MOTT MACDONALD

Chelmsford Wastewater Treatment Works Environmental Permit Application

Bioaerosol risk assessment

March 2021

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Contents

1 Introduction

1.1 Overview

Anglian Water is applying for a substantial variation to their standard rules environmental permit at the Chelmsford Sludge Treatment Centre (STC) ('the Site'). The Site currently has a SR2009 No 4 "Combustion of biogas in engines at a sewage treatment work" permit (EPR/EB3502GB) which is being varied to include sludge treatment activities covered by the Environmental Permitting Regulations (EPR) 2016.

Regulatory Position Statement 209[1], issued 23 January 2018 by the Environment Agency (EA), 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 10m 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].

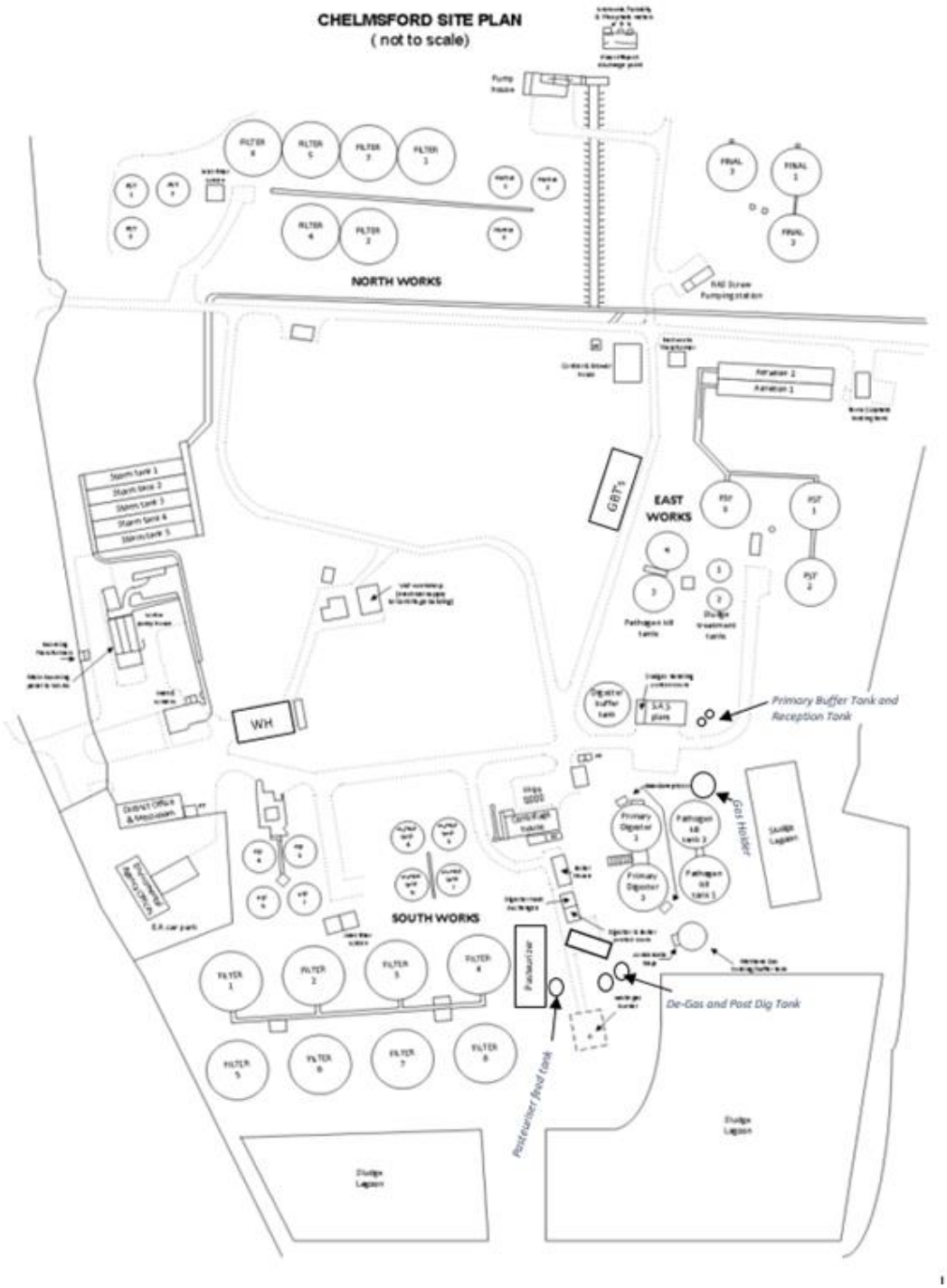
1.2 Site location

The Site is situated on Brook End Road South in Chelmsford. The layout of the Site is shown in Figure 1.1. The Site includes two anaerobic digesters which are in the south east 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.

