MOTT MACDONALD

Fullerton Sludge Treatment Centre Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioaRA_FUL

February 2024

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Contents

1 Introduction

1.1 Overview

Southern Water is applying for a new environmental permit to operate their sludge treatment facility at the Fullerton Wastewater Treatment Works (WTW) and Sludge Treatment Centre (STC) ('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 two environmental permits: one for waste activities (REF: EPR/SP3492HL) and one for combustion activities (REF: EPR/PP3303PQ).

Regulatory Position Statement 209[1], issued 23 January 2018 by the Environment Agency, states that all sites that have a permit for the treatment of biological waste within 250 metres of a sensitive receptor (a place where people live or work for more than 6 hours at a time) must carry out a site-specific bioaerosol risk assessment. As sensitive receptors are found close to the boundary of the Site, the closest of which is approximately 90m 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 500m to the southeast of the village of Goodworth Clatford, approximately 4km south of the town of Andover, Hampshire. The Site is bordered by agricultural and rural land use to the east, south and west. To the north of the Site is the Fullerton Solar Energy Farm.

The layout of the Site is shown in 790101_MSD_SiteLayoutPlan_FUL February 2024.

[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 (AD) 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 AD facilities. Regulatory Position Statement (RPS) 031[4] states that bioaerosol concerns would normally be associated with composting activities, which are defined as: *'biological decomposition of biodegradable waste under conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat'*.

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

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

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

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

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

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

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

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

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

2.3 Methodology

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

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

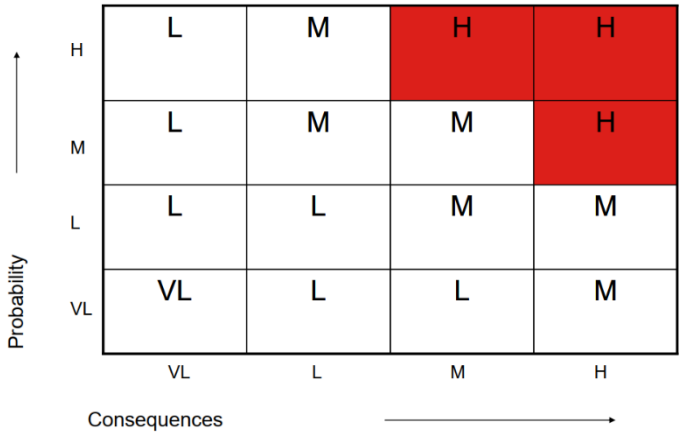
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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

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

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

Figure 2.1: Magnitude of risk matrices



[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.

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:

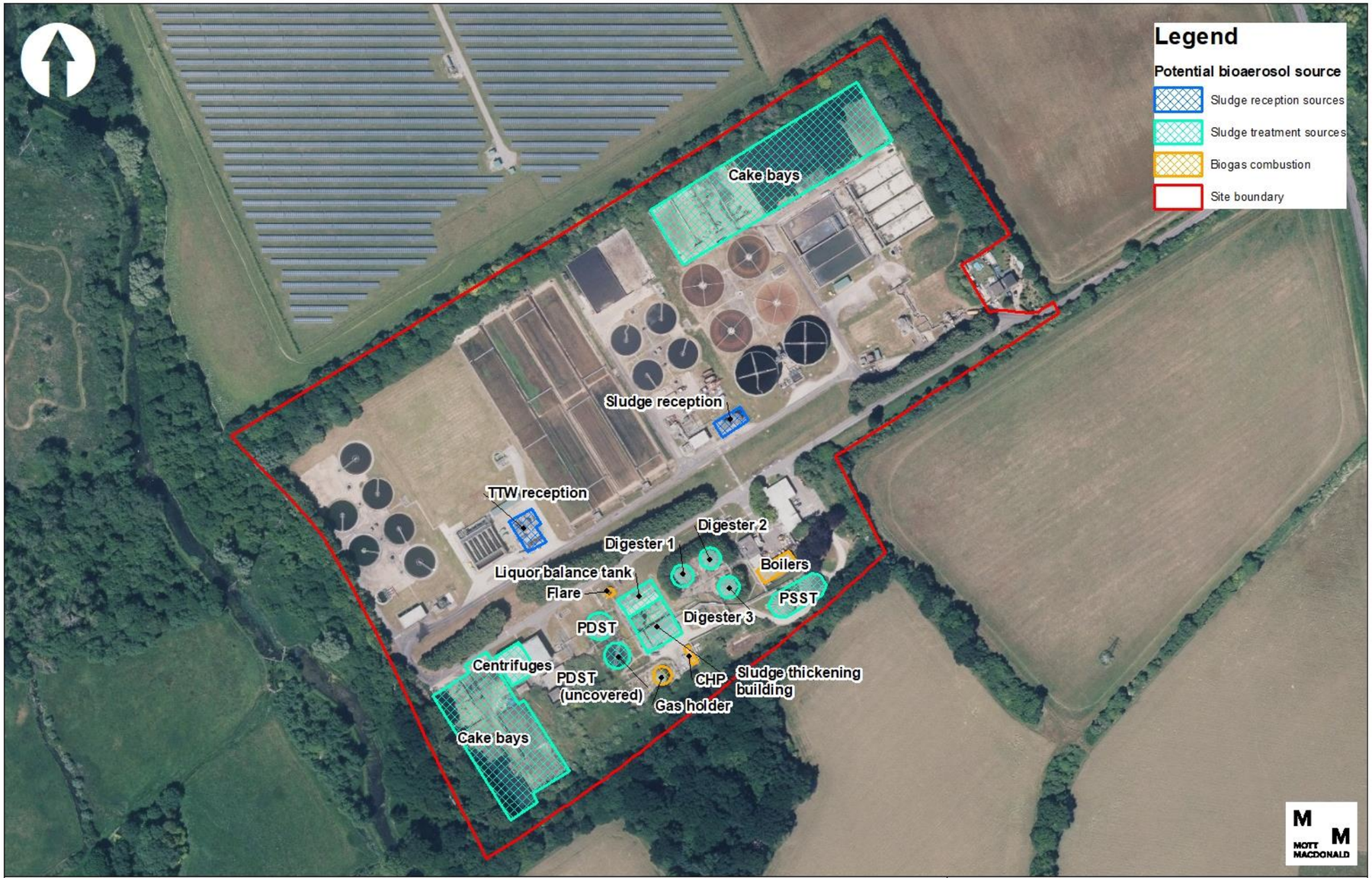
- One sludge reception area (includes two sludge reception tanks)
- One tankered waste (TW) reception area (includes two TW reception tanks)
- Two post-screening storage tanks (PSSTs)
- Sludge thickening building (includes two drum thickeners and one thickened sludge storage tank)
- Three anaerobic digesters
- Two post-digestion storage tanks (PDSTs) (one of which is uncovered)
- Two centrifuges
- Fourteen cake bays
- One liquor balance tank
- Gas holder
- One Combined Heat and Power (CHP) unit
- Two boilers
- One flare

