Site Specific Bioaerosol Risk Assessment

Devon Anaerobic Digestion Plant, Cullompton

Client: Earthcare Technical Ltd

Reference: 10945r2

Date: 15th July 2026



Report Issue

Report Title: Site Specific Bioaerosol Risk Assessment - Devon Anaerobic Digestion Plant, Cullompton

Report Reference: 10945

Field	Report Version			
	1	2	3	4
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Date of Issue	19th June 2026	15th July 2026		
Comments	Draft for Comment	-		

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1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by Earthcare Technical Ltd to undertake a Site Specific Bioaerosol Risk Assessment (SSBRA) in support of an Environmental Permit Application for the Devon Anaerobic Digestion (AD) plant on land off Hide Market Road, Willand, Cullompton, EX15 2FP.

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 SSBRA 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 proposed 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 AD plant is located on land off Hide Market Road, Willand, at approximate National Grid Reference (NGR): 302988, 111218. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 The site comprises an existing operational AD plant. The facility was originally granted planning permission in October 2014 (ref: DCC/3725/2014). Since then, a number of amendments to the plant design and site layout have been approved through the planning process, whilst the site has remained operational as an AD facility. The plant currently treats a range of feedstocks including energy crops, crop residues and livestock manures.

1.2.3 It is proposed to install a new silage clamp at the facility, as well as complete upgrades to the existing infrastructure. Following completion of the modifications, the treatment

capacity of the plant will exceed 100 tonnes per day which constitutes a listed activity under Schedule 1 of the Environmental Permitting (England and Wales) Regulations 2016. As such, there is a requirement for the facility to obtain a Bespoke Environmental Permit from the Environment Agency (EA) in order to authorise operation as an A(1) Installation.

1.2.4 The operation of the plant may result in bioaerosol emissions from a number of activities. These have the potential to cause impacts at sensitive locations within the vicinity of the site and have therefore been assessed within this report.

2.0 PROCESS DESCRIPTION

2.1 Introduction

2.1.1 A brief summary of the AD process, incorporating the proposed changes to operations and infrastructure, is provided in the following Sections. Reference should be made to Figure 2 for a site layout plan.

2.2 Feedstock Delivery and Storage

2.2.1 The plant will process approximately 101,000 tonnes per annum (tpa) of energy crops, crop residues and livestock wastes. A summary of the types and quantities of materials that will be processed is provided in Table 1.

Table 1 Feedstock Types, Storage Areas and Quantities

Feedstock Type	Storage Area	Quantity (tpa)
Maize silage	Silage clamp	25,000
Wholecrop silage	Silage clamp	15,000
Grass	Silage clamp	6,200
Straw	Silage clamp	12,400
Oat pellets	Silage clamp	3,780
Cereal grain	Silage clamp	4,400
Chicken manure	Manure reception building (MRB)	14,000
Pig slurry	Liquid feedstock tank	10,000
Cattle slurry	Liquid feedstock tank	10,000
Dirty Water	Process water lagoon	20,000
Separated liquid digestate	Separated liquid storage tank	25,500
Total		100,780

2.2.2 A summary of the proposed delivery and storage procedures for the feedstocks is provided in the following Sections.

Energy Crops

2.2.3 Energy crops will be transferred to the facility in Heavy Duty Vehicles (HDVs) during harvest periods and deposited within a clamp located on the western section of the site. The clamp has a maximum storage capacity of 21,500m^3.

2.2.4 The clamp will be compacted and covered with an impermeable membrane. This will form an airtight layer to minimise emissions and maintain anaerobic conditions to ensile and preserve the silage throughout the year. It should be noted that any decomposition of the material would affect its effectiveness as a feedstock. As such, the protective sheeting will be specified to prevent water and air reaching the material and hence avoid any unwanted breakdown and associated emissions. The cover on the clamps will be slightly open at one end during cutting phases to allow access to the feedstock for removal and transportation to the AD plant feed hoppers.

2.2.5 Any leachate generated by the feedstocks during storage will be transferred to the covered dirty water lagoon before feeding into the AD process.

Crop Residues

2.2.6 Crop residues, which include oat pellets and cereal grain, will be transferred to the facility in HDVs and temporarily stored within the silage clamp apron.

Solid Animal Wastes

2.2.7 The facility will accept and process solid chicken manure. This will be delivered throughout the year in covered HDVs and will be deposited in the MRB on the eastern section of the site. There is a dedicated internal feed hopper contained within the MRB for the processing of the chicken manure.

2.2.8 Air will be extracted from the MRB and transferred to an odour abatement system for treatment prior to release to atmosphere. Reference should be made to Section 2.6 for further details of the proposed system.

Liquid Animal Wastes

2.2.9 Liquid animal wastes will be delivered to the site in road tankers throughout the year. Following arrival, the tankers will discharge their contents via sealed pipework into the liquid feedstock tanks.

2.2.10 Air displaced from the liquid feedstock tanks during filling will vent to the proposed odour abatement system, as detailed in Section 2.6, and there will be no direct atmospheric emissions.

Separated Liquid Digestate

2.2.11 Separated liquid digestate will be produced on-site and stored within a dedicated separated liquid storage tank. If used as a feedstock, this will be transferred directly into the liquid feedstock tanks via a sealed pipeline to allow incorporation to the AD process.

2.2.12 Air displaced from the separated liquid storage tank during filling will vent to the common gas line.

2.3 Processing of Feedstocks

2.3.1 A summary of the feedstock processing operations is provided in the following Sections.

Energy Crops

2.3.2 Cutting of energy crops will be undertaken two times per working day using a front loader. This will transfer the feedstocks from the working face of the clamps to the external feed hoppers. The feed hoppers will then macerate and blend the material prior processing within the digesters.