Figure 1.1: Site layout and location plan



Source: Anglian Water

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

As sensitive human health receptors are found within 250m of the activities at the Site which have the potential to release bioaerosols, a bioaerosol risk assessment has been undertaken.

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*'[8], 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:

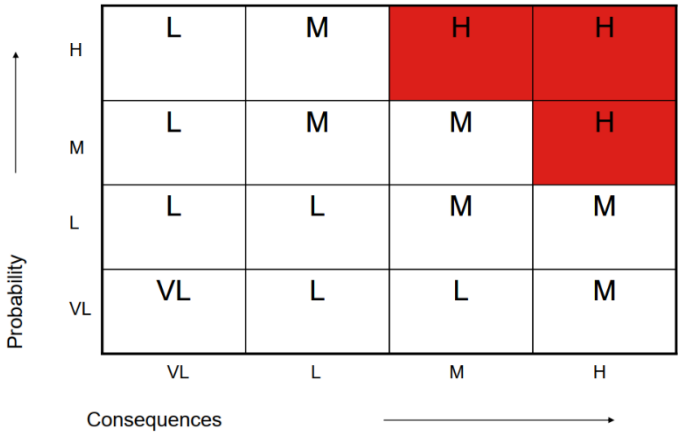
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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] 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:

- Ten Primary Settlement Tanks (PSTs)
- Three aeration lanes (east works)
- 14 biofilters (north and south works)
- Ten Final Settlement Tanks (FSTs)
- One sludge thickening building (4 GBTs)
- One Surplus Activated Sludge (SAS) plant (not in use)
- Two anaerobic digesters (1 in use)
- 7 sludge storage tanks (including SAS and Return Activated Sludge (RAS) storage tanks, pasteuriser feed tank, digester buffer tanks)
- Two centrifuges
- One gas holder
- Three dual fuel boilers
- Two Combined Heat and Power engines (273kWe)
- One flare
- Seven cake skips

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

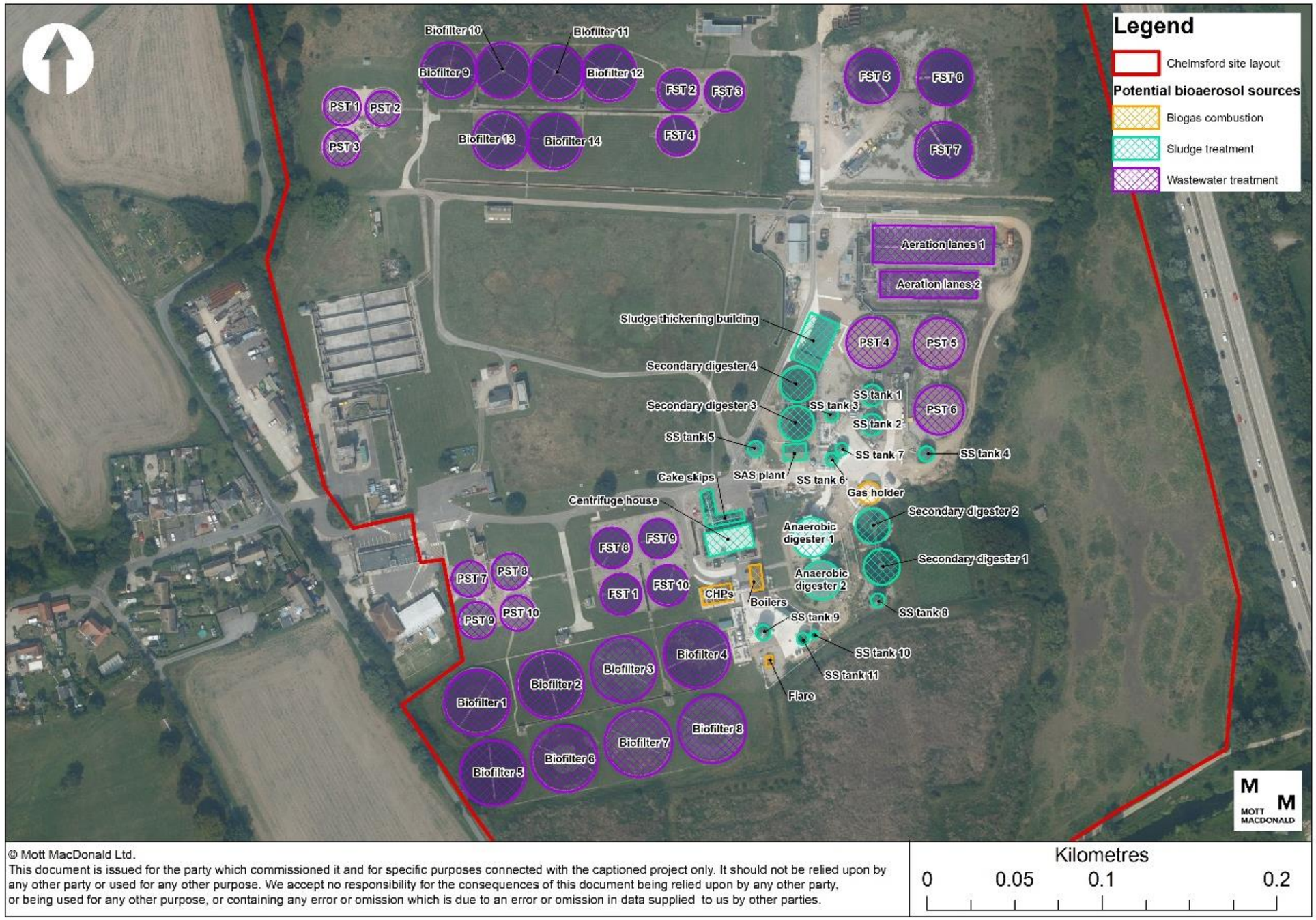
- Wastewater treatment (settlement tanks, aeration lanes, biofilters)
- Sludge treatment (sludge storage, digesters and centrifuge)
- Biogas combustion

