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# Queensferry

## Bioaerosol risk assessment

April 2021

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# Contents

# 1 Introduction

## 1.1 Overview

Dŵr Cymru Welsh Water (DCWW) are applying for a new bespoke environmental permit for the Queensferry Sludge Treatment Centre (STC). Sludge treatment activity is covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The site currently operates under a T21 exemption and does not have an environmental permit.

Technical Guidance Note M17[1], issued October 2015 by Natural Resource Wales (NRW), states that all sites that have a permit for the treatment of biological waste within 250 metres of a sensitive receptor (a place where people live or work for more than 6 hours at a time) must carry out a site-specific bioaerosol risk assessment. As sensitive receptors are found close the boundary of the site, the closest of which is approximately 90m from the nearest potential source of bioaerosols at Queensferry STC, 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 Queensferry STC at nearby sensitive human health receptors. The assessment has been undertaken in accordance with the methods and principles outlined in Environment Agency's (EA) "*Guidance on the evaluation of bioaerosol risk assessments for composting facilities*" [2].

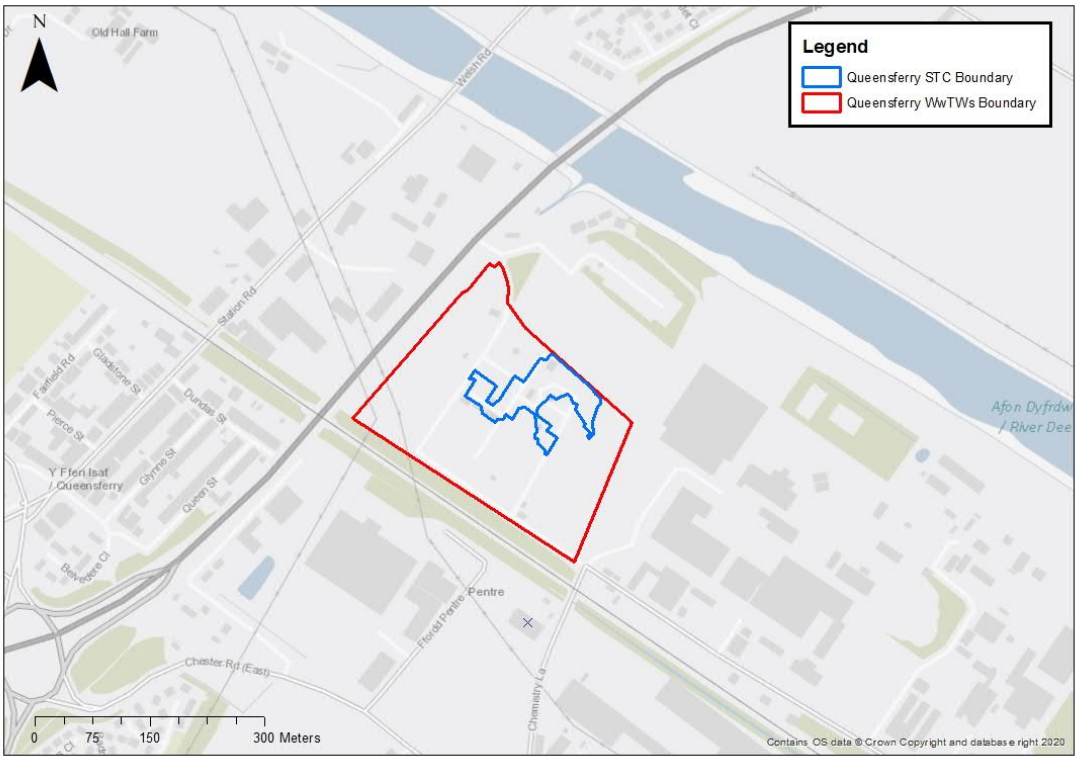
## 1.2 Site location

Queensferry STC is situated within the Queensferry Industrial Estate, adjacent to the River Dee, in Deeside. The location of the STC is shown in **Error! Reference source not found.**. The site includes two anaerobic digestors which are located towards the north east of the site.

[1] Natural Resource Wales (2014) Technical Guidance Note M17 (Monitoring) – Monitoring Particulate Matter in Ambient Air around Waste Facilities. Available online at: https://naturalresources.wales/media/2129/technical-guidance-note-m17-monitoring-monitoring-particulate-matter-in-ambient-air-around-waste-facillities.pdf

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

## Figure 1.1: Queensferry STC site location



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

Nonetheless, current EA 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.'

