MOTT MACDONALD

Ford Sludge Treatment Works Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioaRA_FOR

February 2024

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1 Introduction

1.1 Overview

Southern Water are applying for a new environmental permit to operate their sludge treatment facility at the Ford Wastewater Treatment Works (WTW) (hereafter referred to as 'the Site'). Sludge treatment activity is covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The Site currently operates under a T21, S1, S2 and U6 exemptions and a permit for the use of a sludge dryer and burning of biogas (EPR/KP3130KX).

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 to the boundary of the Site, the closest of which is approximately 65m 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 is located to the west of the hamlet of Ford, approximately 7km northeast of Bognor Regis. The area immediately surrounding the Site is predominantly mixed industrial and agricultural usage; agricultural fields surround the Site in all directions, whilst industrial land use is located to the north, southeast, east and west. In addition to this, to the northeast and west are residential properties, whilst to the northwest is recreational land use.

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

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

2 Methodology

2.1 Overview

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

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

2.2 Guidance

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

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

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

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

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

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

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

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

7 *"Sensitive receptor – any building, other structure or installation, in which at least one person normally lives or works, other than a building, structure or installation within the same ownership or control as the 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:

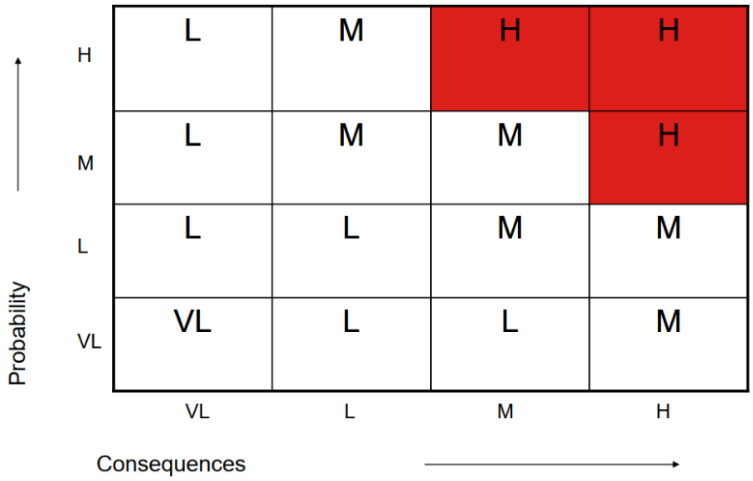
- High – severe consequences, evidence that exposure may result in serious damage
- Medium – significant consequences, evidence that exposure may result in damage that is not severe and is reversible
- Low – minor consequences, damage not apparent, reversible adverse changes possible
- Very low – negligible 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.

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

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

Figure 2.1: Magnitude of risk matrices



Source: Environment Agency, 2009

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

3 Source – Pathway – Receptor model

3.1 Overview

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

3.2 Sources

3.2.1 Overview

The Site includes the following assets which could release bioaerosols:

- Sludge reception building[10]
- Six sludge storage tanks (two post screening storage tanks, one thickened sludge storage tank, two post digestion storage tanks and one Surplus Activated Sludge (SAS) Storage Tank)
- Sludge blending and thickening building[10]
- Return liquor pumping station
- Three anaerobic digesters
- Sludge dryer and centrifuge building
- Cake silo
- Biogas holder
- Combined Heat and Power (CHP) unit[11]
- Two boilers
- One flare stack
- Three odour control units (OCUs), two of which are currently in operation