Figure 3.1 shows the locations of these different processes and assets across the Site. Wastewater treatment processes are found in three separate biological treatment works areas which are called the north, east and south biological treatment works respectively. The sludge treatment and biogas combustion process are found in the south east of the Site.

Note: On Figure 3.1, the SS tanks 1, 2, 4, 5 are either not active anymore or have been demolished. Secondary digesters 1-4 are no longer used.

A summary of the activities which occur at the Site involving these assets is presented in the subsequent sections.

Figure 3.1: Potential sources of bioaerosols at the Site.



3.2.2 Wastewater treatment and sludge treatment

3.2.2.1 Wastewater

The Site receives wastewater from across the catchment area, including from Great Baddow, Springfield, Gallywood, Sandon, Danbury, West Hanningfield and Chelmer village. Wastewater arriving at the site is screened, and depending on flow volume, may be diverted to the storm settlement tanks before entering the inlet works. After the inlet works, wastewater is sent to the PSTs for the primary settlement process.

Settled sewage from the PSTs is then transferred to one of the biological treatment works on the Site. At the biological treatment works on the east of the Site, aeration lanes are used for the activated sludge process. During this secondary biological treatment process, wastewater passes through aeration lanes and mixes with biologically active sludge to remove organic pollutants (a process which releases carbon dioxide and water). Treated effluent from the aeration lanes then passes to the FSTs where mixed liquor settles out and the RAS and SAS is removed. Clarified liquor is then discharged to the River Black Water while the RAS flows to the RAS pumping station to be pumped back to the aeration lanes and the SAS is pumped to the SAS plant.

At the biological treatment works on the north and south of the Site, biological filtration is used instead of the activated sludge process. During biological filtration, wastewater percolates through stone media biofilters (which have microorganisms living on their surface) to break down organic pollutants. The treated wastewater then passes to the FSTs, which are periodically de-sludged to recover the sludge which settles out under gravity, before discharging the treated water to the River Black Water.

3.2.2.2 Sludge treatment

Only indigenous sludge is treated at Chelmsford STW; no sludge imports are received at the Site.

SAS from the east biological treatment works is discharged into the digester buffer tank via the SAS plant before passing to a sludge receptor tanks while sludge from the north and south biological treatment works is transferred directly to the sludge receptor tanks. The sludge from both processes is then thickened within the sludge thickening building.

Thickened sludge is stored in thickened sludge storage tanks before being fed to the pasteurisation plant. During pasteurisation, the sludge is heated to a minimum of 70°C for at least 30 minutes to reduce pathogen levels. The sludge is then cooled to approximately 40°C before it is 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, releasing water, carbon dioxide and methane (biogas).

After anaerobic digestion, digested sludge passes into a degas tank and then onto the new secondary digester tank.

Following secondary digestion, the final digested sludge is dewatered by the centrifuges. The dewatered sludge cake produced is discharged into the cake skips via a conveyor belt before being collected by covered trucks to be transported off site for use on agricultural land.

