Bioaerosol Risk Assessment

Bio Dynamic UK, Nottingham

Client: Bio Dynamic UK Ltd

Reference: 4446-1r1

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1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by H&C Consultancy Ltd to undertake a Bioaerosol Risk Assessment in support of an Environmental Permit Variation Application for the anaerobic digestion (AD) facility operated by the company at Colwick Industrial Estate, Nottingham.

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 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 Bio Dynamic UK Ltd facility is located on land at Colwick Industrial Estate, Nottingham, at National Grid Reference (NGR): 463440, 339830. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 The site operates as an AD facility under an Environmental Permit (No. EPR/DP3935ER) issued by the Environment Agency (EA). The facility is currently undergoing a major refurbishment. This includes changes to existing processes and infrastructure which are being formalised as part of an Environmental Permit Variation Application.

1.2.3 A brief summary of operations at the site incorporating the changes proposed under the application is provided as follows:

- The plant has an annual throughput of up to 150,000-tonnes (t).

- The site can receive quantities of animal by-products which exceed 10t per day. As such, it is permitted as an installation under Section 6.8 A(1)(c) of the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments;
- Most of the waste received at the site is processed through the main AD plant. However, a proportion is stored and treated to produce a 'soup' which is dispatched for processing at other AD facilities;
- The treatment and dispatch activity only applies to approximately 20,000-tonnes per annum (tpa) of wastes and the remaining 130,000tpa is processed through the main AD plant;
- Wastes are received via a weighbridge and transferred into a steel framed reception building or liquid storage tanks situated externally;
- Within the reception building, packaging is removed from solid wastes where required prior to mixing and blending with other liquid materials and/or water to create a pumpable slurry. The waste is then macerated to 12mm and transferred to one of two pasteurisers where it is held at a minimum temperature of 70°C for at least one hour;
- Pasteurised wastes are transferred to a buffer tank which provides a consistent flow into two primary digesters. After being held for the minimum retention time, the material is pumped into the secondary digester. A further secondary digester is intended to be included at the site under future development plans for the facility;
- The biogas produced as part of the AD process is stored in roofs above the primary digesters and used to operate four on site combined heat and power (CHP) units. Two of these were installed when the facility was first developed and two new units have been included as part of the ongoing refurbishment;
- Biogas is also exported via pipeline to the adjacent BD Gas Permits Limited facility where it is upgraded to biomethane for injection into the national gas grid;
- Out of specification or excess unburnt biogas arising from atypical site operations is returned to the AD plant for storage or burnt in one of the two emergency flares;
- Condensate arising from treatment of gas in the adjacent upgrading facility is collected and returned to the AD plant for re-circulation within the process;
- The site features a backup dual fuel (biogas/diesel) fired boiler that can produce heat for the onsite tanks in the event of CHP downtime;
- Air is extracted from the waste reception building and transferred to an odour abatement system for treatment prior to release to atmosphere. Other localised abatement units are also in use at the site to treat displaced air from the waste reception tanks, buffer tanks, pasteurisers and the digestate offtake tankers;

- Digestate generated by the AD process is currently certified to the British Standards Institution (BSI) PAS110 standard and dispatched from site as an end of waste product for use as a biofertiliser in agriculture;
- As part of the ongoing site refurbishment, the operator intends to install a digestate dewatering and filtration treatment system that will be used treat digestate via an aerobic membrane bioreactor (MBR). This will produce a final treated filtrate that can be discharged to surface water or recovered for use in the process;
- Water for onsite usage is obtained from a borehole or rainwater harvested from roofs/ concrete surfaces at the facility;
- Domestic sewage is collected in a sealed cesspool and dispatched from site via tanker; and,
- The site operates in accordance with an Environmental Management System which is reviewed and updated on a regular basis.

1.2.4 The operation of the facility following completion of the refurbishment 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 BIOAEROSOL BACKGROUND

2.1 Bioaerosol Definition

2.1.1 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.

2.1.2 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.

2.2 Health Risks from Bioaerosols

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.3 Bioaerosol Emissions from Waste Management Operations

2.3.1 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.

2.3.2 The 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.

2.3.3 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.

2.3.4 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 of Aspergillus fumigatus, with concentrations being the highest in the autumn. In most

[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.

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

2.3.5 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.

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

2.4 Legislative Control

2.4.1 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 AD plant is included within the Regulations. As such, there is a requirement for the facility to operate in accordance with an Environmental Permit issued by the EA.

