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Wessex Water Services Ltd.

Bioaerosol Risk Assessment:

Trowbridge Bioresources Centre
Bradford Road
Trowbridge
BA14 9BJ

Report Reference: CE-TB-2228-RP02-Final

Report Date: 31 July 2023

Produced by Crestwood Environmental Ltd.

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1 INTRODUCTION

1.1 BACKGROUND

1.1.1 Crestwood Environmental Ltd., a firm of environmental consultants based in Wolverhampton, has been commissioned by Wessex Water Services Ltd. ('the Client') to undertake a Bioaerosol Risk Assessment in relation to operations at Trowbridge Bioresources Centre (BC) which is located at Trowbridge Water Recycling Centre (WRC) ('the Site') on land off Bradford Road, Trowbridge, Wiltshire, BA14 9BJ.

1.1.2 During the operation of the Site there is the potential for bioaerosol emissions and associated impacts at sensitive locations. 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 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 Trowbridge BC is located at Trowbridge WRC, Bradford Road, Trowbridge, at approximate National Grid Reference (NGR): 384760, 158790. The Site is located to the north-west of Trowbridge town and approximately 12km south-east of Bath. Reference should be made to Figure 1 for a map of the Site and surrounding area.

1.2.2 The Trowbridge BC treats primary sewage sludges arising from the wider WRC, as well as sewage sludges generated by smaller Wessex Water 'satellite' works. The main activities undertaken at the installation include:

- Sludge reception and screening;
- Raw sludge thickening;
- Anaerobic digestion (AD) including associated heat generation from a boiler to support AD activities;
- Liquor balancing;
- Digested sludge dewatering;
- Storage and maturation of digested sludge cake transferred to skips prior to transfer off site for land spreading as an agricultural soil conditioning agent;
- Raw material storage and use;
- Surface water and process liquor collection followed by transfer to Trowbridge WRC for treatment; and,
- Associated waste storage and transfer off site.

1.2.3 The operation of Trowbridge BC 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 PROCESS DESCRIPTION

2.1.1 A summary of the operations undertaken at the Site is provided in the following Section. Reference should be made to Figure 2 for a site layout plan.

- Imported sludge is transferred from tankers to a sludge reception tank. The tank is also where the site's indigenous primary sludge is discharged;
- Sludge from the reception tank is pumped forward to the 2 no. strain presses;
- The strained sludge is delivered to 2 no. gravity belt thickeners (GBTs) via two holding tanks (strained transfer tank and pre-thickener tank). The 2 no. GBT liquors are transferred to the head of the works via the return liquor pumping station;
- The thickened sludge is pumped to the post-thickened tank before being forwarded for digestion;
- The AD process is made up of two phases; acid phase digestion (APD) and mesophilic anaerobic digestion (MAD). The "digester boiler" supplies heat to the APD, which is currently operated at around 30^{0}C. Residual heat is used in the MAD to facilitate biological activity;
- Digested sludge is pumped from the secondary digester to two sludge dewatering belts. Filtrate generated by dewatering is forwarded to two liquor balancing tanks (concentration tanks) before being pumped to the head of works for treatment at Trowbridge WRC. The digested cake ("sludge cake") from the dewatering activity is conveyed into skips for storage before being transferred off the Site for disposal;
- The biogas generated by the AD process is mainly utilised by the gas to grid system. If the gas does not meet the required standard or the gas-to-grid system has failed, the biogas is utilised by the Combined Heat and Power (CHP) unit and the boilers. The Site also features two waste gas burners which combust biogas in the event that the gas to grid system or CHP unit and boilers are not operational;
- The waste gas burner design includes the provision of the gas holder with sufficient capacity and the use of high-integrity relief valves. Plant management includes balancing the gas system and using advanced process control;
- The CHP process is designed to optimise the use of biogas and minimise the potential for releases to air. When biogas is available it is preferentially used to power the CHP engine and provide energy to be used by the Site or resold to the National Grid with excess heat being used to maintain the optimum operating temperature of the primary digesters.

3 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 conducive to their growth. Bioaerosols are therefore likely to be associated with sludge and liquor treatment activities, in particular, operations which result in the agitation of materials and the associated release of 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]. In addition, 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.

3.3 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. It is recognised that there are fundamental differences between composting and sludge treatment processes. However, the research has been used to the inform regulatory requirements for biological waste treatment facilities and therefore a review of relevant literature 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 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

1 Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.
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.

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 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 BIOAEROSOL EMISSIONS FROM WASTEWATER TREATMENT PROCESSES

3.4.1 A review of relevant scientific research and industry guidance on bioaerosol emissions from wastewater treatment operations has also been undertaken in order to inform the assessment. The findings are detailed in the following Section.

