MOTT MACDONALD

Bexhill and Hastings Wastewater Treatment Works Environmental Permit Application

Bioaerosol risk assessment

January 2024

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Mott MacDonald
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)1223 463500
mottmac.com

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1 Introduction

1.1 Overview

Southern Water are applying for a new environmental permit to operate their sludge treatment facility at the Bexhill and Hastings 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 currently operates under a T21 exemption and an environmental permit EPR/KP3630KV allowing for burning and storage of biogas produced during the sludge treatment works.

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 the boundary of the Site, the closest of which is approximately 220m 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 northwest of the town of Bexhill in East Sussex. The Site is bordered and screened in all directions by woodland. The layout of the Site is shown in 79010_MSD_SiteLocationPlan_HAS January 2024. The Site includes three anaerobic digesters which are located to the north 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 immuno-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].

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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*

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

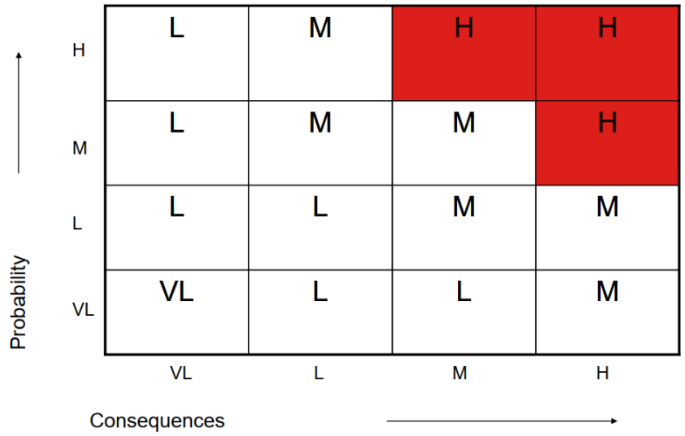
The probability of exposure and consequence of the hazards are then combined to determine the overall magnitude of the risk, as demonstrated in Figure 2.1.

operator/owner of the composting facility." Taken from 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities.'

[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.

Figure 2.1: Magnitude of risk matrices



Source: Environment Agency, 2009

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:

- Cake waste reception areas[10]
- Nine storage tanks (two sludge reception tanks[10], two sludge storage tanks, one cake blending tank[10], two thickened sludge storage tanks[10], two post digestion storage tanks)
- Three gravity belt sludge thickeners[10]
- Three anaerobic digesters
- Two centrifuges (contained within centrifuge building)
- Digested sludge cake silo
- Biogas holder
- One Combined Heat and Power (CHP) unit
- One flare stack
- One standby boiler[10]
- One odour control unit (OCU) within the main sludge treatment building (dual tower 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 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

3.2.2 Cake reception and distribution

Approximately 7 tankers of cake a day are imported to the Site Monday – Saturday and 4 tankers a day on Sunday. The cake is received within the main enclosed building, potential emissions during unloading are controlled with chemical scrubbers to prevent releases from the building. There is currently no tankered sludge imported to the Site. Cake is routinely imported to the Site from Hailsham WTW and Eastbourne WTW. Cake is imported from other sites under emergency conditions.

3.2.3 Sludge treatment

Imported cake is blended with indigenous settled sludge from the primary settlement tanks (PSTs) (from the wastewater treatment process). This blended sludge is then thickened via gravity belt thickeners before being fed into 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 post digestion storage tanks 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 12 hours, five lorries are required per day to remove the treated cake.

3.2.3.1 Odour control

An OCU is located within the main sludge treatment building that contains the sludge cake reception and primary sludge treatment processes. The unit contains a dual tower wet chemical scrubber system. The capacity of the odour control system can treat 90,000 m^3/hour of foul air, removing odorous compounds and bioaerosols. Treated air is then released to the atmosphere.

3.2.4 Biogas combustion

Biogas produced during anaerobic digestion is transferred to the biogas holder and then to the CHP and boilers where it is combusted to generate heat and/or electricity, which is used onsite to assist with the 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 Herstmonceux West End, the nearest representative meteorological site to the Site, is shown in Figure 3.2. This site is located approximately 14km north west of the Site and is considered representative of Site conditions due to its similar topography and surrounding land uses.

