MOTT MACDONALD

Budds Farm Sludge Treatment Centre Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioRA_BUD

February 2024

Mott MacDonald
4th Floor
Mountbatten House
Grosvenor Square
Southampton SO15 2JU
United Kingdom

T +44 (0)23 8062 8800
mottmac.com

Budds Farm Sludge Treatment Centre Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioRA_BUD

February 2024

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	January 2022	G. Cotter	C. Mills	A. Manns	Draft
B	February 2022	G. Cotter	S. Stone	A. Manns	Second Draft
C	March 2022	N. Cunningham	S. Stone	A. Manns	Third Draft
D	February 2024	H.Whalley	J.Dicks	A.Manns	Fourth Draft for client review
E	February 2024	A. Luk	S. Stone	A.Manns	Fifth issue

Document reference: 790101_ERA_BioaRA_BUD February 2024

Information class: Standard

Contents

1 Introduction

1.1 Overview

Southern Water are applying for a new Environmental Permit to operate their sludge treatment facility at the Budds Farm Wastewater Treatment Works (WTW) (hereafter referred to as 'the Site'). Sludge treatment activity is covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The Site operates under registered S1, D5, S2 and U6 exemptions, and has two existing Environmental Permits in operation. Permit EPR/AP3392HG is the Southern Water owned tankered waste and bespoke waste permit existing on site, and Permit EPR/ZP3235XJ allows for the operation of two biogas fuelled combined heat and power (CHP) engines. The CHP engines provide electricity for the Site and excess electrical power is exported to the national grid. The CHP generators fall under the Medium Combustion Plant Directive (MCPD) / Specified Generator controls, with one classed as tranche A and one as tranche B.

Regulatory Position Statement 209[1], issued 23 January 2018 by the Environment Agency, states that all sites that have a permit for the treatment of biological waste within 250 metres of a sensitive receptor (a place where people live or work for more than 6 hours at a time) must carry out a site-specific bioaerosol risk assessment. As sensitive receptors are found close to the boundary of the Site, the closest of which is approximately 20m from the nearest potential source of bioaerosols at the Site, a bioaerosol risk assessment has been undertaken to accompany the permit application for this Site.

This bioaerosol risk assessment has assessed the magnitude of risk from potential emissions of bioaerosols from the Site at nearby sensitive human health receptors. The assessment has been undertaken in accordance with the methods and principles outlined in Environment Agency's "*Guidance on the evaluation of bioaerosol risk assessments for composting facilities*" [2].

1.2 Site location

The Site is situated southwest of the town of Havant in Hampshire. The Site is bordered by industrial units and warehouses to the north and east, the Storehouse Lake to the South and west, and screened in all directions by trees. The layout of the Site is shown in 790101_MSD_SiteLocationPlan_BUD February 2024. The Site includes five anaerobic digesters which are located to the northwest of the Site.

[1] Environment Agency (2018) Bioaerosol monitoring at regulated facilities - use of M9: RPS 209. Available online at: https://www.gov.uk/government/publications/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209

[2] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

2 Methodology

2.1 Overview

Bioaerosols are naturally present in the air, but they are also associated with composting, anaerobic digestion and mechanical biological treatment, which are the main processes used to treat organic waste in the UK.

Bioaerosols are micro-organisms which are suspended in the air; these can include bacteria, fungi and viruses, or parts of living organisms, such as spores and plant pollen. Bioaerosols range in size from 0.02-100µm but are generally smaller than 10µm in diameter so can easily be breathed into the human respiratory system where they can cause adverse health impacts such as respiratory and gastrointestinal illnesses. Especially relevant to waste treatment facilities are infections of the respiratory system caused by *Aspergillus fumigatus*, which can be fatal, especially for at-risk and immune-compromised patients. Bioaerosols can also cause eye irritation and dermatitis if they come into contact with the eyes and skin.[3]

2.2 Guidance

There is minimal regulatory guidance available for assessing bioaerosol emissions from anaerobic digestion facilities. Regulatory Position Statement (RPS) 031[4] states that bioaerosol concerns would normally be associated with composting activities, which are defined as: *'biological decomposition of biodegradable waste under conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat'*.

This RPS also defines operations which are *'likely to result in the uncontrolled release of high levels of bioaerosols'* as including '*the shredding of waste and the turning of waste in the sanitisation, stabilisation and maturation stages of composting where these operations are not contained or are not subject to exhaust ventilation and scrubbing/filtering'*.

These activities do not occur at the Site as the biological decomposition of waste occurs under controlled, anaerobic conditions. Therefore, the Site is unlikely to be a high-risk site for bioaerosol emissions. This is supported by a 2012 Environment Agency guidance note[5] which states that the Environment Agency do not consider bioaerosols from anaerobic digestion to be of serious concern (provided composting activities are not undertaken at the facility).

Nonetheless, current Environment Agency guidance[6] requires any facility which could release bioaerosols to provide a site-specific bioaerosol risk assessment if there are sensitive receptors within 250m of activities. For new permits there is also a requirement to monitor bioaerosols if the Site is within 250m of a sensitive receptor[7].

---

3 Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

4 Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

5 Environment Agency. 2012. Guidance for developments requiring planning permission and environmental permits' (England)

6 Environment Agency (2018) Bioaerosol monitoring at regulated facilities - use of M9: RPS 209. Available online at: https://www.gov.uk/government/publications/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209

7 *"Sensitive receptor – any building, other structure or installation, in which at least one person normally lives or works, other than a building, structure or installation within the same ownership or control as the operator/owner of the composting facility."* Taken from 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities.'

However, following a Schedule 5 notice from the Environment Agency for another similar WTW, a conservative approach has been undertaken and human receptors within 500m of the Site have been considered instead of the 250m specified in the Environment Agency guidance[8].

2.3 Methodology

The method used for this bioaerosol risk assessment is adapted from the Environment Agency's '*Guidance on the evaluation of bioaerosol risk assessments for composting facilities*'[9], which recommends using a Source-Pathway-Receptor model to help determine the magnitude of the risk associated with bioaerosol emissions from a facility.

