Bioaerosol Risk Assessment

Brocklesby Waste Processing Facility, North Cave

Client: H&C Consultancy Ltd

Reference: 4089-2r1

Date: 30th March 2021

Report Issue

Report Title: Bioaerosol Risk Assessment - Brocklesby Waste Processing Facility, North Cave

Report Reference: 4089-2

Field	Report Version			
	1	2	3	4
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Date of Issue	30th March 2021			
Comments	-			

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1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by H&C Consultancy Ltd to produce a Bioaerosol Risk Assessment in support of the Brocklesby Ltd waste processing facility, Crosslands Lane, North Cave.

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 existing and 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 Brocklesby Ltd facility is located on land off Crosslands Lane, North Cave, at National Grid Reference (NGR): 488150, 432180. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 The site operates as a waste processing facility under an Environmental Permit (No. JP3931SG/V002) issued by the Environment Agency (EA). An Environmental Permit Variation Application is currently being made in order to authorise a number of changes to operations. These include the construction of a new tank farm in order to facilitate an increase in waste storage and processing capacity, as well as the replacement of two existing boilers which are used to produce steam for heat processing of materials.

1.2.3 The site operations incorporating the changes proposed under the Environmental Permit Variation can be summarised as follows:

- The site processes used cooking oil and fatty food wastes;
- The facility has the capacity to process up to 225,000tpa of waste using heat treatment, physical treatment, chemical treatment and pre-esterification. The maximum daily processing capacity is 975t;
- Waste fats and oils are received in butter portions, retail packs of spreads, 20l to 200l drums, Intermediate Bulk Containers (IBCs) and liquid tankers. Other solid food waste is delivered to the facility in sealed skips, IBCs, roll-on roll-off skips and bulk tipping trailers;
- The solid materials received are taken to a reception area within a dedicated processing building and tipped into a contained bund;
- Liquid wastes are delivered to the site by tanker. On arrival, these are directed to the tank farm reception point for offloading. The tank farm consists of sixteen 150t vessels and four 500t tanks;
- The tank farm has a total capacity of 4,400t and is used to store incoming wastes, intermediate materials prior to further processing, final wastes that are awaiting dispatch and surface waters before treatment and discharge to foul sewer or use within the process;
- Wastes are treated at the site to recover oils for further use via various combinations of heat treatment, physical treatment, chemical treatment and pre-esterification;
- The wastes are heated to achieve separation of oils from non-oil and water components. Heat utilised as part of this process is generated by two natural gas fired steam boilers. The operation also receives heat generated by a Combined Heat and Power (CHP) unit which is located within the permitted area of the adjacent Anaerobic Digestion (AD) facility;
- Physical treatment is carried out via centrifuging of heated wastes to further accelerate separation of oils and non-oil components/ water fractions;
- Chemical treatment is also carried out to achieve separation and recovery of oils from food waste. The process utilises pH correction whereby sulphuric acid is added to the materials followed by centrifuging to achieve final separation of oils and non-oil components/ water fractions. The oil element arising from the treatment is further processed in the onsite pre-esterification plant;
- In the pre-esterification plant, fatty acid wastes are received in tankers and stored in bulk storage vessels or generated as intermediaries from other processing activities. The feedstocks are processed with sulphuric acid and methanol to convert the fatty acids to methyl esters, leaving the triglycerides intact. Once the fatty acids have been processed, the materials are suitable for use as biodiesel;

- The site includes a range of existing odour abatement measures intended to manage potential impacts from operations. In addition, a number of new abatement systems will be installed to control emissions associated with proposed processes which are subject to the Environmental Permit Variation Application; and,
- Other point source emissions to atmosphere arise from the stacks on the gas fired boilers and the vent serving the vapour adsorber associated with the pre-esterification plant.

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 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 food wastes 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 food waste processing actives, 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

[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.

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. Activities at the site are included within the Regulations. As such, the facility is required 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 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.

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.

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	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 development site as outlined in Section 3.4

3.3 Sources

3.3.1 The operation of the facility may result in bioaerosol emissions from a number of activities. The following potential sources were identified based on a review of existing and proposed operations:

- Air expelled from the proposed the chemical scrubber which will be used to treat emissions from IBC cleaning operations within the main processing building - Emission point A1;
- Air expelled from the existing carbon filters which are used to treat emissions from the unprocessed and processed oil storage tanks - Emission points A5 and A6;
- Air expelled from the proposed carbon filters which will be used to treat emissions from the new tank farm - Emission points A7 to A10;

- Air expelled from the existing carbon filter which is used to treat emissions from the solid waste reception area within the main processing building - Emission points A11 and A12;
- Air expelled from collection tankers during filling;
- Air expelled from the existing carbon filter serving the pre-esterification plant - Emission point A4; and,
- Air discharged to atmosphere from the proposed replacement gas boilers - Emission points A2 and A3.