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

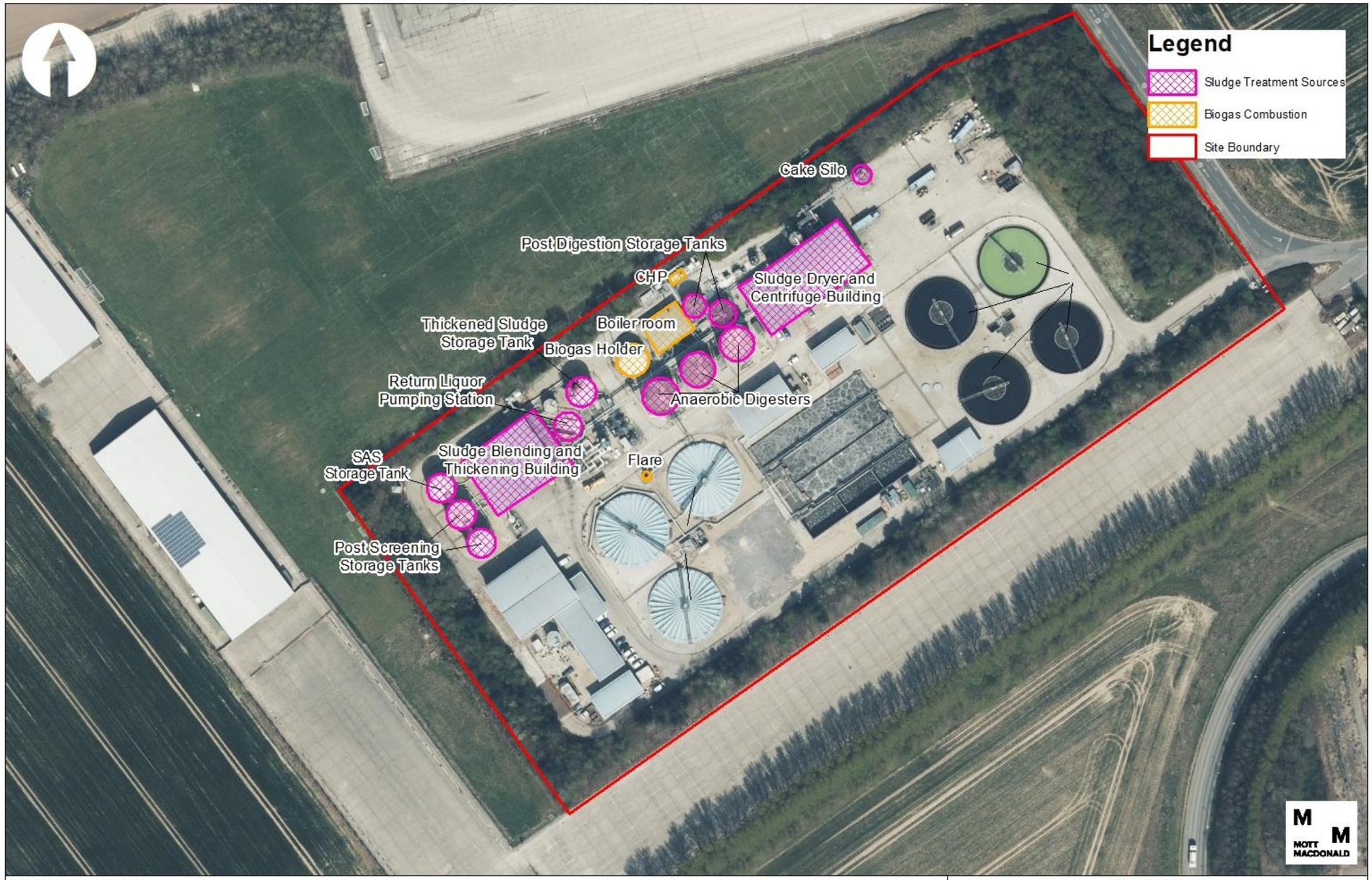
- Sludge reception and cake granule distribution from the Site
- Sludge treatment (sludge storage, thickening, digesters and dryers/centrifuges)
- Biogas combustion

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

[10] Sludge reception (liquid and cake) and sludge blending and thickening occur within the same building.

[11] Contained within sludge dryer and centrifuge building.

Figure 3.1: Potential sources of bioaerosols at the Site



Kilometres
0 0.0375 0.075 0.15

3.2.2 Cake reception and distribution

The impoort of cake has temporarily stopped as of January 2024, but will resume from mid-March 2024. Prior to this, the Site received 8 bins of cake a week.

Typically, sludge cake is received within the main enclosed building, potential emissions during unloading are controlled with chemical scrubbers in an OCU to prevent releases from the building. Sludge is routinely imported to the Site from 24 WTWs, and imported cake is from Horsham WTW.

3.2.3 Sludge Treatment

Imported sludge from the Primary Settlement Tanks (PSTs) and wastewater treatment is screened by two strain presses and then mixed with indigenous settled sludge in two post screening sludge storage tanks. This blended sludge is then thickened by two drum belt thickeners. Imported cake is blended with SAS from the SAS buffer tank and then mixed with the blended sludge and stored in the thickened sludge storage tank. 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 within the sludge to produce water, carbon dioxide and methane (biogas).

After anaerobic digestion, digested sludge passes to the post digestion storage tanks to cool. The digested sludge is then transferred to the sludge dryer and centrifuge building where water is removed from the digested sludge to create dried sludge cake. Sludge liquors removed during these processes are pumped back to the primary treatment sludge tank. The dried sludge cake is then stored within the cake silo which has a capacity of 100m^3. This silo is emptied every Saturday, it requires three tankers to empty the silo.

3.2.3.1 Odour control

There are three OCUs on the Site. One is within the main sludge treatment building that contains the sludge reception and primary sludge treatment processes. This unit contains an activated carbon system. The other two OCUs are located at the centre of the Site and within the dryer and centrifuge building. For the unit to the centre of the Site, odorous air is extracted from the inlet works and PSTs from the wastewater treatment process, and sludge plant, sludge storage tanks and centrifuges from the sludge treatment process. The other unit within the dryer and centrifuge building is not currently running as the dryer is not currently operational. These two units are wet scrubber systems with both utilising alkaline scrubbers. Treated air is then released to the atmosphere.

