (RPS) 'Bioaerosol monitoring at regulated facilities - use of M9: RPS 209'[9] outlines the conditions that apply to facilities in relation to bioaerosol emissions.

3.5.2 The RPS states that if a regulated facility is located within 250m of a sensitive receptor (a place where people live or work for more than 6-hours at a time), the operator must:

8 Bioaerosols and odour emissions from composting facilities, DEFRA, 2013.

9 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.

- Monitor bioaerosols in accordance with EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[10]; and,
- Undertake a site specific Bioaerosol Risk Assessment.

3.5.3 The conditions outlined within the RPS have been considered as appropriate throughout the assessment.

## 3.6 Benchmark Levels

3.6.1 In the absence of dose-response data, the EA have adopted a precautionary risk-based approach in determining guidance levels for bioaerosols. The EA position statement 'Composting and potential health effects from bioaerosols: our interim guidance for permit applicants'[11] specifies the following criteria for acceptable concentrations of Aspergillus fumigatus and total bacteria at sensitive receptor locations:

- Aspergillus fumigatus - 500cfu/$m^3$; and,
- Total bacteria - 1,000cfu/$m^3$.

3.6.2 The relevant benchmark levels have been considered as appropriate throughout the assessment.

## 3.7 Technical Guidance

3.7.1 The EA guidance 'How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion'[12] sets out indicative Best Available Technique (BAT) or appropriate measures for the AD of organic materials. The document provides practical guidance on how and why bioaerosol emissions occur, as well as measures that can be employed to prevent or minimise release.

3.7.2 The requirements of the guidance have been considered throughout the assessment.

[10] M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.

[11] Composting and potential health effects from bioaerosols: our interim guidance for permit applicants, EA, 2010.

[12] How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion, EA, 2013.

# 4.0 PROBLEM DEFINITION

## 4.1 Introduction

4.1.1 The first stage of any risk assessment is to clearly set out the problem, including what will be addressed and what will not. This determines the scope, level of detail and focus. In particular, the temporal and spatial scales, contaminants to be assessed, persons at risk and the endpoint are identified. These factors are considered in the following Sections.

## 4.2 Conceptual Model

4.2.1 Potential hazards from bioaerosols are summarised in the conceptual model in Table 1.

**Table 1 Conceptual Model**

| Criteria | Comment |
|---|---|
| Source | Feedstocks and products on the site as outlined in Section 4.3 |
| Hazard | Potential adverse health impacts as outlined in Section 2.2 |
| Transport Mechanism | Airborne |
| Medium of Exposure | Inhalation, ingestion, absorption, injection |
| Receptor | Human receptors at the proposed site as outlined in Section 4.4 |

## 4.3 Sources

4.3.1 The operation of the AD plant may result in bioaerosol emissions from a number of activities. A review of operations was undertaken in order to identify relevant emissions sources for inclusion in the assessment. This identified the following:

- Fugitive emissions from the waste reception building;
- Fugitive emissions from the digestate separation unit; and,
- Emissions from the biofilter dispersion stack.

4.3.2 Reference should be made to Figure 2 for a visual representation of the source locations.

4.3.3 As stated previously, the actual AD process itself is sealed and therefore does not form a source of bioaerosols under normal operation. The digesters feature release valves to avoid over pressure. Any gases emitted from the valves are likely to contain bioaerosols as a result of the digestion processes. However, releases from these sources are likely to be extremely infrequent and short-term as they would only occur in an emergency situation. As such, the risk of impact from emissions is not considered to be significant and they have not been evaluated further in the context of this assessment.

4.3.4 The CHP units and flare stack only emit products of combustion which do not contain any bioaerosols. As such, they have not been considered further in this report.

4.3.5 Biogas for potential upgrade to biomethane will be passed through an activated carbon filter to remove specific compounds before $CO_2$ is stripped through selective membranes and vented to atmosphere. The system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the carbon media during operation. As such, the risk of impact from residual emissions is not considered to be significant and they have not been evaluated further in the context of this assessment.