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

- Sludge reception and distribution
- Sludge treatment (sludge storage, thickening, digesters, centrifuges and cake bays)
- 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 then presented below.

Figure 3.1: Potential sources of bioaerosols at the Site



Metres
0 55 110 220

3.2.2 Sludge reception and distribution

The Site accepts Southern Water owned tankered waste and sludge waste, which arrives by tanker. On average, per day, the Site accepts 18 tankers containing sludge, cess, septic, and chemical toilet waste. This consists of approximately six tankers per day of liquid sludge imports, and an average of 12 tankers per day of imported cess, septic and chemical toilet waste. All imported liquid waste and sludges are transported in enclosed tankers. The tankered waste and sludge is pumped from the tanker directly into the respective reception tanks.

The Site also receives imports of digested cake. During normal operation, the Site will receive deliveries of up to eight trucks a day from Millbrook WTW. The Site can also receive up to 16 trucks a day from Budds Farm WTW for up to three days a month. Millbrook cake is untreated and stored for up to 42 days to mature. Budds Farm cake is treated with lime at Budds Farm WTW and goes to Fullerton for short term storage when this cake requires further maturation and sampling.

3.2.3 Sludge treatment

The Site treats indigenous sludge (from auto de-sludging of the primary settlement tanks (PSTs), immediate settlement tanks (ISTs) and final settlement tanks (FSTs) from the wastewater treatment process as well as imported sludge from tankered imports of sludge wastes. Imported sludge and indigenous sludge from the sludge storage tanks is pumped through two strain presses before passing to two post screening storage tanks. The sludge is then pumped through drum thickeners before being stored within a thickened sludge storage tank in the sludge thickening building.

The thickened sludge is then 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 to form water, carbon dioxide and methane (biogas). After digestion, the sludge is stored in the PDSTs before being dewatered by the two centrifuges. The resulting cake is then transferred to the receiving cake bay by a conveyor before it is transported via telehandler for storage in the relevant cake bay. Indigenous cake is stored in the six cake bays in the southwest of the Site for up to 64 days to allow it to mature. In emergencies, the Site also receives cake from nearby SWS wastewater sites such as Millbrook and Budds Farm. This cake is stored within the eight cake bays in the northeast of the Site until matured. Once deposited within the relevant cake bay, cake is not disturbed until it is collected by trucks and taken to agricultural land for spreading.

Sludge liquors from the drum thickeners and centrifuges are collected at the liquor balance tank and returned to the primary tank distribution chamber prior to the PSTs.

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 electricity, which is used on-site to assist with the wastewater and sludge treatment processes. When more biogas is produced on-site than can be combusted within the CHP and there is insufficient space in the gas bag holder to store surplus biogas, excess biogas is sent to the flare to be burned. However, the flare is used for less than 10% of the year during emergencies.

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 2019-2023 wind rose for the nearest meteorological site, Middle

Wallop (located approximately 7km southwest of the Site), is shown in Figure 3.2. The Middle Wallop meteorological site experiences the most frequent winds from the west and southwest, although also experiences frequent winds from the northwest.

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 also experiences strong prevailing winds from the west and southwest.

Overall, the two datasets show general agreement with the modelled data indicating the predominant wind originate from a west and south westerly direction. This suggests that sensitive receptors located to the east and northeast of the Site would be at the greatest risk from bioaerosol emissions from the Site as they would be downwind of the prevailing wind direction.