2.5 Environment Agency Policy

2.5.1 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.

2.5.2 The RPS states that if a regulated facility is located within 250m of a sensitive receptor (a place where people live of 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, 2018.

- Monitor bioaerosols in accordance with EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[7]; and,
- Undertake a site specific Bioaerosol Risk Assessment.

2.5.3 The RPS indicates that existing permit holders have until 31st March 2019 to meet these requirements. Environmental Permits issued after 1st April 2017 must demonstrate compliance with the requirements from the date on the permit.

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

2.6 Benchmark Levels

2.6.1 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.

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

2.7 Technical Guidance

2.7.1 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, 2017.

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

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

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

3.0 PROBLEM DEFINITION

3.1 Introduction

3.1.1 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.

3.2 Conceptual Model

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

Table 1 Conceptual Model

Criteria	Comment
Source	AD feedstocks and products on the site as outlined in Section 3.3
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 3.4

3.3 Sources

3.3.1 Potential bioaerosol emission sources were identified through a visit to the facility and discussions with Bio Dynamic UK Ltd. These are summarised in Table 2.

Table 2 Bioaerosol Sources

Source		Source Type	Emission Point	Emission Potential and Characteristics
1	Reception building carbon filter	Point Source - Residual emissions from a proposed carbon filter which will be used to treat air extracted from the reception building	A15	Treated air from the carbon filter will be released to atmosphere via a dedicated stack at a height of 13m The carbon filter is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the impaction of microorganisms onto the media during operation. However, there may be the potential for the release of residual components which pass straight through the filter
2	Tank farm carbon filter	Point Source - Residual emissions from a carbon filter which is used to treat air extracted from the waste reception tanks, de-pack tank buffer tank and pasteurisers	A19	Treated air from the carbon filter is released to atmosphere via a dedicated stack at a height of 4.5m The carbon filter is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the impaction of microorganisms onto the media during operation. However, there may be the potential for the release of residual components which pass straight through the filter

Source		Source Type	Emission Point	Emission Potential and Characteristics
3	Digestate tanker carbon filter	Point Source - Residual emissions from a proposed carbon filter which will be used to treat air displaced from digestate tankers during filling	A6	Treated air from the carbon filter will be released to atmosphere via a vent on the top of the unit The carbon filter is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the impaction of microorganisms onto the media during operation. However, there may be the potential for the release of residual components which pass straight through the filter
4	MBR tank	Diffuse - Bioaerosol emissions from digestate during treatment	-(a)	Fugitive surface emissions from digestate within the open MBR tank during treatment The wet nature of materials is likely to limit the potential for bioaerosol emissions. However, aerosolisation of biological components may occur as a result of surface wind stripping and/or agitation during treatment

NOTE: (a) Emission point reference not provided.

3.3.2 Reference should be made to Figure 3 for a graphical representation of the source locations.

3.3.3 It should be noted that 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 released 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 these emissions is not considered to be significant and they have not been evaluated further in the context of this assessment.

3.3.4 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.

3.4 Receptors

3.4.1 EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[10] defines the Nearest Sensitive Receptor (NSR) 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."

3.4.2 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. In accordance the requirements of the EA RPS[11], this focussed on locations within 250m of the facility boundary where people may be present for more than 6-hours at one time. The identified receptors are summarised in Table 3.

Table 3 Sensitive Receptors

Receptor		NGR (m)		Distance from Closest Source (m)	Direction from Facility
		X	Y		
R1	Industrial - Colwick Industrial Estate	463339.0	339894.3	80	North-west
R2	Industrial - Colwick Industrial Estate	463365.9	339924.8	90	North-west
R3	Industrial - Colwick Industrial Estate	463276.9	339889.4	130	North-west
R4	Industrial - Colwick Industrial Estate	463279.6	339920.2	140	North-west
R5	Industrial - Colwick Industrial Estate	463243.5	339820.6	150	West
R6	Industrial - Colwick Industrial Estate	463238.4	339952.5	200	North-west

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

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

Receptor		NGR (m)		Distance from Closest Source (m)	Direction from Facility
		X	Y		
R7	Industrial - Colwick Industrial Estate	463196.2	339985.8	250	North-west

3.4.3 As shown in Table 3, the sensitive locations are located between 80m and 250m from the identified sources at their closest points.