The magnitude of risk is a function of both the probability of exposure and the consequences of the hazard. The probability of exposure to bioaerosols can be described as:

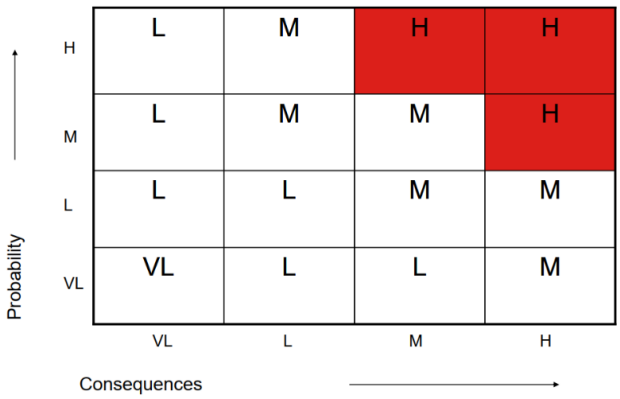
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

The consequence of the hazard considers the nature of the source, the hazard and receptor. These consequences can be described as:

- 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
- Very low – negligible consequences, no evidence for adverse changes

The probability of exposure and consequence of the hazards are then combined to determine the overall magnitude of the risk, as demonstrated in Figure 2.1.

Figure 2.1: Magnitude of risk matrices



Source: Environment Agency, 2009

[8] Environment Agency (2018) Bioaerosol monitoring at regulated facilities - use of M9: RPS 209. Available online at: https://www.gov.uk/government/publications/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209

[9] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

For this bioaerosol risk assessment, a Source-Pathway-Receptor model has been used to help assess the probability of exposure associated with different processes at the Site (Section 3). Existing control measures have also been identified to help inform the probability of exposure (Section 4). This has then been combined with the consequence of the hazard in Section 5 to determine the overall magnitude of risk associated with the different sources of bioaerosols at the Site, using the risk matrix above.

3 Source – Pathway – Receptor model

3.1 Overview

This section provides a summary of the sources of bioaerosols at the Site and the potential pathways that the bioaerosols could travel to sensitive human health receptors.

3.2 Sources

3.2.1 Overview

The Site includes the following assets which could release bioaerosols:

- Sludge reception area
- Cake waste reception area[10]
- Two Tankered Waste (TW) reception areas
- Cake silo
- Five anaerobic digesters
- Nine storage tanks (one sludge reception tank[10], two screened sludge storage tanks[10], two thickened sludge storage tanks (TSST), two post digestion storage tanks (PDSTs), two surplus activated sludge (SAS) holding tanks)
- Five drum thickeners[10]
- Three centrifuges[10]
- Alternative sludge storage tanks
- Alternative cake bay
- Biogas holder
- Two Combined Heat and Power (CHP) units
- One flare stack
- Three dual fuel boilers (biogas/ natural)
- One odour control unit (wet chemical scrubber system)

The following processes undertaken at the Site involve the assets listed above, and therefore, have the potential to release bioaerosols:

- Sludge and sludge cake reception and distribution from the Site
- Sludge treatment (sludge storage, digesters and centrifuges)
- Biogas combustion

Figure 3.1 shows the locations of these different processes and assets across the Site. A summary of the activities which occur at the Site involving these assets is presented in the subsequent sections.

[10] Contained within the primary sludge treatment building

Figure 3.1: Potential sources of bioaerosols at the Site

Metres
0 30 60 120

3.2.2 Cake and sludge reception and distribution

Imported sludge cake is discharged into the 1 No. cake silo and blended with Surplus Activated Sludge (SAS) before being pumped to the Thickened Sludge Storage Tanks.

Approximately –nine tankers a day of liquid sludge are imported to the Site. Imported liquid sludge is received in the Sludge Reception Tank. It is then pumped through Strain Presses and stored in the Screened Sludge Storage Tanks. Deliveries of sludge cake occur and imported sludge can occur at any time in the week (24 hours a day, 7 days a week).

The Site receives Southern Water owned tankered waste. There are two reception areas for tankered waste, one to the east of the Site and another to the north; the northern reception area is only used in dry weather to avoid potential sea outfall of untreated sewage due to the lack of storm separation between wastewater and imported sludge. Deliveries of tankered waste can occur at any time in the week (24 hours a day, 7 days a week).

3.2.3 Sludge treatment

Indigenous primary sludge is screened by the strain presses and then pumped to Screened Sludge Storage Tanks where it is combined with imported liquid sludge and thickened using drum thickeners. Surplus Activated Sludge (SAS) is stored in SAS Holding Tanks. Part of the SAS is pumped to drum thickeners.

The thickened sludge is pumped to TSSTs and then fed to the Anaerobic Digesters; The anaerobic digestion process provides a controlled environment where micro-organisms (including bacteria and fungi) can grow, multiply and break-down organic material within the sludge to produce water, carbon dioxide and methane (biogas). After anaerobic digestion, digested sludge passes to the PDSTs to cool. The digested sludge is then transferred to the centrifuges where water is removed from the digested sludge to create dried sludge cake.

Sludge liquors removed during these processes are pumped back to the primary treatment sludge tank. Lime is then added to the sludge cake to kill any remaining pathogens before discharging the sludge cake into the sludge cake silo where it is stored until it is unloaded into trucks and transported offsite for use on agricultural land. The cake silo fills in approximately 6 hours; a maximum of eight lorries per day remove the treated cake. There is a small cake bay available onsite for use in emergencies.

3.2.3.1 Odour control

There is one odour control unit on the Site which connects to the main sludge treatment building, containing the sludge cake reception and primary sludge treatment processes. This unit contains one wet chemical scrubber system. After treatment, air is released to the atmosphere. A dry vapour system is used around the cake silo to mask odours during unloading.

A Cobra Odourmaster Mobile unit is retained onsite for emergency or unexpected odour and/or dust problems; this unit sprays a fine mist which suppresses odour and dust.

3.2.4 Biogas combustion

Biogas produced during anaerobic digestion is transferred to the biogas holder and then to the boilers and CHP where it is combusted to generate heat and/or electricity, which is used onsite to assist with the wastewater and sludge treatment processes. When more biogas is produced onsite than can be combusted within the boilers and CHP, and there is insufficient space in the

gas holder to store surplus biogas, excess biogas is sent to the flare to be burned. The flare is regularly used as there is generally an excess of biogas.

3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transported by the wind from their source to a receptor. The 2019-2023 wind rose for the meteorological site at Thorney Island, the nearest representative meteorological site to the Site, is shown in Figure 3.2 This site is located approximately 6km southeast of the Site and is considered representative of Site conditions due to its similar topography and surrounding land uses.