4.3.6 The potential for bioaerosol emissions from each remaining source is considered further in the following Sections.

**Reception Building**

4.3.7 The reception building is fully enclosed and a fast-acting roller shutter door is utilised in order to promote effective containment of bioaerosols. In addition, air is extracted from the building and transferred to a biofilter abatement system for treatment prior to discharge to atmosphere via a dedicated dispersion stack. This arrangement helps to promote negative pressure within the building and reduce the potential for fugitive bioaerosol emissions when the roller shutter door is opened to allow vehicle access.

4.3.8 Notwithstanding the stated control measures, there may be the potential for fugitive bioaerosol releases from the reception building when the roller shutter door is opened to allow vehicle access. As such, potential emissions have been considered further as part of the assessment.

**Digestate Separation Unit**

4.3.9 As stated previously, the digestate separation unit is enclosed in order to promote effective containment of bioaerosols. In accordance with EA guidance[13], air is extracted from the structure and transferred to the biofilter abatement system for treatment prior to discharge to atmosphere via the dispersion stack. This arrangement helps to promote negative pressure within the unit and reduce the potential for fugitive bioaerosol emissions during operation.

4.3.10 Notwithstanding the stated control measures, there may be the potential for fugitive bioaerosol releases when the access door is opened. As such, potential emissions have been considered further as part of the assessment.

**Biofilter**

4.3.11 Air extracted from the reception building is transferred to an existing LECA media wet scrubbing biofilter system for treatment prior to discharge to atmosphere via a dedicated dispersion stack at a height of approximately 6m above ground level at the point of release and 16m above the overall yard level. The biofilter also provides abatement of air displaced from liquid waste delivery and digestate tankers.

4.3.12 There is currently limited scientific evidence in regards the effectiveness of biofilters in reducing bioaerosol emissions. However, the SNIFFER document 'Understanding biofilter performance and determining emission concentrations under operational conditions'[14] indicates that biofilters have the capacity to remove large concentrations of bioaerosols, which is thought to be facilitated through physical impaction of microorganisms onto the media. However, it is also noted within the report that biofilters can act as emitters of bioaerosols, particularly bacteria, which naturally populate the media.

[13] How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion, EA, 2013.

[14] Understanding biofilter performance and determining emission concentrations under operational conditions, Sniffer, 2014.

4.3.13 In accordance with EA guidance[15], the biofilter has been designed to provide a minimum air residence time of 45s in order to promote effective capture and treatment of emissions. In addition, the biofilter is maintained in accordance with EA guidance[16] to ensure optimum performance. However, there is the potential for residual bioaerosol emissions from the system. As such, potential releases have been considered further as part of the assessment.

## 4.4 Other Sources of Bioaerosols

4.4.1 There is agricultural land use in the immediate vicinity of the site. Arable fields may form further sources of bioaerosols if fertilised with animal manures or slurries, as well as during crop harvest periods. However, likely impacts associated with these releases are not considered to be significant and would be expected for any rural location within the UK.

## 4.5 Receptors

4.5.1 EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[17] defines a sensitive receptor as follows:

> "Nearest sensitive receptor means the nearest place to the permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation, but would apply to dwellings occupied by the family of those controlling the facility."

15 How to comply with your environmental permit. Additional technical guidance for: composting and aerobic treatment sector, EA, 2013.

16 How to comply with your environmental permit. Additional technical guidance for: composting and aerobic treatment sector, EA, 2013.

17 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.

4.5.2 A desk-top study was undertaken in order to identify any sensitive receptors in the vicinity of the site that required specific consideration during the assessment. These are summarised in Table 2.

4.5.3 It should be noted that R11 to R14 were selected to represent residential properties associated with a proposed development to the north of the site. This provided a robust appraisal of potential impacts should planning consent be granted for the scheme.