2.3.3 Each loading phase will take approximately two hours. Standard operating procedures will include the clearing of any silage deposits that form during delivery or daily cutting of silage.

Solid Animal Wastes

2.3.4 Solid animal wastes will be temporarily stored within the MRB prior to transfer to the internal feed hopper using a front loader. This will take place two times per day. As with energy crops, the wastes will be macerated and blended within the hopper and then transferred then the digesters for further processing.

Liquid Wastes

2.3.5 Liquid wastes will be pumped from the storage tanks directly into the digestors. The pumping arrangement is a closed system and therefore the feedstocks will not be exposed to atmosphere during transfer.

Dirty Water

2.3.6 Runoff from the bunded areas will be collected and reused within the process. Surface runoff from the hardstanding will drain to the dirty water lagoon where it will be held prior to reuse in the AD process. The lagoon features a floating cover in order to provide containment and the minimise the quantity of rainwater ingress.

2.4 AD Plant Operation

2.4.1 The feedstocks will be digested within three sealed primary digester tanks and two sealed post-digester tanks. Biogas generated by the AD process will be stored in the domes above the digesters which are connected to the main gas line. All of the AD tanks will include pressure relief values (PRVs) to emit biogas if there is an over pressure event or to take in air if there is under-pressure. The PRVs will not operate during normal conditions and will activate only as an emergency contingency to ensure there are no losses from any part of the process. The facility will be fully automated to maintain maximum efficiency at all times.

2.4.2 It should be noted that frequent or extended use of the PRVs would indicate the plant is not being managed correctly and would have financial consequences for the operator due to loss of biogas and potential impacts to the digester conditions. It is therefore in their best interest to ensure they are utilised as infrequently as possible.

2.4.3 The majority of the biogas generated by the process will be converted to biomethane on site in a Biogas Upgrading Plant (BUP) and then injected into the National Gas Grid. Carbon dioxide (CO_2) which is stripped during the upgrade process will be captured and recovered for distribution off-site via road tankers. CO_2 may be released via a vent on the BUP when the carbon capture equipment in not operational. The BUP will incorporate a PRV as a safety feature for over and under pressure events.

2.4.4 The site will include two Combined Heat and Power (CHP) units which will provide electricity and heat to the facility. These are expected to operate continuously all year round. If the CHP units are unable to meet the full demand, a biogas fired boiler will operate as a supplementary heat source. The site will also include a flare to burn any excess biogas during scheduled routine maintenance or in the event of breakdown of the CHP unit and/or boiler.

2.4.5 An emergency standby generator will utilise natural gas to supply power to the site in the event that both the CHP unit and the electrical grid are unavailable. The generator will only be used as an emergency backup and is expected to operate less than 12-hours per year for testing and less than 500-hours per year as a 3-year rolling average.

2.5 Digestate Separation, Storage and Transfer Off-site

2.5.1 The process will create digestate in liquid and solid form which can be used as a biofertiliser. Whole digestate from the AD process will be pumped to a screw press in the separator hall, which is located within the MRB, where it will be divided into liquid and solid fractions.

2.5.2 Solid digestate produced by the process will be deposited onto the floor of the separator hall and stored until it is removed in covered vehicles. The liquid fraction will be stored in the separated liquid storage tank prior to either re-circulation to the AD plant or removal from site. Air displaced from the separated liquid storage tank during filling will vent to the common gas line.

2.5.3 Air will be extracted from the separator hall and transferred to the odour abatement system for treatment prior to release to atmosphere, as detailed in Section 2.6.

2.5.4 Liquid digestate will be transported off site in road tankers. Air displaced from the tankers during offtake will vent to atmosphere.

2.6 Odour Abatement Plant

2.6.1 The facility will include a dedicated odour control system design by Exeon, a specialist abatement technology supplier. A summary of the abatement stages is provided as follows:

- Stage 1: An UltraD50 Acid Scrubber - This will provide primary treatment of emissions associated with the liquid waste reception and mixing tanks and separators prior to final abatement; and,
- Stage 2: Two HG32 activated carbon filters to provide primary treatment of air extracted from the MRB and secondary abatement of residual emissions from Stage 1.

2.6.2 The system has been designed to handle a total airflow of 55,750m^3/hr. This comprises air extracted from the MRB at a rate of 42,4250m^3/hr, as well as process airflow from the liquid waste reception and mixing tanks and separators at rate of 10,500m^3/hr.

2.6.3 Treated air off the abatement system will be discharged to atmosphere via a dedicated stack in order to promote effective dilution and dispersion of any residual emissions.

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[1]. 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

[1] Guidance on the evaluation of bioaerosol risk assessments for composting facilities, Environment Agency, 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 Environment Agency (EA) document 'Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data'[2] 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'[3] 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'[4] 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

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

[3] Bioaerosol Monitoring and Dispersal from Composting Sites, ADAS, 2005.

[4] Measurement and Modelling of Emissions from Three Composting Sites, SNIFFER, 2007.

of Aspergillus fumigatus, with concentrations being the highest in the autumn. In most 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'[5] 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 the proposed AD plant is included within the Regulations. As such, the facility is required to obtain 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'[6] 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:

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

6 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2023.

- Monitor bioaerosols in accordance with EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[7];
- Undertake a site specific Bioaerosol Risk Assessment; and,
- Comply with all other conditions set out in your permit.

3.5.3 It should be noted that the RPS was withdrawn on 9th October 2025. However, given that there are receptors within 250m of the proposed facility, as detailed in Section 4.4, the requirements of RPS are still considered to be relevant and appropriate in the context of the operation of the plant. As such, 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'[8] 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 Best Practice Guidance

3.7.1 The EA guidance 'How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion'[9] 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.