The Thorney Island meteorological site experiences frequent winds from the southwest. This suggests that sensitive receptors located to the northeast of the Site would be at the greatest risk from bioaerosol emissions from the Site as they would be downwind of the prevailing wind direction.

An atmospheric hindcast model (Vortex) has also been used to assess the wind conditions at the Site. The Vortex model uses historic ERA5 data from the European Centre for Medium-Range Weather Forecasts (ECMWF) and works by combining past meteorological data with current weather models. This allows meteorological parameters, such as wind speed and direction, to be predicted at any location for any time period from the past 40 years, accounting for some localised effects. The data from this model is a popular dataset for climate modellers and is used by the World Meteorological Organization for their annual State of the Climate report.

Figure 3.3 presents the wind rose generated for the Site from the Vortex model for the period from 2019-2023. The wind rose demonstrates that historically, this location experiences strong prevailing winds from the southwest.

Overall, the two datasets show general agreement with both the monitored and modelled data indicating the prevailing winds originate from the southwest. Therefore, sensitive receptors located to the northeast of the Site would be at the greatest risk from bioaerosol emissions from the Site.

Figure 3.2: Average wind rose for Thorney Island meteorological site, 2019- 2023

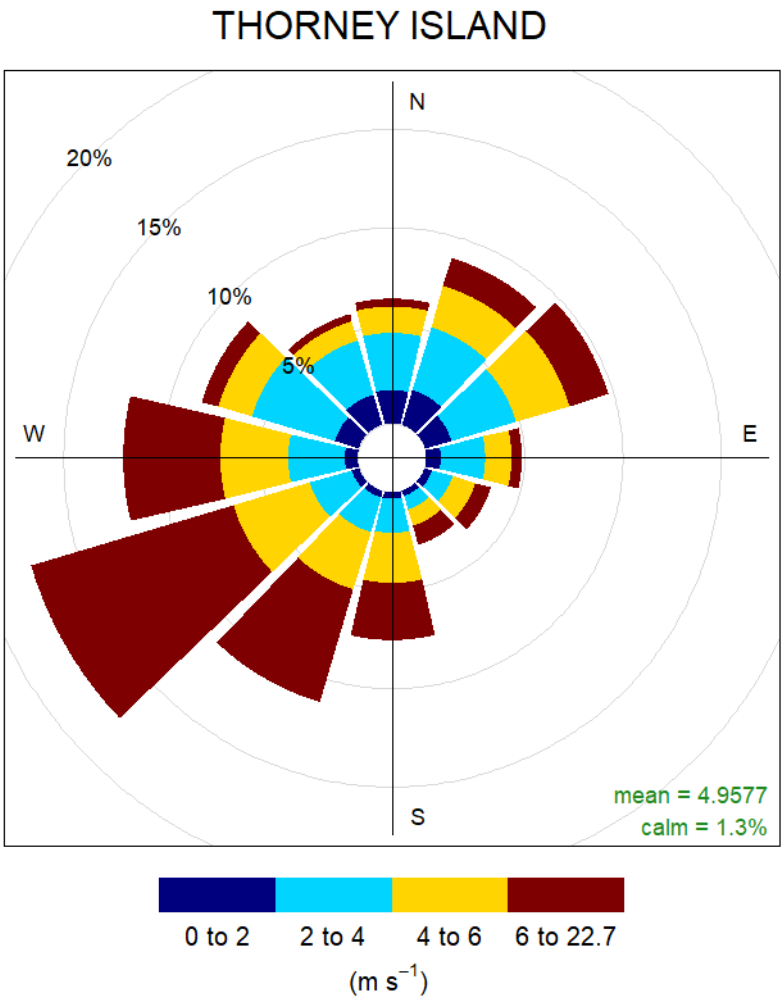
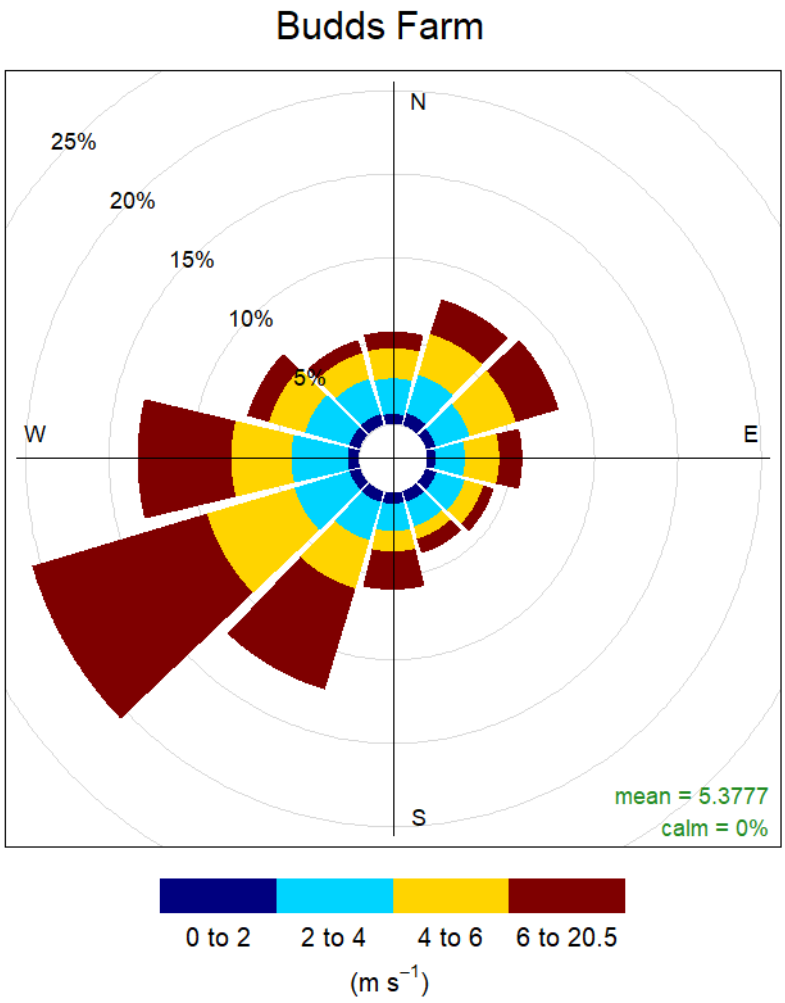


Figure 3.3: Average wind rose for the Site from the Vortex model, 2019- 2023



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[11,12]. The local terrain in the 250m area surrounding the Site is relatively flat and much of the Site is screened by trees, which may present a natural barrier to the transportation of bioaerosols by the wind. There are industrial land uses within 250m of the Site.