**Table 2 Sensitive Receptors**

| Receptor | | NGR (m) | | Distance from Closest Source (m) | Direction from AD Plant |
|---|---|---|---|---|---|
| | | X | Y | | |
| R1 | Residential - Deverill Road | 386747.9 | 143697.8 | 70 | north-east |
| R2 | Residential - Butler's Coombe Farm | 386961.4 | 143589.2 | 250 | East |
| R3 | Residential - A350 | 386795.7 | 143432.0 | 180 | South-east |
| R4 | Farm - A350 | 386709.6 | 143315.8 | 280 | South |
| R5 | Residential - Bradley Close | 386505.3 | 143833.9 | 220 | North-west |
| R6 | Residential - Ludlow Close | 386594.3 | 143881.0 | 220 | North-west |
| R7 | Residential - Ludlow Close | 386685.4 | 143890.7 | 230 | North |
| R8 | Residential - Ludlow Close | 386765.2 | 143865.5 | 210 | North |
| R9 | Residential - Ashley Place | 386845.7 | 143815.0 | 220 | North-east |
| R10 | Residential - Ashley Coombe | 387018.9 | 143842.7 | 370 | North-east |
| R11 | Residential - Proposed development | 386570.6 | 143720.6 | 90 | North-west |
| R12 | Residential - Proposed development | 386632.2 | 143745.6 | 80 | North |
| R13 | Residential - Proposed development | 386691.3 | 143747.9 | 90 | North-east |
| R14 | Residential - Proposed development | 386737.8 | 143736.9 | 100 | North-east |

4.5.4 Reference should be made to Figure 3 for a visual representation of the identified receptors.

## 4.6 Prevailing Meteorological Conditions

4.6.1 The potential for bioaerosol emissions to impact at sensitive locations depends significantly on the meteorology, particularly wind direction, during release. In order to consider prevailing conditions at the site review of historical weather data was undertaken. Boscombe Down meteorological station is located at NGR: 417750, 140293, which is approximately 31.2km east of the facility. It is anticipated that conditions would be reasonably similar over a distance of this magnitude. The data was therefore considered suitable for an assessment of this nature.

4.6.2 Meteorological data was obtained from Boscombe Down meteorological station over the period 1st January 2017 to 31st December 2021 (inclusive). The frequency of wind from the eight sectors which best describe the directions which may cause impacts in the vicinity of the site is shown in Table 3. Reference should be made to Figure 4 for a wind rose of the meteorological data.

**Table 3 Wind Frequency Data**

| Wind Direction (°) | Frequency of Wind (%) |
|---|---|
| 337.5 - 22.5 | 10.18 |
| 22.5 - 67.5 | 7.57 |
| 67.5 - 112.5 | 8.63 |
| 112.5 - 157.5 | 6.46 |
| 157.5 - 202.5 | 16.64 |
| 202.5 - 247.5 | 16.71 |
| 247.5 - 292.5 | 18.21 |
| 292.5 - 337.5 | 11.19 |
| Sub-Total | 95.59 |
| Calms | 0.75 |
| Missing/Incomplete | 3.66 |

4.6.3 All meteorological data used in the assessment was provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of meteorological data within the UK.

4.6.4 As shown in Table 3, the prevailing wind direction at the AD facility is from the west. Winds from the north and east are relatively infrequent, which is indicative of conditions throughout the UK.

# 5.0 RISK ASSESSMENT METHODOLOGY

## 5.1 Overview

5.1.1 The Bioaerosol Risk Assessment has been undertaken in accordance with the general principles of EA document 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities'[18]. This included consideration of the following:

- Receptor - what is at risk? What do I wish to protect?
- Source - what is the agent or process with potential to cause harm?
- Harm - what are the harmful consequences if things go wrong?
- Pathway - how might the receptor come into contact with the source?
- Probability of exposure - how likely is this contact?
- Consequence - how severe will the consequences be if this occurs?
- Magnitude of risk - what is the overall magnitude of the risk? and,
- Justification for magnitude - on what did I base my judgement?

5.1.2 Based on the Bioaerosol Risk Assessment outcomes potential mitigation and control options were identified.

5.1.3 Further explanation for the key assessment areas is provided below.

## 5.2 Receptor

5.2.1 The first step was to consider how the activity could harm the environment. This involved identifying 'receptors' that may be affected and included people, property, and the natural and physical environment.

