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Stantec

Environmental Services, Stantec UK

Bioaerosol Risk Assessment:

Sludge Treatment Centre at Hayle Wastewater Treatment Works
Hayle
TR27 6LA

Report Reference: CE-HS-2193-RP02-Final

Report Date: 19 December 2022

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 Environmental Services, Stantec UK ('the Client') to undertake Bioaerosol Risk Assessment in relation to operations at the new installation of the Sludge Treatment Centre at Hayle Wastewater Treatment Works ('the Site') in Hayle, TR27 6LA. The Hayle WWTW is operated by South Waste Water Ltd.

1.1.2 During the operation of the Site there is the potential for bioaerosol emissions and associated impacts at sensitive locations in the vicinity of the Site. A Risk Assessment has therefore been undertaken to identify potential emissions 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 Hayle WwTWs is located on land off Station Approach, St Erth, Hayle, at approximate National Grid Reference (NGR): 154679, 035721. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 The Site treats indigenous sludges arising from treatment processes operated within the wider Hayle Sewage Treatment Works (STW), as well as sludges generated by smaller SWW 'satellite' works in the local area. The principal activities undertaken at the facility include:

- Sludge reception and screening;
- Raw sludge thickening;
- Anaerobic digestion (AD) (including associated heat generation from digester boiler to support AD activities);
- Combined Heat and Power (CHP) facilities;
- Liquor balancing;
- Digested sludge dewatering;
- Storage and maturation of digested sludge 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 for treatment; and
- Waste storage and transfer off site.

1.2.3 The operation of the WwTWs 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 sludge treatment processes at the Site is provided as follows:

- Interworks sludge (from SWW satellite sites) is imported to Hayle WWTW via the CDE screen and then passed to the screened sludge tank (B). Alternatively, interworks sludge can be imported via the chopper pumps and stored in the imported sludge balancing tank before being pumped via the screen transfer sump to the screened sludge tank. However, this option is currently not used and there are no immediate plans to re-instate for interworks sludge imports;

- Sludge from the balancing tank, is transferred via a macerator pump to the thickener feed pumps and then to two drum thickeners (D). These receive poly dosing from the powder poly dosing system (E). The return liquor from the thickeners is collected in the thickener is collected in the pumping station (PS) (H) before being pumped to the return liquor balancing tank (G). After the drum thickeners, the sludge is pumped by the thickened sludge pumps to the thickened sludge tank (F);

- The sludge from the thickened sludge tank (F) is fed to the two primary digesters (L1-2) by the digester feed pumping station (K);

- Digested sludge from the primary digesters (L1-L2) gravitates to two secondary digesters (N1-N2) and is subsequently pumped by the centrifuge PS (O) to the centrifuge (Q). This receives polymer from a dosing system (R). The return liquor from the centrifuge is discharged to the return liquor pumping station and pumped back to the return liquor balancing tank;

- The flow from the return liquor balancing tank is discharged through to the inlet of the Primary Settlement Tanks (PSTs);

- The dewatered cake is discharged to the centrifuge storage area (S) before being transported by trailer to the cake barn. In the cake barn (T), the material is stored for 21-days before being exported off site;

- Gas produced by the primary digesters is stored in a gas bag (Z) before being transferred via the booster to three CHP units (W), two boilers (X) or the flare (1);

- 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 units and provide energy for use at the Site;

- Under normal operating conditions, biogas is burned in either the CHP engines or boilers. However, when biogas volumes are in excess of operational requirements and cannot be reduced sufficiently by operation of the CHP engines and boilers, it is combusted by the flare stack; and,

- In the unlikely event that there is still excess biogas in the gasholder, it is vented to atmosphere via the pressure release valve (PRVs). However, this situation is only anticipated in an emergency event when all planned combustion and abatement operations are unable to operate. As such, there are no planned emissions of biogas to the atmosphere under normal operations.

2.1.2 Reference should be made to Figure 2 for a map of the Site layout plan. Each asset in the summary description above is provided with a corresponding letter to show its location within the Site.

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 In-Vessel Composting (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

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.