3.2.4 Biogas combustion

Biogas produced during anaerobic digestion is transferred to the biogas holder and then to the CHP and standby boilers (when CHP units are not in operation) where it is combusted to generate heat and/or 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 boilers and CHP, and there is insufficient space in the gas holder to store surplus biogas, excess biogas is sent to the flare to be burned. The flare is currently used more than 10% of the year.

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 meteorological site at Shoreham airport, the nearest representative meteorological site to the Site, is shown in Figure 3.2. This

monitoring site experiences strong prevailing winds from the southwest, with frequent mild winds from the north. However, this meteorological site is located within a wide valley which channels winds from the north, resulting in the frequent mild northerly winds. The Site is not located in a valley and has relatively flat surrounding land uses. Therefore, an atmospheric hindcast model (Vortex) has also been used to assess the wind conditions at the Site.

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

Figure 3.3 presents the wind rose generated for the Site from the Vortex model for the period from 2019-2023. The wind rose demonstrates that historically that this location experiences strong prevailing winds from the southwest, with occasional gusts from the northeast. This suggests that sensitive receptors located to the northeast of the Site would be at the greatest risk from bioaerosol emissions from the Site as they would be downwind of the prevailing wind direction.

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

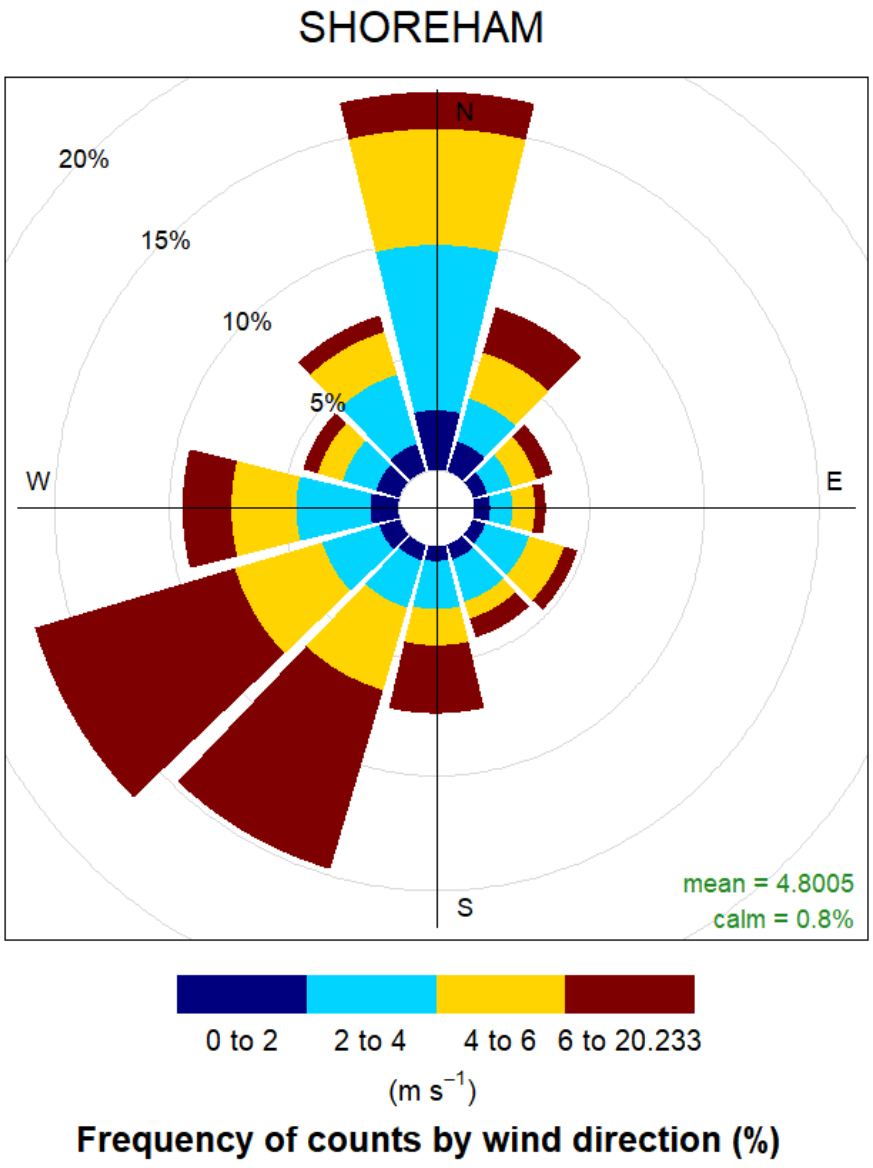
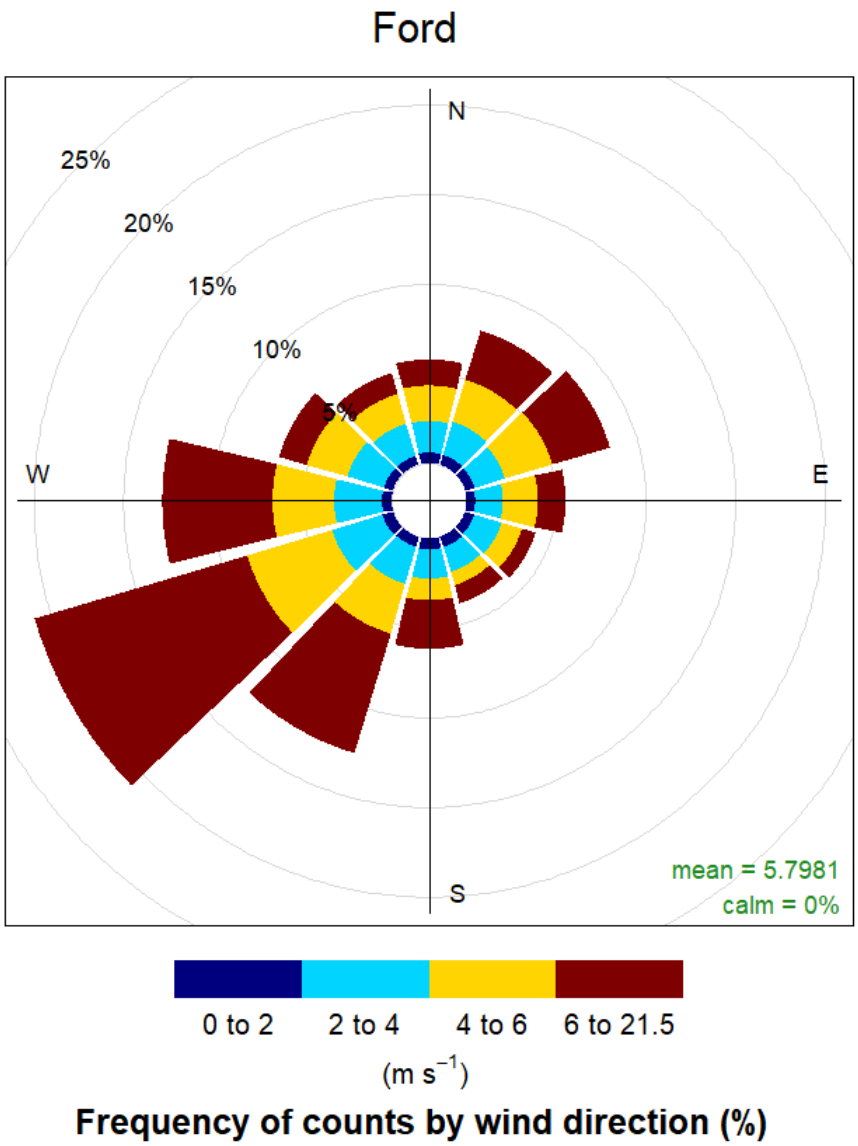