## 5.3 Probability of Exposure

5.3.1 The probability of exposure was defined based on the likelihood of exposure of the specific receptor to the identified sources. This depended on several factors, such as:

- Distance between source and receptor;

[18] Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.

- Dispersion potential of emission;
- Duration of emission; and,
- Frequency of emission.

5.3.2 Probability was categorised in accordance with the following criteria:

- High - exposure is probable, direct exposure likely with no/few barriers between source and receptor;
- Medium - exposure is fairly probable, barriers less controllable;
- Low - exposure unlikely, barriers exist to mitigate; or,
- Very low - exposure very unlikely, effective and multiple barriers.

## 5.4 Harm

5.4.1 The severity of harm from a risk depends on:

- How much a person or part of the environment is exposed; and,
- How sensitive a person or part of the environment is.

5.4.2 Some parts of the environment can be very sensitive. For example, serious health effects can occur if humans are exposed to certain chemicals for only short periods of time.

5.4.3 Harm can be described as follows:

- High - severe consequences, evidence that exposure may result in serious damage;
- Medium - significant consequences, evidence that exposure may result in damage that is not severe and is reversible;
- Low - minor consequences, damage not apparent, reversible adverse changes possible; and,
- Very low - negligible consequences, no evidence for adverse changes.

## 5.5 Magnitude of Risk

5.5.1 The level of risk is a combination of:

- How likely a problem is to occur; and,

- How serious the harm might be.

5.5.2 Risk is highest where both the likelihood of a problem is high and the potential harm is severe. Risk is lowest where a problem is unlikely to occur and the harm that might result is not serious.

5.5.3 Risk was defined based on the interaction between the probability of exposure and potential harm, as outlined in Table 4.

**Table 4 Magnitude of Risk**

| Probability of Exposure | Potential Harm | | | |
|---|---|---|---|---|
| | Very Low | Low | Medium | High |
| High | Low | Medium | High | High |
| Medium | Low | Medium | Medium | High |
| Low | Low | Low | Medium | Medium |
| Very Low | Very Low | Low | Low | Medium |

## 5.6 Further Requirements

5.6.1 Based on the outcomes of the risk assessment the EA document provides guidance on further requirements for different risks. These can be summarised as follows:

- High risks - additional assessment and active management;
- Medium risks - likely to require further assessment and may require either active management or monitoring; and,
- Low and very low risk - will only require periodic review.

5.6.2 Mitigation to reduce risk can also be applied to avoid the requirement for further assessment and/or monitoring.

## 6.0 RISK ASSESSMENT

6.1.1 The Bioaerosol Risk Assessment is shown in Table 5.

**Table 5 Risk Assessment**

| Source | Probability of Exposure | Harm | Magnitude of Risk | Control Measures | Residual Risk | Justification for Residual Risk |
|---|---|---|---|---|---|---|
| Fugitive emissions from the waste reception building | **Low** at R1, R13 and R14 due to containment of emissions within the building, the distance between the source and receptors, which ranges between approximately 70m and 100m, and the frequency of winds blowing towards the locations<br><br>**Very Low** at R2 to R12 due to containment of emissions within the building, the distance between the source and receptors, which ranges between approximately 110m and 370m and the frequency of winds blowing towards the locations | **Medium** | **Low** or **Medium** | The building features a fast-acting roller shutter door. This remains closed at all times, except for when vehicles require access to the building, in order to reduce the potential for fugitive emissions<br><br>Air is extracted from the building and transferred to the biofilter abatement system for treatment prior to discharge to atmosphere via a dedicated dispersion stack. This arrangement helps to promote negative pressure within the building and reduce the potential for fugitive bioaerosol emissions when the roller shutter door is opened to allow vehicle access | **Low** | Effective containment of emissions within the building and the stated control measures are considered to result in **low** residual risk of impact occurring |