3.3.2 Vapours generated by the pre-esterification process are discharged to atmosphere via a dedicated stack at a height of 10.5m. Information provided by the operator indicates that all extract air from the process is subject to carbon filtration prior to release and that emissions from the stack only occur for approximately 2-hours each day. Based on the stated factors, it is considered that there is a low risk of impact as a result of residual releases from the carbon stack. As such, emissions from A4 have not been considered further in the context of the assessment.

3.3.3 The proposed replacement gas boilers will only emit products of combustion which do not contain any bioaerosols. As such, emissions from A2 and A3 they have not been considered further in this report.

3.3.4 The potential for bioaerosol emissions from each remaining source is considered further in the following Sections. Reference should be made to Figure 2 for visual representation of the source locations.

Chemical Scrubber

3.3.5 Air extracted from the IBC cleaning area within the main processing building will be treated by a Forbes Environmental Technologies chemical scrubber prior to release to atmosphere. This will utilise a sodium hydroxide dosing system in order to neutralise acid gas emissions associated with the process. Treated air will be discharged via a dedicated dispersion stack represented by emission point A1.

3.3.6 The proposed system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the potential for capture and suspension of microorganisms in the liquid scrubbing reagent. However, there may be the potential for

release of residual components. As such, emissions have been considered further as part of the assessment.

Unprocessed and Processed Oil Storage Tank Carbon Filters

3.3.7 Air displaced from the existing unprocessed and processed oil storage tanks is treated by two carbon filters prior to discharge to atmosphere via dedicated vents represented by emission points A5 and A6.

3.3.8 The carbon filters are 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. However, there may be the potential for the release of residual components which pass straight through the filters. As such, impacts associated with emissions from the sources have been considered further as part of the assessment.

New Tank Farm Carbon Filters

3.3.9 Air displaced from vessels within the proposed new tank farm will be treated by four carbon filters prior to discharge to atmosphere via dedicated vents represented by emission points A7 to A10.

3.3.10 The carbon filters are 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. However, there may be the potential for the release of residual components which pass straight through the filters. As such, impacts associated with emissions from the sources have been considered further as part of the assessment.

Solid Waste Reception Area Carbon Filter

3.3.11 Air is extracted from the solid waste reception area and treated by a carbon filter prior to discharge to atmosphere via two dedicated vents which are represented as follows:

- A11 - Solid waste reception area vent 1; and,
- A12 - Solid waste reception area vent 2.

3.3.12 The carbon filter 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. However, there may be the potential for the release of residual components which pass straight through the filter. As such, impacts associated with emissions from the source have been considered further as part of the assessment.

Collection Tankers

3.3.13 Materials will be pumped from the storage vessels into a tanker for transfer off-site. Emissions from the tanker are associated with the air being expelled during filling. The bioaerosol release potential depends largely on the material previously being transported rather than the offload material itself.

3.3.14 Tankers are most commonly used to transport liquids and semi-solid materials which generally have a low emission potential. As such, releases from this source are not considered to be significant. However, emissions have been considered further as part of the assessment in order to provide a comprehensive appraisal of potential impacts.

3.4 Receptors

3.4.1 EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[9] 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."

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

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[10], 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 2.

Table 2 Sensitive Receptors

Receptor		NGR (m)		Distance from Facility (m)	Direction from Facility
		X	Y		
R1	Residential - Newport Road	488282.1	431986.0	150	South-east
R2	Residential - Newport Road	488301.3	431984.8	160	South-east
R3	Residential - Newport Road	488331.0	432001.7	160	South-east
R4	Residential - Newport Road	488446.2	432091.6	200	East
R5	Residential - Walnut Grove	488106.8	431839.8	240	South
R6	Industrial - North Cave Quarry	488059.7	432159.9	25	West
R7	Industrial - JB Timber	488442.9	432353.4	240	East
R8	Industrial - Brocklesby Biogas	488060.9	432263.7	15	North

3.4.3 As shown in Table 2, the sensitive locations are located between approximately 15m and 240m from the site at their closest points. Reference should be made to Figure 3 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. Leconfield observation station is located at NGR: 503329, 442674, which is approximately 18.1km north-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.