3.4.2 The Indian Institute of Science report 'Gaseous and bioaerosol emissions from municipal wastewater treatment plants'[6] concludes that wastewater treatment works (WwTWs) are identified as potential emission sources of bioaerosols, and the most significant releases are likely to occur as a result of Activated Sludge Processes (ASPs).

3.4.3 The research report 'Microorganisms in bioaerosol emissions from wastewater treatment plants during summer at a Mediterranean site'[7] provides a summary of the findings of measurement work undertaken in the vicinity of a WwTWs in order to assess ambient bioaerosol concentrations under intensive solar radiation. Air samples were taken at various stages of the ASPs carried out at the site. Cultivation of viable mesophilic bacteria and fungi colonies collected onto the samples was then undertaken. The findings indicated that the highest concentrations of airborne microorganisms were observed at the aerated grit removal stage of the process. A gradual decrease in bioaerosol emissions was observed during the advanced stages of treatment.

3.4.4 The research report 'Emissions of bacteria and fungi in the air from wastewater treatment plants - a review'[8], confirms that the principal mechanism for transfer of microorganisms from wastewater to the atmosphere is through the entrainment of water droplets. The potential for this process to occur is increased by the movement of materials between treatment areas and agitation as part of forced aeration and sludge thickening. The report indicates that viability of bioaerosols once entrained into the atmosphere is largely governed by meteorological and climatic conditions which can contribute to desiccation and annihilation of microorganisms.

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

3.5 BIOAEROSOL LEGISLATIVE CONTROL

3.5.1 Atmospheric emissions from industry are controlled in the UK through the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. The operation of Trowbridge BC is included within the Regulations. As such, the site is required to operate in

5 Bioaerosols and odour emissions from composting facilities, DEFRA, 2013.
6 Gaseous and bioaerosol emissions from municipal wastewater treatment plants, Department of Civil Engineering, Indian Institute of Science, 2013.
7 Microorganisms in bioaerosol emissions from wastewater treatment plants during summer at a Mediterranean site, Karra et al, Water Research Volume 41 Issue 6, 2007.
8 Emissions of bacteria and fungi in the air from wastewater treatment plants - a review, Korzeniewska.E, 2011.

accordance with an Environmental Permit (No. EPR/BB3934AG) issued by the EA.

3.6 ENVIRONMENT AGENCY POLICY

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

3.6.2 The RPS states that if a regulated biological waste treatment 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:

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

3.6.3 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.

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

3.7 BENCHMARK LEVELS

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

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

3.8 BEST PRACTICE GUIDANCE

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

3.8.2 The EA guidance for 'Biological waste treatment: appropriate measures for permitted facilities'[13] sets out the factors that should be considered when assessing appropriate measures for biowaste installations.

3.8.3 The requirements of the stated guidance documents have been considered throughout the assessment.

9 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.
10 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2018.
11 Composting and potential health effects from bioaerosols: our interim guidance for permit applicants, EA, 2010.
12 How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion, EA, 2013.
13 Biological waste treatment: appropriate measures for permitted facilities, EA, 2022.

3.9 REPORTING REQUIREMENTS

3.9.1 This bioaerosol risk assessment is required to support the application for a Substantial Variation to the existing Permit number EPR/BB3934AG currently in place for Trowbridge BC, to introduce the AD activity and the directly associated activities within the Permit boundary. The EA requirements for bioaerosol risk assessments for such sites are typically as follows:

i) Include relevant point source emissions i.e., odour control units situated within 250m of a sensitive receptor.

ii) Include relevant diffuse sources i.e., cake pad situated within 250m of a sensitive receptor.

iii) Provide quantitative results for Bio-aerosol point source and diffuse emissions identified on site that are situated within 250m of a sensitive receptor in line with M9: RPS 209 guidance.

iv) Include a map of sensitive receptors within 250m of potential bio-aerosol sources.

v) Explain how the wind rose data reflects that of the site considering topography.

vi) Explain how representative data has been captured at the wind rose locations.

vii) Demonstrate using the above data in point iii that there are no impacts on sensitive receptors in line with RPS 209.

viii) Explain how you will monitor bioaerosols in line with M9 Guidance, or if you cannot demonstrate this that there are no impacts at sensitive receptors. The above requirements have been considered and addressed as appropriate throughout the report."

3.9.2 The above requirements have been considered and addressed as appropriate throughout the report.

4 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.

4.1.2 The EA document 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities'[14] indicates that the problem definition should state any limitations, uncertainties and assumptions in order to justify any potential gaps in the appraisal approach. The principal elements for consideration with respect to this assessment are as follows:

- Uncertainties in dispersal due to particle size and aggregation which can affect how far downwind bioaerosols can travel;
- Uncertainties in the bioaerosol emission potential of different sources at the Site;
- Uncertainties in bioaerosol dose response relationships; and,
- Variation in sampling procedures and the affect that this has on ambient concentrations measured as part of monitoring campaigns.