3.2.2.3 Odour control

Odour control systems are attached to the covered sludge storage tanks. All tanks are covered apart from the degas tanks and the new secondary digestion tank. The control system extracts

odorous air and treats the air using a bio-trickling filter (lava rock) followed a dry chemical scrubber to remove odorous compounds and bioaerosols. Treated air is released to the atmosphere via stacks to assist dispersion.

All OCUs are listed in the Odour Modelling Report (101265_OMR_CHEL).

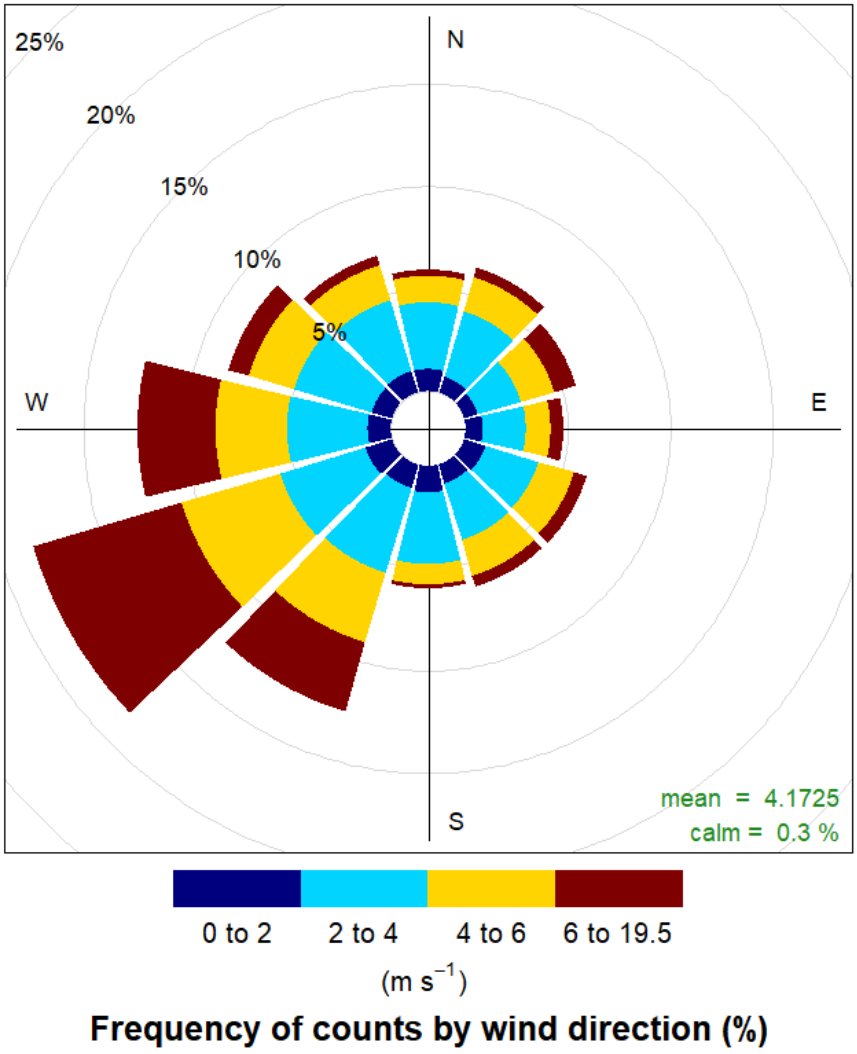
3.2.3 Biogas combustion

Biogas produced during anaerobic digestion is transferred to the gas holder and then to the CHPs and boilers 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 CHPs 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 currently used onsite for less than 10% of operational hours.

3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transport by the wind from their source to a receptor. The 2016-2020 wind rose for the nearby meteorological site at Andrewsfield aerodrome (located approximately 18.5km north of the Site), is shown in Figure 3.2. This monitoring site experiences strong prevailing winds from the southwest, with occasional strong winds from the west. 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.

Figure 3.2: Average wind rose for Andrewsfield meteorological site, 2016- 2020



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[9,10]. The local terrain in the 250m area surrounding the Site is relatively flat, with some low-lying trees bordering the Site on most sides (so there would be few obstacles to inhibit the pathway between source and receptor).

3.4 Receptors

Environment Agency guidance[11] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations. 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 to many types of*

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

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

[11] 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

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 multiple sensitive receptors found within 250m of potential bioaerosol emission sources at the Site. As demonstrated in Figure 3.3, these receptors are primarily found to the west of the Site. To the north east of the Site, downwind of the prevailing wind direction, there are several recreational fishing lakes. This area has been included within the assessment as a sensitive receptor as it is possible that receptor could be present at this location for periods of more than 6 hours at a time.