[11] Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

[12] Health and Safety Executive, 2010. Bioaerosol emissions from waste composting and the potential for workers' exposure.

3.4 Receptors

Although Environment Agency guidance[13] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations, a screening distance of 500m has been used as a conservative approach. Sensitive receptors are defined as:

"*permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and too 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*."

There are four areas of sensitive receptors found within 500m of potential bioaerosol emission sources at the Site. As demonstrated in Figure 3.4, an area of residential properties is located to the northeast, whilst areas of industrial land use are located to the north, east and northwest.

For each area of sensitive receptors, the distance and direction from each potential bioaerosol emission source to a sensitive receptor within the area has been identified below in Table 3.1. Where multiple assets exist for the same process, such as digesters, only the closest asset has been presented.

Sensitive receptors are found downwind of the prevailing wind direction within 500m of the potential emission sources. The receptor closest to a potential emission source is an industrial facility, which is located approximately 20m northeast of the Tankered Waste (TW) reception area, downwind of the facility.

Table 3.1: Receptors within 500m of potential emission sources at the Site

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[(a)] from nearest potential emission source [(b)]			
		Residential properties northeast of the Site (m)	Industrial facilities east of the Site (m)	Industrial facilities north of the Site (m)	Industrial facilities northwest of the Site (m)
Sludge reception	Cake reception and sludge treatment	420, northeast	245, east	**195**, north	255, northwest
Primary sludge treatment building[14]	Cake reception and sludge treatment	420, northeast	230, east	**170**, northeast	185, northwest
TTW reception	Cake reception and sludge treatment	305, northeast	75, east	**20**, northeast	155, northwest
Anaerobic digesters	Sludge treatment	400, northeast	285, east	130, northeast	**120**, northwest

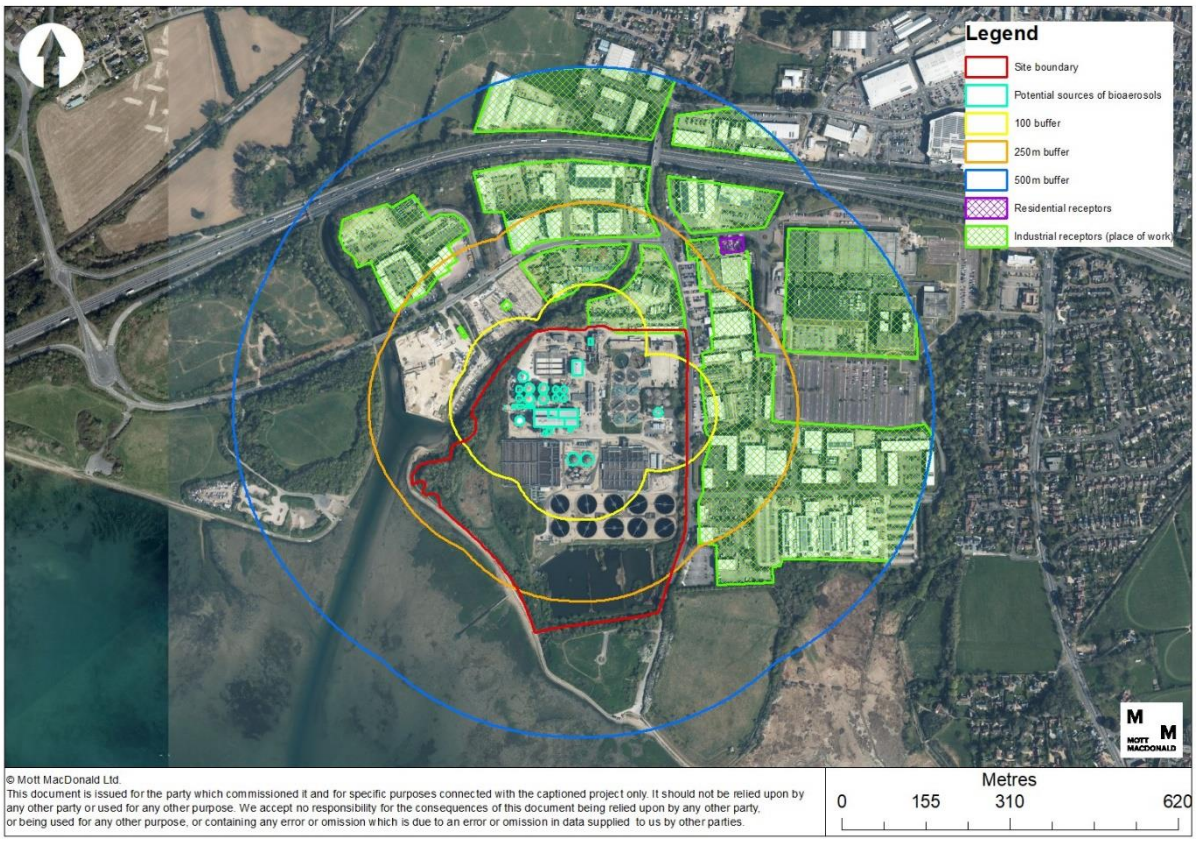
[13] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 – Environmental monitoring of bioaerosols at regulated facilities. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

[14] Primary sludge building contains the cake reception areas, cake blending tank, sludge reception, drum thickeners and centrifuges.

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]			
		Residential properties northeast of the Site (m)	Industrial facilities east of the Site (m)	Industrial facilities north of the Site (m)	Industrial facilities northwest of the Site (m)
PDSTs	Sludge treatment	440, northeast	335, east	165, northeast	**130**, northwest
SAS & TSST tanks	Sludge treatment	375, northeast	250, east	**120**, north	185, northwest
Alternative sludge storage tanks	Sludge treatment	440, northeast	**205**, east	230, north	290, northwest
Digested sludge cake silo	Sludge treatment	460, northeast	295, east	**210**, north	225, northwest
Alternative cake bay	Sludge treatment	450, northeast	280, east	**200**, northeast	225, northwest
Biogas holder	Biogas combustion	475, northeast	340, east	205, northeast	**175**, northwest
CHP		445, northeast	310, east	180, northeast	**150**, northwest
Flare		490, northeast	365, east	215, northeast	**150**, northwest
Boilers		415, northeast	270, east	**160**, northeast	200, northwest

Note: (a) Distance from source to receptor is rounded to the nearest 5m. Receptors are presented within Figure 3.4.
(b) Value in **bold** represents the nearest potential emission source for each process which is closest to a sensitive receptor

Figure 3.4: Sensitive receptors within 500m



3.5 Summary

Table 3.2 summarises the potential sources of bioaerosol emissions at the Site, the sensitive receptors most at risk and the pathways through which the bioaerosols could travel from source to receptor.