4.1.3 The stated elements have been considered and addressed as follows in order to ensure a robust assessment and limit the number of gaps associated with the appraisal:

- Uncertainties in dispersal - The assessment considered the results of bioaerosol monitoring undertaken by Crestwood Environmental at Trowbridge BC, as shown in Section 4.6. The monitoring was undertaken in order to provide a site-specific assessment of baseline conditions and potential impacts at the Nearest Sensitive Receptor (NSR) as a result of emissions from the facility. As such, the use of the data is considered to reduce uncertainties associated with bioaerosol dispersal at the Site;
- Uncertainties in bioaerosol emission potential - Worst-case assumptions were utilised as appropriate throughout the assessment with respect to the emission potential for different sources at the Site in order to ensure a precautionary appraisal of impact;
- Uncertainties in bioaerosol dose-response relationships - A 'medium' harm classification was utilised as part of the assessment. This is considered to represent a worst-case approach as it assumes that there is the potential for significant consequences as a result of emissions from all sources at the site; and,
- Variation in sampling procedures - The Bioaerosol Monitoring undertaken by Crestwood Environmental was completed in accordance with approved methods specified in EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[15] in order to limit uncertainties associated with sampling techniques. Please refer to CE-TB-2228-RP01-Final for full details of the sampling procedures.

4.1.4 It is considered that the use of the stated measures and worst-case assumptions where necessary has resulted in an assessment accuracy of an acceptable level.

4.2 CONCEPTUAL MODEL

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

14 Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.
15 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2018.

Table 1 Conceptual Model

Criteria	Comment
Source	Sludges and liquors 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 as outlined in Section 4.4

4.3 SOURCES

4.3.1 A review of operations at the Site was undertaken in order identify potential bioaerosol emission sources which required further consideration as part of the assessment. A summary of the relevant sources is provided in Table 2.

4.3.2 Reference should be made to Figure 3 for a map of the source locations.

Table 2 Bioaerosol Emission Sources

Source	Source Type	Emission Potential and Characteristics
Post digested tanks 1 & 2	Digested sludge	The post digested tanks are open to atmosphere. As such, there may be the potential for diffuse emissions from the surface of material within the vessels
Post thickened tank	Digested sludge	The post thickened tank is covered. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential for emissions as a result of air displaced during filling
Strained transfer tank	Digested sludge	The strained transfer tank is covered. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential fugitive emissions from the vent serving the vessel which expels headspace air to atmosphere during filling
Pre-thickened tank	Digested sludge	The pre-thickened tank is covered. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential fugitive emissions from the vent serving the vessel which expels headspace air to atmosphere during filling
Strain presses 1 & 2	Raw sludge	The strain pressures are covered. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential fugitive emissions during operation of the strain presses
Sludge reception tank	Digested sludge	The sludge reception tank is covered. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential fugitive emissions from the vent serving the vessel which expels headspace air to atmosphere during filling
2 extraction stacks serving the belt presses	Raw sludge	The belt presses are contained within the dewatering building. Air is extracted from both belt presses and discharged vertically to the atmosphere via two vent stacks. There may be the potential for bioaerosol releases via the stacks as such emissions have been considered further as part of the assessment
Cake skips	Raw sludge	The cake skips are open to atmosphere. As such, there may be the potential for diffuse emissions from the surface of material within the skips

Source	Source Type	Emission Potential and Characteristics
Return liquor balance tanks 1 & 2	Sludge liquors	The return liquor balance tanks are covered. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential fugitive emissions from the vent serving the vessel which expels headspace air to atmosphere during filling
Gas to grid vent	Air expelled from the gas to grid vent	The gas to grid facility includes a granular activated carbon (GAC) unit. This contains copper impregnated activated carbon (type SA-70) and is used to reduce pollutant concentrations in the biogas prior to upgrade to biomethane. Exhaust air from the upgrading process is vented to atmosphere via a dedicated stack at a height of 6m. The stated arrangements are likely to provide beneficial reductions in bioaerosol concentrations due to the impaction of microorganisms onto the carbon media during operation. However, there may be the potential for the release of residual components via the vent which pass straight through the filter

4.3.3 It should be noted that all digesters at Trowbridge BC are completely enclosed and during normal operation, biogas produced by the AD processes is transferred to the gas to grid plant, the CHP unit or boilers for combustion.

4.3.4 Should the waste gas burners fail for any reason, the digesters and gas holder are fitted with emergency release valves to avoid over pressure. These are a necessary safety feature to avoid any possibility of explosion or other damage to the plant.