The Herstmonceux West End meteorological site experiences frequent winds from the southwest. This suggests that sensitive receptors located to the north east 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 south west. Overall, the two datasets show general agreement with both the monitored and modelled data indicating the prevailing winds originate from the south west. Therefore, sensitive receptors located to the north east of the Site would be at the greatest risk from bioaerosol emissions from the Site.

Figure 3.2: Average wind rose for Herstmonceux West End meteorological site, 2019- 2023

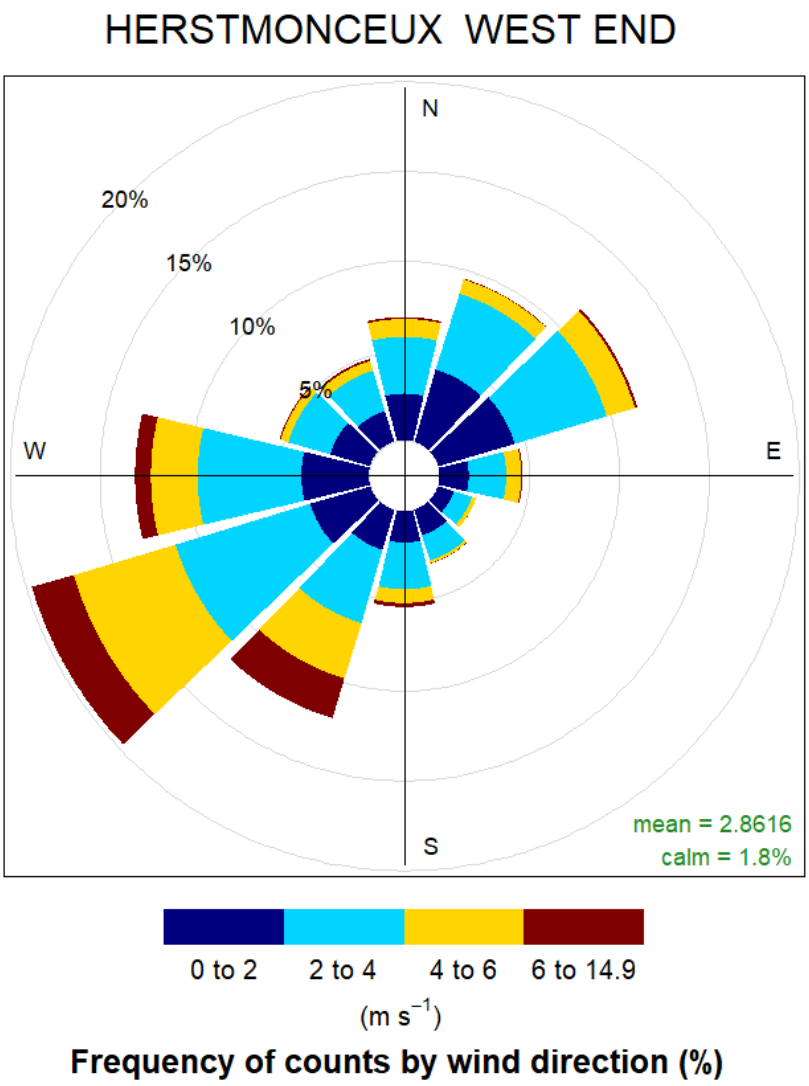
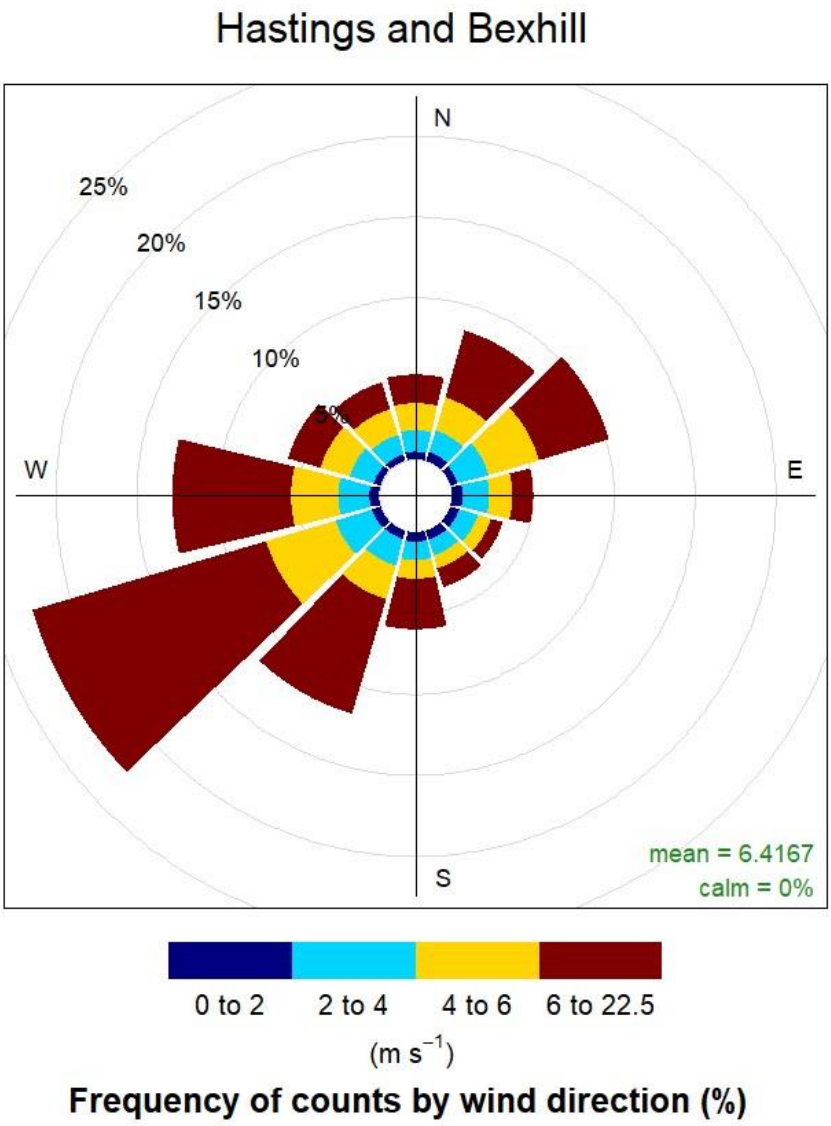