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

## 2.3 Methodology

The method used for this bioaerosol risk assessment is adapted from the EA's '*Guidance on the evaluation of bioaerosol risk assessments for composting facilities*'[8], which recommends using a Source-Pathway-Receptor model to help determine the magnitude of the risk associated with bioaerosol emissions from a facility.

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

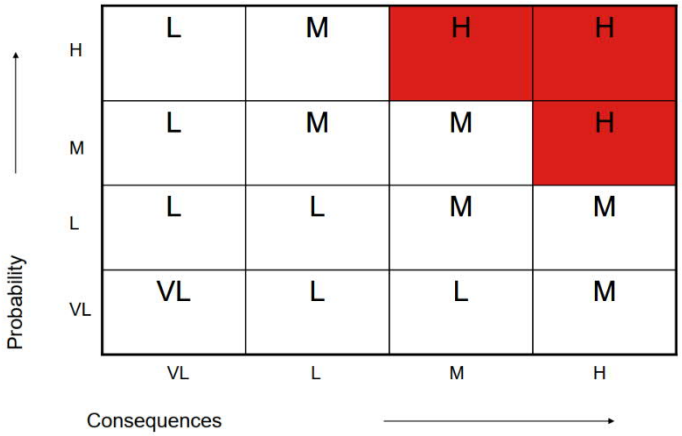
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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

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

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

**Figure 2.1: Magnitude of risk matrices**




Source: Environment Agency, 2009

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

For this bioaerosol risk assessment, a Source-Pathway-Receptor model has been used to help assess the probability of exposure associated with different processes at the Queensferry STC (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 Queensferry STC, using the risk matrix above.

# 3 Source – Pathway – Receptor model

## 3.1 Overview

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

## 3.2 Sources

### 3.2.1 Overview

Queensferry STC includes the following assets which could release bioaerosols:

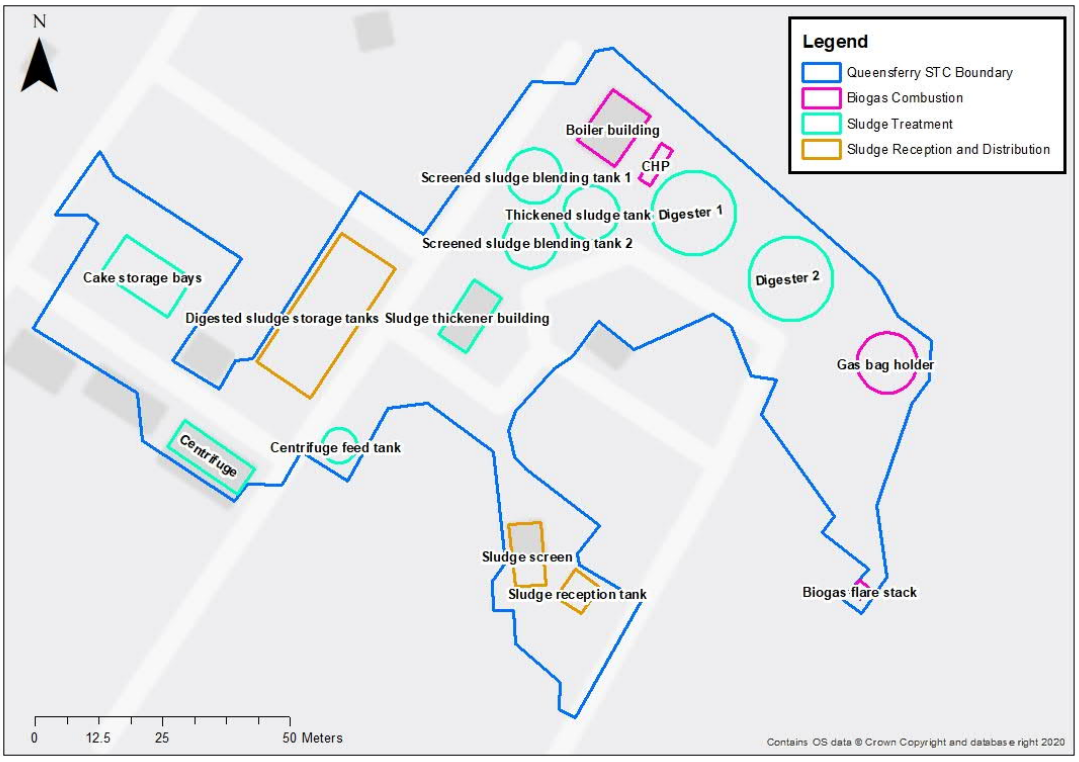
- One Sludge reception tank
- One Sludge screen
- Two Screened sludge blending tanks
- One Sludge thickener
- One Thickened sludge tank
- Two Digesters
- One Gas bag holder
- One CHP unit
- Three Boilers
- One Biogas flare stack
- Two Digested sludge storage tanks
- One Centrifuge feed tank
- One Centrifuge
- Three Cake storage bays

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

- Sludge reception and distribution
- Sludge treatment
- Biogas combustion

**Error! Reference source not found.** shows the locations of these different processes and assets across the site. A summary of the activities which occur at Queensferry STC involving these assets is then presented below.