4.3.5 Any gases released from the pressure release valves are likely to contain bioaerosols due to the nature of housed materials and as a result of the digestion processes. However, releases from these sources are expected 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 releases from the pressure release valves serving the digesters or gas holder have not been evaluated further as part of the assessment.

4.3.6 Combustion gases do not contain bioaerosols. As such, releases from CHP unit, boilers and waste gas burners at the Site have not been considered further in the assessment.

4.4 RECEPTORS

4.4.1 EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'[16] defines the 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."

4.4.2 A desk-top study was undertaken in order to identify any sensitive locations in the vicinity of the site that required specific consideration during the assessment. In accordance with the EA EPS[17], 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.

16 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2018.
17 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.

Table 3 Sensitive Receptor Location

Receptor		NGR (m)		Direction from Closest Source	Approximate Distance from the installation boundary (m)
		X	Y		
R1	Residential - Francis Street	385099.0	158479.5	South-east	200

4.4.3 Reference should be made to Figure 4 for a visual representation of the identified receptor.

4.5 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. Lyneham Meteorological Station is located at NGR: 401484, 177895, which is approximately 25.3km north-east of the site. It is considered that conditions are likely to be reasonably similar over a distance of this magnitude and the information is a suitable source of data for an assessment of this nature.

4.5.2 Meteorological data was obtained from Lyneham 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	5.72
15 - 45	6.24
45 - 75	5.81
75 - 105	5.15
105 - 135	3.67
135 - 165	5.33
165 - 195	10.08
195 - 225	16.20
225 - 255	18.06
255 - 285	11.09
285 - 315	5.91
315 - 345	4.39
Sub-Total	97.66
Calms	1.26
Missing/Incomplete	1.08

4.5.3 As shown in Table 4, the prevailing wind direction at the Site 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.

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.

4.6 BIOAEROSOL MONITORING DATA

4.6.1 In accordance with the requirements of the EA RPS[18], a programme of bioaerosol monitoring has been undertaken at the Site in order to determine baseline levels and quantity potential impacts at the NSR.

4.6.2 The monitoring included quantification of Aspergillus fumigatus and mesophilic bacteria concentrations at the following locations in accordance with the methods specified in EA guidance 'M9: Environmental monitoring of bioaerosols at regulated facilities'[19]:

- Upwind of the facility approximately 50m from the cake skip holding area; and,
- At three separate downwind locations positioned downwind of the cake skip holding area in a fan shape arrangement to account for variation in the emission plume as a result of meteorological conditions throughout the monitoring period.

4.6.3 It should be noted that the closest housing estate to Trowbridge BC is located approximately 200m south-east of the Site's cake skip holding area therefore, it is regarded as the NSR. Bioaerosol sources on the west corner of the Site are located further away from the NSR than 250m and therefore they were eliminated from the monitoring.

4.6.4 A summary of the monitoring results is provided in Table 5.

Table 5 Median Bioaerosol Monitoring Results

Location	Distance from the centre of active area (m)	Median of upwind samples (cfu/m³)		Median of downwind replicate field samples (cfu/m³)	
		Aspergillus fumigatus	Mesophilic bacteria	Aspergillus fumigatus	Mesophilic bacteria
Upwind	50	0	0	-	-
Downwind 1	180	-	-	139	0
Downwind 2	200			0	556
Downwind 3	145			0	0

4.6.5 As shown in Table 5, median concentrations of Aspergillus fumigatus and mesophilic bacteria were below the respective EA guidance levels of 500cfu/m³ and 1,000cfu/m³ at all monitoring locations. This indicates that there is limited potential for emissions from Trowbridge BC and other background sources in the immediate vicinity of the Site to contribute to ambient bioaerosol concentrations at sensitive locations.

4.6.6. The results of the monitoring have been considered as appropriate throughout the assessment.

4.7 OTHER SOURCES OF BIOAEROSOLS

4.7.1 The area surrounding the facility is predominantly rural, comprising agricultural land. Arable fields

18 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.
19 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2018.

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.

4.7.2 There is existing infrastructure associated with Trowbridge WRC situated outside the installation boundary for the BC. This includes open sewage tanks surrounding the site which have the potential to result in bioaerosol emissions and therefore contribute to ambient concentrations locally.

4.7.3 As detailed in Section 4.6, a programme of bioaerosol monitoring was undertaken at the site in order to determine baseline levels and quantity potential impacts at the NSR. This included sampling at three locations which were situated broadly downwind of the sewage tanks at the WRC on the day of monitoring. The results indicated that median concentrations of Aspergillus fumigatus and mesophilic bacteria were below the relevant EA criteria at all positions. As such, is considered there is limited potential for emissions from the stated infrastructure at the WRC to contribute to ambient bioaerosol concentrations at sensitive locations in the vicinity of the Site.