Figure 3.3: Average wind rose for the Site from the Vortex Model, 2019-2023



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, there is dense woodland to the north, west and south of the Site with woodland to the east. These trees could inhibit a pathway between source and receptor.

[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 seven areas of sensitive receptors found within 500m of potential bioaerosol emission sources at the Site. As demonstrated in Figure 3.4, four areas of residential properties are located to the southwest, whilst three areas of industrial land use are located to the south east, east and south west.

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.

As demonstrated in Figure 3.4, no sensitive receptors are found within 500m of a potential emission source downwind of the prevailing wind direction; the receptor closest to a potential emission source is a residential property, which is located approximately 220m southwest of the sludge storage tanks.

[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

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)]						
		Industrial land use southeast of the Site (m)	Industrial land use southeast of the Site (m)	Industrial land use southwest of the Site (m)	Residential properties southwest of the Site (m)	Residential properties southwest of the Site (m)	Residential properties southwest of the Site (m)	Residential properties southwest of the Site (m)
Primary sludge treatment building[14]	Cake reception and sludge treatment	320, Southeast	470, Southeast	340, Southwest	305, Southwest	345, Southwest	**240**, Southwest	390, Southwest
Two sludge storage tanks	Sludge treatment	350, Southeast	475, Southeast	315, Southwest	275, Southwest	325, Southwest	**220**, Southwest	370, Southwest
Anaerobic digesters	Sludge treatment	345, Southeast	>500, Southeast	400, Southwest	355, Southwest	405, Southwest	**295**, Southwest	435, Southwest
Post digestion sludge storage tanks	Sludge treatment	390, Southeast	>500, Southeast	385, Southwest	350, Southwest	370, Southwest	**260**, Southwest	400, Southwest
Centrifuge building	Sludge treatment	290, Southeast	440, Southeast	335, Southwest	290, Southwest	370, Southwest	**270**, Southwest	430, Southwest
Digested sludge cake silo	Sludge treatment	295, Southeast	440, Southeast	340, Southwest	**290**, Southwest	390, Southwest	**290**, Southwest	455, Southwest
Biogas holder	Biogas combustion	405, Southeast	535, Southeast	355, Southwest	325, Southwest	335, Southwest	**225**, Southwest	360, Southwest
CHP	Biogas combustion	325, Southeast	485, Southeast	400, Southwest	350, Southwest	425, Southwest	**320**, Southwest	475, Southwest
Boiler[10]	Biogas combustion	320, Southeast	470, Southeast	340, Southwest	305, Southwest	345, Southwest	**240**, Southwest	390, Southwest
Flare	Biogas combustion	**315**, Southeast	485, Southeast	410, Southwest	360, Southwest	445, Southwest	340, Southwest	490, Southwest