3.4.4 Reference should be made to Figure 4 for a visual representation of the identified receptors.

3.5 Prevailing Meteorological Conditions

3.5.1 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. Nottingham Watnall observation station is located at NGR: 450431, 345004, which is approximately 14.3km north-west 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.

3.5.2 Meteorological data was obtained from Nottingham Watnall meteorological station over the period 1st January 2017 to 31st December 2021 (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 4. Reference should be made to Figure 5 for a wind rose of the meteorological data.

Table 4 Wind Frequency Data

Wind Direction (°)	Frequency of Wind (%)
345 - 15	4.11
15 - 45	6.85
45 - 75	8.41
75 - 105	4.53
105 - 135	3.08

Wind Direction (°)	Frequency of Wind (%)
135 - 165	3.85
165 - 195	5.89
195 - 225	14.42
225 - 255	21.02
255 - 285	13.54
285 - 315	7.53
315 - 345	4.57
Sub-Total	97.80
Calms	0.57
Missing/Incomplete	1.62

3.5.3 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.

3.5.4 As shown in Table 4, the prevailing wind direction at the AD facility is from the south-west. Winds from the north and east are relatively infrequent, which is indicative of conditions throughout the majority of the UK.

3.6 Other Sources of Bioaerosols and Cumulative Effects

3.6.1 The Bio Dynamic UK plant is bordered to the west by the Enva waste management facility. As detailed in Section 2.3, it is well established that waste management operations have the potential to result in bioaerosol emissions. However, it should be noted that the stated facility operates in accordance with an Environmental Permit issued by the EA. In accordance with the provisions of the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments, this should include appropriate conditions in order to restrict the potential for environmental impacts as a result of emissions and therefore the potential for cumulative bioaerosol effects at sensitive locations in the vicinity of the sites.

4.0 RISK ASSESSMENT METHODOLOGY

4.1 Overview

4.1.1 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 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?

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

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

4.2 Receptor

4.2.1 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.

4.3 Probability of Exposure

4.3.1 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;

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

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

4.3.2 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.

4.4 Harm

4.4.1 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.

4.4.2 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.

4.4.3 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.

4.5 Magnitude of Risk

4.5.1 The level of risk is a combination of:

- How likely a problem is to occur; and,

- How serious the harm might be.

4.5.2 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.

4.5.3 Risk was defined based on the interaction between the probability of exposure and potential harm, as outlined in Table 5.

Table 5 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

4.6 Further Requirements

4.6.1 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.

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

5.0 RISK ASSESSMENT

5.1.1 The Bioaerosol Risk Assessment is shown in Table 6.

Table 6 Risk Assessment

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Reception building carbon filter	**Very Low** due to abatement of emissions using carbon filtration prior to discharge to atmosphere, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	The proposed abatement system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to impaction of microorganisms onto the carbon media during operation The proposed discharge arrangements will help to promote effective dilution and dispersion of any residual components The carbon filter will be maintained in accordance with the supplier's instructions and relevant best practice guidance in order to ensure optimum performance	**Low**	Full application of the proposed control measures is considered to result in a **very low** risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Tank farm carbon filter	**Very Low** due to abatement of emissions using carbon filtration prior to discharge to atmosphere, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	The abatement system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to impaction of microorganisms onto the carbon media during operation The carbon filter is maintained in accordance with the supplier's instructions and relevant best practice guidance in order to ensure optimum performance	**Very Low**	Full application of the stated control measures is considered to result in a **very low** risk of impact occurring
Digestate tanker carbon filter	**Very Low** due to abatement of emissions using carbon filtration prior to discharge to atmosphere, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	The proposed abatement system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to impaction of microorganisms onto the carbon media during operation The carbon filter will be maintained in accordance with the supplier's instructions and relevant best practice guidance in order to ensure optimum performance	**Very Low**	Full application of the proposed control measures is considered to result in a **very low** risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
MBR tank	**Very Low** due to the wet nature of materials which is likely to limit bioaerosol release potential, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	The wet nature of materials processes within the MBR tank will help to limit the potential for bioaerosol release Regular inspection of the MBR tank will be undertaken by site operatives in order to ensure that it is providing effective containment of materials	**Very Low**	Full application of the proposed control measures is considered to result in a **very low** risk of impact occurring

5.1.2 As shown in Table 6, the results of the assessment indicated residual risk from all sources was determined as **very 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.