| Source | Probability of Exposure | Harm | Magnitude of Risk | Control Measures | Residual Risk | Justification for Residual Risk |
|---|---|---|---|---|---|---|
| Fugitive emissions from the digestate separation unit | **Low** at R1, R13 and R14 due to containment of emissions within the unit, the distance between the source and receptors, which ranges between approximately 110m and 150m, and the frequency of winds blowing towards the locations<br><br>**Very Low** at R2 to R12 due to containment of emissions within the building, the distance between the source and receptors, which ranges between approximately 170m and 400m, and the frequency of winds blowing towards the locations | **Medium** | **Low** or **Medium** | The unit is enclosed and the door remains closed at all times, except for when access is required, in order to reduce the potential for fugitive emissions<br><br>Air is extracted from the unit and transferred to the biofilter abatement system for treatment prior to discharge to atmosphere via a dedicated dispersion stack. This arrangement helps to promote negative pressure and reduce the potential for fugitive bioaerosol emissions when the door is opened to allow access | **Low** | Effective containment of emissions within the building and the stated control measures are considered to result in **low** residual risk of impact occurring |

| Source | Probability of Exposure | Harm | Magnitude of Risk | Control Measures | Residual Risk | Justification for Residual Risk |
|---|---|---|---|---|---|---|
| Emissions from the biofilter dispersion stack | **Low** at R1, R12, R13 and R14 due to the distance between the source and receptors, which ranges between approximately 80m and 120m, and the frequency of winds blowing towards the locations<br><br>**Very Low** at R2 to R11 due to the distance between the source and receptors, which ranges between approximately 90m and 410m, and the frequency of winds blowing towards the locations | **Medium** | **Low** or **Medium** | The biofilter provides a minimum air residence time of 45s in order to promote effective capture and treatment of emissions<br><br>Treated air from the biofilter is discharged to atmosphere at high level via a dedicated stack in order to promote effective dilution and dispersion of any residual bioaerosol emissions<br><br>The biofilter is maintained in accordance with relevant best practice guidance | **Low** | Biofilters have the capacity to remove large concentrations of bioaerosols, through physical impaction of microorganisms onto the media<br><br>Implementation of the stated control measures is considered to result in a **low** residual risk of impact occurring due to emissions |

6.1.2 As shown in Table 5, the results of the assessment indicated that the residual risk from all sources was **low** at all existing and proposed receptor locations. As such, it is concluded that no further control measures, other than those specified, are required in order reduce the potential for impacts at sensitive locations in the vicinity of the site.

## 7.0 CONCLUSION

7.1.1 Redmore Environmental Ltd was commissioned by Malaby Biogas to undertake a Bioaerosol Risk Assessment in support of an Environmental Permit Application for the AD plant operated by the company at Bore Hill Farm Biodigester, Deverill Road, Warminster, BA12 8FB.

7.1.2 During the operation of the facility there is the potential for bioaerosol emissions and associated impacts at existing sensitive locations and a proposed residential development to the north of the site. A Risk Assessment was therefore undertaken to identify potential emission sources and evaluate effects in the local area.

7.1.3 The following potential bioaerosol emission sources were identified:

- Fugitive emissions from the waste reception building;
- Fugitive emissions from the digestate separation unit; and,
- Emissions from the biofilter dispersion stack.