'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 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

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

of Hayle WwWTs is included within the Regulations. As such, the site is required to operate in accordance with an Environmental Permit (No. EPR/NP3696HH) issued by the EA.

3.6 ENVIRONMENT AGENCY POLICY

3.6.1 The Environmental Agency (EA) A 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. The requirements of the guidance have been considered throughout the assessment.

3.9 REPORTING REQUIREMENTS

3.9.1 This bioaerosol risk assessment is required to support the application for the new Installation Environmental Permit for the AD activities at the Site. The EA requirement for bioaerosol risk assessment for such sites is typically as follow:

9 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.
10 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.
11 Composting and potential health effects from bioaerosols: our interim guidance for permit applicants, EA, 2010.
12 How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion, EA, 2013.

"Update your Bioaerosol Risk assessment to:

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."

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'[13] 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 Hayle WwTWs, 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'[14] in order to limit uncertainties associated with sampling techniques.

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.

13 Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.
14 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.

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 It should be noted all processes and infrastructure at the Site are contained and served by the Odour Control Unit (OCU) with the exception of the sludge screens skips, dewatering centrifuge and cake barn.

4.3.3 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
Sludge screens skip	Screenings	The imported sludge screening skip is open to atmosphere. As such, there may be the potential for diffuse emissions from the surface of stored material
Dewatering centrifuge	Digested sludge	The dewatering centrifuge is covered and housed within a building. This is likely to contribute to effective containment of bioaerosols. However, there may be the potential fugitive emissions from the building when doors are opened to provide access
Cake barn	Digested sludge	The barn is partially covered which is likely to contribute to containment of bioaerosol emissions. However, there may be the potential for fugitive releases
OCU 2 serving fine screens, grit plant, secondary digesters and centrifuge	Treated air from OCU 2 outlet	Air is extracted from the stated plant/ processes and treated using a cockle shell biofilter prior to discharge to atmosphere via a dedicated stack. The stated arrangements are likely to contribute to effective containment and control of bioaerosol emissions. However, there may be the potential for residual emissions from the OCU 2 outlet
OCU 3 serving the sludge treatment area	Treated air from OCU 3 outlet	Air is extracted from the stated plant/ processes and treated using a lavarock pumice stone biofilter prior to discharge to atmosphere via a dedicated stack at a height of 3m. The stated arrangements are likely to contribute to effective containment and control of bioaerosol emissions. However, there may be the potential for residual emissions from the OCU 3 outlet
OCU 5 serving sludge thickening building	Treated air from OCU 5 outlet	Air is extracted from the stated plant/ processes and treated using a peace marker P8000 biofilter prior to discharge to atmosphere via a dedicated stack at a height of 3m. The stated arrangements are likely to contribute to effective containment and control of bioaerosol emissions. However, there may be the potential for residual emissions from the OCU outlet

Source	Source Type	Emission Potential and Characteristics
OCU 6 serving the sludge screen (CDE)	Treated air from OCU 6 outlet	Air is extracted from the stated plant/ processes and treated using a peace marker P8000 biofilter prior to discharge to atmosphere via a dedicated stack at a height of 3mThe stated arrangements are likely to contribute to effective containment and control of bioaerosol emissions. However, there may be the potential for residual emissions from the OCU outlet

4.3.4 It should be noted that the primary digesters and gas holder at Hayle WwTWs are completely enclosed and during normal operation, biogas produced by the AD processes is transferred to the CHP units or boilers for combustion. The WwTWs also features an automatic back-up flare which burns biogas in a controlled manner if the CHP units or boilers stop temporarily e.g., during periods of on-site maintenance.

4.3.5 Should the flare fail for any reason the primary 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.

4.3.6 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 primary digesters or gas holder have not been evaluated further as part of the assessment.

4.3.7 Combustion gases do not contain bioaerosols. As such, releases from CHP units, boilers and flare 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'[15] 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[16], 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 Receptor Locations

Receptor		NGR (m)		Direction from Closest Source	Approximate Distance from Closest Source (m)
		X	Y		
R1	Commercial - SUEZ recycling and recovery UK	154486.6	35820.9	North-west	165
R2	Residential - Chenhalls Road	155081.6	35826.6	East	310

15 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.190
16 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.