6.0 CONCLUSION

6.1.1 Redmore Environmental Ltd was commissioned by Bio Dynamic UK Ltd to undertake an Bioaerosol Risk Assessment in support of an Environmental Permit Variation Application for the AD facility operated by the company at Colwick Industrial Estate, Nottingham.

6.1.2 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 was therefore undertaken to identify potential emission sources and evaluate effects in the local area.

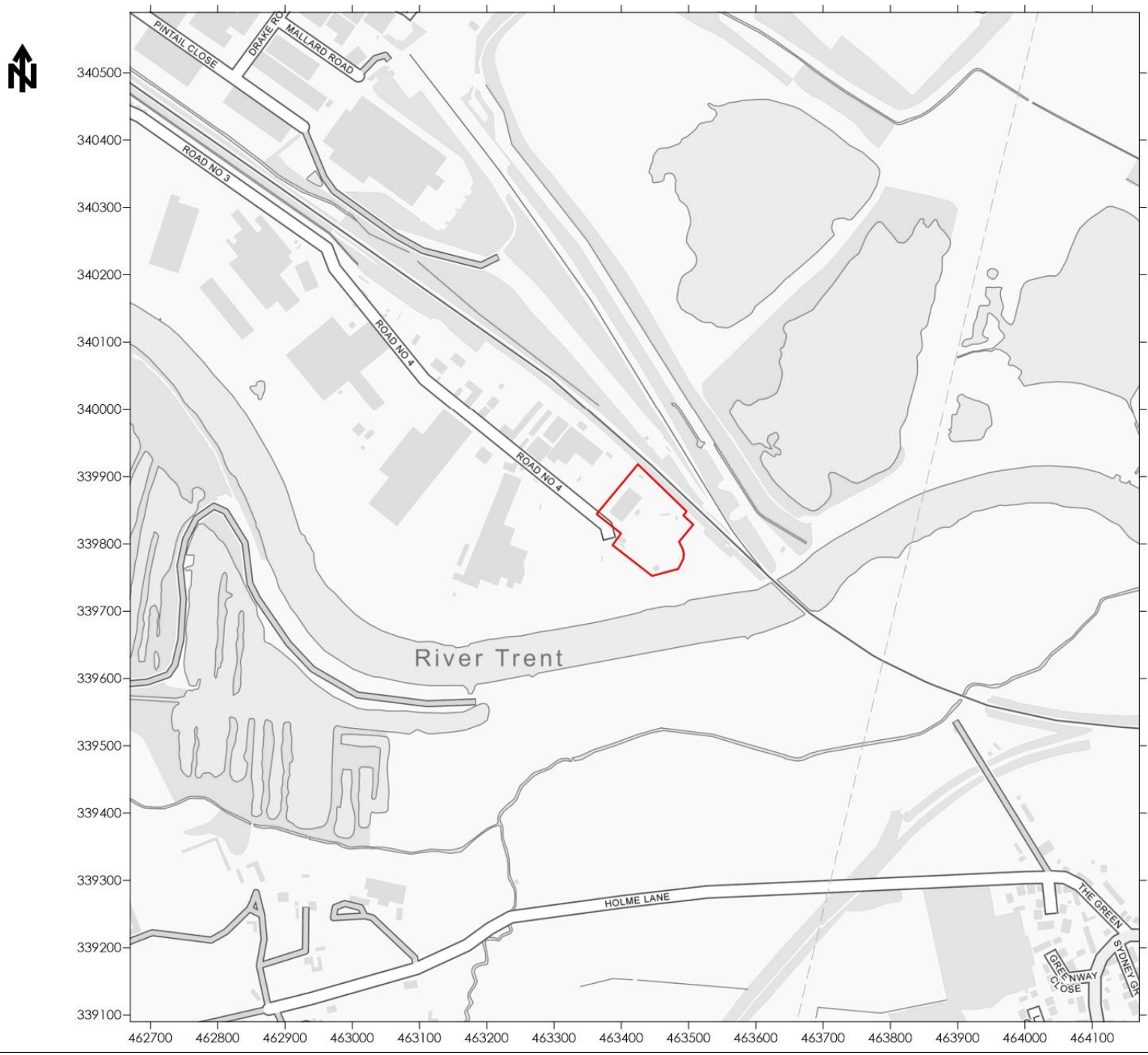
6.1.3 A review of operations at the facility was undertaken in order to identify relevant bioaerosol emissions sources. The risk of significant bioaerosol impact at sensitive locations in the vicinity of the site for each of the identified sources was subsequently assessed using a source - pathway - receptor approach. This considered the nature of the potential emission, any barriers to dispersion and the severity of harm.