Figure 3.3: Average wind rose for the Site from the Vortex model, 2019-2023



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[12,13]. The local terrain in the 250m area surrounding the Site is relatively flat, there is a landscape bund that surrounds the Site on all sides. This bund could possibly inhibit a pathway between source and receptor.

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

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

3.4 Receptors

Although Environment Agency guidance[14] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations, a screening distance of 500m has been used as a conservative approach. Sensitive receptors are defined as:

"*permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and 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 six areas of sensitive receptors found within 500m of potential bioaerosol emission sources at the Site. As demonstrated in Figure 3.4, three areas of industrial land use are found to the north, southeast and west, whilst areas of residential receptors are found to the northeast and west and recreational land use to the northwest.

For these seven areas of receptors, the distance and direction from each potential bioaerosol emission source to a sensitive receptor within the area has been identified below in Table 3.1.

Where multiple assets exist for the same process, such as digesters, only the closest asset has been presented.

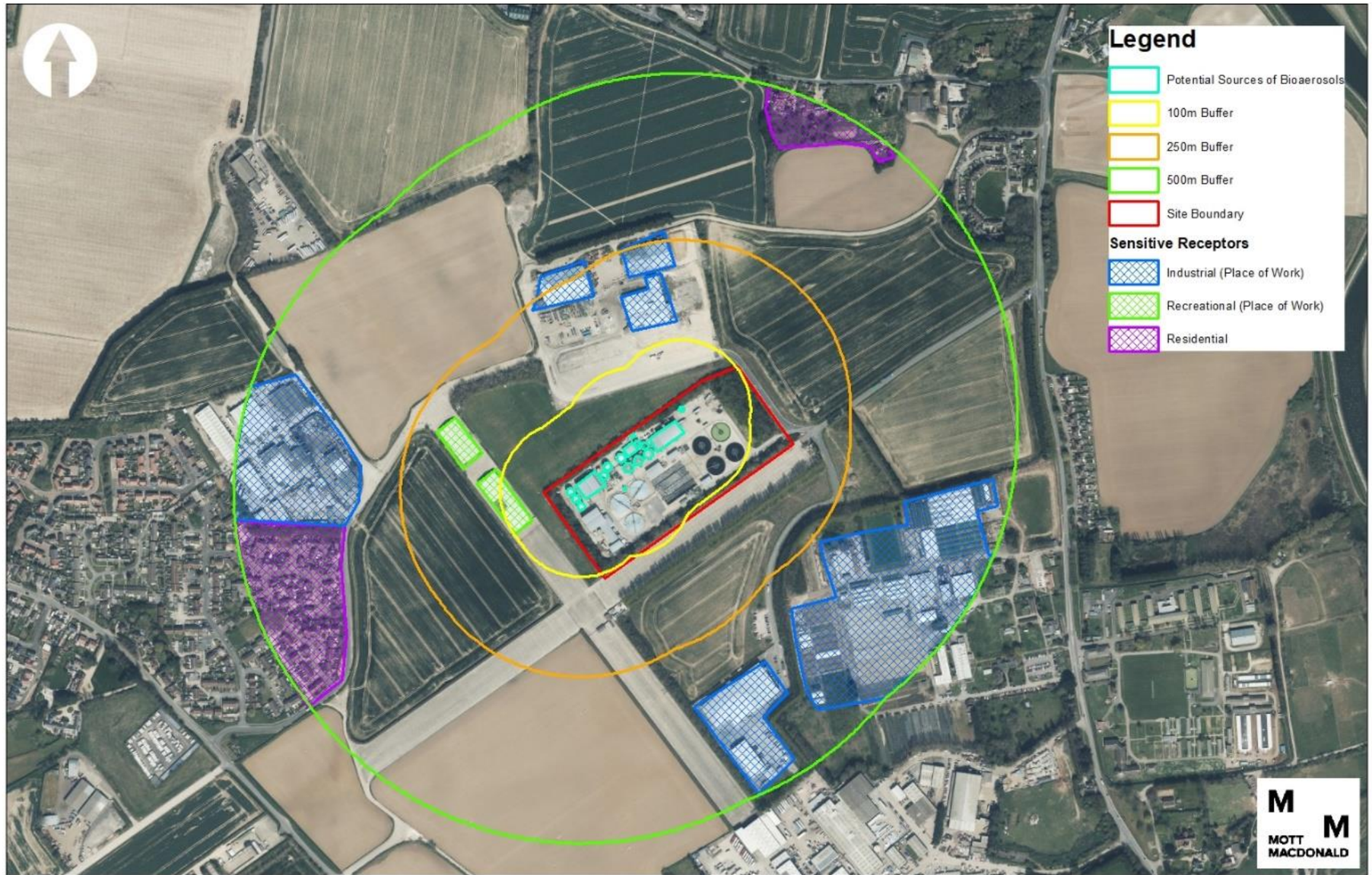
[14] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 – Environmental monitoring of bioaerosols at regulated facilities. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

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

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]					
		Industrial land use north of the Site (m)	Industrial land use southeast of the Site (m)	Industrial land use west of the Site (m)	Residential properties northeast of the Site (m)	Residential properties west of the Site (m)	Recreational land use northwest of the Site (m)
Sludge reception and blending/thickening building	Sludge reception/ Sludge treatment	220, North	330, Southeast	325, West	>500, Northeast	350, West	**85**, West
Two post screening sludge storage tanks	Sludge treatment	260, North	345, Southeast	320, West	>500, Northeast	345, West	**65**, West
SAS storage tank	Sludge treatment	250, North	370, Southeast	310, West	>500, Northeast	335, West	**65**, West
Thickened sludge storage tank	Sludge treatment	200, North	330, Southeast	370, West	>500, Northeast	400, West	**135**, Southwest
Two post digestion storage tanks	Sludge treatment	**165**, North	290, Southeast	420, West	490, Northeast	450, West	190, Southwest
Return liquor pumping station	Sludge treatment	215, North	335, Southeast	360, West	550, Northeast	390, West	**120**, Southwest
Anaerobic digesters	Sludge treatment	190, North	280, Southeast	415, West	490, Northeast	430, West	**155**. Southwest
Sludge dryer and centrifuge building	Sludge treatment	**150**, North	260, Southeast	445, West	440, Northeast	480, West	215, Southwest
Cake silo	Sludge treatment	**125**, North	285, Southeast	485, West	415, Northeast	535, West	280, Southwest
Biogas holder	Biogas combustion	185, North	315, Southeast	390, West	515, Northeast	420, West	**155**, Southwest
CHP	Biogas combustion	**155**, North	190, Southeast	415, West	480, Northeast	450, West	320, Southwest
Boilers	Biogas combustion	**170**, North	315, Southeast	405, West	495, Northeast	445, West	185, Southwest
Flare	Biogas combustion	235, North	300, Southeast	395, West	>500, Northeast	420, West	**145**, West

Note: (a) Refers to the receptors 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
Sludge reception (liquid and cake) and sludge blending and thickening occur within the same building.