5 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'[20]. This included consideration of the following:

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

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

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

5.2 RECEPTOR

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

5.3 PROBALITY 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.

20 Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.

5.4 HARM

5.4.1 The severity of harm from a risk depends on:

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

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

5.4.3 Harm can be described as follows:

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

5.5 MAGNITUDE OF RISK

5.5.1 The level of risk is a combination of:

- How likely a problem is to occur; and,
- How serious the harm might be.

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

5.5.3 Risk was defined based on the interaction between the probability of exposure and potential harm, as outlined in Table 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 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
Post digested tanks 1 & 2	**Medium** due to the distance between the sources and receptor, the open nature of the tanks, the wet nature of materials within the tanks which is likely to limit release potential and the frequency of winds towards the receptor	**Medium**	**Medium**	Regular inspection of the tanks is undertaken by site operatives in order to ensure that they are providing effective containment of materials	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Post thickened tank	**Low** due to the enclosed nature of the source and associated containment of emissions, the distance between the source and the receptor, as well as the frequency of winds towards the location	**Medium**	**Medium**	The post thickened tank is covered in order to provide containment of materials and associated emissions Regular inspection of the tank is undertaken by site operatives in order to that there is effective containment of materials and emissions	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Strained transfer tank	**Low** due to the enclosed nature of the source and associated containment of emissions, the distance between the source and the receptor, as well as the frequency of winds towards the location	**Medium**	**Medium**	The strained transfer tank is covered in order to provide containment of materials and associated emissions Regular inspection of the tank is undertaken by site operatives in order to that there is effective containment of materials and emissions	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Pre-thickened tank	**Low** due to the enclosed nature of the source and associated containment of emissions, the distance between the source and the receptor, as well as the frequency of winds towards the location	**Medium**	**Medium**	The pre-thickened tank is covered in order to provide containment of materials and associated emissions Regular inspection of the tank is undertaken by site	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring

Source	Probability of Exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
				operatives in order to that there is effective containment of materials and emissions		
Strain presses 1 & 2	**Low** due to the enclosed nature of the source and associated containment of emissions, the distance between the source and the receptor, as well as the frequency of winds towards the location	**Medium**	**Medium**	The strain presses are covered in order to provide containment of materials and associated emissions Regular inspection of the strain presses is undertaken by site operatives in order to that there is effective containment of materials and emissions	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Sludge reception tank	**Low** due to the enclosed nature of the source and associated containment of emissions, the distance between the source and the receptor, as well as the frequency of winds towards the location	**Medium**	**Medium**	The sludge reception tank is covered in order to provide containment of materials and associated emissions Regular inspection of the tank is undertaken by site operatives in order to that there is effective containment of materials and emissions	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
2 extraction stacks serving the belt presses	**Low** at all receptors due to the prevailing meteorological conditions, the distance between the source and receptors and the potential effectiveness of the abatement system in reducing bioaerosol concentrations	**Medium**	**Medium**	The belt presses are contained within the dewatering building and air is extracted from both units and discharged vertically to the atmosphere via two vent stacks	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Cake skips	**Low** at all receptors due to the limited quantity of material within the skip, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Medium**	Regular inspection of the skips are undertaken by site operatives in order to ensure that it is providing effective containment of materials No excess of materials are stored on site	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring

Source	Probability of Exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
				The skips are replaced when full		
Return liquor balance tanks 1 & 2	**Low** due to the enclosed nature of the source and associated containment of emissions, the distance between the source and the receptor, as well as the frequency of winds towards the location	**Medium**	**Medium**	The return liquor balance tanks are covered in order to provide containment of materials and associated Regular inspection of the tank is undertaken by site operatives in order to that there is effective containment of materials and emissions	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Gas to grid vent	**Very Low** at all receptors due to the prevailing meteorological conditions, the distance between the source and receptors and the potential effectiveness of the GAC abatement system in reducing bioaerosol concentrations	**Medium**	**Low**	The carbon filter serving the gas to grid system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the carbon media during operation. It is anticipated that the residual release potential will be limited	**Very Low**	Full application of the proposed control measures is 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 that the residual risk from all sources is **very low** or **low**. This is supported by the results of the Bioaerosol Monitoring undertaken by Crestwood Environmental Ltd at the facility which indicated that concentrations of Aspergillus fumigatus and mesophilic bacteria were below the relevant EA criteria downwind of the site at equivalent separation distances to the NSR.

6.1.3 Based on the findings, 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 CONCLUSION

7.1.1 Crestwood Environmental was commissioned by Wessex Water Services Ltd to undertake a Bioaerosol Risk Assessment in relation to operations at Trowbridge BC.