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

7.0 ABBREVIATIONS

AD	Anaerobic Digestion
BAT	Best Available Techniques
BSI	British Standards Institution
CHP	Combined Heat and Power
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
IVC	In-Vessel Composting
MBR	Membrane Bioreactor
NGR	National Grid Reference
RPS	Regulatory Position Statement
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research

Figures



Legend

Site Boundary

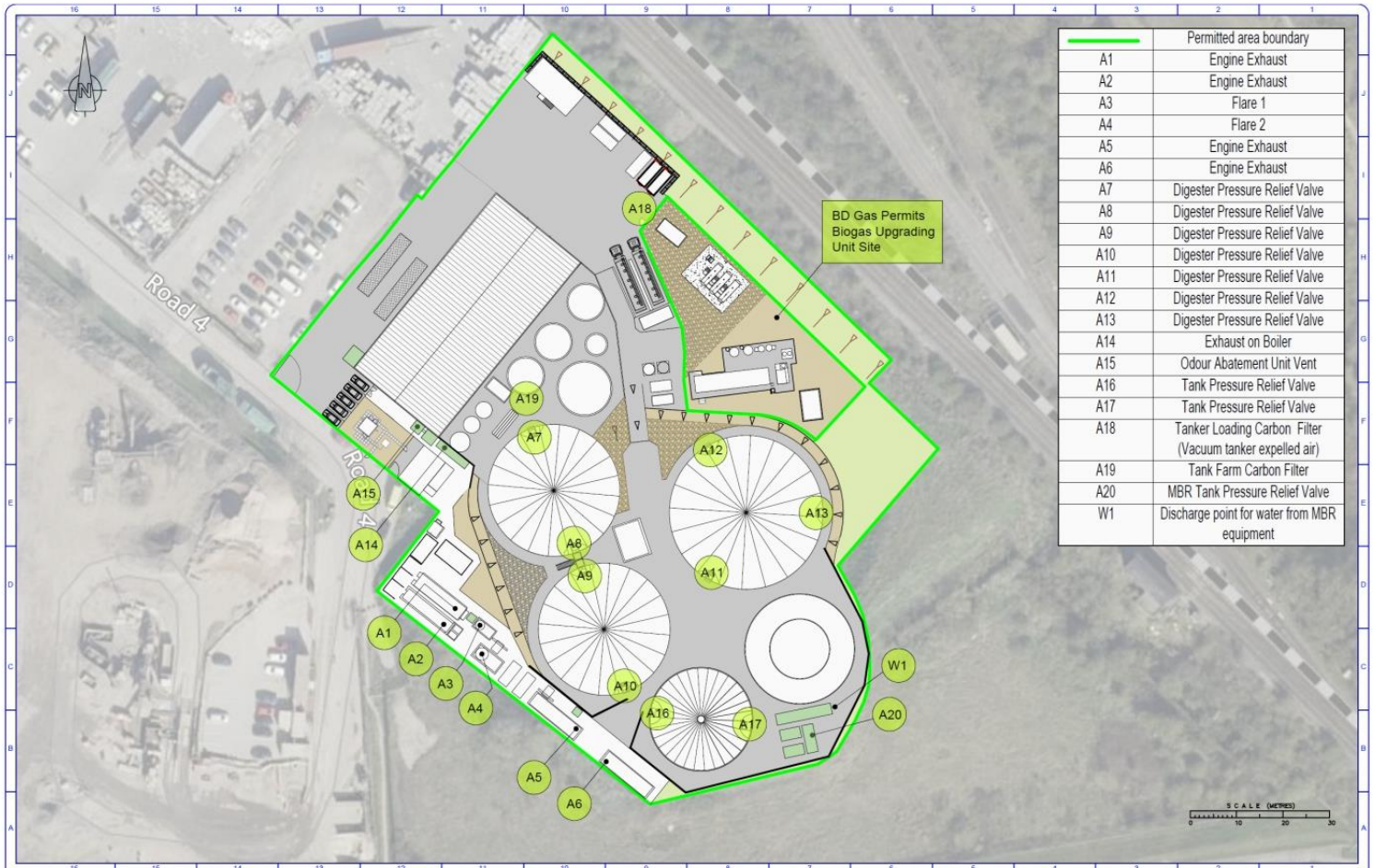
Title
Figure 1 - Site Location Plan

Project
Bioaerosol Risk Assessment -
Bio Dynamic UK, Nottingham

Project Reference
4446-1

Client
Bio Dynamic UK Ltd

Redmore environmental
www.red-env.co.uk | 0161 7060075



	Permitted area boundary
A1	Engine Exhaust
A2	Engine Exhaust
A3	Flare 1
A4	Flare 2
A5	Engine Exhaust
A6	Engine Exhaust
A7	Digester Pressure Relief Valve
A8	Digester Pressure Relief Valve
A9	Digester Pressure Relief Valve
A10	Digester Pressure Relief Valve
A11	Digester Pressure Relief Valve
A12	Digester Pressure Relief Valve
A13	Digester Pressure Relief Valve