Four areas of sensitive receptors have been identified below in Table 3.1 based on their location relative to the Site. For each of these areas, the distance and direction from each potential bioaerosol emission source to a sensitive receptor within the area has been identified. Where multiple assets exist for the same process, such as digesters or settlement tanks, only the closest asset has been presented.

The majority of receptors are found to the west (upwind) of a potential emission source; the receptor closest to a potential emission source is an office, which is located approximately 10m west of the PSTs in the south of the Site. The potential emission source closest to a receptor downwind of the prevailing wind direction are the FSTs in the north east of the Site which are 130m from the amenity area north east of Site.

Table 3.1: Receptors within 250m of potential emission sources at the Site

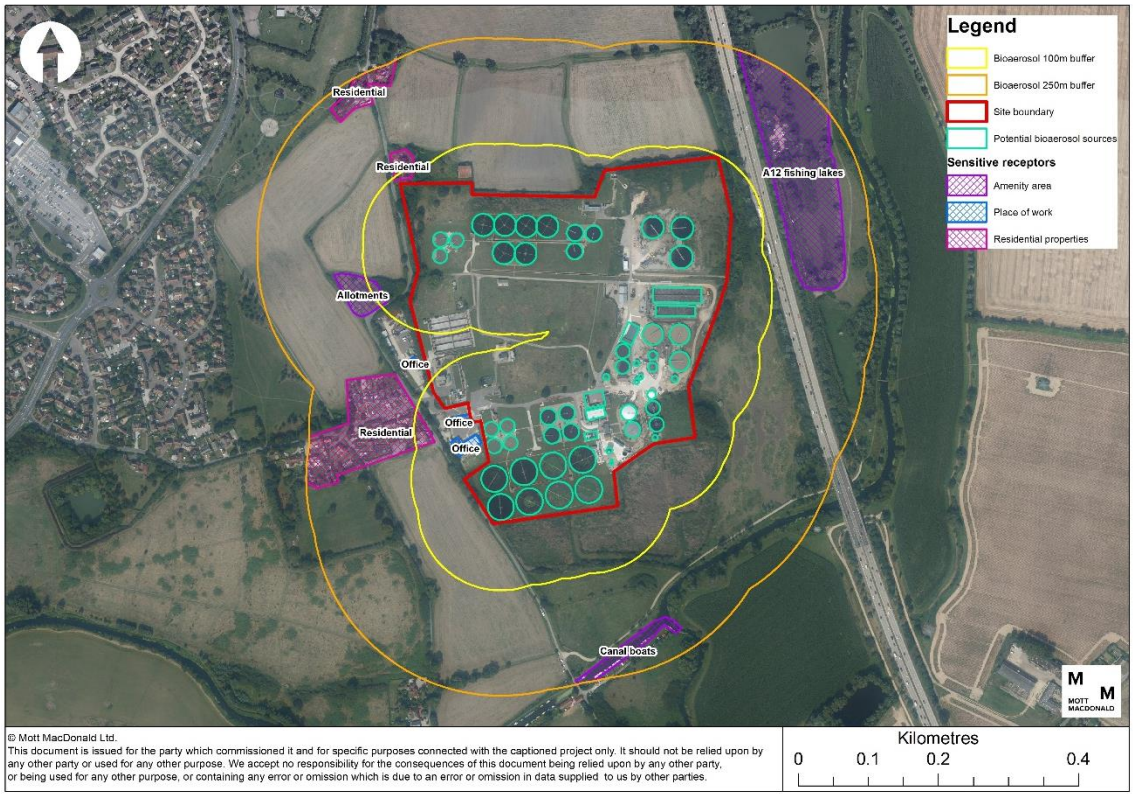
Receptor	Nearest potential emission source to receptor	Process	Distance (m) from nearest potential emission source [(a)]	Direction of receptor from closest emission source
Sensitive receptors west of the Site (places of work, amenity areas and residential)	PSTs	Wastewater treatment	**10**	**West**
	Biofilters	Wastewater treatment	35	West
	Aeration lanes	Wastewater treatment	305	West
	FSTs	Wastewater treatment	90	West
	Anaerobic digesters	Sludge treatment	210	West
	Secondary digesters	Sludge treatment	220	West
	Centrifuge building	Sludge treatment	**160**	**West**
	Sludge thickening building	Sludge treatment	240	West
	Covered sludge storage tank [(b)]	Sludge treatment	180	West
	SAS plant	Sludge treatment	215	West
	Uncovered sludge storage tank [(c)]	Sludge treatment	195	West
	Cake skips	Sludge treatment	160	West
	Gas holder	Biogas combustion	250	West
	Boilers	Biogas combustion	175	West
	CHPs	Biogas combustion	**150**	**West**
	Flare	Biogas combustion	185	West
	PSTs	Wastewater treatment	**85**	**North west**