Table 3.2: Source-Pathway-Receptor model

Source process	Potential emission source	Pathway	Nearest receptor
Cake reception and sludge treatment	Primary sludge treatment building[15]	Air transport then: • Inhalation (through nose or mouth) • Ingestion (eating or swallowing) • Absorption/contact (through skin or eyes) • Injection (by high pressure equipment/ contaminated sharp objects)	170m northeast – industrial facility
	TTW reception		20m northeast – industrial facility
	Sludge reception		195m north – industrial facility
Sludge treatment	Anaerobic digesters		120m northwest – industrial facility
	PDSTs		130m northwest – industrial facility
	SAS & TSST tanks		120m north – industrial facility

Source process	Potential emission source	Pathway	Nearest receptor
	Alternative sludge storage tanks		205m east – industrial facility
	Digested sludge cake silo		210m north – industrial facility
	Alternative cake bay		200m, northeast – industrial facility
Biogas combustion	Biogas holder		175m northwest – industrial facility
	CHP		150m northwest – industrial facility
	Flare		150m northwest – industrial facility
	Boilers		160m north – industrial facility

4 Control measures

4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[15] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site for sludge reception and distribution, sludge treatment and biogas combustion processes. These control measures aim to reduce and contain emissions of bioaerosols to prevent the source-pathway-receptor link associated with each of the potential emission sources identified in Section 3.2.5.

4.2 Control measures

4.2.1 Sludge reception and distribution

Approximately 7-10 tankers of sludge cake a day are imported to the Site. Imported sludge cake is discharged into the cake silo and then blended with SAS before being pumped to the Thickened Sludge Storage Tanks. Approximately 5-6 tankers a day of liquid sludge are imported to the Site. Sludge Cake is unloaded within the primary sludge treatment building; shutters are kept closed on this building, except during deliveries, which limits the risk of bioaerosols escaping the building. There is one chemical scrubber in operation during the unloading of sludge cake. Imported liquid sludge is piped into the Sludge Reception Tank, which is a closed system.

If a spillage of cake occurs, operators are required to carry out clean up as soon as possible (using disinfectant where necessary). If the spillage is caused by a lorry or tanker, the driver is responsible for cleaning up the spill before leaving Site. If a lorry or tanker left a spillage behind, operators will log and report any incident observed and the driver or company involved will be asked to return to the Site immediately to clean up. Significant spillage incidents will be recorded in the Site diary.

Wash up facilities are also provided for drivers to clean the vehicles after loading or unloading and lorry and tanker drivers are required to clean contaminated wheels before leaving the Site. The wheel wash facility at Site is not in use, however hose wash facilities are in place at waste receptions.

4.2.2 Sludge treatment

4.2.2.1 Containment of emissions

To contain emissions of bioaerosols, all sludge treatment processes on the Site are contained or covered. The sludge thickening and blending activities are contained in the odour-controlled primary sludge treatment building to prevent the uncontrolled release of bioaerosols and reduce the likelihood of exposure of receptors to bioaerosols.

[15] Wheeler P.A., Stewart, I., Dumitrean, P. and Donovan, B., 2001. Health Effects of Composting: A Study of Three Compost Sites and Review of Past Data. R&D Technical Report P1-315/TR, Environmental Agency, Bristol.

4.2.2.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down. This primarily occurs during anaerobic digestion, with subsequent processes such as liming being undertaken to further remove microorganisms by raising the pH and temperature. Therefore, at each stage of the sludge treatment process, the quantity of bioaerosols decreases, reducing the risk of exposure; the concentration of bioaerosols that could potentially be emitted from the cake (at the end of the sludge treatment process) is much lower than the sludge prior to anaerobic digestion.

Digested cake is stored within a 220-tonne silo that is enclosed; the pipes and conveyors that move the cake to the silo are also enclosed. This silo is emptied daily, and the contents dropped directly from the silo into tipper trucks.

To further reduce potential bioaerosol emissions, sludge produced on Site is processed immediately. Sludge cake arriving onsite is also processed immediately to help minimise bioaerosol emissions. This prevents processing of old sludge and sludge cake which is more odorous and difficult to process.

As discussed above in Section 4.2.2.1, to prevent emissions from sludge treatment activities, processes with the greatest potential to release bioaerosols such as sludge thickening are covered and odour controlled. The odorous air is then treated within the odour control unit to remove odour and bioaerosols before it is released to the atmosphere.

4.2.3 Biogas combustion

All tanks capable of producing biogas are sealed and connected to the biogas system. Biogas produced from these tanks are stored within the biogas holder before being combusted at high temperatures within the CHP, boilers or flare. The gas holder stores the biogas within an air-tight container which mitigates the release of bioaerosol emissions. During combustion, any bioaerosols present within the biogas would be destroyed. Therefore, emissions of bioaerosols associated with biogas combustion and probability of exposure to bioaerosols would be *de minimis.*

4.3 Maintenance of control measures

Daily checks, measurements and sampling is conducted of the treatment processes on Site to ensure the equipment is working correctly. The parameters measured include: sludge blanket thickness, dissolved oxygen content, turbidity, temperature, pH and alkalinity (full list of parameters monitored are found within the operating plan for the Site). Where desired operating parameters are not met, various corrective actions and operating procedures are in place to rectify the problem. Performance issues and equipment problems are also reported promptly to Process Scientists, M&E technicians, ICA technicians or Specialist Contractors as appropriate.

Daily, weekly and monthly maintenance tasks/servicing is also performed on key equipment across the Site by Southern Water staff and specialist contractors. Southern Water has also issued generic maintenance task manuals for use across all their sites which include protocols for the maintenance of equipment such as absorbers, biofilters, odour extraction, fresh air supply ducting, direct driven fan, belt driven fan and dryer exhaust ducting.