A14	Exhaust on Boiler
A15	Odour Abatement Unit Vent
A16	Tank Pressure Relief Valve
A17	Tank Pressure Relief Valve
A18	Tanker Loading Carbon Filter (Vacuum tanker expelled air)
A19	Tank Farm Carbon Filter
A20	MBR Tank Pressure Relief Valve
W1	Discharge point for water from MBR equipment

REV NUM	DESCRIPTION	DRWN BY	CHKD BY	APRD BY	DATE
01	Pasteurisation tank removed	SC	--	AC	13-08-21
02	Updated to latest layout	SC	SG	SS	09-12-21
03	Updated to latest layout	SC	DM	SS	03-05-22
04	Updated to latest layout	SC	DM	SS	12-07-22

ORIGINATOR LOGO

Anaergia
Breaking Barriers to Sustainability

Eng Stmp

DRAWN:	SC
CHECKED:	**
APPROVED:	**
DATE:	09-04-2021
PROJECT NO.:	125
SCALE:	1:1000

Bio Dynamic

Permit Boundary and Emissions Points Plan

DRAWING NUMBER: 125-08

Status 04

Legend

Title
Figure 2 - Site Layout Plan

Project
Bioaerosol Risk Assessment - Bio Dynamic UK, Nottingham

Project Reference
4446-1

Client
Bio Dynamic UK Ltd

Redmore environmental
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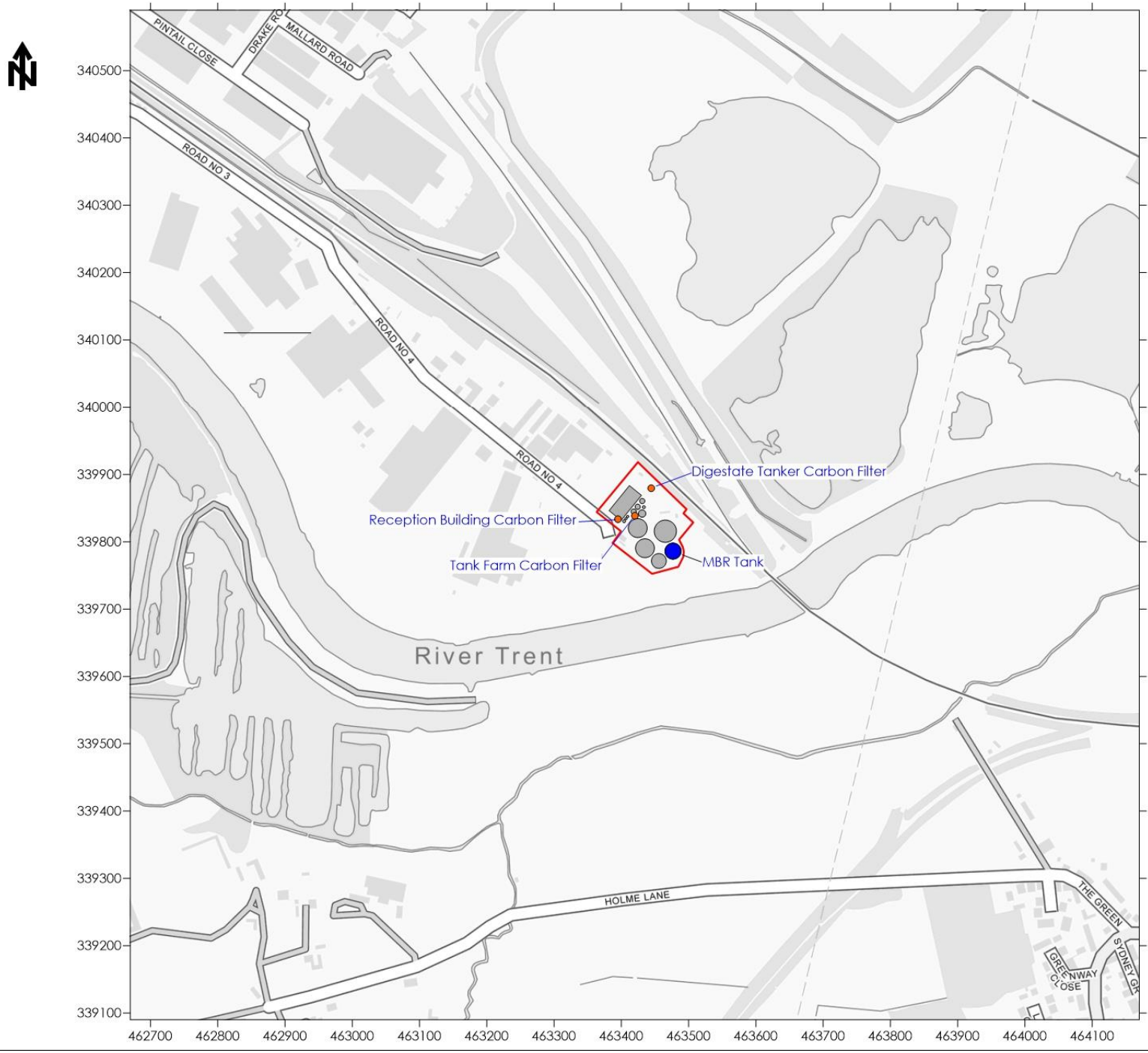