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 treatment	Sludge reception and blending/thickening building	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)	Recreation facility – 85m west
	Two post screening sludge storage tanks		Recreation facility – 65m west
	SAS storage tank		Recreation facility – 65m west
	Thickened sludge storage tank		Recreation facility – 135m southwest
	Two post digestion storage tanks		Industrial facility – 165m north
	Return liquor pumping station		Recreation facility – 120m southwest
	Anaerobic digesters		Recreation facility – 155m southwest
	Sludge dryer and centrifuge building		Industrial facility – 150m north
	Cake silo		Industrial facility – 125m north
Biogas combustion	Biogas holder		Recreation facility – 155m southwest
	CHP		Industrial facility – 155m north
	Boilers		Industrial facility – 170m north
	Flare		Recreation facility – 145m west

Note: Sludge reception (liquid and cake) and sludge blending and thickening occur within the same building.

4 Control measures

4.1 Overview

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

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site for sludge reception 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 Cake reception and distribution

The Site typically imports, on average 8 tankers/day of liquid sludge and sludge cake. Liquid sludge and cake are unloaded within the sludge blending and thickening building, shutters are kept closed on this building unless there is a vehicle moving through them which limits the risk of bioaerosols escaping the building. During deliveries doors closed for 4k tankers but not 6k tankers, due to their length. There is an activated carbon odour control system in use within this building.

If a spillage of cake occurs, operators are required to carry out clean up as soon as possible (using disinfectant where necessary). If the spillage is caused by a lorry or tanker, the driver is responsible for cleaning up the spill before leaving 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.

4.2.2 Sludge treatment

4.2.2.1 Containment of emissions

To contain emissions of bioaerosols, all sludge treatment processes on the Site are contained or covered. The sludge thickening and blending activities are contained in the odour-controlled sludge blending and thickening building to prevent the uncontrolled release of bioaerosols and reduce the likelihood of exposure of receptors to bioaerosols. Shutters are kept closed at all time apart from when vehicles are moving through them.

4.2.2.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down. This primarily occurs during anaerobic digestion, with subsequent processes such as liming being undertaken to further remove microorganisms by raising the pH and temperature. Therefore, at each stage of the sludge treatment process, the

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

quantity of bioaerosols decreases, reducing the risk of exposure; the concentration of bioaerosols that could potentially be emitted from the cake (at the end of the sludge treatment process) is much lower than the sludge prior to anaerobic digestion.

Digested cake is stored within a 100m^3 silo that is enclosed, the pipes and conveyors that move the cake to the silo are also enclosed. This silo is emptied every Saturday and the contents are dropped directly from the silo into tipper trucks.

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

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

4.2.3 Biogas combustion

The gas holder stores the biogas within an air-tight container which mitigates the release of bioaerosol emissions. During combustion, any bioaerosols present within the biogas would be destroyed. Therefore, emissions of bioaerosols associated with biogas combustion and probability of exposure to bioaerosols would be de minimis.

4.3 Maintenance of control measures

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

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

Currently bioaerosols are not directly monitored, however future monitoring will be accordance with M9 where appropriate. Alternatively, the Odour Management Plan requires routine sniff tests and mitigation to odours, and therefore the Plan will indirectly aid the prevention and monitoring of bioaerosol.

Odour is controlled via two current OCUs. This consists of an alkaline scrubber to treat odorous air Filtered odour streams are discharged into the environment through the OCU stack as shown by A09 in 79010_MSD_SiteLayoutPlan_FOR February 2024 and are monitored hourly to ensure the absence of odorous compounds.

The OCUs are maintained in accordance with manufacturer’s requirements to ensure treatment of bioaerosols and odours are effective.

All of the Site operations are fully enclosed or covered.

To minimise odour nuisance, it is important to ensure that the Ford 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 that the necessary treatment processes, control measures and maintenance activities can be undertaken when required.

4.4 Emergency procedures

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

One such emergency event would be failure of the flare stack and/or CHP. Such an event would result in releases of biogas from the Whessoe Valves located on the roofs of the digesters and in the gas holder compound, which would release bioaerosols. This occurs to prevent over pressurisation of the digesters and gas systems. The flow can be completely shut off in an emergency, or a percentage reduction of 50% or more can take place dependent on the requirement.

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[16] requirements to monitor effectiveness of control measures.