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

3.5.2 Meteorological data was obtained from Leconfield observation station over the period 1st January 2015 to 31st December 2019 (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	8.3
22.5 - 67.5	6.6
67.5 - 112.5	8.2
112.5 - 157.5	6.4
157.5 - 202.5	14.3
202.5 - 247.5	20.6
247.5 - 292.5	25.8
292.5 - 337.5	7.8
Sub-Total	98
Calms	1.0
Missing/Incomplete	1.0

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 3, the prevailing wind direction at the AD plant is from the west, with significant frequencies from the south and 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

3.6.1 The area surrounding the facility is predominantly rural, comprising agricultural land. Arable fields may form 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.

3.6.2 There are also a number of industrial facilities in the vicinity of the site which may form sources of bioaerosols. Those closest to the facility and therefore most likely to contribute to cumulative atmospheric concentrations are summarised as follows:

- Breedon Southern Ltd at North Cave Quarry - Located immediately to the west and approximately 90m to the north of the facility; and,
- Brocklesby Biogas AD Plant - Located immediately to the north of the facility.

3.6.3 Operations at the Breedon Southern Ltd facility include the extraction and processing of inert materials in order to produce sand and gravel. As such, it is considered that there is limited potential for bioaerosol release as a result of operations undertaken at the site and emissions have not been considered further in the context of the assessment.

3.6.4 The Brocklesby Biogas AD plant may result in bioaerosol release during normal operation. However, the existing infrastructure at the facility is likely to provide effective containment of emissions and result in minimal exposure at sensitive locations in the vicinity of the site. In addition, the plant operates under an Environmental Permit issued by the EA. In accordance the provisions of the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments, this should include appropriate conditions to restrict environmental impacts beyond the boundary. These conditions will help to limit the potential for any cumulative effects as a result of bioaerosol emissions from the plant and the Brocklesby Ltd facility.

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'[11]. 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;

[11] 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 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

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 5.

Table 5 Risk Assessment

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
A1 - Air expelled from the proposed the chemical scrubber	**Very Low** due to the distance between the source and receptors, the prevailing meteorological conditions and the potential effectiveness of the abatement system in reducing bioaerosol concentrations	**Medium**	**Low**	The scrubbing system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air as a result of the capture and suspension of microorganisms in the liquid scrubbing reagent High level release from the stack serving the system will help to promote effective dilution and dispersion of any residual emissions	**Very Low**	The distance between source and receptors, as well as and full implementation of the stated 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
A5 and A6 - Air expelled from the existing carbon filters serving the unprocessed and processed oil storage tanks	**Very Low** due to the distance between the source and receptors, the prevailing meteorological conditions and the potential effectiveness of the abatement systems in reducing bioaerosol concentrations	**Medium**	**Low**	The wet nature of materials stored within the tanks will limit the potential for bioaerosol release The existing carbon filters serving the storage tanks are likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the media	**Very Low**	The distance between source and receptors, as well as and full implementation of the stated control measures, is considered to result in a **very low** risk of impact occurring
A7 to A10 - Air expelled from the proposed carbon filters which will serve the new tank farm	**Very Low** due to the distance between the source and receptors, the prevailing meteorological conditions and the potential effectiveness of the abatement systems in reducing bioaerosol concentrations	**Medium**	**Low**	The wet nature of materials stored within the tanks will limit the potential for bioaerosol release It is anticipated that the carbon filters will provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the media	**Very Low**	The distance between source and receptors, as well as and full implementation of the stated 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
A11 and A12 - Air expelled from the existing carbon filter serves the solid waste reception area	**Low** due to the distance between the source and receptors, the prevailing meteorological conditions and the potential effectiveness of the abatement systems in reducing bioaerosol concentrations	**Medium**	**Medium**	The existing carbon filter serving the solid waste reception area is likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the media High-level release from the exhaust vents will help to promote effective dilution and dispersion of residual emissions	**Low**	The distance between source and receptors, as well as and full implementation of the stated control measures, is considered to result in a **low** risk of impact occurring
Air expelled from collection tankers	**Very low** due the distance between source and receptors and the limited release potential	**Medium**	**Low**	Residual material within the tanker is likely to have a low release potential due to associated moisture content The low frequency of tanker loading events is likely to limit potential exposure durations	**Very Low**	The low release potential of residual material within the tanker is considered to result in a **very low** risk of impact occurring

6.0 CONCLUSION

6.1.1 Redmore Environmental Ltd was commissioned by H&C Consultancy Ltd to produce a Bioaerosol Risk Assessment in support of the Brocklesby Ltd waste processing facility, Crosslands Lane, North Cave.