7 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2023.

8 Composting and potential health effects from bioaerosols: our interim guidance for permit applicants, EA, 2022.

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

3.7.2 The EA guidance for 'Biological waste treatment: appropriate measures for permitted facilities'[10] sets out the factors that should be considered when assessing appropriate measures for biowaste installations.

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

10 Biological waste treatment: appropriate measures for permitted facilities, EA, 2024.

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 2.

Table 2 Conceptual Model

Criteria	Description
Source	Feedstocks and output materials on the site as outlined in Section 4.3
Hazard	Potential adverse health impacts as outlined in Section 3.2
Transport Mechanism	Airborne
Medium of Exposure	Inhalation, ingestion, absorption, injection
Receptor	Human receptors at the proposed development 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 the proposed operations was undertaken in order to identify relevant emissions sources for inclusion in the assessment. These are summarised in Table 3.

4.3.2 It should be noted that the actual AD process itself is sealed and therefore does not form a source of bioaerosols under normal operation. However, as stated previously, the digesters, biogas upgrading unit and CO_2 recovery plant feature PRVs to avoid over pressure. Any gases emitted from these may contain bioaerosols as a result of the processes. As such, the PRVs have been considered as potential emission sources in order to ensure a comprehensive assessment.

4.3.3 The CHP units, flare, standby boiler and emergency generator only emit products of combustion when in use which do not contain bioaerosols. As such, they have not been considered further in this report.

Table 3 Bioaerosol Sources and Emission Characteristics

Source		Emission Characteristics	Emission Potential	Justification for Emission Potential
1	Exposed crop feedstocks within the clamp during delivery and storage	Diffuse emissions from exposed materials	Low to Medium	Crop feedstocks will be delivered to the facility and deposited within storage clamps located on the western section of the site. Disturbance of the material during delivery may cause bioaerosol release. However, the seasonal nature of deliveries and short amount of time required to deposit loads is likely to minimise potential exposure durations During delivery, the drop height of material will be minimised as far as practicable in order to limit agitation and the associated potential for emissions. In addition, where practicable, crops will be tipped as bulk loads to reduce material separation and the overall emitting surface area that is exposed to atmosphere Following delivery, the feedstocks will be compacted and covered with protective sheeting. This will help to minimise bioaerosol release during storage The clamps will be inspected on a daily basis to ensure the sheeting is intact and providing effective coverage of the feedstock material Only the working face of the clamps will be exposed and this will be tightly packed to minimise disturbance which may give rise to bioaerosols
2	Exposed feedstocks during transfer to the feed hoppers	Diffuse emissions from exposed materials	Low to Medium	Crop and animal waste feedstocks will be transferred from the relevant storage areas to the feed hoppers using a front loader The cover on the clamps will be slightly open at one end during cutting phases to allow access to the feedstock for removal and transfer to the external feed hoppers. It is anticipated that there will be two cutting phases per working day. The area of uncovered material during transfer to the hoppers will be kept to a minimum at all times in order to limit the potential for surface wind stripping of microorganisms Solid animal waste will be stored within the MRB and then processed using the internal feed hopper within the MRB. As such, any associated emissions will be extracted and treated by the proposed abatement system There is the potential for bioaerosol release during removal of feedstocks from the relevant storage areas and transfer to the feed hoppers. As such, all reasonable

Source		Emission Characteristics	Emission Potential	Justification for Emission Potential
				measures will be undertaken to minimise disturbance of the material during this operation. In addition, the shortest transfer routes will be utilised to limit the number of movements and potential exposure durations
3	Exposed feedstocks during maceration within the feed hoppers	Diffuse emissions from exposed materials	Medium	The feed hoppers will macerate and blend crop and animal manure feedstocks prior to processing within the AD plant. Bioaerosol emissions may occur from exposed materials during operation of the external feed hoppers. As such, potential releases have been considered further as part of the assessment
4	Air expelled from the abatement system stack	Residual bioaerosols in treated air released to atmosphere from the abatement system stack	Low	Air extracted from the MRB and feedstock tanks/ areas will be transferred to an abatement system comprising a wet scrubber and an activated carbon filter for treatment prior to exhaust to atmosphere via a dedicated dispersion stack adjacent to the building The proposed abatement system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the following: • The scrubbing system is a wet process which is likely to result in capture and blowdown of bioaerosols contained within the inlet airstream; and, • Secondary treatment using activated carbon is likely to result in the impaction of fungi and residual viable bacterial components not removed by the scrubbing stage Notwithstanding the potential effectiveness of the abatement systems in controlling bioaerosol emissions, there may be the potential for the release of residual microorganisms from the dispersion stack
5	Air released from the dirty water lagoon	Fugitive emissions from the vents on the dirty water lagoon	Low	Dirty water is likely to have a low bioaerosol emission potential due to the stabilised and wet nature of the material The process water lagoon will feature a floating cover to provide containment of runoff and any associated bioaerosol emissions
6	Gas expelled from the PRVs in the event of use	Emissions released during operation of PRVs during	Low	The PRVs will only operate in emergency event of under/over pressure Gas pressure will be monitored by the site Supervisory Control and Data Acquisition (SCADA) system. Gas usage by the boiler and CHP unit will be balanced to ensure

Source		Emission Characteristics	Emission Potential	Justification for Emission Potential
		an under or over pressure event		there is not a build-up of excess biogas The PRVs will be subject to monthly visual checks to ensure they are seated correctly A flare will be used to combust any excess biogas during maintenance or in an event of an emergency
7	CO_2 recovery plant vent	Residual bioaerosols released to atmosphere from CO_2 recovery vent	Low	The CO_2 recovery process includes multiple treatment stages which are likely to provide beneficial reductions in bioaerosol concentrations. It is anticipated that the residual release potential via the vent serving the process will be limited
8	Digestate collection tankers	Air displaced from tankers during filling which vents directly to atmosphere	Low	The wet nature of the liquid digestate will limit the potential for bioaerosol release. In addition, the short duration of tanker filling events will limit the duration of any associated emission periods

4.4 Receptors

4.4.1 EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[11] 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."

4.4.2 A desk-top study was undertaken in order to identify any sensitive receptor locations in the vicinity of the site that required specific consideration during the assessment. This focussed on locations within 250m of the facility boundary where people may be present for more than 6-hours at one time.