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

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. Camborne Meteorological Station is located at NGR: 163462, 40488, which is approximately 9.9km 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 In addition, Camborne Meteorological Station is located approximately 2.9km from the coastline. Hayle WwTWs is located at a similar distance of approximately 2.6km from the coastline. As such, it is considered meteorological conditions at both sites are comparable.

4.5.3 Meteorological data was obtained from Camborne 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	8.44
15 - 45	6.18
45 - 75	4.71
75 - 105	5.73
105 - 135	5.91
135 - 165	5.85
165 - 195	10.65
195 - 225	13.63
225 - 255	10.25
255 - 285	10.18
285 - 315	9.50
315 - 345	7.79
Sub-Total	98.84
Calms	0.68
Missing/Incomplete	0.49

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.

4.5.5 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.

4.6 BIOAEROSOL MONITORING DATA

4.6.1 In accordance with the requirements of the EA RPS[17], a programme of bioaerosol monitoring has been undertaken at the Site in order to determine baseline levels and quantity potential impacts at the NSR to the site.

4.6.2 The monitoring was completed on 6th October 2022 and 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'[18]:

- Upwind of the facility approximately 63m from the centre of the active operational area; and,
- At three separate downwind locations which were positioned at equivalent or comparable separation distances from the centre of the active operational area to the NSR, and taking into account access restrictions and other sources of bioaerosols that may influence the results.
- Implementation of the fan-like shape sampling arrangement was difficult because the Site was not visible from the desired sampling locations DW2 and DW3. A central traverse was determined based on the mean wind direction blowing to 47° from the true north. Sampling point DW1 was located at an angle of 5°, DW2 at 77° and DW3 at 18° to the centre traverse.

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

Table 5 Bioaerosol Monitoring Results

Monitoring Location	Distance from Centre of Operational Area (m)	Median Bioaerosol Concentration (cfu/m³)	
		Aspergillus fumigatus	Mesophilic bacteria
Upwind	63	0	0
Downwind 1	105	0	694
Downwind 2	113	0	139
Downwind 3	119	0	0

4.6.4 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 Hayle WwTWs and other background sources in the immediate vicinity of the Site to contribute to ambient bioaerosol concentrations at sensitive locations.

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

17 Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.
18 M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.

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'[19]. 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.

19 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
Sludge screens skip	**Low** at all receptors due to the limited quantity of screenings stored, the distance between the skips and receptors, as well as the frequency of winds towards the locations	**Medium**	**Medium**	Regular inspection of the skips is undertaken by site operatives in order to ensure that they are providing effective containment of materials No excess screenings are stored on site The skips are replaced when full	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
Dewatering centrifuge	**Very Low** at all receptors due to the enclosed nature of the source and associated containment of emissions, the wet nature of materials which is likely to limit release potential, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	The dewatering centrifuge is covered and housed within a building in order to provide containment of emissions Doors to the building are kept closed unless access is required in order to reduce the potential for fugitive releases Plant inspection hatches are kept closed unless in use Regular inspection of the plant is undertaken by site operatives in order to ensure correct performance and that there is effective containment of materials and emissions	**Very Low**	Full implementation of the stated control measures is considered to result in a **very low** risk of impact occurring
Cake barn	**Low** at all receptors due to the partially enclosed nature of the source and associated containment of emissions, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Medium**	The cake barn is partially enclosed which is likely to contribute to containment of emissions Regular inspection of the building is undertaken by site operatives in order to ensure there is effective containment of materials	**Low**	Full implementation of the stated control measures is considered to result in a **low** risk of impact occurring
OCU 2 serving fine screens,	**Very Low** at all receptors due to the	**Medium**	**Low**	Treatment of air by the OCU 2 is likely to	**Very Low**	Full implementation