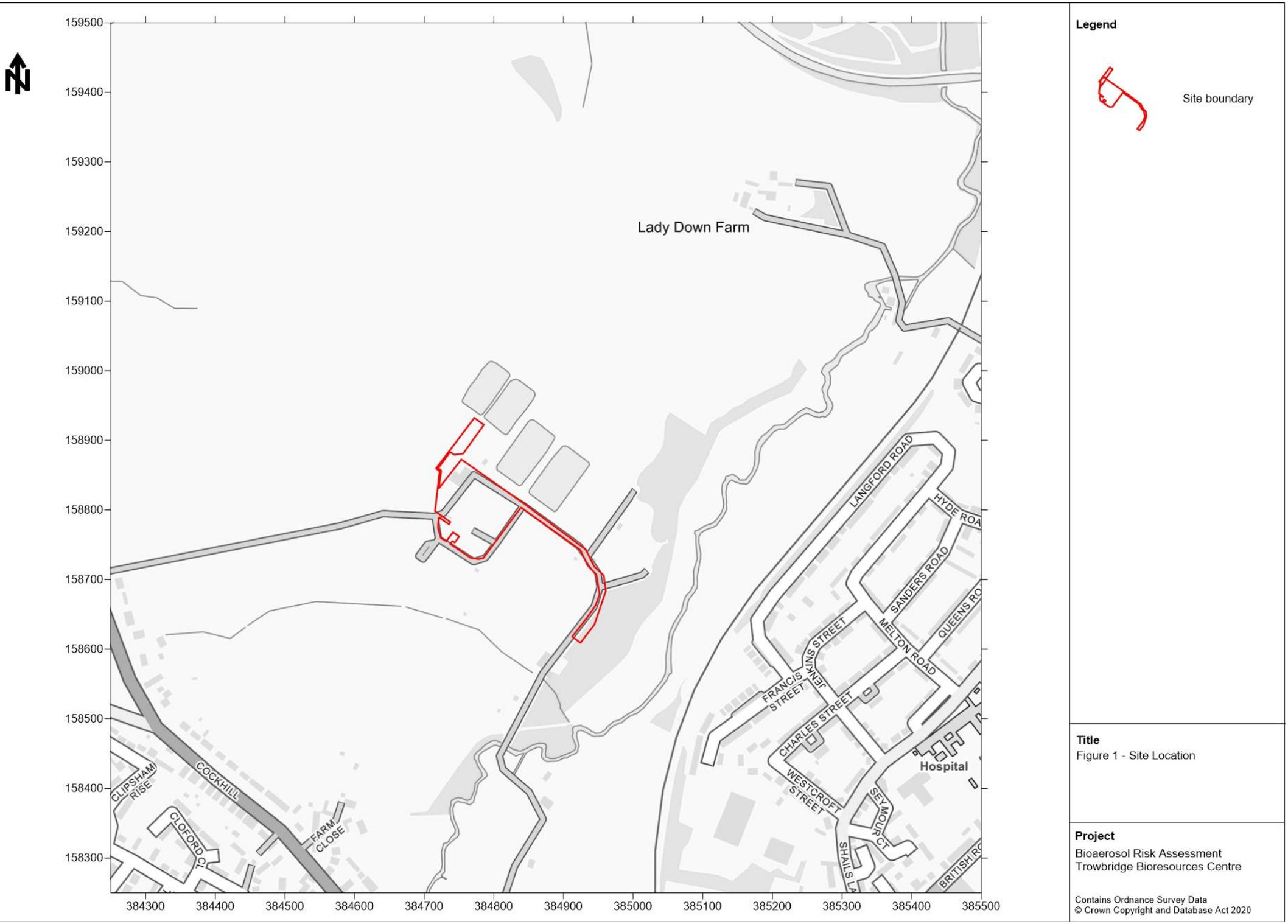
7.1.2 During the operation of the Site, there is the potential for bioaerosol emissions and associated impacts at the sensitive receptor location in the vicinity of the Site. A Risk Assessment was therefore undertaken to identify potential emissions sources and evaluate effects in the local area.

7.1.3 A review of operations at the facility was undertaken in order to identify relevant bioaerosol emission sources.

7.1.4 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.

7.1.5 The results of the assessment indicated that the residual risk from all sources was **very low** or **low**. This is supported by the results of the Bioaerosol Monitoring undertaken by Crestwood Ltd at the Site which indicated that concentrations of Aspergillus fumigatus and mesophilic bacteria were below the relevant EA criteria downwind of the Site at equivalent separation distances to the NSR.