Legend

- Site Boundary
- Area Source
- Point Source

Title
Figure 3 - Bioaerosol Source Locations

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4446-1

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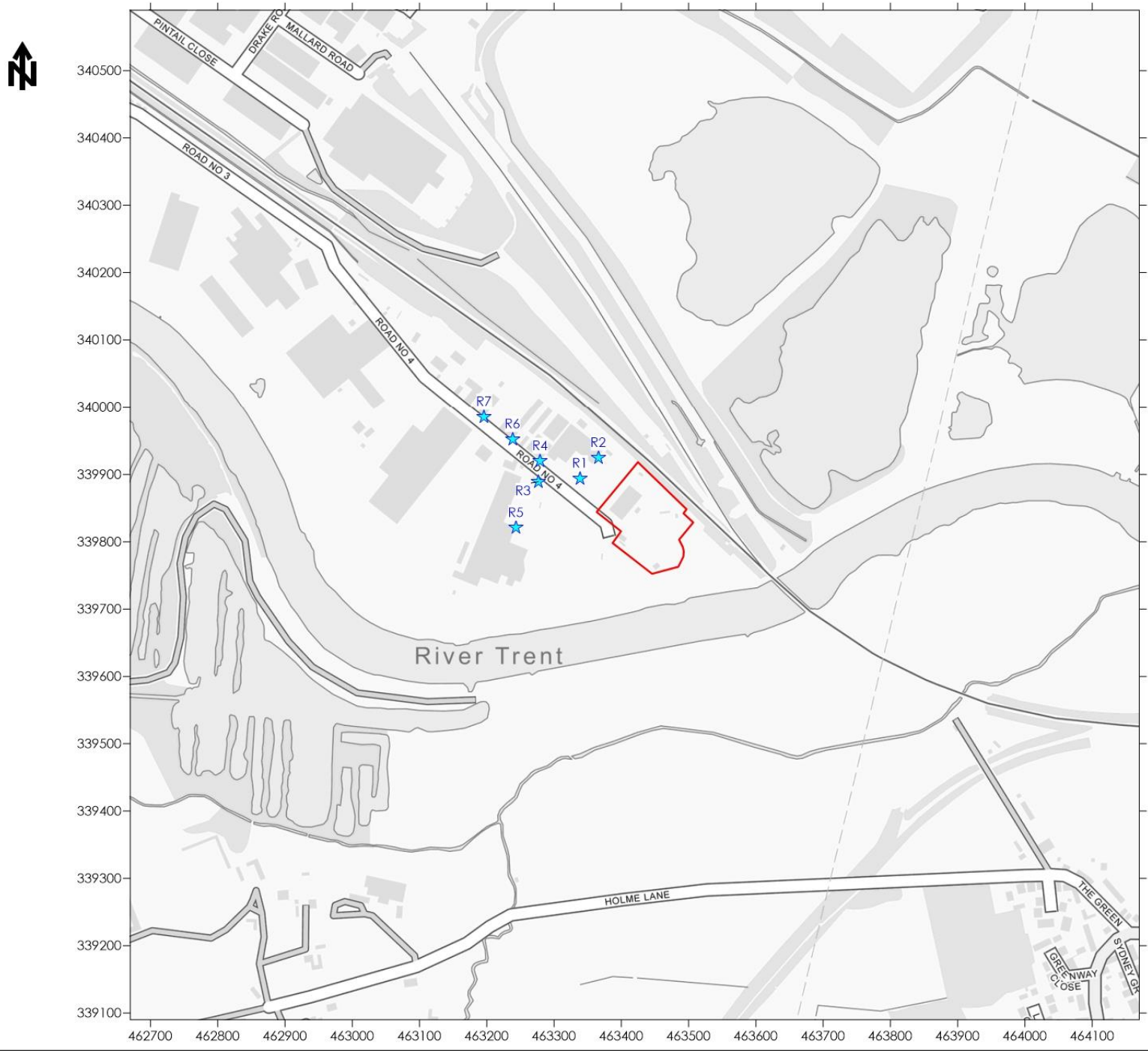