Figure 3.2: Average wind rose for Middle Wallop meteorological site 2019- 2023

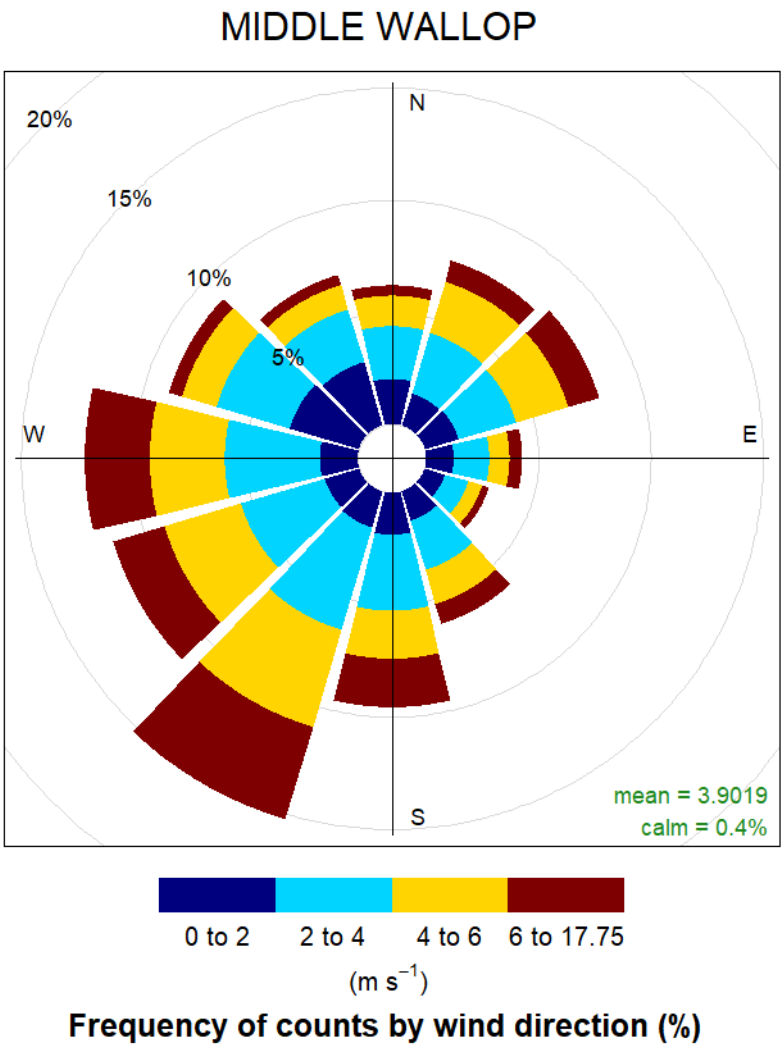
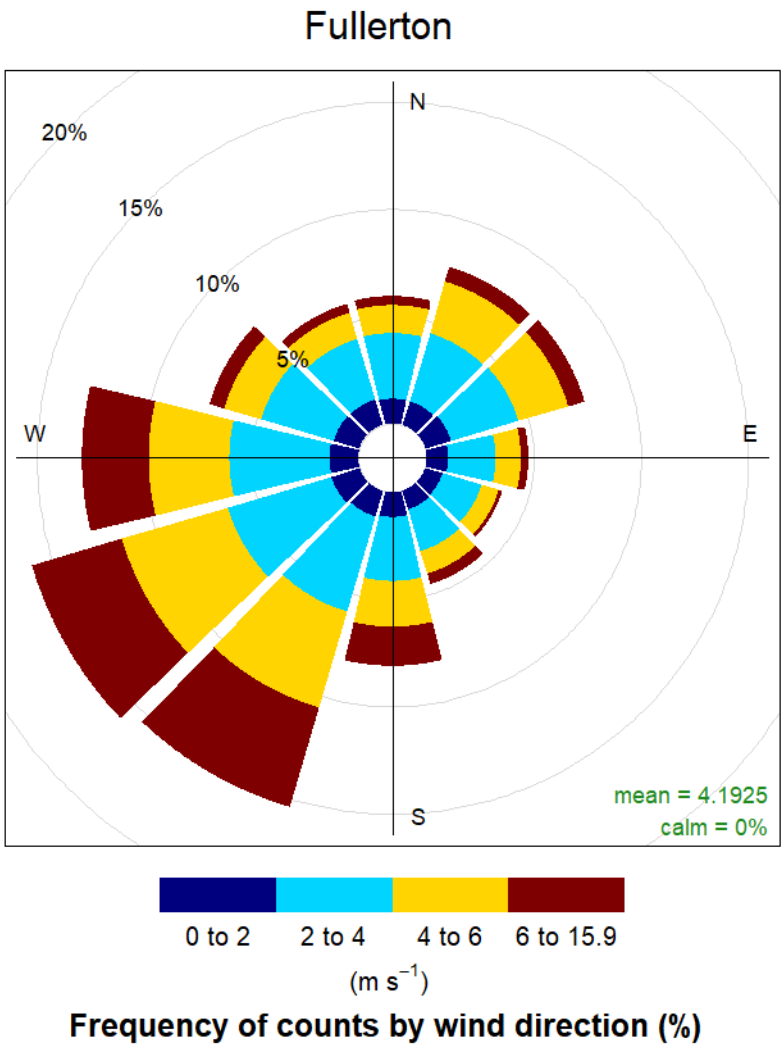


Figure 3.3: Average wind rose for the Site from the Vortex model, 2019- 2023



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[10,11]. Much of the Site is screened by trees and heavy vegetation. This could present a natural barrier to the transportation of bioaerosols by the wind. However, this would be dependent on the release height of bioaerosols on Site. The area surrounding the Site has relatively flat terrain.