Source	Probability of Exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
grit plant, secondary digesters and centrifuge	potential for abatement of bioaerosols by the OCU which is likely to limit residual emissions, the distance between the source and receptors, as well as the frequency of winds towards the locations			contribute to abatement of bioaerosols, through physical impaction of microorganisms onto the media Treated air is discharged to atmosphere vertically via a dedicated stack in order to promote effective dilution and dispersion of any residual emissions Regular inspection of the OCU 2 is undertaken by site operatives in order to ensure that it is operating correctly and providing effective treatment of emissions		of the stated control measures is considered to result in a **very low** risk of impact occurring
OCU 3 serving the sludge treatment area	**Very Low** at all receptors due to the potential for abatement of bioaerosols by the OCU which is likely to limit residual emissions, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	Treatment of air by the OCU3 is likely to contribute to abatement of bioaerosols, through physical impaction of microorganisms onto the media Treated air is discharged to atmosphere vertically via a dedicated stack in order to promote effective dilution and dispersion of any residual emissions Regular inspection of the OCU 3 is undertaken by site operatives in order to ensure that it is operating correctly and providing effective treatment of emissions	**Very Low**	Full implementation of the stated control measures is considered to result in a **very low** risk of impact occurring
OCU 5 serving the sludge thickening building	**Very Low** at all receptors due to the potential for abatement of bioaerosols by the OCU which is likely to limit residual emissions, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	Treatment of air by the OCU 5 is likely to contribute to abatement of bioaerosols, through physical impaction of microorganisms onto the media Treated air is discharged to atmosphere vertically via a dedicated stack in order to promote effective dilution and	**Very Low**	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
				dispersion of any residual emissions Regular inspection of the OCU 5 is undertaken by site operatives in order to ensure that it is operating correctly and providing effective treatment of emissions		
OCU 6 serving the sludge screen (CDE)	**Very Low** at all receptors due to the potential for abatement of bioaerosols by the OCU which is likely to limit residual emissions, the distance between the source and receptors, as well as the frequency of winds towards the locations	**Medium**	**Low**	Treatment of air by the OCU 6 is likely to contribute to abatement of bioaerosols, through physical impaction of microorganisms onto the media Treated air is discharged to atmosphere vertically via a dedicated stack in order to promote effective dilution and dispersion of any residual emissions Regular inspection of the OCU is undertaken by site operatives in order to ensure that it is operating correctly and providing effective treatment of emissions	**Very Low**	Full implementation of the stated control measures is considered to result in a **very low** 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 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.

8 CONCLUSION

8.1.1 During the operation of the Site, 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 emissions sources and evaluate effects in the local area.

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

8.1.3 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.