4.4.3 The identified receptors are summarised in Table 4.

Table 4 Sensitive Receptors

Receptor		NGR (m)		Distance from Boundary (m)	Direction from Facility
		X	Y		
R1	2 Sisters Food Group	303054.9	111171.6	10	South
R2	2 Sisters Food Group	302950.8	111148.8	10	South
R3	2 Sisters Food Group	302849.3	111087.5	20	South
R4	Bagsters Cottages	302674.2	110988.2	95	South-West
R5	Burn Rew	302839.3	110962.6	130	South
R6	1 Lloyd Maunder Road	303152.1	111107.2	100	South-east

[11] M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2018.

Receptor		NGR (m)		Distance from Boundary (m)	Direction from Facility
		X	Y		
R7	GCR Vehicle Repairs	303211.0	111290.8	120	East
R8	43 Park Street	303329.7	111231.4	240	East
R9	19 Barnes Close	303313.7	111199.5	220	East
R10	18 Somerville Close	303290.4	111113.7	210	South-east
R11	15 Somerville Close	303255.6	111048.4	230	South-east

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

4.5 Prevailing Meteorological Conditions

4.5.1 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. Exeter Airport meteorological station is located at NGR: 300821, 93986, which is approximately 17.2km south 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.

4.5.2 Meteorological data was obtained from Exeter meteorological station over the period 1st January 2020 to 31st December 2024 (inclusive). The frequency of wind from the twelve sectors which best describe the directions which may cause impacts in the vicinity of the site is shown in Table 5. Reference should be made to Figure 4 for a wind rose of the meteorological data.

Table 5 Wind Frequency Data

Wind Direction (°)	Frequency of Wind (%)
345 - 15	6.19
15 - 45	7.75
45 - 75	4.92

Wind Direction (°)	Frequency of Wind (%)
75 - 105	3.76
105 - 135	5.30
135 - 165	8.23
165 - 195	12.96
195 - 225	11.88
225 - 255	7.99
255 - 285	9.29
285 - 315	10.59
315 - 345	5.97
Sub-Total	94.83
Calms	3.83
Missing/Incomplete	1.35
Total	100

4.5.3 As shown in Table 5, the prevailing wind direction at the AD facility is from the south with significant frequencies from the west-south-west, south-south-west and west. Winds from the north and east are relatively infrequent, which is indicative of conditions throughout the majority of the UK.

4.5.4 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.

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'[12]. This represents the most up to date and authoritative guidance on completion of Bioaerosol Risk Assessments in the UK and was therefore considered appropriate for use in the determination of potential impacts as a result of emissions from the identified sources.

5.1.2 The Risk Assessment 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?

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

5.1.4 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.

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

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;
- 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 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 6.

Table 6 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 7.