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

4.5.2 Monitoring Locations

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

Figure 4.1 presents the indicative sampling locations identified for the Site. Locations 1, 2 and 3 represent the proposed locations for the three downwind samplers and are located at the same

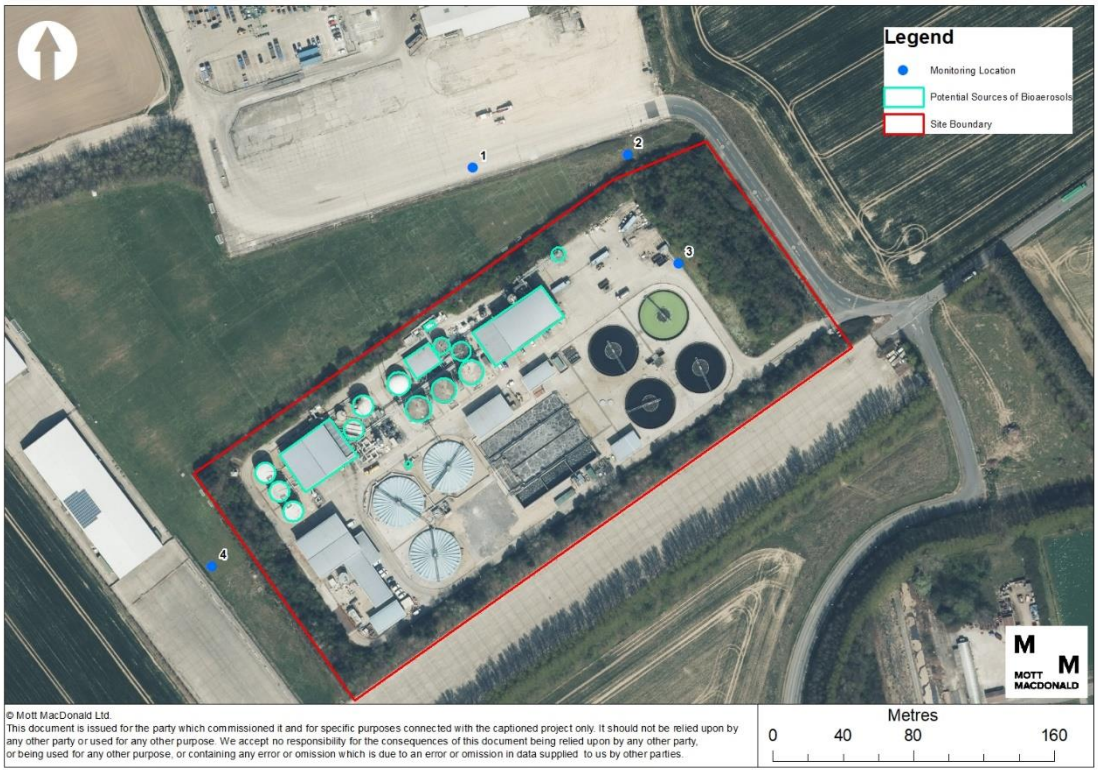
[16] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 - Environmental monitoring of bioaerosols at regulated facilities. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

distance as the closest sensitive receptor (65m) from the nearest source of bioaerosols. The downwind samplers are arranged in a fan shape to ensure the maximum concentrations of bioaerosols are captured and variable wind directions will be accounted for.

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

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

Figure 4.1: Indicative bioaerosol monitoring locations



4.5.3 Sampling methodology and frequency

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

Sampling will be undertaken during appropriate weather conditions such as avoiding rain, sleet and snow, depending on the sampling technique, and will consider the wind speed and direction at the time of sampling. Meteorological conditions including wind speed, wind direction, cloud cover, temperature, relative humidity, and atmospheric conditions will be recorded by an

automatic weather station with an integral data logger during monitoring periods and this data will be recorded. The meteorological station will be positioned in a suitable location, away from anything which could influence measurements, such as at locations very close to buildings.

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

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

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

4.6 Summary

As discussed above, there are a number of control measures in place at the Site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.

Across the Site, the potential for bioaerosol emissions which could result in significant consequences is limited. The greatest risk of significant bioaerosol emissions from the Site where there would be the greatest consequence of the hazard, is associated with emergency situations such as a failure of the flare or CHP/boilers, which could result in uncontrolled emissions of bioaerosols. However, such an emergency event would be unlikely, temporary, and infrequent due to the extensive monitoring and maintenance programmes undertaken at the Site as well as the emergency procedures and warning systems in place.

5 Risk assessment

5.1 Overview

This section assesses the probability of exposure and consequence of the hazard associated with potential emissions of bioaerosols at the Site to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the Environment Agency guidance[17], as summarised in Section 2.3.