Currently bioaerosols are not directly monitored, however, future monitoring will be accordance with Environment Agency's Technical Guidance Note (TGN) M9[16] requirements to monitor effectiveness of control measures, where appropriate. Alternatively, the Odour Management Plan requires routine sniff tests and mitigation to odours, and therefore the Plan will indirectly aid the prevention and monitoring of bioaerosol.

Odour from the main sludge treatment building, containing the sludge cake reception and primary sludge treatment processes, is controlled via one current odour control unit, a chemical scrubber system with an odour removal efficiency of >99% and total flow rate of 53,100 m^3/hour. Filtered odour streams are discharged into the environment through odour control unit stack as shown by A16 in 790101_MSD_SiteLayoutPlan_BUD February 2024 and are monitored hourly to ensure the absence of odorous compounds.

The odour control unit is maintained in accordance with manufacturer's requirements to ensure treatment of bioaerosols and odours are effective.

All of the Site operations are fully enclosed or covered with the exception of the alternative cake bay which is uncovered. Diffuse emissions from the alternative cake bay are minimised by:

- Sludge cake is not handled once in the cake bay, (unless liming is required, however this requires minimal handling) until it is being removed from the Site;
- All sludge cake being exported is transported in covered lorries.

To minimise odour nuisance, it is important to ensure that the Budd's Farm WTW and STC is operating as designed. Covers and hatches are replaced to maintain the integrity of enclosures provided to collect odorous air.

The effectiveness of measures to prevent and limit bioaerosols, as well as odour, is undertaken by reviewing the Supervisory Control and Data Acquisition (SCADA) system to identify out of specification operation of assets. Whereby alerts are raised the measures within the Odour Management Plan will be followed to bring the operations in line with normal conditions.

Stocks of chemicals onsite are also carefully managed to ensure that the necessary treatment processes, control measures and maintenance activities can be undertaken when required.

4.4 Emergency procedures

In the event of plant failures or emergency situations an alarm would be raised on the Site SCADA or telemetry systems, which will be reacted to by onsite or regional control room operators and Duty Managers. Depending upon the nature of the fault or emergency, a mechanical or electrical technician, both of whom are on-call 24-hours a day, would be contacted and would attend Site as soon as practicable if required. Where the on-call technicians are already engaged upon other response work, there is the facility to access staff from other Southern Water geographic divisions, coordinated by the Duty Manager. All faults, breakdowns and emergencies are logged electronically together with records of the action taken and the solutions reached.

One such emergency event would be failure of the flare stack and/or CHP. Such an event would result in releases of biogas from the Whessoe Valves located on the roofs of the digesters and in the gas holder compound, which would release bioaerosols. This occurs to prevent over

[16] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 - Environmental monitoring of bioaerosols at regulated facilities. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

pressurisation of the digesters and gas systems. While the problem is rectified, biogas generation is managed by reducing or inhibiting the digester feed.

4.5 Monitoring

4.5.1 Overview

Bioaerosol emissions associated with the operation of the Site will be monitored in line with the Environment Agency Technical Guidance Note (TGN) M9[17] requirements to monitor effectiveness of control measures.

Sampling of bioaerosols using either impaction, filtration or impingement samplers will be undertaken by an MCERTS accredited organisation. The final approach would be determined prior to appointment in accordance with the requirements of TGN M9.

4.5.2 Monitoring Locations

As detailed in Section 3.3 the prevailing wind direction at the Site is from the southwest, therefore, in accordance with TGN M9, three samplers will be positioned to the northeast of the Site to capture downwind bioaerosol concentrations and one sampler will be located upwind, to the southwest of the Site.

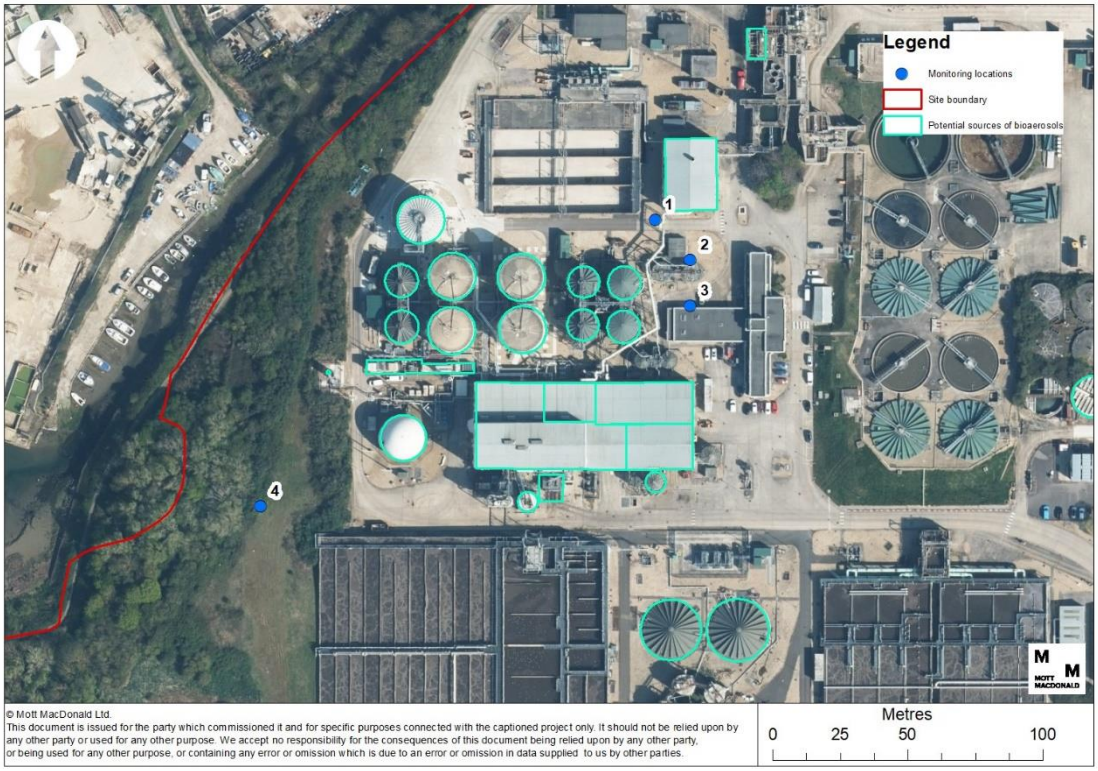
Figure 4.1 presents the indicative sampling locations identified for the Site. Locations 1, 2 and 3 represent the proposed locations for the three downwind samplers and are located at the same distance as the closest sensitive receptor (20m) from the nearest source of bioaerosols. The downwind samplers are arranged in a fan shape to ensure the maximum concentrations of bioaerosols are captured and variable wind directions will be accounted for.