Table 7 Risk Assessment

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed Crop Feedstocks within the Clamp During Delivery and Storage	**Low** at R1 and R4 to R11 based on consideration of the separation distance between the source and receptors, containment of the crop feedstocks during storage and the frequency of winds blowing towards the locations **Medium** at R2 and R3 based on consideration of the separation distance between the source and receptor, containment of the crop feedstocks during storage and the frequency of winds blowing towards the locations	**Medium**	**Medium**	All reasonable measures will be undertaken to reduce the drop height of materials during unloading of the delivery vehicles. Where practicable, feedstocks will be tipped as bulk loads to reduce material separation and the overall emitting surface area Crop feedstocks will be stored under impermeable sheeting following delivery. The clamps will be inspected on a daily basis to ensure the cover is intact and providing effective containment. The area of uncovered material will be kept to a minimum during storage. This will help to limit the potential for surface wind stripping of microorganisms	**Low**	Full implementation of the stated control measures, is considered to result in a **low** residual risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed feedstocks during transfer to the feed hoppers	**Very Low** at R1 and R4 to R11 based on consideration of the separation distance between the transfer routes and receptors, the transient nature of transfer operations and the frequency of winds blowing towards the locations **Low** at R2 and R3 based on consideration of the separation distance between the transfer routes and receptors, the transient nature of transfer operations and the frequency of winds blowing towards the locations	**Medium**	**Low** to **Medium**	Transfer to the feed hoppers will only be undertaken twice per day over a period of approximately 2-hours All reasonable measures will be undertaken to minimise disturbance of the material during loading and movement between the process areas The shortest transfer routes will be utilised in order to limit potential exposure durations Full training will be provided to the top loader operative to avoid material spillage during transfer Any spilled material will be cleared by a site operative within the working day	**Low**	The short duration of transfer activities and use the stated control measures is considered to result in a **low** residual risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed feedstocks during maceration within the feed hoppers	**Very Low** at R1 and R4 to R11 based on consideration of the separation distance between the hoppers and receptors, the short duration of hopper loading and operation, and the frequency of winds blowing towards the locations **Low** at R2 and R3 based on consideration of the separation distance between the hoppers and receptors, the short duration of hopper loading and operation, and the frequency of winds blowing towards the locations	**Medium**	**Low** to **Medium**	Feed hoppers will only be filled twice per day over a period of approximately 2-hours All reasonable measures will be undertaken to minimise disturbance of the material during loading Full training will be provided to the top loader operative to avoid material spillage during filling and maceration Any spilled material will be cleared by a site operative within the working day	**Low**	Full implementation of the stated control measures, is considered to result in a **low** residual risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Air expelled from the abatement system stack	**Low** at all receptors due to: • The potential effectiveness of the abatement system in reducing bioaerosol concentrations • High-level release of residual emissions from the stack which is likely to promote effective dilution and dispersion • The separation distance between the source and receptors • The frequency of the wind blowing towards the receptors	**Medium**	**Medium**	The proposed abatement system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the use of wet scrubbing and carbon filtration Discharge of treated air to atmosphere via a dedicated stack will help to promote effective dilution and dispersion of any residual emissions	**Low**	The low emission potential and proposed control measures are considered to result in a **low** residual risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Air released from the Dirty Water Lagoon	**Very low** at all receptors due to: • The low release potential due to the wet nature of material stored within the lagoon • The use of a floating cover to contain emissions • The separation distance between the source and receptors • The frequency of the wind blowing towards the receptors	**Medium**	**Low**	Dirty water is likely to have a low bioaerosol emission potential due to its liquid nature The lagoon will feature a floating cover with a collection ring to a single vent in order to provide partial containment of the material and any associated bioaerosol emissions	**Low**	The low emission potential and proposed control measures are considered to result in a **low** residual risk of impact occurring
Gas expelled from the PRVs in the event of use	**Very low** at all receptors due to: • The low frequency of PRV use which will be limited to emergency events only • The separation distance between the source and receptors • The frequency of the wind blowing towards the receptors	**Medium**	**Low**	The PRVs will only operate in emergency event of under/over pressure The PRVs will be regularly maintained in order to ensure correct operation	**Very low**	The infrequent use of the PRVs and proposed control measures are considered to result in a **very low** residual risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
CO_2 recovery plant vent	**Very low** at all receptors due to: • The low frequency of vent use and multiple treatment stages that form part of the recovery process • The separation distance between the source and receptors • The frequency of the wind blowing towards the receptors	**Medium**	**Low**	The CO_2 recovery process includes multiple treatment stages which are likely to provide beneficial reductions in bioaerosol concentrations. It is anticipated that the residual release potential via the vent serving the process will be limited	**Very low**	The low emission potential and proposed control measures are considered to result in a **very low** residual risk of impact occurring
Digestate collection tankers	**Very low** at all receptors due to: • The wet nature of digestate within the is likely to limit the bioaerosol release potential • The infrequent nature and short duration of tanker filling events is likely to limit the potential for impacts • The frequency of the wind blowing towards the receptors	**Medium**	**Low**	The wet nature of digestate within the is likely to limit the bioaerosol release potential The infrequent nature and short duration of tanker filling events is likely to limit the potential for impacts Any spillages that occur during offtake will be cleaned immediately	**Very Low**	The low emission potential, short duration of activities and proposed control measures are considered to result in a **very low** residual risk of impact occurring

6.1.2 As shown in **Table 7**, the results of the assessment indicated residual risk from all sources was determined as **very low** or **low**. 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 Earthcare Technical Ltd to undertake a SSBRA in support of an Environmental Permit Application for Devon AD plant on land off Hide Market Road, Willand, Cullompton, EX15 2FP.

7.1.2 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 SSBRA 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:

- Exposed feedstocks within the clamp area;
- Exposed feedstocks during transfer to the feed hoppers;
- Exposed feedstocks during maceration in the feed hoppers;
- Air expelled from the abatement system stack;
- Air released from the dirty water lagoon;
- Gas expelled from the PRVs in the event of use;
- CO_2 recovery plant vent; and,
- Digestate tanker offtake.