**Figure 3.1: Queensferry STC potential sources of bioaerosols**




Source: DCWW

### 3.2.2 Sludge reception and distribution

Queensferry STC receives domestic sludge imports from the Queensferry Wastewater Treatment Work's (WwTWs) primary settlement tanks which are pumped directly into the inlet works and from DCWW satellite sludge imports via the sludge centre. Imported sludge arrives to the STC via enclosed tankers which discharge the sludge into the enclosed sludge reception tank.

### 3.2.3 Sludge treatment

Indigenous primary sludge is transferred to two 206m$^3$ covered concrete sludge holding tanks where it is mixed with screened sludge imports. The Imported sludge is initially discharged below ground to the covered concrete reception tank, then pumped up to a rotomat screen where rag is removed. The screened sludge is then transferred to the two-sludge holding tanks where it is combined with indigenous site sludge.

The combined sludge is pumped to a covered drum thickener, which thickens the sludge to approximately 6% dry solids with the aid of a polymer. The sludge is then stored in the third covered concrete sludge storage tank, which is called the digester feed tank. From here the combined sludge is transferred to two 1600m$^3$ concrete digester tanks on a timed basis to undergo mesophilic anaerobic digestion. After a set retention time the digested sludge is then transferred and held in three 950m$^3$ open topped concrete rectangular secondary digesters for a further set time period. The treated sludge is then pumped to a 142m$^3$ open glass fused steel centrifuge feed tank and then de-watered via a single centrifuge with the aid of polymer to

increase the percentage dry solids to between 20 and 25%. The de-watered sludge is then transferred and stored on open concrete cake pads ready for export.

Refer to B14411-123532-XX-XX-DR-AD-PR8401 - IED Queensferry - Block Flow Diagram for a schematic of the sludge treatment process and B14411-123532-XX-XX-DR-AC-PN8202 - IED Queensferry - Site Layout Plan (Emissions), for location of the sludge treatment assets.

#### 3.2.3.1 Odour control

The biological treatment and sludge treatment processes are all covered or enclosed. The only exceptions are the two sludge storage tanks, the centrifuge tank and the cake storage bays.

A leak detection (methane gas analyser) is installed on the biogas holder to ensure any leaks from the inner bag are detected. Any leaks detected on the biogas system would always be fixed immediately by DCWW due to the process safety risk of posed by biogas.