8.1.4 The results of the assessment indicated 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.

8.1.5 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

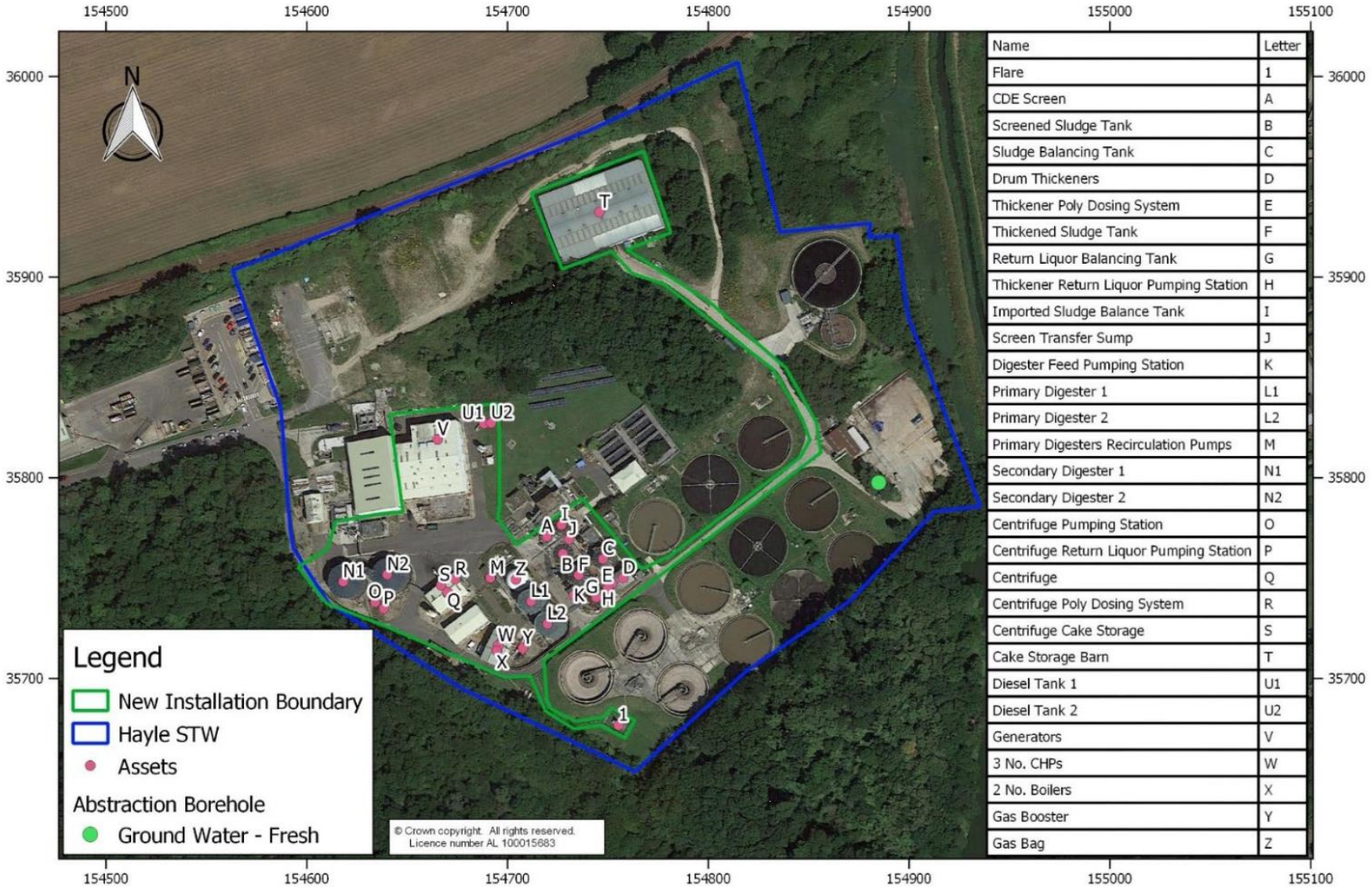
Installation Boundary

Title

Figure 1 - Site Location

Project

Bioaerosol Risk Assessment
Hayle Wastewater Treatment Works



Name	Letter
Flare	1
CDE Screen	A
Screened Sludge Tank	B
Sludge Balancing Tank	C
Drum Thickeners	D
Thickener Poly Dosing System	E
Thickened Sludge Tank	F
Return Liquor Balancing Tank	G
Thickener Return Liquor Pumping Station	H
Imported Sludge Balance Tank	I
Screen Transfer Sump	J
Digester Feed Pumping Station	K
Primary Digester 1	L1
Primary Digester 2	L2
Primary Digesters Recirculation Pumps	M
Secondary Digester 1	N1
Secondary Digester 2	N2
Centrifuge Pumping Station	O
Centrifuge Return Liquor Pumping Station	P
Centrifuge	Q
Centrifuge Poly Dosing System	R
Centrifuge Cake Storage	S
Cake Storage Barn	T
Diesel Tank 1	U1
Diesel Tank 2	U2
Generators	V
3 No. CHPs	W
2 No. Boilers	X
Gas Booster	Y
Gas Bag	Z