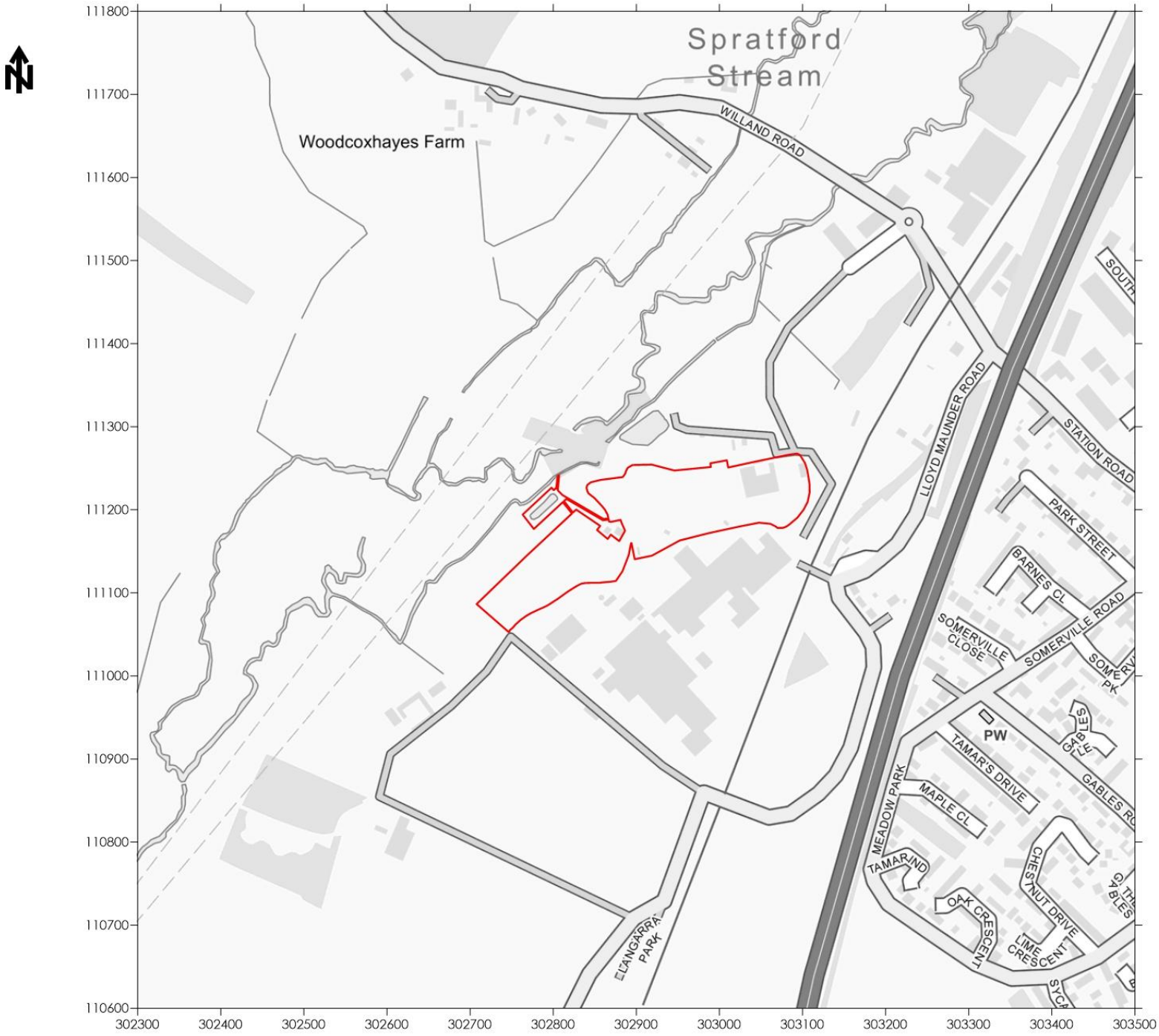
7.1.4 The risk of significant bioaerosol impact at sensitive locations in the vicinity of the site for each of the identified sources was assessed using a source - pathway - receptor approach. This considered the nature of the potential emission, any barriers to dispersion and the severity of harm.

7.1.5 The results of the assessment indicated residual risk from all sources was determined as **low** or **very low**. As such, it is concluded that no further control measures, other than those detailed in the assessment, are required in order to reduce the potential for impacts at sensitive locations in the vicinity of the site.

8.0 ABBREVIATIONS

AD	Anaerobic Digestion
ac/hr	Air changes per hour
BAT	Best Available Technique
BUP	Biogas Upgrading Plant
CFU	Colony Forming Units
CHP	Combined Heat and Power
CO_2	Carbon dioxide
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
HDV	Heavy Duty Vehicle
IVC	In-Vessel Composting
MRB	Manure Reception Building
NGR	National Grid Reference
NH_3	Ammonia
PRVs	Pressure relief values
RPS	Regulatory Position Statement
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SSBRA	Site Specific Bioaerosol Risk Assessment
tpa	Tonnes per annum

Figures



Legend

Site Location

Title
Figure 1 - Site Location

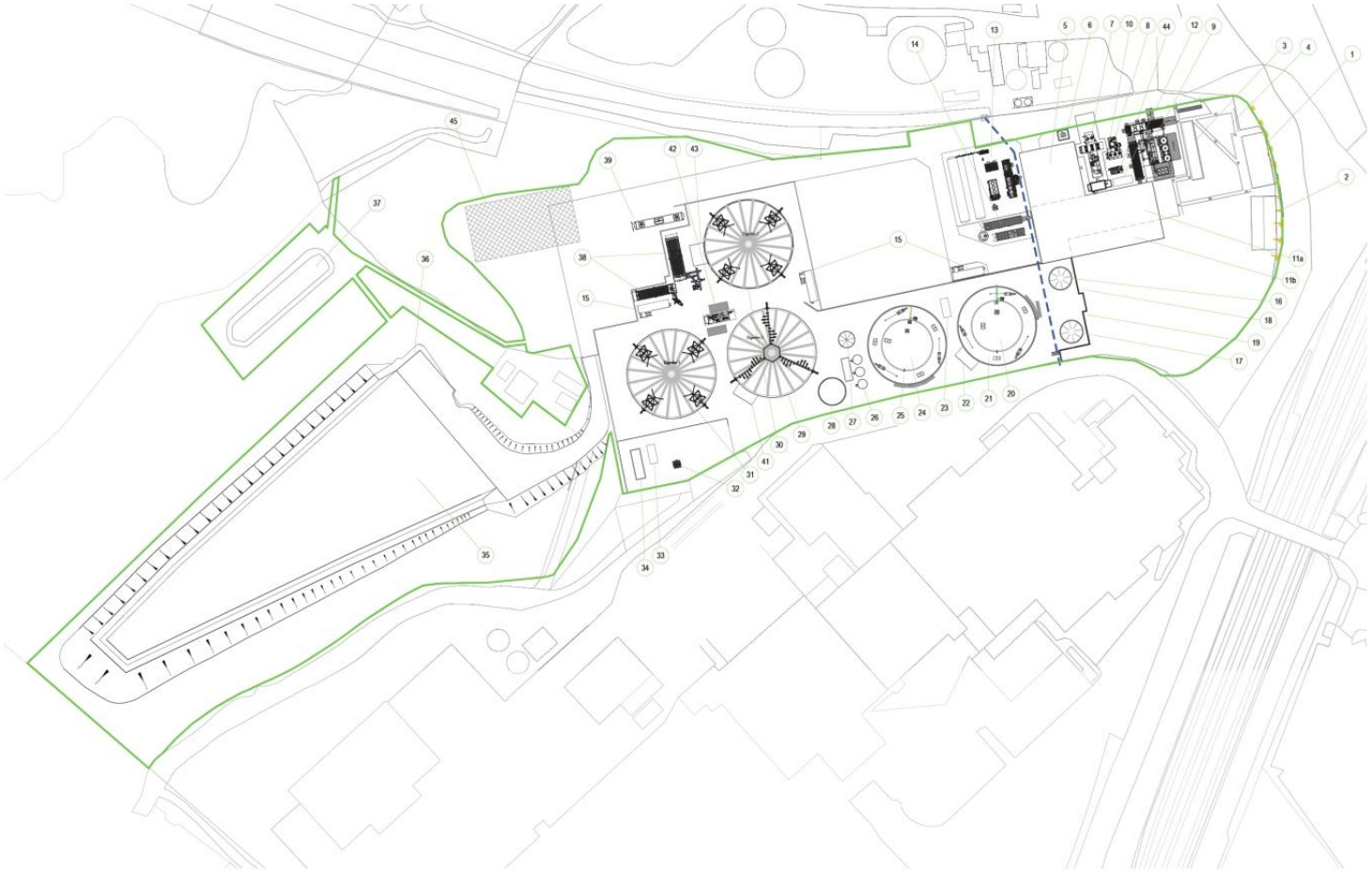
Project
Site Specific Bioaerosol Risk Assessment
Willand AD Plant, Cullompton