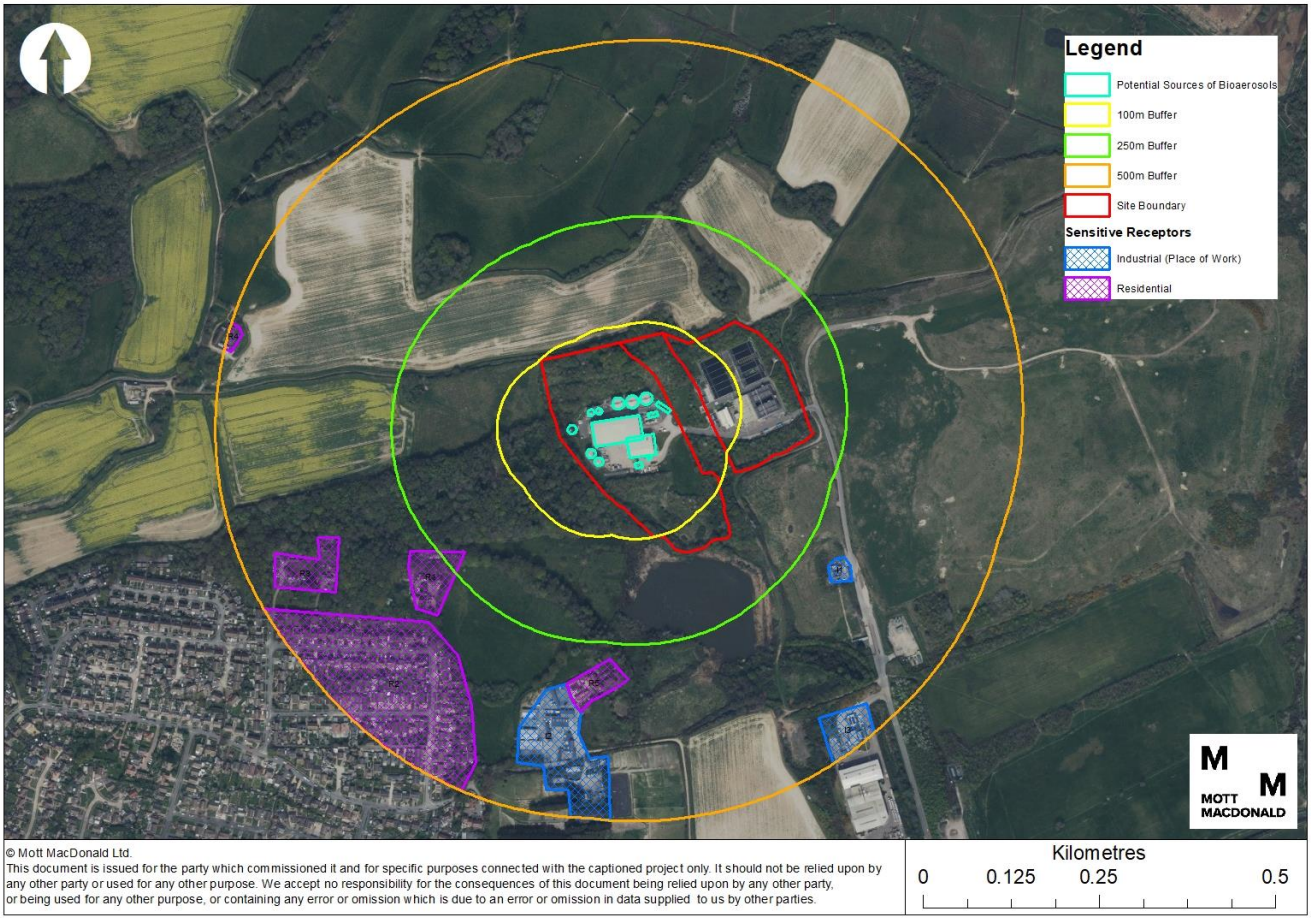
Note:

(a) Refers to the receptors presented within Figure 3.4. Distance from source to receptor is rounded to the nearest 5m.