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 The following potential bioaerosol emission sources were identified considered as part of the assessment:

- Air expelled from the proposed the chemical scrubber which will be used to treat emissions from IBC cleaning operations within the main processing building - Emission point A1;
- Air expelled from the existing carbon filters which are used to treat emissions from the unprocessed and processed oil storage tanks - Emission points A5 and A6;
- Air expelled from the proposed carbon filters which will be used to treat emissions from the new tank farm - Emission points A7 to A10;
- Air expelled from the existing carbon filter which is used to treat emissions from the solid waste reception area within the main processing building - Emission points A11 and A12; and,
- Air expelled from collection tankers during filling.

6.1.4 The risk of significant bioaerosol impact at sensitive locations in the vicinity of the site 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.

6.1.5 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 reduce the potential for impacts at sensitive locations in the vicinity of the site.

7.0 ABBREVIATIONS

AD	Anaerobic Digestion
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
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

Figures

Legend

Site Boundary

Title
Figure 1 - Site Location

Project
Bioaerosol Risk Assessment
Brocklesby Waste Processing Facility,
North Cave

Project Reference
4089-2

Client
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Legend

- Site Boundary
- Building
- Bioaerosol Source

Title
Figure 2 - Bioaerosol Source Locations

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Site Boundary

Sensitive Receptor

Title
Figure 3 - Sensitive Receptor Locations

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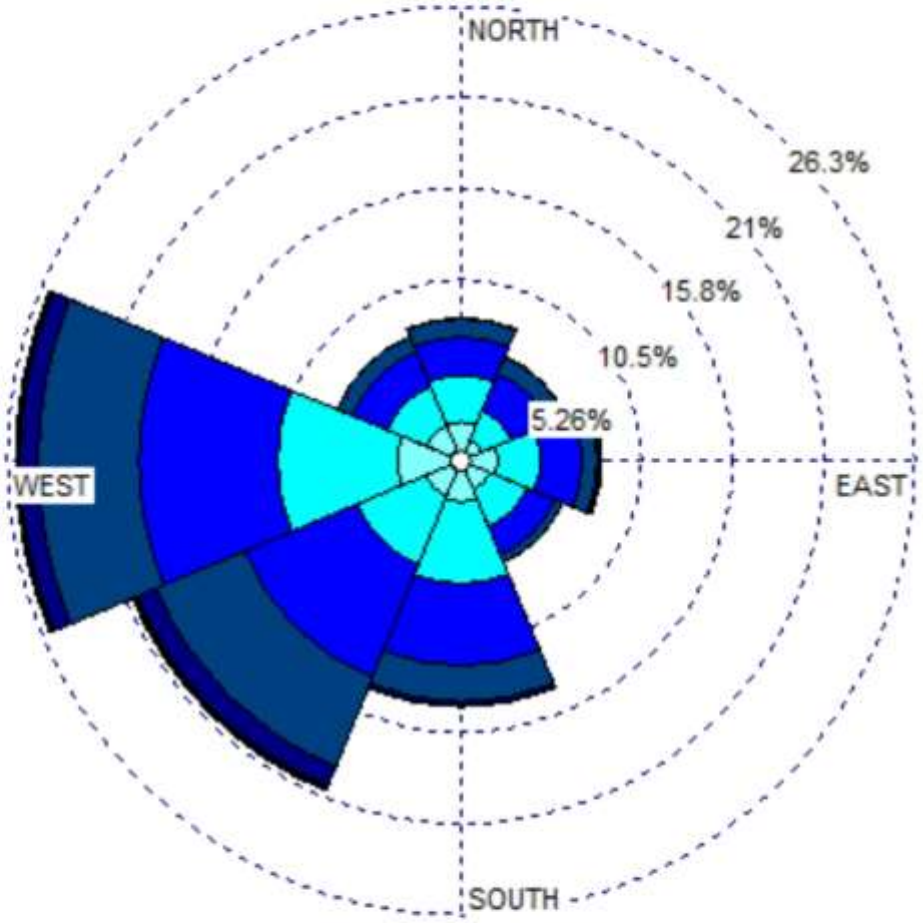

Legend

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: 0.99%

Title
Figure 4 - Wind Rose of 2015 to 2019 Leconfield Meteorological Data

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