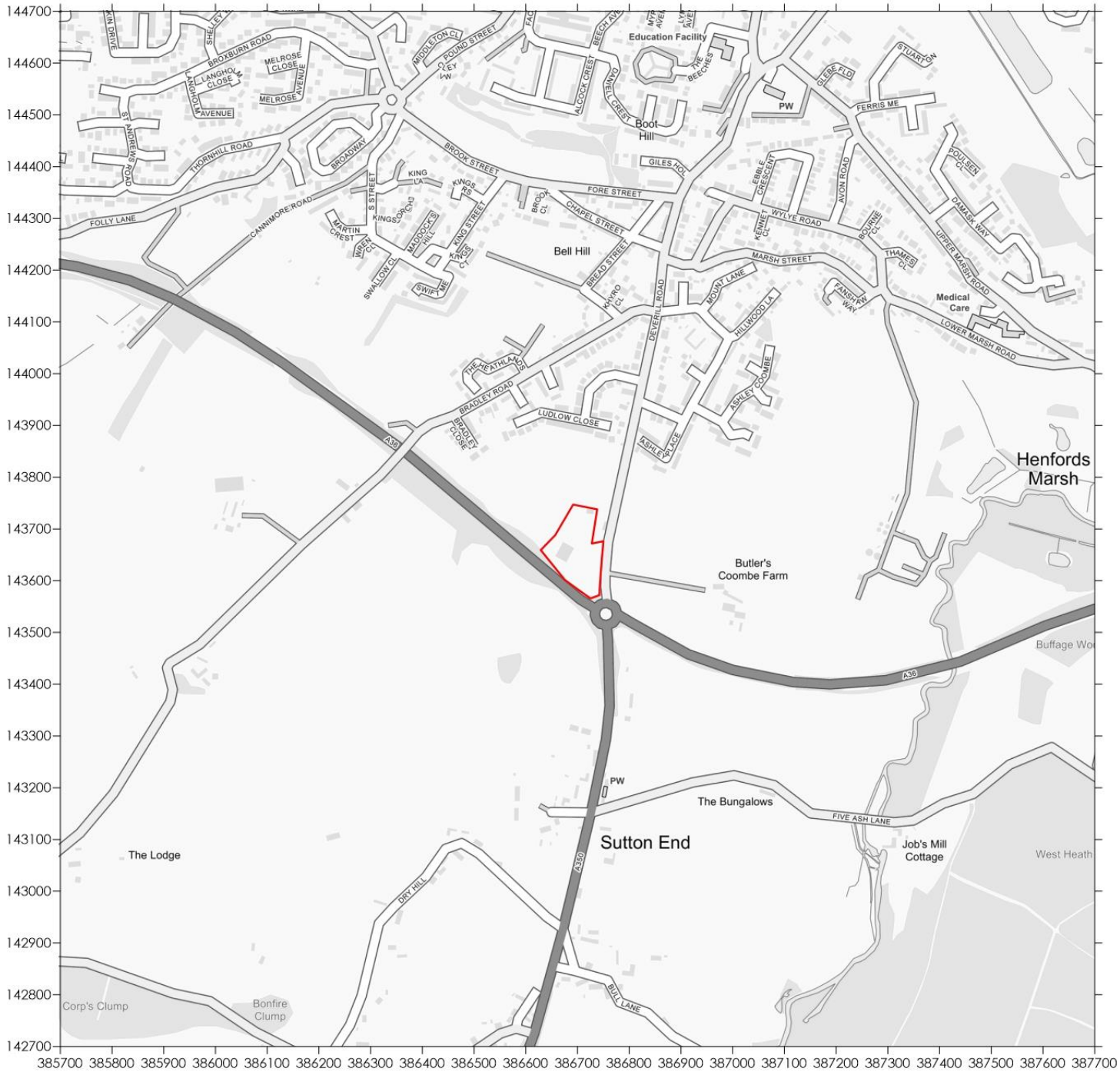
7.1.4 The risk of significant bioaerosol impact at sensitive locations in the vicinity of the site for each of the identified sources was assessed using a source - pathway - receptor approach. This considered the nature of the potential emission, any barriers to dispersion and the severity of harm.

7.1.5 The results of the assessment indicated that the residual risk from all sources was **low** at all existing and proposed receptor locations. As such, potential impacts as a result of bioaerosol emissions from the facility are not considered to be **not significant** and no further control measures, other than those specified, are required in order reduce the potential for impacts at sensitive locations in the vicinity of the site.

## 8.0 ABBREVIATIONS

| | |
|---|---|
| AD | Anaerobic Digestion |
| BAT | Best available Techniques |
| $CH_4$ | Methane |
| CHP | Combined Heat and Power |
| $CO_2$ | Carbon dioxide |
| DEFRA | Department for Environment, Food and Rural Affairs |
| EA | Environment Agency |
| HGV | Heavy Goods Vehicle |
| $H_2S$ | Hydrogen sulphide |
| IBC | Intermediate Bulk Container |
| IVC | In-Vessel Composting |
| NGR | National Grid Reference |
| RPS | Regulatory Position Statement |
| SNIFFER | Scotland and Northern Ireland Forum for Environmental Research |
| VOC | Volatile Organic Compound |