3.4 Receptors

Although Environment Agency guidance[12] 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:

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

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

[12] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 – Environmental monitoring of bioaerosols at regulated facilities. Available online at:

"*permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation, but would apply to dwellings occupied by the family of those controlling the facility*."

There are two sensitive receptors found within 500m of potential bioaerosol emission sources at the Site, both of which are residential properties. As demonstrated in Figure 3.4, these receptors are found to the east and southwest of the Site, approximately 90m east of the cake bays and approximately 390m southwest of the cake bays respectively.

For both receptors, the distance and direction from each potential bioaerosol emission source on Site, to the receptors has been identified below in Table 3.1. Where multiple assets exist for the same process, such as digesters or settlement tanks, only the closest asset to the receptors has been presented.

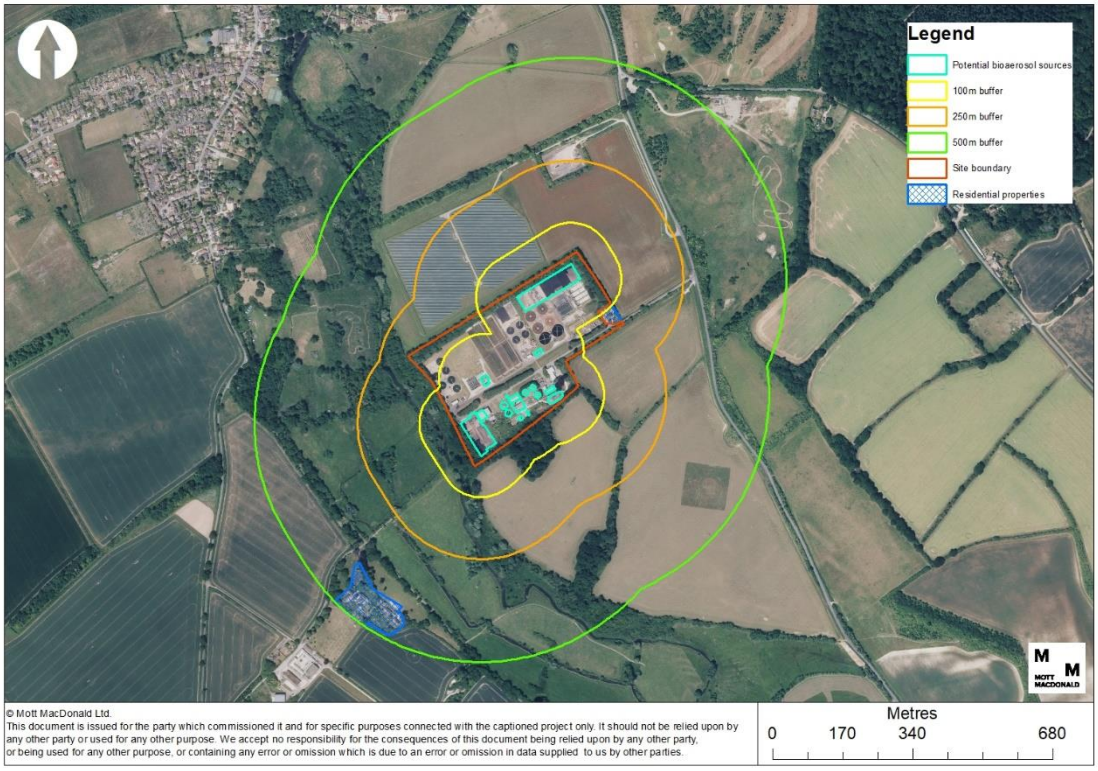
Table 3.1: Receptors within 500m of potential emission sources at the Site

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]	
		Residential properties east of the Site (m)	Residential properties southwest of the Site (m)
Sludge reception	Sludge reception and distribution	**165**, east	>500, southwest
Tankered waste (TW) reception	Sludge reception and distribution	**315**, east	>500, southwest
Post-screening storage tanks	Sludge treatment	**200**, northeast	>500, southwest
Sludge thickening building	Sludge treatment	**275**, northeast	>500, southwest
Anaerobic digesters	Sludge treatment	**230**, northeast	>500, southwest
Post-digestion storage tanks (PDSTs) (one of which is uncovered)	Sludge treatment	**310**, northeast	>500, southwest
Centrifuges	Sludge treatment	**360**, northeast	455, southwest
Cake bays	Sludge treatment	**90**, southeast	390, southwest
Liquor balance tank	Sludge treatment	**270**, northeast	>500, southwest
Gas holder	Biogas combustion	**305**, northeast	>500, southwest
Combined Heat and Power (CHP) unit	Biogas combustion	**285**, northeast	>500, southwest
Boilers	Biogas combustion	**195**, northeast	>500, southwest
Flare	Biogas combustion	**295**, northeast	>500, southwest