Legend

Site Boundary

Sensitive Receptor

Title
Figure 4 - Sensitive Receptor Locations

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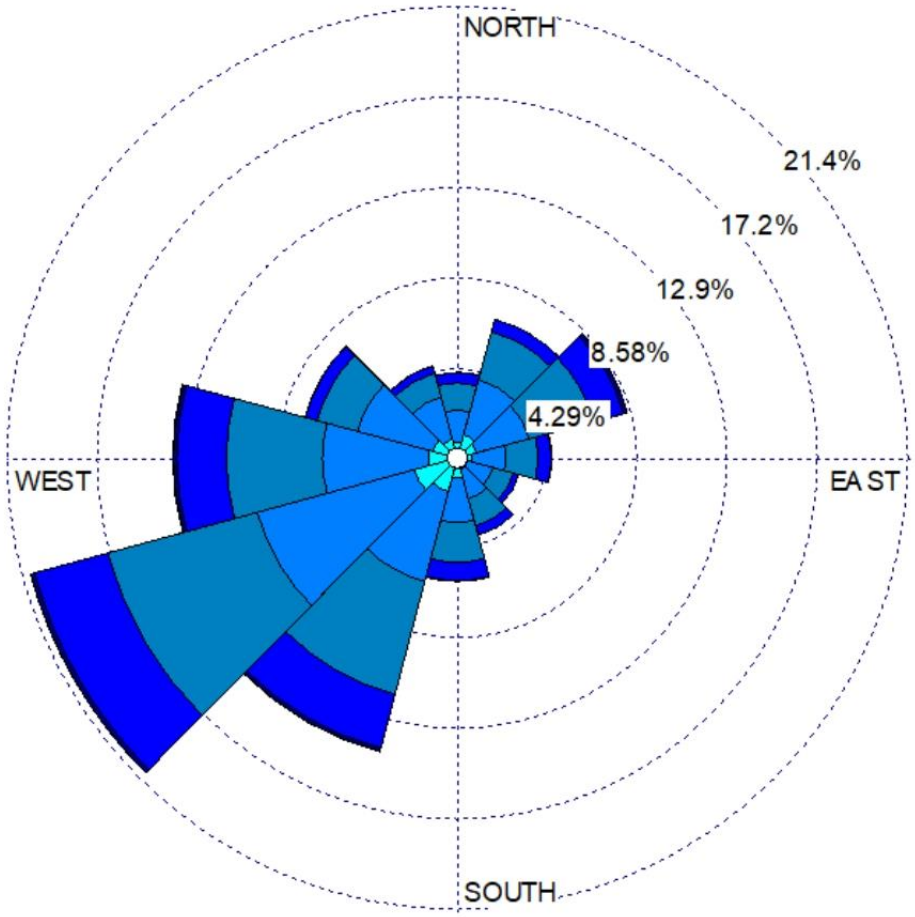

Legend

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: 0.57%

Title
Figure 5 - Wind Rose of 2017 to 2021 Nottingham Watnall Meteorological Data

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