The indicative monitoring location 4 represents the upwind sampler and is positioned approximately 50m from the nearest bioaerosol source. This location will provide a baseline concentration of bioaerosols, representative of background concentrations and any neighbouring sources of bioaerosols, such as agricultural activities, without contributions from the Site.

The exact sampling locations are dependent on the accessibility of each location and will be confirmed by the MCERTS accredited organisation that will conduct the sampling.

[17] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 - Environmental monitoring of bioaerosols at regulated facilities. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

Figure 4.1: Indicative bioaerosol monitoring locations



4.5.3 Sampling methodology and frequency

Appropriate sampling of bioaerosols will be conducted by an MCERTS accredited organisation using procedures relevant to the sampler type, as described in TGN M9. Sampling at the upwind and downwind locations will be undertaken concurrently so that results can be compared. Monitoring will be undertaken on a quarterly basis for the first 12months after permit issue and then six monthly thereafter. Where the bioaerosol action limit is exceeded, then quarterly monitoring will resume until such time that is it demonstrated that the Site has adequate mitigation for a 12month period. Where it is confirmed that the risk is very low or low, Southern Water will make the decision as to whether further monitoring will be needed and under what circumstances it may need to be resumed, if at all.

Sampling will be undertaken during appropriate weather conditions such as avoiding rain, sleet and snow, depending on the sampling technique, and will consider the wind speed and direction at the time of sampling. Meteorological conditions including wind speed, wind direction, cloud cover, temperature, relative humidity, and atmospheric conditions will be recorded by an automatic weather station with an integral data logger during monitoring periods and this data will be recorded. The meteorological station will be positioned in a suitable location, away from anything which could influence measurements, such as at locations very close to buildings.

A minimum of three measurements of Aspergillus fumigatus and mesophilic bacteria will be taken from each sampler during each monitoring visit. Appropriate equipment and methodologies for each sampler type are described in TGN M9 and this guidance will be followed during the bioaerosol monitoring.

Following the measurements, samples will be stored and transported appropriately before being analysed in a laboratory.

Detailed and accurate records of the bioaerosol monitoring will be kept and the data will be recorded using the standard report forms provided in TGN M9 or an appropriate alternative.

4.6 Summary

As discussed above, there are a number of control measures in place at the Site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure. The greatest risk of significant bioaerosol emissions from the Site is associated with emergency situations such as a failure of the flare or CHP/boilers, which could result in uncontrolled emissions of bioaerosols. Such an emergency event would be expected to occur very infrequently, if at all, and not for extended periods, due to the extensive monitoring and maintenance programmes undertaken at the Site as well as the emergency procedures and warning systems in place.

5 Risk assessment

5.1 Overview

This section assesses the probability of exposure and consequence of the hazard associated with potential emissions of bioaerosols at the Site to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the Environment Agency guidance[18], as summarised in Section 2.3.

5.2 Probability of exposure

As described in Section 3, the main potential sources of bioaerosols at the Site are associated with:

- Sludge and sludge cake reception and distribution from the Site
- Sludge treatment (sludge storage, digesters and centrifuges)
- Biogas combustion

These processes have the potential to emit bioaerosols, which are transported through the air by the wind and could cause harm to nearby human health receptors. However, as discussed in Section 4, there are multiple control measures in place at the Site which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes.

The probability of exposure of sensitive receptors to bioaerosols from uncovered sources at the Site, which includes the alternative cake bay, is considered to be '**very low**' as the cake within the bays is at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land. Therefore bioaerosol concentrations would be very low/de minimis and any exposure would not result in any 'significant' consequences.

The probability of exposure from the sludge treatment processes is considered to be '**very low**' as exposure of the receptors to bioaerosols is "very unlikely" due to the "effective and multiple barriers" (control measures) in place, which consist of covered processes.

The final probability of exposures to bioaerosols assessed for each emission source is presented below in Table 5.2.

Table 5.1: Probability of exposure to bioaerosols from different sources at the Site

Process	Potential source of bioaerosols	Probability of exposure	Justification
Cake reception and sludge treatment	Primary sludge treatment building[10]	Very Low	All processes within the primary sludge treatment building are covered, process monitored and regularly maintained. Odour control unit is sealed, and the air released from the unit has been treated to remove bioaerosols, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely

[18] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

Process	Potential source of bioaerosols	Probability of exposure	Justification
	TTW reception	Very Low	TTW reception tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge reception	Very Low	Sludge reception tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Sludge treatment	Anaerobic digesters	Very Low	Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	PDSTs	Very Low	PDSTs covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	SAS & TSST tanks	Very Low	SAS & TSST tanks are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Alternative sludge storage tanks	Very Low	Sludge reception tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Digested sludge cake silo	Very Low	Digested sludge cake silo covered – uncontrolled release of bioaerosols very unlikely
	Alternative cake bay	Very Low	Alternative cake bay uncovered, however cake within bay at the end of treatment process so bioaerosol concentrations would be at very low/de minimis (any exposure would not result in “significant” consequences). No disturbance of cake while in bays except for removal.
Biogas combustion	Biogas holder	Very Low	Gas holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHP	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	Flare	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	Boilers	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely

5.3 Consequence of hazard

While the probability of exposure of receptors to bioaerosols is ‘very low’ as a result of the control measures in place or the nature of processes on Site, there is still a risk that nearby receptors could be exposed to bioaerosols, for example while loading cake into lorries or if there was a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary, any fault would be detected by the SCADA system and the emergency protocols would be undertaken to rectify the fault as soon as possible.

However, if exposure to bioaerosols did occur, this could result in adverse health impacts at sensitive receptors. These impacts could include (but are not limited to):

- Respiratory infections and inflammation of the respiratory system

- Reduced lung function
- Allergic reactions
- Gastro-intestinal disorders
- Dermatitis
- Eye irritation

The consequence of the hazard at sensitive receptors (i.e. the severity of impacts on human health) is largely determined by the proximity of the receptor to the emission source; concentrations of bioaerosols decline rapidly within the first 50-100m from a source (and generally decrease to background concentrations within 250m) [19,20]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source.