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

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

Figure 3.4: Sensitive receptors within 500m



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
Sludge reception and distribution	Sludge reception	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)	Residential property – 165m east
	Tankered waste reception		Residential property – 315m east
Sludge treatment	Post-screening storage tanks		Residential property – 200m northeast
	Sludge thickening building		Residential property – 275m northeast
	Anaerobic digesters		Residential property – 230m northeast
	Post-digestion storage tanks (PDSTs) (one of which is uncovered)		Residential property – 310m northeast

Source process	Potential emission source	Pathway	Nearest receptor
	Centrifuges		Residential property – 360m northeast
	Cake bays		Residential property – 90m northeast
	Liquor balance tank		Residential property – 270m northeast
Biogas combustion	Gas holder		Residential property – 305m northeast
	Combined Heat and Power (CHP) unit		Residential property – 285m northeast
	Boilers		Residential property – 195m northeast
	Flare		Residential property – 295m northeast

4 Control measures

4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[13] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site for sludge reception cake 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 3.5.

4.2 Control measures

4.2.1 Sludge reception and distribution

The transfer of liquid sludge from the tankers has a short duration and, under normal operations takes place up to 13 times a day, so the potential for release of bioaerosols is minimal. Tankers are unloaded via hose into the imported sludge storage tank.

The Site also receives imports of cake. During normal operation, the Site will receive deliveries of up to eight trucks a day from Millbrook WTW. The Site can also receive up to 16 trucks a day from Budds Farm WTW for up to three days a month. These imports arrive to the Site via covered tipper trucks and are offloaded directly into the cake bays in the northeast of the Site. As with the tanks, the unloading of cake from the trucks has a short duration so the potential for release of bioaerosols is minimal.

If a spillage of sludge/cake occurs, operators will 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 the 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.

Appropriate wash up facilities are also provided for drivers to clean the vehicles after loading or unloading in sludge storage bays and loading points. Lorry and tanker drivers are required to hose down any spillage after each loading or unloading and clean contaminated wheels before leaving the Site.

4.2.2 Sludge treatment

4.2.2.1 Containment of emissions

To contain emissions of bioaerosols during sludge treatment, doors, covers and hatches to the buildings housing the sludge thickening activities, liquor balance tank and centrifuges are kept

[13] 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.

closed at all times except when access is required. When access is required for operation and maintenance, the doors and hatches to these treatment facilities will only be opened for minimum periods. If access is required for an extended period of time, such as for maintenance activities, additional mitigation measures are implemented to minimise the impact associated with bioaerosols.

To further contain bioaerosol emissions, all sludge tanks and processes associated with sludge treatment are sealed and covered, except one of the PDSTs.

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 which removes microorganisms which could give rise to bioaerosols. Therefore, at each stage of the sludge treatment process, the potential quantity of bioaerosols decreases, reducing the risk of exposure; the concentration of bioaerosols that could potentially be emitted from the PDSTs and cake (at the end of the sludge treatment process) is much lower than the sludge prior to anaerobic digestion.

Therefore, while the cake bays and one of the PDSTs is uncovered, these areas both contain digested sludge products which are near the end of the sludge treatment process so the bioaerosol content and associated risk of exposure is reduced. In addition, once the cake is deposited within its cake bay, it is not handled further until it is loaded into trucks to be transported offsite to farmland. This reduces the risk of bioaerosol emissions as agitation of cake could facilitate the resuspension of any remaining bioaerosols into the air.

To further reduce potential bioaerosol emissions associated with sludge treatment, sludge produced on-site is processed immediately. This prevents processing of old sludge which is more odorous and difficult to process. Liquid sludge arriving on-site is also processed immediately to help minimise bioaerosol emissions.

4.2.3 Biogas combustion

Biogas produced during anaerobic digestion is stored within the biogas holder before being combusted at high temperatures within the CHP, boilers or flare. The biogas holder stores the biogas within an air-tight container which prevents the release of bioaerosol emissions. During combustion, any bioaerosols present within the biogas would be destroyed. Therefore, emissions of bioaerosols associated with biogas combustion would be de minimis.

4.3 Maintenance of control measures

Daily checks, measurements and sampling are conducted of the treatment processes on-site to ensure the equipment is working correctly. The parameters measured include: sludge blanket thickness, raw sludge volume, turbidity, temperature and methane production (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 are 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, biological filters, fresh air supply ducting,

wet scrubber (cleaning, pre-winter service, pH probe calibration, redox probe calibration), direct driven fan, belt driven fan and dryer exhaust ducting.

Currently bioaerosols are not directly monitored, however, future monitoring will be accordance with Environment Agency's Technical Guidance Note (TGN) M9[14] requirements to monitor effectiveness of control measures, where appropriate. Alternatively, the Odour Management Plan requires routine sniff tests and mitigation to odours, and therefore the Plan will indirectly aid the prevention and monitoring of bioaerosol.