(b) Value in **bold** represents the nearest potential emission source for each process which is closest to a sensitive receptor

[14] Primary sludge building contains the cake reception areas, sludge reception tanks, cake blending tank, thickened sludge storage tanks and gravity belt sludge thickeners and chemical scrubber OCU

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
Sludge treatment	Primary sludge treatment building[14]	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)	240m southwest – residential receptor
	Two sludge storage tanks		220m southwest – residential receptor
	Anaerobic digesters		295m southwest – residential receptor
	Post digestion sludge storage tanks		260m southwest – residential receptor
	Centrifuge building		270m southwest – residential receptor
	Digested sludge cake silo		290m southwest – residential receptor
Biogas combustion	Biogas holder		225m southwest – residential receptor
	CHP		320m southwest – residential receptor
	Boiler		240m southwest – residential receptor
	Flare		315m southeast – 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 Cake reception and distribution

There are approximately 7 tankers on average arriving at the Site per day Monday-Saturday and 4 tankers on Sunday. The Site does not import sludge, only cake is imported to the Site. Cake is unloaded within the primary sludge treatment building, shutters are kept closed on this building unless there is a vehicle moving through them which limits the risk of bioaerosols escaping the building. There are also two chemical scrubbers in operation during the unloading of cake.

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. Shutters are kept closed at all time apart from when vehicles are moving through them.

[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.

Cake is stored within a 100 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 are dropped directly from the silo into tipper trucks.

To further reduce potential bioaerosol emissions, sludge produced on Site is processed immediately. Cake arriving onsite is also processed immediately to help minimise bioaerosol emissions. This prevents processing of old sludge and 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 OCU 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 boilers/CHP 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 M9 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 is controlled via an OCU within the main sludge treatment building that contains a dual tower wet chemical scrubber system. The odour control system has an odour removal efficiency of 98% and total flow rate of 90,000 m^3/hr. Filtered odour streams are discharged into the environment through the OCU stack as shown by A08 in 790101_MSD_SiteLayoutPlan_HAS and are monitored hourly to ensure the absence of odorous compounds.

The OCU 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.

To minimise odour nuisance, it is important to ensure that the Bexhill and Hastings 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 on-site 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, 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 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 Locations

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[16] 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.

[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

4.5.2 Monitoring Locations

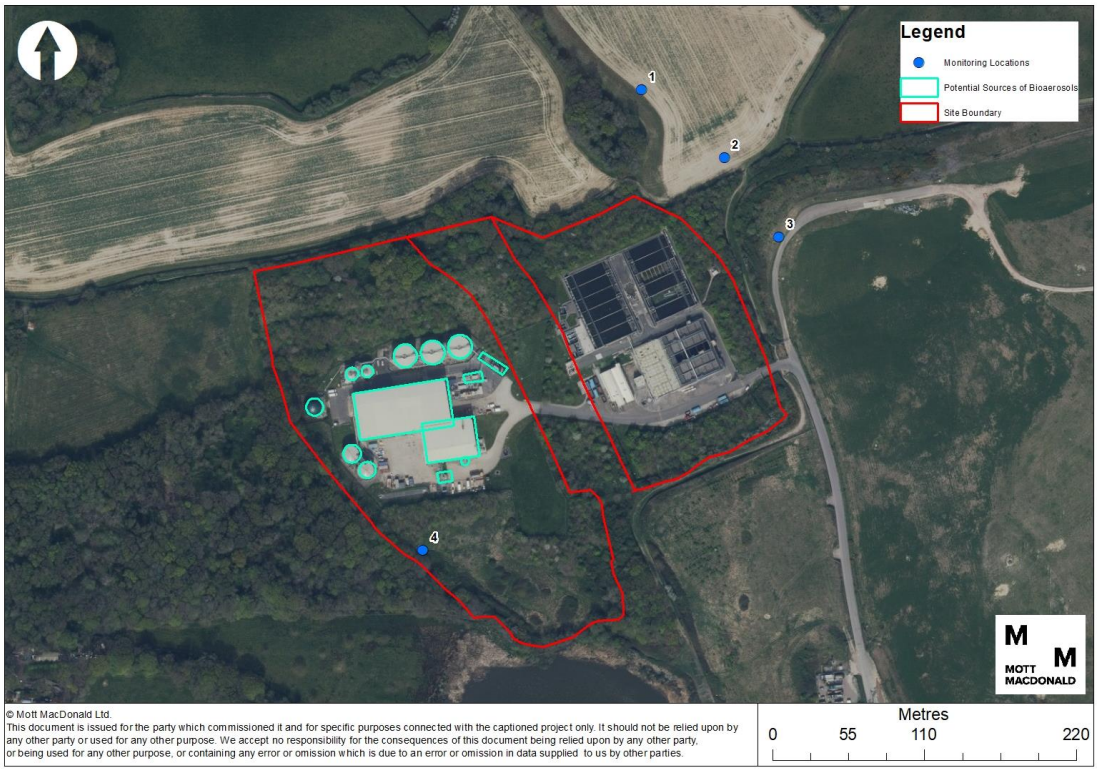
As detailed in Section 3.3, the prevailing wind direction at the Site is from the south west, therefore, in accordance with TGN M9, three samplers will be positioned to the north east of the Site to capture downwind bioaerosol concentrations and one sampler will be located upwind, to the south west of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