# Figures




**Legend**

Site Boundary

**Title**
Figure 1 - Site Location

**Project**
Bioaerosol Risk Assessment
Malaby Biogas, Warminster

**Project Reference**
5141

**Client**
Malaby Biogas



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**Legend**

Site Boundary

Bioaerosol Source

**Title**
Figure 2 - Bioaerosol Sources

**Project**
Bioaerosol Risk Assessment
Malaby Biogas, Warminster

**Project Reference**
5141

**Client**
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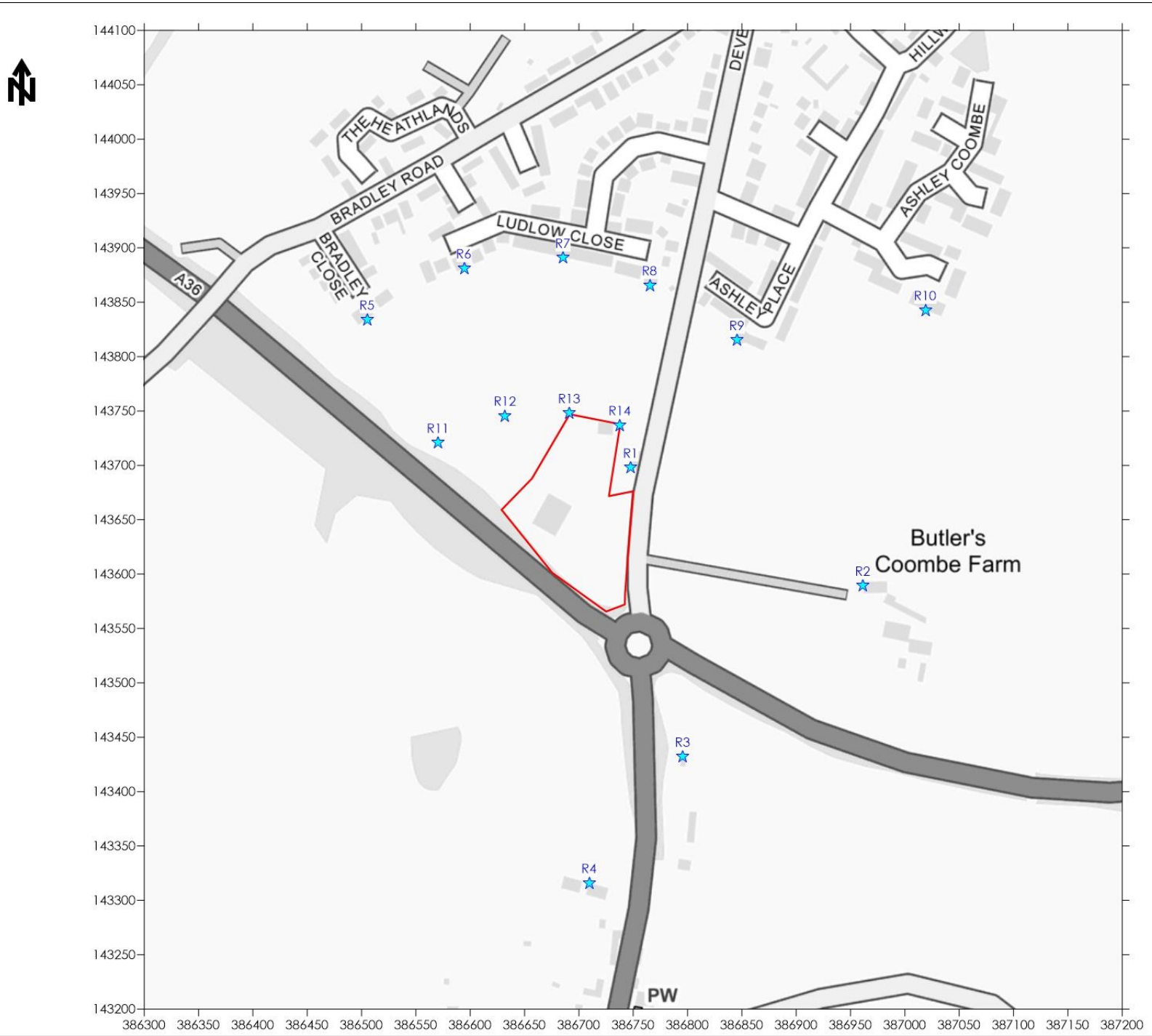