Three odour control biofilter systems are installed in the inlet works, sludge treatment area (sludge wells, drum thickeners and centrifuges) and sludge storage tanks. The odour control units are not operational due to the Site being in a rural location with limited sensitive receptors within 500m and processes generating limit odour issues. There are no mobile odour control units available for use on-site.

All of the Site operations are fully enclosed or covered with the exception of one PDST and the cake bays which are uncovered. The PDST however is a 'wet' process and therefore the likelihood of the resuspension of bioaerosols, and the probability of exposure, is minimised.

Diffuse emissions from the cake bay are minimised by:

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

To minimise odour nuisance, it is important to ensure that the Fullerton 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 on-site are also carefully managed to ensure there are sufficient stocks of chemicals on-site so 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 the 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.

[14] 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

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 reduced by reducing or inhibiting the digester feed by 50%.

4.5 Monitoring

4.5.1 Overview

Bioaerosol emissions associated with the operation of the Site will be monitored in line with the Environment Agency Technical Guidance Note (TGN) M9[15] requirements to monitor effectiveness of control measures.

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

4.5.2 Monitoring Locations

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

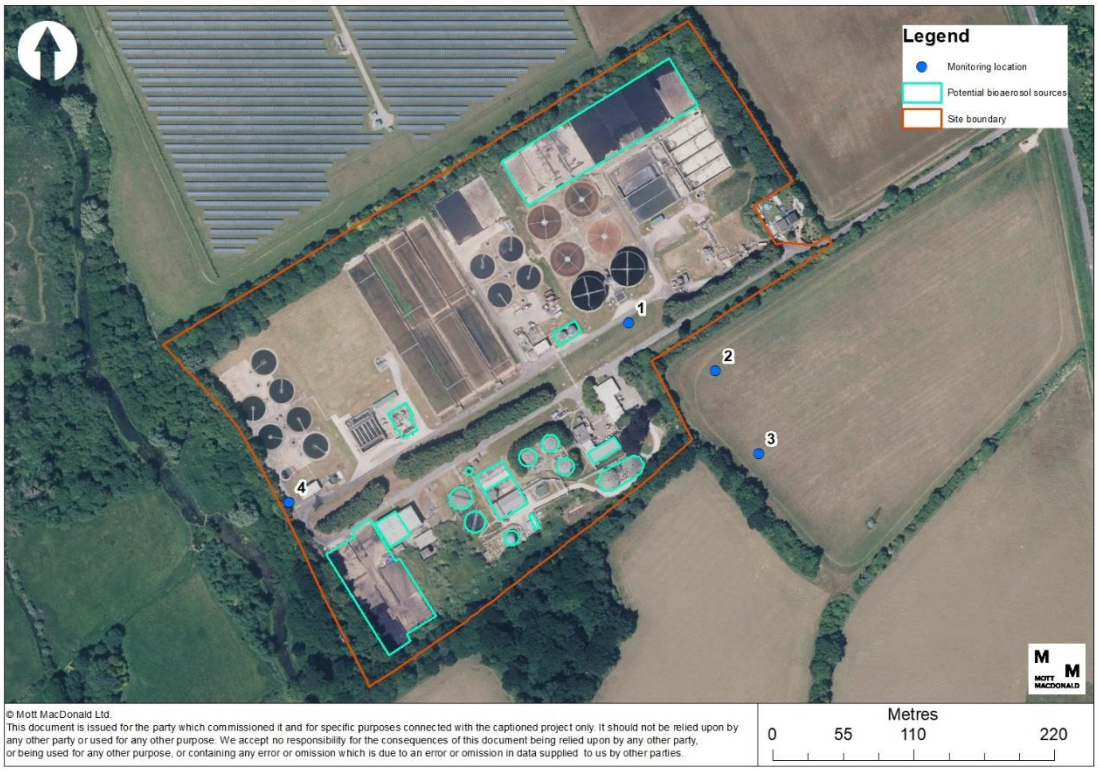
Figure 4.1 presents the indicative sampling locations identified for the Site. Locations 1, 2 and 3 represent the proposed locations for the three downwind samplers and are located at the same distance as the closest sensitive receptor (90m) from the nearest source of bioaerosols. The downwind samplers 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.

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

Figure 4.1: Indicative bioaerosol monitoring locations



4.5.3 Sampling methodology and frequency

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

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

A minimum of three measurements of Aspergillus fumigatus and mesophilic bacteria will be taken from each sampler during each monitoring visit. Appropriate equipment and

methodologies for each sampler type are described in TGN M9 and this guidance will be followed during the bioaerosol monitoring.

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

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

4.6 Summary

As discussed above, there are a number of control measures in place at the Site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure. The greatest probability of exposure from a potential source of bioaerosols from the Site is associated with the uncovered PDST. However, this uncovered process is ‘wet’ 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 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[16], 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, thickening, digesters, centrifuges and cake bays)
- 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. Therefore, across all potential bioaerosol sources at the Site, the overall probability of exposure is either '**very low**' or '**low**'.

The probability of exposure at the majority of sludge reception and distribution, sludge treatment and biogas combustion bioaerosol sources at the Site is considered to be '**very low**' as exposure of the receptors to bioaerosols is "very unlikely" due to the "effective and multiple barriers" (control measures) in place. The probability of exposure at the uncovered PDST is considered to be '**low**' because it is a 'wet' process. Therefore, 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.