Project Reference
10945

Client
Earthcare Technical Ltd

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Legend

Reference Table	
1	Site Office / Staff Welfare
2	Site Workshop
3	Weighbridge
4	Site Parking
5	Switchgear and site storage section of building
6	DNO Transformer Kiosk
7	CHP No1
8	CHP No2
9	Biogas Upgrade Unit
10	Emergency Generator
11	(a) Manure Reception Building with (b) Separation Hall
12	Emergency Boiler container
13	CO2 Recovery Unit and CO2 tanks
14	Odour Abatement
15	E-Comm containers
16	Liquid Feedstock Tank 1 - Volume 400m³
17	Liquid Feedstock Tank 2 - Volume 400m³
18	Liquid Feedstock Loading area
19	Digestate offtake area
20	Separated Liquid Storage Tank - Volume 1508m³
21	Post Digester 3 - Volume 2172m³
22	Pump Room
23	Pump Room
24	Post Digester 2 - Volume 1508m³
25	Post Digester 1 - Volume 2172m³
26	3 No. Pasteurisation tanks (25m³ each)
27	Process Water Tank - Volume 100m³
28	Existing tank Not in Use
29	Primary Digester 3 Tank - Volume 4455m³
30	Primary Digester 2 Tank - Volume 4618m³
31	Primary Digester 1 Tank - Volume 4618m³
32	Emergency Flare
33	Control Panel Kiosk
34	Grid Entry Unit Kiosk
35	Covered Storage Clamp - Volume 21,500m³
36	Silage Leachate catchment sump
37	Process Water Lagoon - Volume 1150m³
38	Feed Hoppers - 170m³ Volume and 115m³ Volume
39	Propane Tank - Volume 24tonne
40	Oxygen dosing Unit
41	Pump Room
42	Biogas Booster and Chiller
43	Pump Room
44	Gas Treatment System
45	Underground Cellular Storage Crates