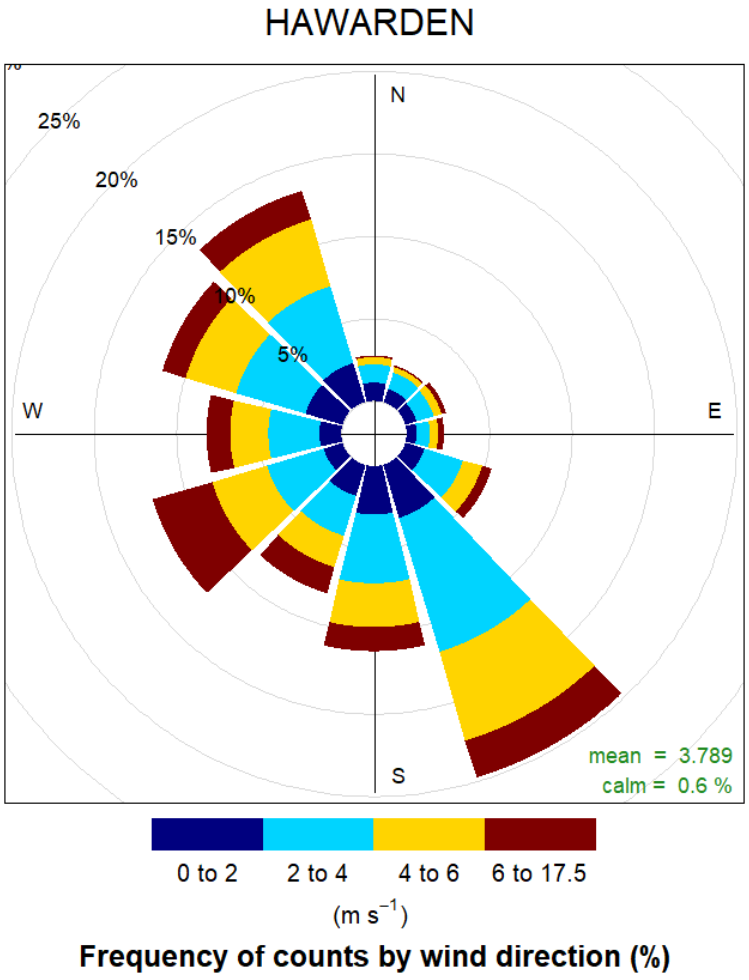
### 3.2.4 Biogas combustion

Biogas produced during AD is transferred to the gas bag holder and then to the CHP and boilers where it is combusted to generate heat and electricity, which is used onsite to assist with the wastewater and sludge treatment processes. When more biogas is produced onsite than can be combusted within the CHP and boilers and there is insufficient space in the gas bag holder to store surplus biogas, excess biogas is sent to the flare to be burned.

## 3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transport by the wind from their source to a receptor. The 2016-2020 wind rose for the nearest meteorological site, Hawarden Airport (located approximately 3.5km south east of Queensferry STC), is shown in Figure 3.2. This monitoring site experiences strong prevailing winds from the south east, with frequent winds from the south east.

**Figure 3.2: Average wind rose for Hawarden Airport meteorological site, 2016- 2020**




Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[9]. The local terrain in the 250m area surrounding the Queensferry STC is generally flat, with some low-lying trees bordering the site to the north, east and south which could present natural obstacles to the transportation of bioaerosols by the wind.

## 3.4 Receptors

Environment Agency guidance[10] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations. Sensitive receptors are defined as:

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

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

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

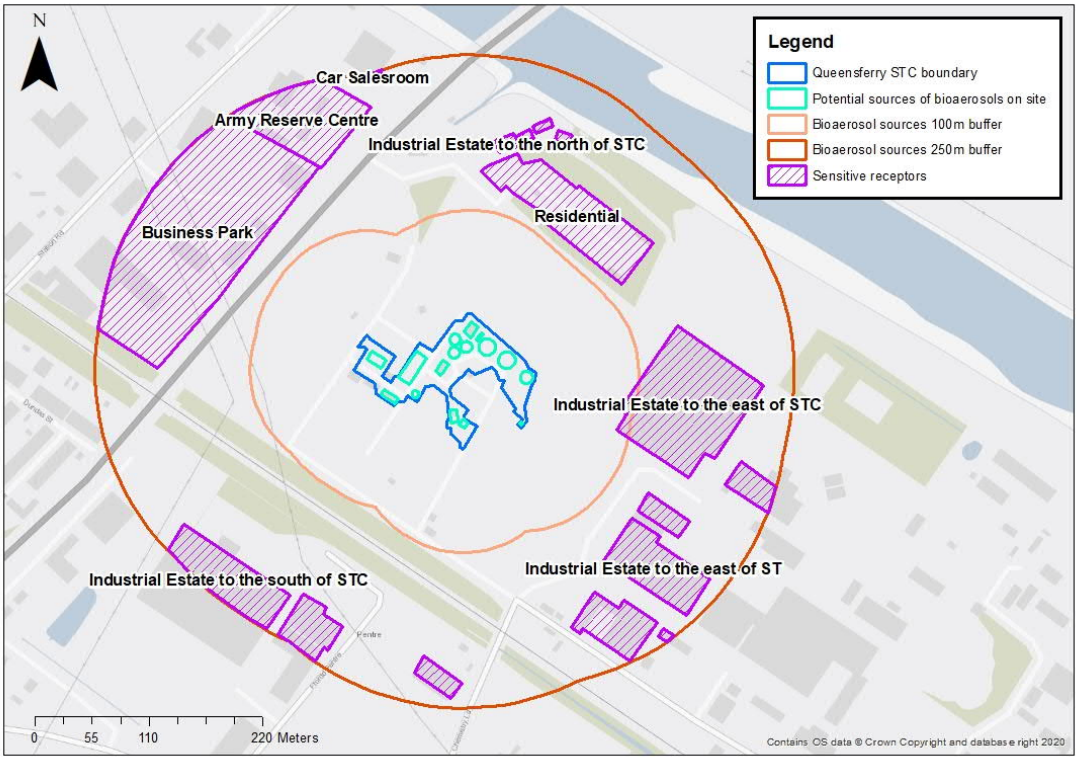
*workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health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

There are multiple sensitive receptors found within 250m of potential bioaerosol emission sources at Queensferry STC. As demonstrated in Figure 3.3, these receptors are found to the surrounding site in all directions. A small number of sensitive receptors are found to the north west of the site, downwind of the prevailing wind direction. The closest potential bioaerosol emission source to these receptors are the cake storage bays, which are approximately 150m upwind of these receptors.