[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.

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge reception and distribution	Sludge reception	Very Low	Stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely
	Tankered waste (TW) reception	Very Low	Stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely
Sludge treatment	Post-screening storage tanks	Very Low	Tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge thickening building	Very Low	All processes within the building are 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 (PDSTs) (one of which is uncovered)	Low	One tank is covered. Other tank, while uncovered, is a 'wet' process which is monitored and regularly maintained – uncontrolled release of bioaerosols unlikely. Sludge in the tanks also at the end of treatment process so bioaerosol concentrations would be very low/de minimis (any exposure would not result in "significant" consequences) so exposure from this source is unlikely
	Centrifuges	Very Low	Located within a building and are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Cake bays	Very Low	While uncovered, cake within bays at the end of treatment process so bioaerosol concentrations would be very low/de minimis (any exposure would not result in "significant" consequences). No disturbance of cake once placed in bays except to remove from Site to disperse on farmland - uncontrolled release of bioaerosols unlikely.
	Liquor balance tank	Vey Low	All processes within the building are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Biogas combustion	Gas 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
	Boilers	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 when sludge and cake is unloaded/loaded into trucks or tankers or if there was a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary/infrequent. Furthermore, if the exposure was due to a failure of control equipment, the 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) [17,18]. 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, receptors within 50m of bioaerosol sources and downwind of the prevailing wind direction are considered to be '**high**' consequence of hazard. This is because within 50m of a source, consequences could be "severe", and "exposure may result in significant damage", as being downwind of the prevailing wind direction also increases the likelihood of exposure. Receptors within 50m of bioaerosols that are upwind of the prevailing wind direction are considered to have a '**medium**' consequence of hazard, as though they are in close proximity to a bioaerosol source, they are less likely to be exposed due to the prevailing wind direction.

Sources of bioaerosols within 50-100m of receptors are also considered to have a '**medium**' consequence of hazard, irrespective of whether they are upwind or downwind of the emission source. This is because within 50-100m of the source, concentrations of bioaerosols would reduce, so temporary exposure could result in "significant consequences" and potentially result in "damage that is not severe and is reversible". Beyond 100m, up to 250m, the consequence of the hazard is considered to be '**low**' as concentrations of bioaerosols would be lower so the consequence of the hazard would also be lower, resulting in "minor consequences" where damage is "not apparent, reversible adverse changes possible". Beyond 250m, the consequence is considered '**very low**' as concentrations of bioaerosols generally decrease to background concentrations at this distance so there would be "no evidence for adverse

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

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

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**' to '**medium**'.

Table 5.2: Consequence of hazard from bioaerosols at the Site

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Sludge reception and distribution	Sludge reception	165m east	Low	Nearest receptor <250m from potential source
	Tankered waste (TW) reception	315m east	Very Low	Nearest receptor >250m from potential source
Sludge treatment	Post-screening storage tanks	200m northeast	Low	Nearest receptor <250m from potential source
	Sludge thickening building	275m northeast	Very Low	Nearest receptor >250m from potential source
	Anaerobic digesters	230m northeast	Low	Nearest receptor <250m from potential source
	Post-digestion storage tanks (PDSTs) (one of which is uncovered)	310m northeast	Very Low	Nearest receptor >250m from potential source
	Centrifuges	360m northeast	Very Low	Nearest receptor >250m from potential source
	Cake bays	90m northeast	Medium	Nearest receptor <100m from potential source
	Liquor balance tank	270m northeast	Very Low	Nearest receptor >250m from potential source
Biogas combustion	Gas holder	305m northeast	Very Low	Nearest receptor >250m from potential source
	Combined Heat and Power (CHP) unit	285m northeast	Very Low	Nearest receptor >250m from potential source
	Boilers	195m northeast	Low	Nearest receptor <250m from potential source
	Flare	295m northeast	Very Low	Nearest receptor >250m from potential source

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 hazard is described as 'very low' to 'medium' depending on the proximity of the potential emission source to a sensitive receptor.

In accordance with Environment Agency guidance[19], across all potential bioaerosol emission sources, the magnitude of risk is described as '**very low**' or '**low**'. Therefore, based on the maximum level of risk assessed, 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[20]. 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.

[19] 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.

[20] 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 reception and distribution	Sludge reception	Very Low	Low	Low	Nearest receptor <250m from potential source. Stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely
	Tankered waste (TW) reception	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source. Stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely
Sludge treatment	Post-screening storage tanks	Very Low	Low	Low	Nearest receptor <250m from potential source. Tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge thickening building	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source. All processes within the building are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Anaerobic digesters	Very Low	Low	Low	Nearest receptor <250m from potential source. Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Post-digestion storage tanks (PDSTs) (one of which is uncovered)	Low	Very Low	Low	Nearest receptor >250m from potential source. One tank is covered. Other tank, while uncovered, is a 'wet' process which is monitored and regularly maintained – uncontrolled release of bioaerosols unlikely. Sludge in the tanks also at the end of treatment process so bioaerosol concentrations would be very low/de minimis (any exposure would not result in "significant" consequences) so exposure from this source is unlikely
	Centrifuges	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source. Located within a building and are covered, process monitored and regularly