Table 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 (220m) 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.

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.

Across the Site, the potential for bioaerosol emissions which could result in significant consequences is limited. The greatest risk of significant bioaerosol emissions from the Site where there would be the greatest consequence of the hazard, is associated with emergency situations such as a failure of the flare or CHP/boilers, which could result in uncontrolled emissions of bioaerosols. However, such an emergency event would be unlikely, temporary, and infrequent 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[17], 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 reception and distribution
- 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 overall probability of exposure of sensitive receptors to bioaerosols at all of the sludge reception and distribution, sludge treatment and biogas combustion bioaerosol sources at the Site is therefore 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.

The final probability of exposures to bioaerosols assessed for each emission source is presented below in Table 5.1.

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge treatment	Primary sludge treatment building[14]	Very Low	All processes within the primary sludge treatment building are covered, process monitored and regularly maintained. OCU 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
	Two sludge storage tanks	Very Low	Sludge storage tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Anaerobic digesters	Very Low	Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Post digestion storage tanks	Very Low	Post digestion tanks covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely

[17] 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
	Centrifuges	Very Low	Centrifuges are covered and located within centrifuge building, within the centrifuge building, 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
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
	Boiler	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

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 cake was being loaded 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) [18,19]. 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

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

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

"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, up to 500m, 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 '**very low**' or '**low**'.

Table 5.2: Consequence of hazard from bioaerosols at the Site

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Sludge treatment	Primary sludge treatment building[14]	240m southwest – residential receptor	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	Two sludge storage tanks	220m southwest – residential receptor	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	Anaerobic digesters	295m southwest – residential receptor	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction
	Post digestion sludge storage tanks	260m southwest – residential receptor	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction
	Centrifuge building	270m southwest – residential receptor	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction
	Digested sludge cake silo	290m southwest – residential receptor	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction
Biogas combustion	Biogas holder	225m southwest – residential receptor	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	CHP	320m southwest – residential receptor	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction.
	Boiler	240m southwest – residential receptor	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
	Flare	315m southeast – industrial facility	Very 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 'very low' to 'low' depending on the proximity of the potential emission source to a sensitive receptor.

In accordance with Environment Agency guidance[20], across all potential bioaerosol emission sources, the magnitude of risk is described as '**very low**' or '**low**' 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[21]. 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.

[20] 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.

[21] 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

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
Sludge treatment	Primary sludge treatment building[14]	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. All processes within the primary sludge treatment building are covered, process monitored and regularly maintained. OCU 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
	Two sludge storage tanks	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction. Sludge storage tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Anaerobic digesters	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Post digestion sludge storage tanks	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction Post digestion tanks covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Centrifuges building	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source, not downwind of the prevailing wind direction Centrifuges are covered and located within centrifuge building, within the centrifuge building, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Digested sludge cake silo	Very Low	Very Low	Very 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

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
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 bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHP	Very Low	Very Low	Very 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
	Boiler	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	Very Low	Very 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:

- Cake reception and distribution
- 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 ‘very low’ to ‘low’ 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 ‘very low’ to ‘low’. 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.