7.1.6 Based on the findings, 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.



Legend

Site boundary

Title

Figure 1 - Site Location

Project

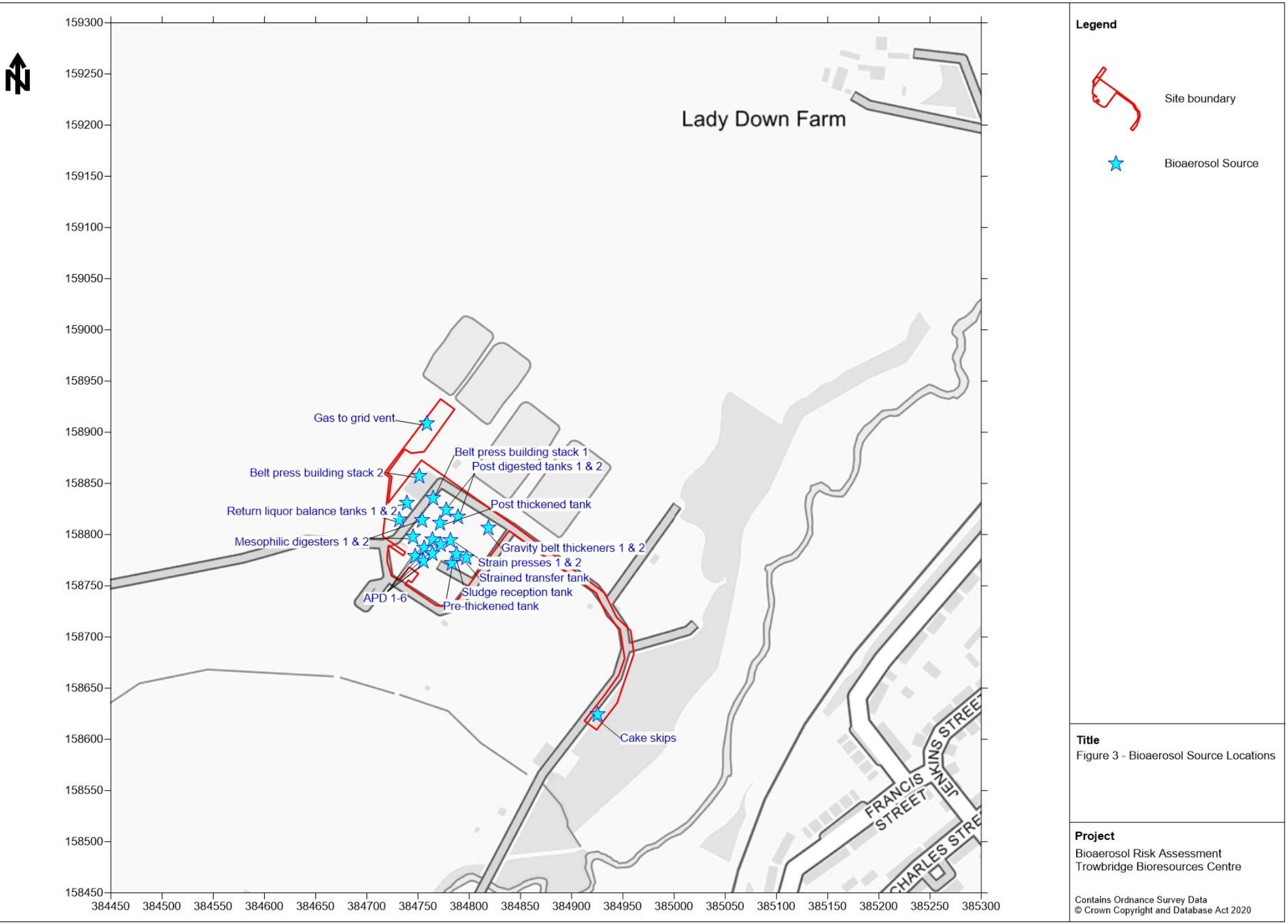
Bioaerosol Risk Assessment
Trowbridge Bioresources Centre

Name	Letter
Red Diesel Tank	2
S MAX Screen (to be decommissioned)	3
Liquor Fixed PS	4
Initial Skip Loading	5
Site Generator	6
Strain Presses	7
Gas Holder	A1
APD4	B1
APD5	B2
APD6	B3
APD1	B4
APD2	B5
APD3	B6
Mesophilic Digester 1	C1
Mesophilic Digester 2	C2
Siloxane Filter	D
Post Digested Tank 1	E1
Post Digested Tank 2	E2
Return Liquor Balance Tank 1	F1
Return Liquor Balance Tank 2	F2
Belt Press Building (No.2)	G1
Return Liquor PS	H
Works Liquor Return PS	I
Sludge Reception Tank	K
Gravity Belt Thickeners (No.2)	L
Belt Press Building Stack 2	N
Belt Press Building Stack 1	O
Post Thickened Tank	P
Strained Transfer Tank	Q
Boiler Building	T
Dehumidifier Chiller	W
Skip Storage Area	X
Waste Gas Burner (CHP)	Y