Residential properties NW of Site	Biofilters	Wastewater treatment	105	North west
	Aeration lanes	Wastewater treatment	380	North west
	FSTs	Wastewater treatment	240	West
	Anaerobic digesters	Sludge treatment	445	North west
	Secondary digesters	Sludge treatment	380	North west
	Centrifuge building	Sludge treatment	415	North west
	Sludge thickening building	Sludge treatment	**370**	**North west**
	Covered sludge storage tank [(b)]	Sludge treatment	390	North west
	SAS plant	Sludge treatment	400	North west
	Uncovered sludge storage tank [(c)]	Sludge treatment	495	North west
	Cake skips	Sludge treatment	390	North west
	Gas holder	Biogas combustion	455	North west
	Boilers	Biogas combustion	445	North west
	CHPs	Biogas combustion	**440**	**North west**
	Flare	Biogas combustion	490	North west
Amenity area north east of Site (fishing lakes)	PSTs	Wastewater treatment	175	North east
	Biofilters	Wastewater treatment	315	East
	Aeration lanes	Wastewater treatment	145	North east
	FSTs	Wastewater treatment	**130**	**East**
	Anaerobic digesters	Sludge treatment	295	North east
	Secondary digesters	Sludge treatment	265	North east
	Centrifuge building	Sludge treatment	330	North east
	Sludge thickening building	Sludge treatment	240	North east
	Covered sludge storage tank [(b)]	Sludge treatment	**225**	**North east**
	SAS plant	Sludge treatment	280	North east
	Uncovered sludge storage tank [(c)]	Sludge treatment	345	North east
	Cake skips	Sludge treatment	325	North east
	Gas holder	Biogas combustion	**260**	**North east**
	Boilers	Biogas combustion	340	North east
	CHPs	Biogas combustion	360	North east
	Flare	Biogas combustion	370	North east
Amenity area south of the Site (canal boat)	PSTs	Wastewater treatment	320	South
	Biofilters	Wastewater treatment	**190**	**South**
	Aeration lanes	Wastewater treatment	430	South
	FSTs	Wastewater treatment	285	South
	Anaerobic digesters	Sludge treatment	260	South
	Secondary digesters	Sludge treatment	265	South
	Centrifuge building	Sludge treatment	300	South
	Sludge thickening building	Sludge treatment	390	South
	Covered sludge storage tank [(b)]	Sludge treatment	**250**	**South**

	SAS plant	Sludge treatment	340	South
	Uncovered sludge storage tank (c)	Sludge treatment	235	South
	Cake skips	Sludge treatment	315	South
	Gas holder	Biogas combustion	310	South
	Boilers	Biogas combustion	275	South
	CHPs	Biogas combustion	275	South
	Flare	Biogas combustion	**240**	**South**

Note: (a) Distance from source to receptor is rounded to the nearest 5m
(b) Covered sludge storage tank includes SAS and RAS storage tanks, pasteuriser feed tank and digester buffer tanks (SS tanks 1-9 in Figure 3.1)
(c) Uncovered sludge storage tanks are post digestion buffer tanks which store sludge prior to dewatering. These are no longer used. (SS tanks 10-11 in Figure 3.1)
Value in bold represents the nearest potential emission source for each process which is closest to a sensitive receptor

Figure 3.3: Sensitive receptors within 250m



3.5 Summary

Table 3.2 below 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
Wastewater treatment	PSTs	Air transport then:	10m, west – office

	Biofilters	• Inhalation (through nose or mouth) • Ingestion (eating or swallowing) • Absorption/contact (through skin or eyes)	35m, west – office
	Aeration lanes		145m, north east – fishing lakes
	FSTs		90m, west - office
Sludge treatment	Anaerobic digesters		210m, west – office
	Secondary digesters		220m, west – office
	Centrifuge building		160m, west – office
	Sludge thickening building		240m, west – office
	Covered sludge storage tank		180m, west – office
	SAS plant		215m, west – office
	Uncovered sludge storage tank		195m, west – office
	Cake skips		160m, west – office
Biogas combustion	Gas holder		250m, west – office
	Boilers		175m, west – office
	CHPs		150m, west – office
	Flare		185m, west - office

4 Control measures

4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[12] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site for 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.