5.2 Probability of exposure

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

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

These processes have the potential to emit bioaerosols, which are transported through the air by the wind and could cause harm to nearby human health receptors. However, as discussed in Section 4, there are multiple control measures in place at the Site which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes. The overall probability of exposure of sensitive receptors to bioaerosols at the majority of sludge reception and distribution, sludge treatment and biogas combustion bioaerosol sources at the Site is therefore considered to be '**very low**' as exposure of the receptors to bioaerosols is "very unlikely" due to the "effective and multiple barriers" (control measures) in place.

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

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge treatment	Sludge reception and blending/thickening building	Very Low	All processes within the building are covered, process monitored and regularly maintained. OCU sealed, and the air released from the unit has been treated to remove bioaerosols, process monitored and regularly maintained –uncontrolled release of bioaerosols very unlikely
	Two post screening sludge storage tanks	Very Low	Tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	SAS storage tank	Very Low	Tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Thickened sludge storage tank	Very Low	Tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
	Two post digestion storage tanks	Very Low	Tanks covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Return liquor pumping station	Very low	Return liquor pumping station covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Anaerobic digesters	Very low	Digesters covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge dryer and centrifuge building	Very Low	All processes within the building are covered, process monitored and regularly maintained. OCU sealed, and the air released from the unit has been treated to remove bioaerosols, process monitored and regularly maintained –uncontrolled release of bioaerosols very unlikely
	Cake silo	Very Low	Digested sludge cake silo covered – uncontrolled release of bioaerosols very unlikely
Biogas combustion	Biogas holder	Very Low	Gas holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHP	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	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

Note: Sludge reception (liquid and cake) and sludge blending and thickening occur within the same building.

5.3 Consequence of hazard

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

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

- Respiratory infections and inflammation of the respiratory system
- Reduced lung function
- Allergic reactions
- Gastro-intestinal disorders
- Dermatitis
- Eye irritation

The consequence of the hazard at sensitive receptors (i.e. the severity of impacts on human health) is largely determined by the proximity of the receptor to the emission source;

concentrations of bioaerosols decline rapidly within the first 50-100m from a source (and generally decrease to background concentrations within 250m) [18,19]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source.

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

The final consequence of hazard assessed for each emission source is presented below in Table 5.2. Across all potential bioaerosol emission sources at the Site, the consequence of hazard is '**low**' or '**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 treatment	Sludge reception and blending/thickening building	85m west – recreational facility	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction.
	Two post screening sludge storage tanks	65m west – recreational facility	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction.
	SAS storage tank	65m west – recreational facility	Medium	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction.
	Thickened sludge storage tank	135m southwest – recreational facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction

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

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

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
	Two post digestion storage tanks	165m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Return liquor pumping station	120m southwest – recreational facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Anaerobic digesters	155m southwest – recreational facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Sludge dryer and centrifuge building	150m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
	Cake silo	125m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction
Biogas combustion	Biogas holder	155m southwest – recreational facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	CHP	155m north – industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	Boilers	170m north - industrial facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.
	Flare	145m west - recreation facility	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction.

Note: Sludge reception (liquid and cake) and sludge blending and thickening occur within the same building.

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 ‘low’ or ‘medium’ depending on the proximity of the potential emission source to a sensitive receptor.

In accordance with Environment Agency guidance[20], across all potential bioaerosol emission sources, the magnitude of risk is described as ‘**low**’ and therefore operation of the Site is unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions.

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

Nonetheless, due to the proximity of the Site to sensitive receptors, monitoring of bioaerosols should be undertaken at the Site[21]. The requirements for bioaerosol monitoring at the Site will need to be agreed with the Environment Agency within the Environmental Permit issued for the Site.

Table 5.3: Magnitude of risk from bioaerosols at the Site

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Sludge treatment	Sludge reception and blending/thickening building	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction - All processes within the building are covered, process monitored and regularly maintained. OCU sealed, and the air released from the unit has been treated to remove bioaerosols, process monitored and regularly maintained –uncontrolled release of bioaerosols very unlikely
	Two post screening sludge storage tanks	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction - Tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	SAS storage tank	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of the prevailing wind direction - Tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Thickened sludge storage tank	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Two post digestion storage tanks	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Tanks covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely

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

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
	Return liquor pumping station	Very low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Return liquor pumping station covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Anaerobic digesters	Very low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Digesters covered, odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Sludge dryer and Centrifuge building	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - All processes within the building are covered, process monitored and regularly maintained. OCU sealed, and the air released from the unit has been treated to remove bioaerosols, process monitored and regularly maintained –uncontrolled release of bioaerosols very unlikely
	Cake silo	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Digested sludge cake silo covered – uncontrolled release of bioaerosols very unlikely
Biogas combustion	Biogas holder	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Gas holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHP	Very Low	Low	Low	Nearest receptor <250m from potential source, not downwind of the prevailing wind direction - Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely

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

Note: Sludge reception (liquid and cake) and sludge blending and thickening occur within the same building.

6 Summary

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

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

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

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

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