**Legend**

Site Boundary

Sensitive Receptor

**Title**
Figure 3 - Sensitive Receptors

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Malaby Biogas, Warminster

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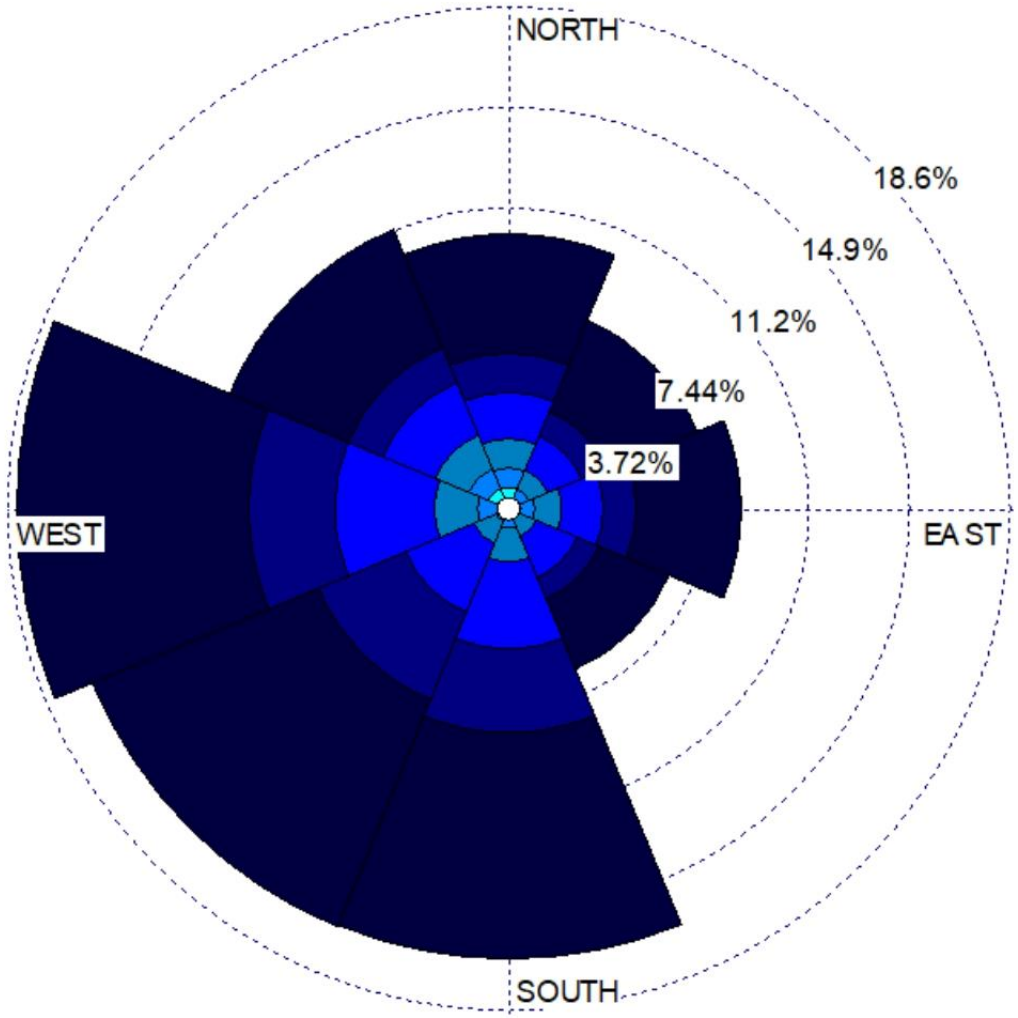


**Legend**

WIND SPEED (m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 0.75%

**Title**
Figure 4 - Wind Rose of 2017 to 2021 Boscombe Down Meteorological Data

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