No specific bioaerosol control measures, such as covers, are in place for the wastewater treatment processes at the Site (PSTs, biofilters, aeration lanes and FSTs). However, these are 'wet' processes so the likelihood of the resuspension of bioaerosols from these potential sources and therefore the probability of exposure is minimised so no additional control measures would be required.

4.2 Control measures

4.2.1 Sludge treatment

4.2.1.1 Containment of emissions

To contain emissions of bioaerosols during sludge treatment, the anaerobic and secondary digesters, centrifuges and all but two sludge storage tanks on the site are covered. The sludge thickeners, SAS plant and centrifuge are also contained in covered buildings to prevent the uncontrolled release of bioaerosols and reduce the likelihood of exposure of receptors to bioaerosols. The doors to these buildings are kept closed unless entry is required for work purposes.

4.2.1.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down. This occurs during pasteurisation as well as anaerobic and secondary digestion. 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/pre-dewatered sludge (at the end of the sludge treatment process) is much lower than sludge within the sludge thickening building (prior to pasteurisation and digestion). Therefore, while there are two uncovered sludge storage tanks, as these contain pre-dewatered sludge at the end of the sludge treatment process, the sludge is also wet so the likelihood of the resuspension of bioaerosols is minimised.

Several covered sludge treatment activities are also odour controlled; odorous air from the covered sludge storage tanks is treated with wet chemical biofilter scrubbers and carbon polish media to remove odour and bioaerosols before it is released to the atmosphere. While the

[12] 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.

scrubbers are unable to remove 100% of bioaerosols, any bioaerosol emissions from odour control are anticipated to be negligible.

Chelmsford uses chemical sprays (aero pure fresh berry) to minimise odour. This is sprayed continuously to mask the odour from the north and south works.

4.2.2 Biogas combustion

All tanks capable of producing biogas are sealed and connected to the biogas system (such as the anaerobic digesters). Biogas produced from these processes are stored within the gas holder before being combusted at high temperatures within the boilers/CHPs 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 sampling of dry solids and flow recording of tds into digesters is done. Daily walk around checks (GBTs, maintenance checks of tanks and for risk of spillages).

Weekly samples of digestors (VFA, ammonias, alkalinity, dry solids), and chemical checks to ensure efficient works.

POSMAINT (included in the application pack) has specific maintenance procedures for individual assets.

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

If a spillage of material which could contain bioaerosol occurs (for example, a spillage of sludge from a sludge storage tanks), the spill must be cleaned up immediately. Routine inspections of the Site are undertaken by the treatment manager to monitor for such spills.

4.4 Emergency procedures

There are a SCADA and HMI system in place at Chelmsford. These are there to control and monitor the process, and allows AWS to trend tank levels and investigate any potential issues on site. This is also used as an alarm system and will highlight any faults that are currently in the process.

In an emergency, on the WRC and STC the on-site works technicians would respond as they are on a 24/7 call out system which is monitored and maintained by the OMC. For any CHP related issue, the CHP team would be on call 24/7.

In the gas bag there is a gas alarm (methane alarm) and high and low alarms, condensate pots with low level alarms which are coded to an L alarm (life threatening) and would be attended by the site team who would follow the gas plan to resolve the situation. Any CHP gas alarm would be attended by the CHP team and the same gas pan would be followed.

In the event on an emergency, bio-aerosols would be released into the atmosphere and the feeds to the digesters would be stopped to limit the amount of biogas produced and subsequently the volume of biogas to atmosphere. Depending on the fault, operations would be able to call on Veolia to attend site to assist in rectifying the issue.

4.5 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 probability of exposure from a potential source of bioaerosols from the Site is associated with uncovered operations such as the PSTs, FSTs, aeration lanes, biofilters and some sludge storage tanks. However, these uncovered processes are ‘wet’ processes so the likelihood of resuspension of bioaerosols and therefore the probability of exposure is minimised.

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 and therefore 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 EA guidance[13], 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:

- Wastewater treatment (settlement tanks, aeration lanes, biofilters)
- Sludge treatment (sludge storage, digesters and centrifuge)
- 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 the majority of 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 exception to this is are the uncovered sludge storage tanks and uncovered wastewater treatment processes at the Site: PSTs, FSTs, aeration lanes and biofilters. However, all of these are 'wet' processes so the probability of exposure is considered to be '**low**'; exposure of the receptors to bioaerosols is "unlikely" as some "barriers exist to mitigate".