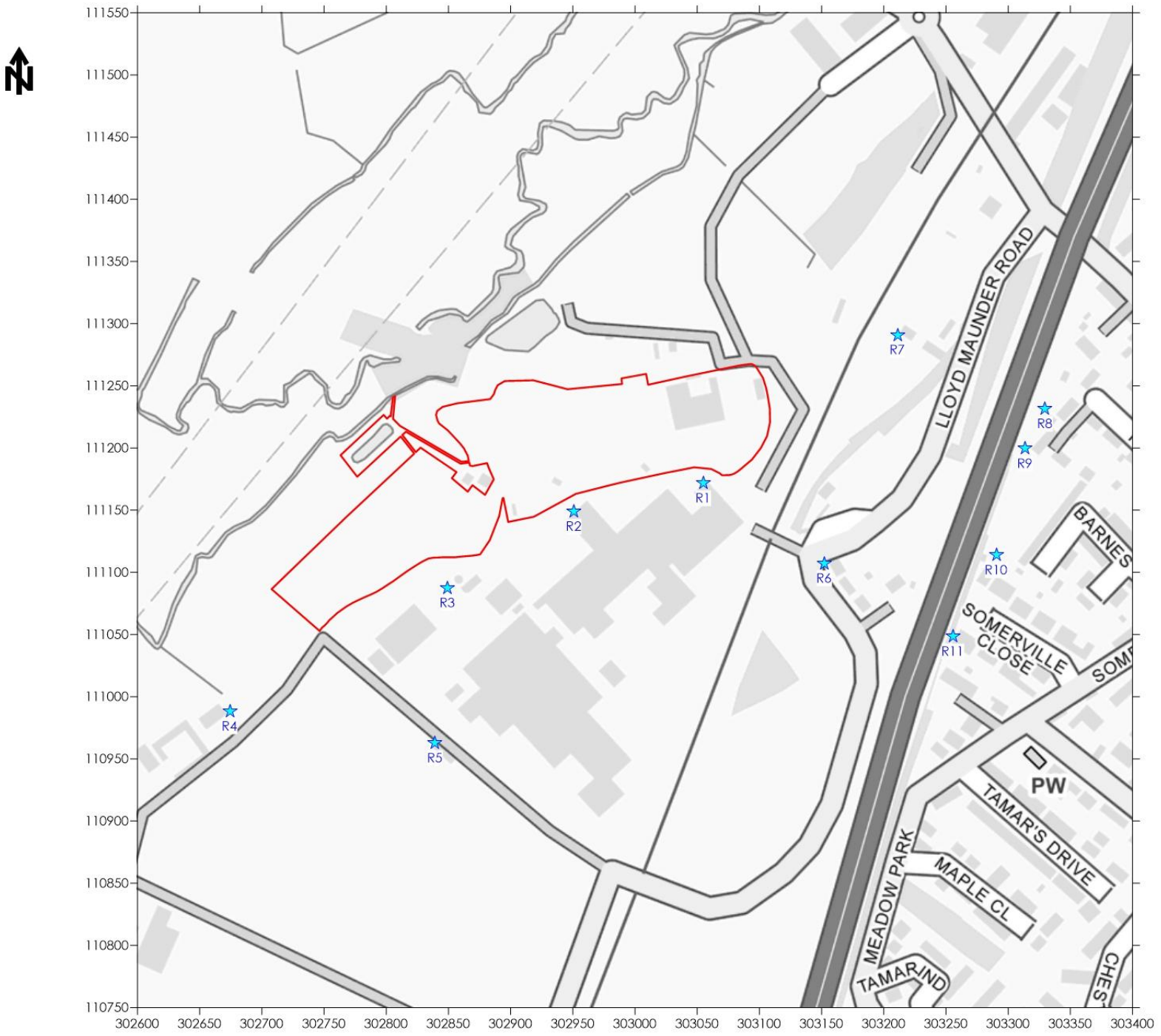
Title
Figure 2 - Site Layout

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Legend

Site Location

Receptor

Title
Figure 3 - Sensitive Receptor Locations

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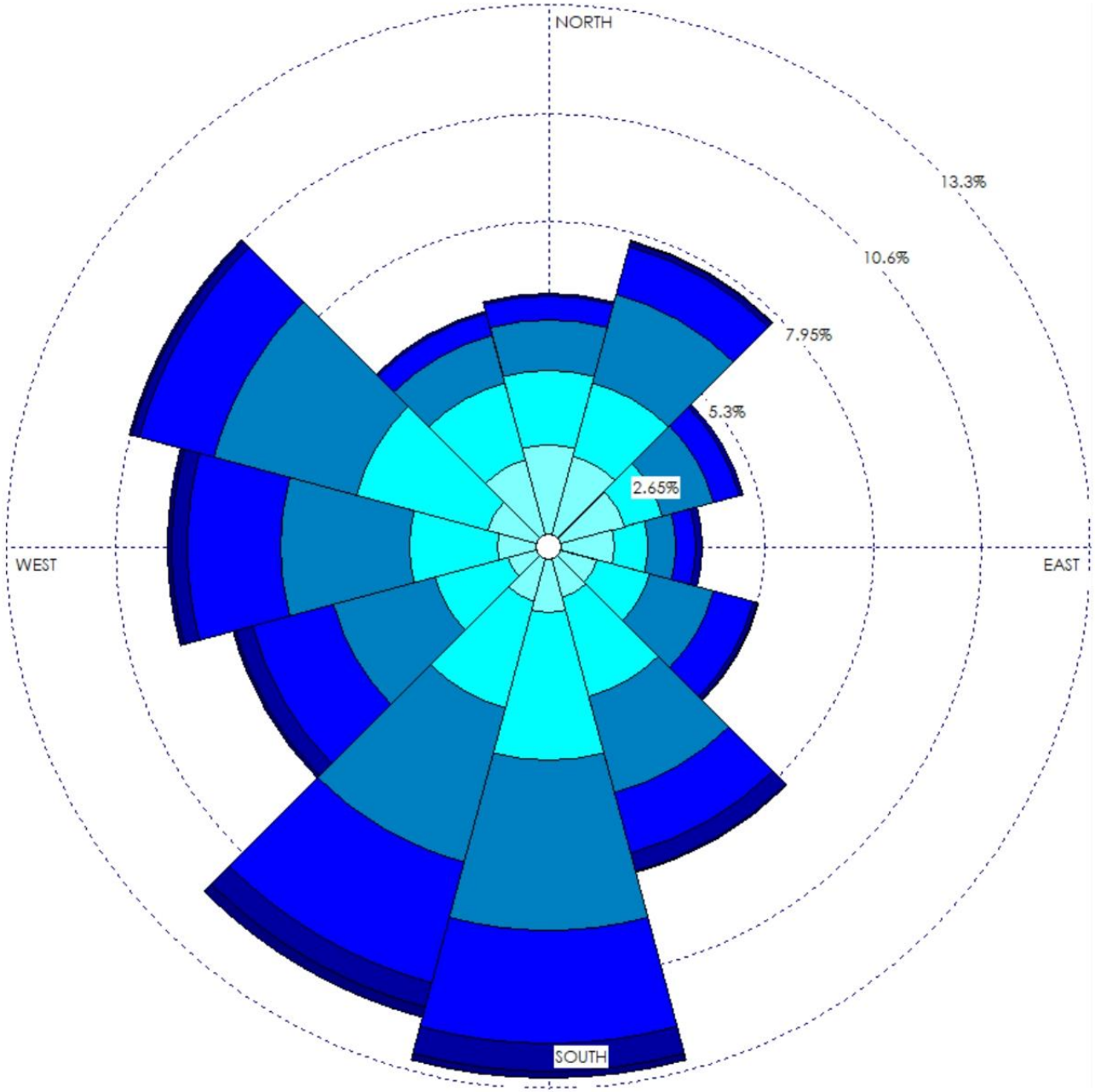
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WIND SPEED
(m/s)

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

Calms: 3.82%

Title
Figure 4 - Wind Rose of 2020 to 2024 Exeter Airport Meteorological Data

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