Legend

Title
Figure 2 - Site Layout Plan

Project
Bioaerosol Risk Assessment
Hayle Wastewater Treatment Works

Legend

Site Boundary

Installation Boundary

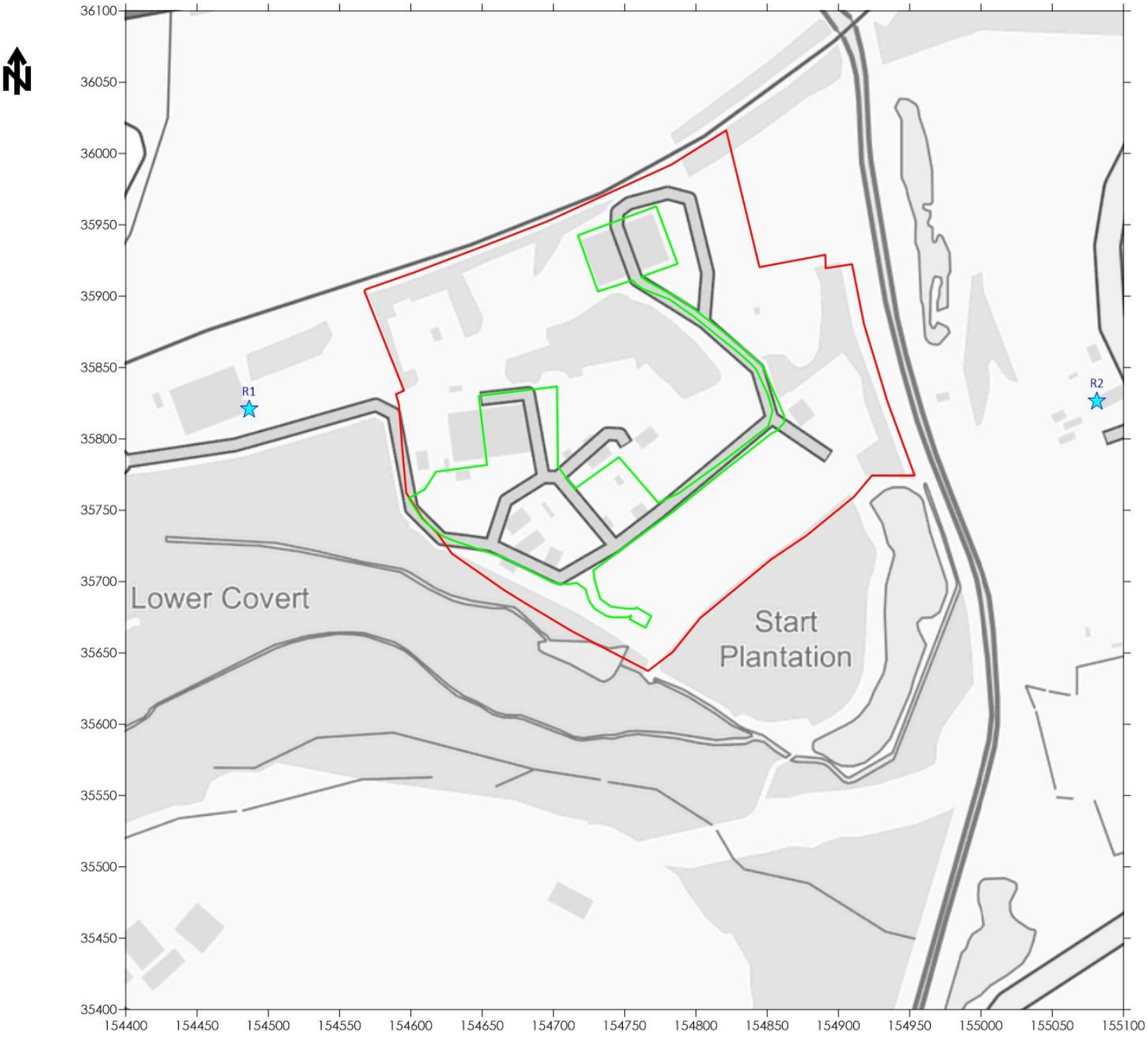
Bioaerosol Source

Title

Figure 3 - Bioaerosol Source Locations

Project

Bioaerosol Risk Assessment
Hayle Wastewater Treatment Works



Legend

Site Boundary

Installation Boundary

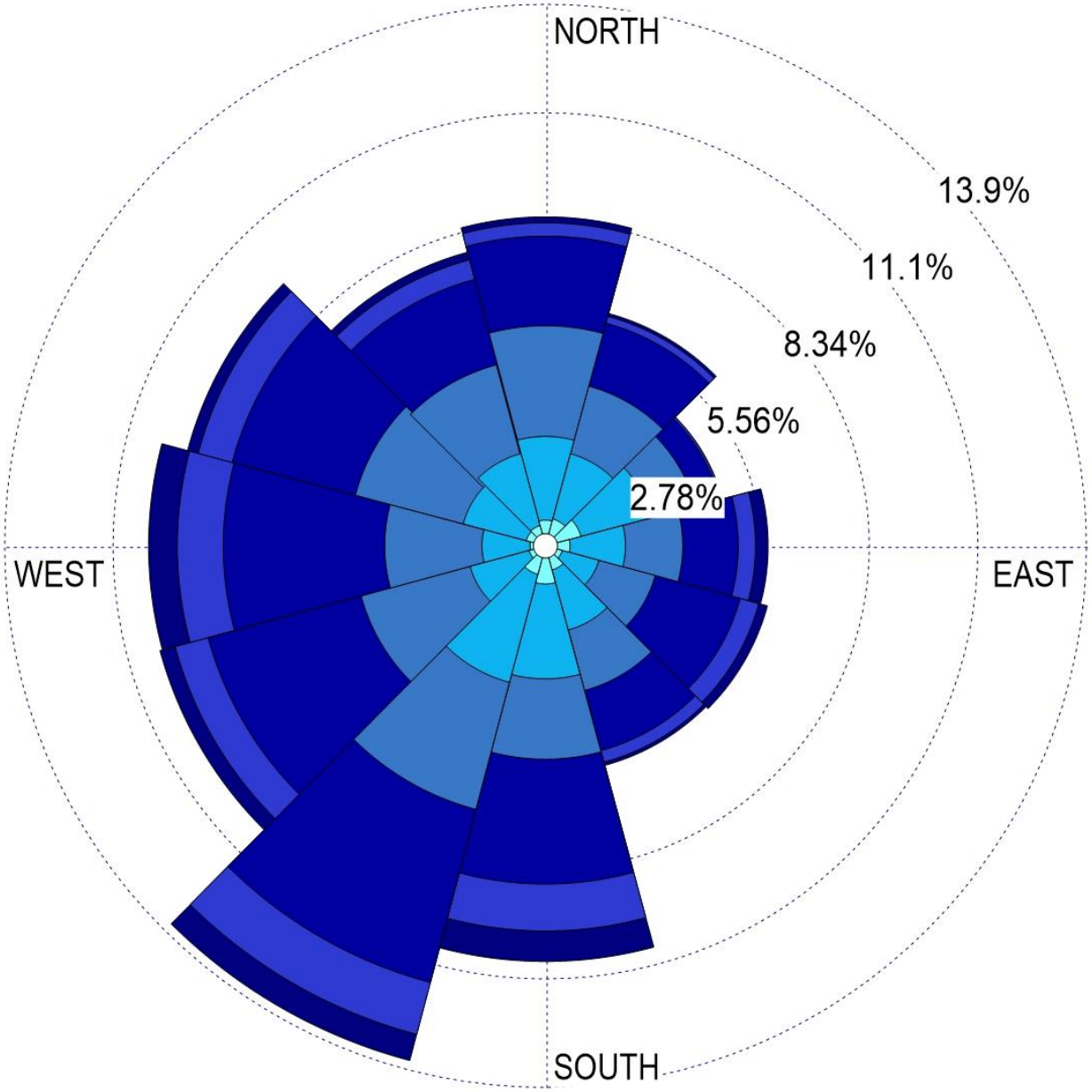
Receptors

Title

Figure 4 - Sensitive Receptor Locations

Project

Bioaerosol Risk Assessment
Hayle Wastewater Treatment Works



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: 0.68%

Title

Figure 5 - Wind Rose of 2017 to 2021 Camborne Meteorological Data

Project

Bioaerosol Risk Assessment
Hayle Wastewater Treatment Works

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