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
Wastewater treatment	PSTs	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Biofilters	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Aeration lanes	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	FSTs	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely

[13] 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
Sludge treatment	Anaerobic digesters	Very Low	Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Secondary digester	Very Low	Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Centrifuge building	Very Low	Centrifuge activities covered and enclosed, process monitored and regularly maintained –uncontrolled release of bioaerosols very unlikely
	Sludge thickening building	Very Low	Sludge thickening activities covered and enclosed, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Covered sludge storage tank	Very Low	Sludge storage tanks covered and odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	SAS plant	Very Low	SAS covered and enclosed, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Cake skips	Very Low	Cake at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land – release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis
Biogas combustion	Gas holder	Very Low	Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks. – 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
	CHPs	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’ or ‘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 if there was a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary as faults 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) [14,15]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source. Receptors downwind of the prevailing wind direction which are more than 100m from an emission sources will also experience a greater hazard consequence than those upwind of the emission source at these distances.

For the purpose of this assessment, sources of bioaerosols within 100m of receptors are therefore considered to have a '**medium**' consequence of hazard. This is because within 100m of the source, concentrations of bioaerosols would be greatest so temporary exposure could result in "significant consequences" and potentially result in "damage that is not severe and is reversible". Beyond 100m, 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". For the receptors more than 100m (but less than 250m) from the emission source which are downwind of the prevailing wind direction, the consequence of the hazard is also considered to be '**medium**'.

The final consequence of hazard assessed for each emission source is presented below in Table 5.2.

Table 5.2: Consequence of hazard from bioaerosols at the Site

Process	Potential source of bioaerosols	Nearest receptor	Consequence of exposure	Justification
Wastewater treatment	PSTs	10m, west – office	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction
	Biofilters	35m, west – office	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction
	Aeration lanes	145m, north east – fishing lakes	Medium	Nearest receptor >100m from potential source, downwind of the prevailing wind direction
	FSTs	90m, west - office	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction
Sludge treatment	Anaerobic digesters	210m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction
	Secondary digester	220m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction
	Centrifuge building	160m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction
	Sludge thickening building	240m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction
	Covered sludge storage tank	180m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction

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

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

Process	Potential source of bioaerosols	Nearest receptor	Consequence of exposure	Justification
	SAS plant	215m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction
	Cake skips	160m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction
Biogas combustion	Gas holder	250m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction.
	Boilers	175m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction.
	CHPs	150m, west – office	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction.
	Flare	185m, west - office	Low	Nearest receptor >100m 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’ or ‘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 exposure is described as ‘low’ to ‘medium’ depending on the potential emission source due to their proximity to sensitive receptors and the location of the receptor relative to the prevailing wind direction and potential emission source.

In accordance with EA guidance[16], across all potential bioaerosol emission sources, the magnitude of risk is described as ‘**low**’ or ‘**medium**’ and therefore operation of the Site is unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions.

Table 5.3: Magnitude of risk from bioaerosols at the Site

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
Wastewater treatment	PSTs	Low	Medium	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction Uncovered, ‘wet’ process - exposure to bioaerosol emissions unlikely
	Biofilters	Low	Medium	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction Uncovered, ‘wet’ process - exposure to bioaerosol emissions unlikely
	Aeration lanes	Low	Medium	Medium	Nearest receptor >100m from potential source, but downwind of the prevailing wind direction Uncovered, ‘wet’ process - exposure to bioaerosol emissions unlikely

[16] 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	Consequence of exposure	Magnitude of risk	Justification
	FSTs	Low	Medium	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
Sludge treatment	Anaerobic digesters	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Secondary digesters	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Centrifuge building	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction Centrifuge activities covered and enclosed, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge thickening building	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction Sludge thickening activities covered and enclosed, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Covered sludge storage tank	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction Sludge storage tanks covered and odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	SAS plant	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction SAS covered and enclosed, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Cake skips	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction Cake at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land –uncontrolled release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
Biogas combustion	Gas holder	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of the prevailing wind direction. Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks - uncontrolled release of bioaerosols very unlikely
	Boilers	Very Low	Low	Low	Nearest receptor >100m 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
	CHPs	Very Low	Low	Low	Nearest receptor >100m 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 >100m 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:

- Wastewater treatment (settlement tanks, aeration lanes, biofilters)
- Sludge treatment (sludge storage, digesters and centrifuge)
- 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 potential emission sources at the Site, a bioaerosol risk assessment has been undertaken in accordance with EA guidance.

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’ to ‘low’ probability of exposure and ‘low’ to ‘medium’ 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’. This is primarily due to the ‘wet’ nature of several processes undertaken at the Site and the control measures in place which are considered to be effective at reducing and containing emissions of bioaerosols, inhibiting the pathway between source and receptor.