Legend

Title
Figure 2 - Site Layout Plan

Project
Bioaerosol Risk Assessment
Trowbridge Bioresources Centre



Legend

Site boundary

Bioaerosol Source

Title

Figure 3 - Bioaerosol Source Locations

Project

Bioaerosol Risk Assessment
Trowbridge Bioresources Centre

Legend

Site boundary

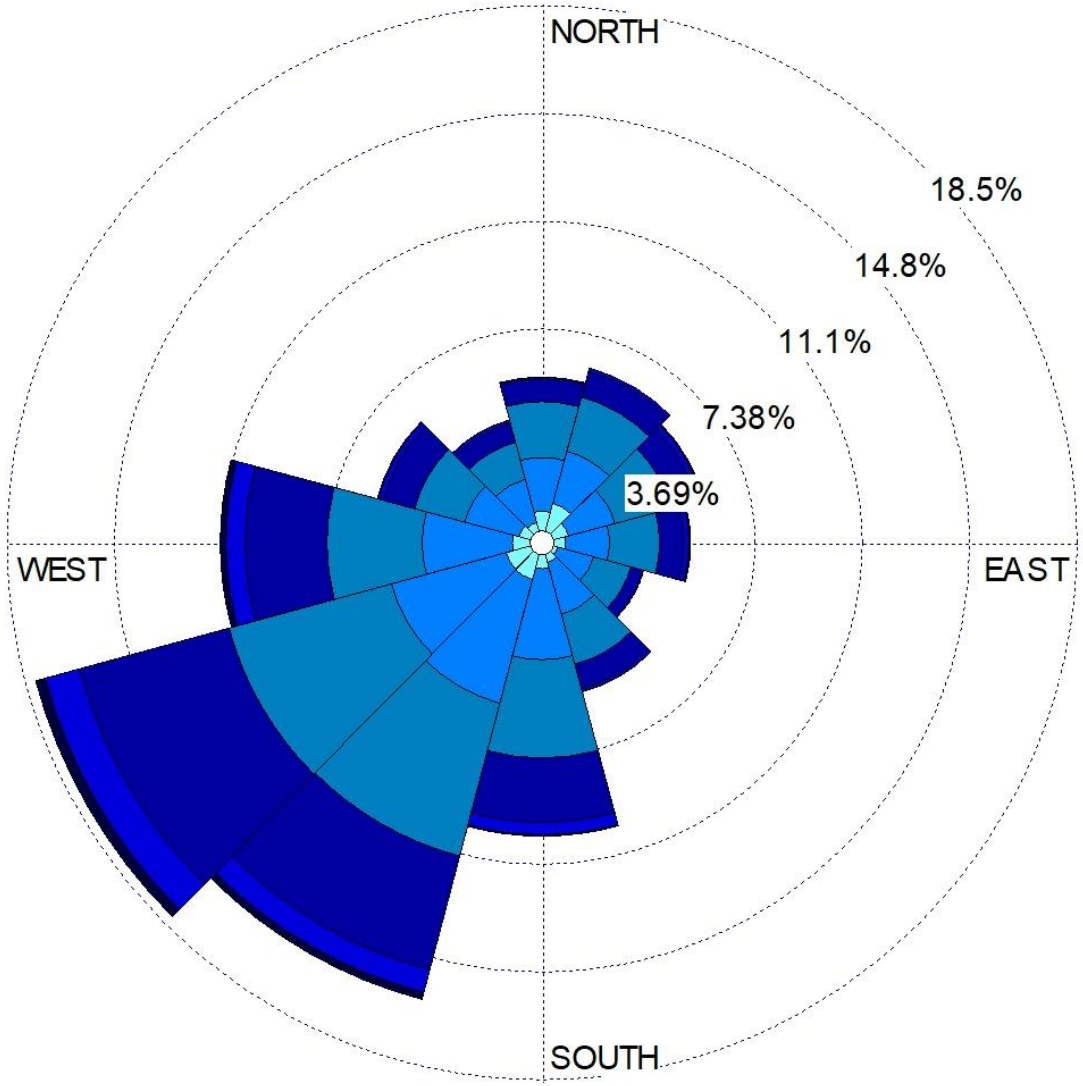
Receptor

Title

Figure 4 - Sensitive Receptor Location

Project

Bioaerosol Risk Assessment
Trowbridge Bioresources Centre



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: 1.26%

Legend

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

Project
Bioaerosol Risk Assessment
Trowbridge Bioresources Centre

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