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
					maintained –uncontrolled release of bioaerosols very unlikely
	Cake bays	Very Low	Medium	Low	Nearest receptor <100m from potential source. While uncovered, cake within bays at the end of treatment process so bioaerosol concentrations would be very low/de minimis (any exposure would not result in “significant” consequences). No disturbance of cake once placed in bays except to remove from Site to disperse on farmland - uncontrolled release of bioaerosols unlikely.
	Liquor balance tank	Vey Low	Very Low	Very Low	Nearest receptor >250m from potential source. All processes within the building are covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Biogas combustion	Gas holder	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source. Gas holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	Combined Heat and Power (CHP) unit	Very Low	Very Low	Very Low	Nearest receptor >250m from potential source. Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	Boilers	Very Low	Low	Low	Nearest receptor <250m from potential source. 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. Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely

6 Summary

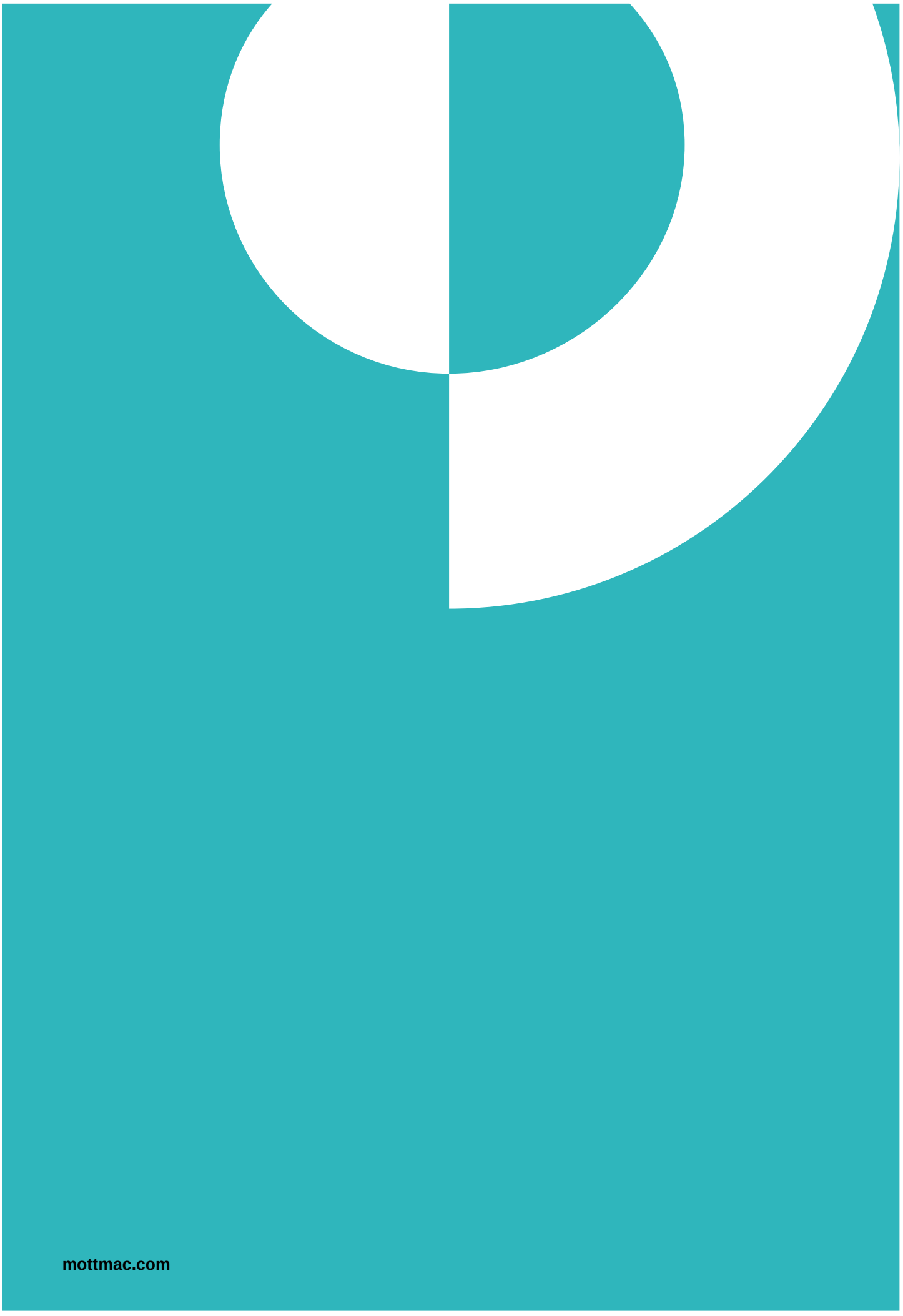
At the Site, there is the potential for bioaerosol emissions from:

- Sludge reception and distribution
- Sludge treatment (sludge storage, thickening, digesters, centrifuges and cake bays)
- 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 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’ to ‘low’ probability of exposure and ‘very 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 ‘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 which are considered to be effective at reducing and containing emissions of bioaerosols, inhibiting the pathway between source and receptor.



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