For the purpose of this assessment, sources of bioaerosols within 50m are considered to be '**high**' consequence of hazard. This is because within 50m of a source, consequences could be "severe", and "exposure may result in significant damage". Sources of bioaerosols within 50-100m of receptors are considered to have a '**medium**' consequence of hazard. This is because within 50-100m of the source, concentrations of bioaerosols would reduce, so temporary exposure could result in "significant consequences" and potentially result in "damage that is not severe and is reversible". Beyond 100m, up to 250m, the consequence of the hazard is considered to be '**low**' as concentrations of bioaerosols would be lower so the consequence of the hazard would also be lower, resulting in "minor consequences" where damage is "not apparent, reversible adverse changes possible". Beyond 250m, the consequence is considered '**very low**' as concentrations of bioaerosols generally decrease to background concentrations at this distance so there would be "no evidence for adverse changes" at sensitive receptors at this distance. Beyond 500m, the consequence is not applicable (n/a).

The final consequence of hazard assessed for each emission source is presented below in Table 5.2. Across all potential bioaerosol emission sources at the Site, the consequence of hazard is '**low**' except at the TTW reception where it is '**high'** due to its proximity to its nearest receptor.

Table 5.2: Consequence of hazard from bioaerosols at the Site

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Cake reception and sludge treatment	Primary sludge treatment building	170m northeast – industrial facility	Low	Nearest receptor <250m from potential source, downwind of the prevailing wind direction.
	TTW reception	20m northeast – industrial facility	High	Nearest receptor <50m from potential source, downwind of the prevailing wind direction.
	Sludge reception	195m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.

[19] Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

[20] Health and Safety Executive, 2010. Bioaerosol emissions from waste composting and the potential for workers' exposure.

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Sludge treatment	Anaerobic digesters	120m northwest – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	PDSTs	130m northwest – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	SAS & TSST tanks	120m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Alternative sludge storage tanks	205m east – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Digested sludge cake silo	210m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Alternative cake bay	200m northeast – industrial facility	Low	Nearest receptor <250m from potential source, downwind of the prevailing wind direction.
Biogas combustion	Biogas holder	175m northwest – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	CHP	150m northwest – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	Flare	150m northwest – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	Boilers	160m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.

5.4 Magnitude of risk

Table 5.3 below summarises the probability of exposure, consequence of hazard and resulting magnitude of risk for each potential bioaerosol emission source at the Site. Across all sources, there is a ‘very low’ probability of exposure due to the nature of the processes and control measures in place which would prevent uncontrolled releases of bioaerosols. The consequence of hazard is described as ‘low’ to ‘high’ depending on the proximity of the potential emission source to a sensitive receptor.

In accordance with Environment Agency guidance[21], across all potential bioaerosol emission sources, the magnitude of risk is described as '**low**' to '**medium**' and therefore operation of the Site is unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions.

Nonetheless, due to the proximity of the Site to sensitive receptors, monitoring of bioaerosols should be undertaken at the Site[22]. The requirements for bioaerosol monitoring at the Site will need to be agreed with the Environment Agency within the Environmental Permit issued for the Site.

Table 5.3: Magnitude of risk from bioaerosols at the Site

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Cake reception and sludge treatment	Primary sludge treatment building	Very Low	Low	Low	Nearest receptor <250m from potential source, downwind of the prevailing wind direction. All processes within the primary sludge treatment building are covered, process monitored and regularly maintained. Odour control unit is sealed and the air released from the unit has been treated to remove bioaerosols, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	TTW reception	Very Low	High	Medium	Nearest receptor <50m from potential source, downwind of the prevailing wind direction. TTW reception tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge reception	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. Sludge reception tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Sludge treatment	Anaerobic digesters	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction Digesters covered, process monitored and regularly

[21] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

[22] Environment Agency (2018) Bioaerosol monitoring at regulated facilities - use of M9: RPS 209. Available online at: https://www.gov.uk/government/publications/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
					maintained – uncontrolled release of bioaerosols very unlikely
	PDSTs	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction PDSTs covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	SAS & TSST tanks	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction SAS & TSST tanks are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Alternative sludge storage tanks	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction Alternative sludge storage tanks are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Digested sludge cake silo	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction Digested sludge cake silo covered – uncontrolled release of bioaerosols very unlikely
	Alternative cake bay	Very Low	Low	Low	Nearest receptor <250m from potential source, downwind of the prevailing wind direction. While uncovered, cake within bay at the end of treatment process so bioaerosol concentrations would be at very low/de minimis (any exposure would not result in “significant” consequences). No disturbance of cake while in bays except for removal.
Biogas combustion	Biogas holder	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. Gas holder sealed to prevent uncontrolled release of

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
					bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHP	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	Flare	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	Boilers	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely

6 Summary

At the Site, there is the potential for bioaerosol emissions from:

- Sludge and sludge cake reception and distribution from the Site
- Sludge treatment (sludge storage, digesters, centrifuges and cake silo)
- Biogas combustion

Bioaerosol emissions associated with these processes could be transported by the wind to nearby sensitive human health receptors bordering the Site, resulting in adverse health effects. As these sensitive human health receptors are within 250m of a potential emission source at the Site, a bioaerosol risk assessment has been undertaken in accordance with Environment Agency guidance. However, based on comments from the Environment Agency on a bioaerosol risk assessment undertaken for another similar WTW, a conservative approach has been undertaken and human receptors within 500m of the Site have been considered instead of 250m in the bioaerosol risk assessment.

To inform the assessment, a Source-Pathway-Receptor model was developed and the control measures at the facility to reduce and contain bioaerosol emissions were reviewed. This was undertaken to determine the probability of exposure, consequence of hazard and overall magnitude of risk associated with different processes at the Site.

Based on the ‘very low’ probability of exposure and ‘low’ to ‘high’ consequence of hazards associated with different processes at the Site, the overall magnitude of the risk associated with bioaerosols emissions from the Site is considered to be ‘low’ to ‘medium’. Operation of the Site is therefore unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions. This is primarily due to the ‘wet’ nature of several processes undertaken at the Site and the control measures in place are considered to be effective at reducing and containing emissions of bioaerosols which inhibits the pathway between source and receptor.