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

The receptor closest to a potential emission source is an industrial estate east of the STC, which is located approximately 90m east of the gas bag holder.

## Figure 3.3: Sensitive receptors within 250m




## Table 3.1: Receptors within 250m of potential emission sources at East Worthing WTW

| Receptor | Nearest potential emission source to receptor | Process | Distance (m) from nearest potential emission source (a) | Direction of receptor from closest emission source |
|---|---|---|---|---|
| Industrial area (place of work) to the east of the STC | Screened sludge blending tanks | Sludge treatment | 165 | East |
| | Thickened sludge tank | Sludge treatment | 155 | East |
| | Digesters | Sludge treatment | 110 | East |
| | Gas bag holder | Biogas combustion | 90 | East |
| | CHP unit | Biogas combustion | 150 | East |
| | Boilers | Biogas combustion | 160 | East |
| | Flare stack | Biogas combustion | 90 | North east |
| | Digested sludge storage tanks | Sludge reception and distribution | 195 | North east |
| | Centrifuge feed tank | Sludge treatment | 195 | North east |
| | Centrifuge | Sludge treatment | 210 | North east |
| | Cake storage bays | Sludge treatment | 230 | North east |
| | Sludge reception tank | Sludge reception and distribution | 145 | North east |
| | Sludge screen | Sludge reception and distribution | 155 | North east |

| | | | | |
|---|---|---|---|---|
| Business park (place of work) to the north west of the STC | Screened sludge blending tanks | Sludge treatment | 200 | North west |
| | Thickened sludge tank | Sludge treatment | 215 | North west |
| | Digesters | Sludge treatment | 225 | North west |
| | CHP unit | Biogas combustion | 220 | North west |
| | Boilers | Biogas combustion | 210 | North west |
| | Digested sludge storage tanks | Sludge reception and distribution | 185 | North west |
| | Centrifuge feed tank | Sludge treatment | 205 | North west |
| | Centrifuge | Sludge treatment | 180 | North west |
| | Cake storage bays | Sludge treatment | 150 | North west |
| | Sludge screen | Sludge reception and distribution | 245 | North west |
| Army reserve centre (place of work) to the north west of the STC | Screened sludge blending tanks | Sludge treatment | 205 | North west |
| | Thickened sludge tank | Sludge treatment | 220 | North west |
| | Digesters | Sludge treatment | 230 | North west |
| | CHP unit | Biogas combustion | 220 | North west |
| | Boilers | Biogas combustion | 210 | North west |
| | Digested sludge storage tanks | Sludge reception and distribution | 200 | North west |
| | Centrifuge feed tank | Sludge treatment | 230 | North west |
| | Centrifuge | Sludge treatment | 220 | North west |
| | Cake storage bays | Sludge treatment | 185 | North west |
| Car salesroom (place of work) to the north west of the STC | Boilers | Biogas combustion | 250 | North west |
| Industrial area (place of work) to the north of the STC | Screened sludge blending tanks | Sludge treatment | 180 | North |
| | Thickened sludge tank | Sludge treatment | 185 | North |
| | Digesters | Sludge treatment | 180 | North |
| | Gas bag holder | Biogas combustion | 215 | North |
| | CHP unit | Biogas combustion | 175 | North |
| | Boilers | Biogas combustion | 165 | North |
| | Digested sludge storage tanks | Sludge reception and distribution | 210 | North |
| | Centrifuge feed tank | Sludge treatment | 245 | North |
| | Centrifuge | Sludge treatment | 255 | North |
| | Cake storage bays | Sludge treatment | 230 | North |
| | Sludge reception tank | Sludge reception and distribution | 250 | North |
| | Sludge screen | Sludge reception and distribution | 260 | North |
| Residential area to the north of the STC | Screened sludge blending tanks | Sludge treatment | 140 | North |
| | Thickened sludge tank | Sludge treatment | 135 | North |
| | Digesters | Sludge treatment | 120 | North |

| | | | | |
|---|---|---|---|---|
| | Gas bag holder | Biogas combustion | 120 | North |
| | CHP unit | Biogas combustion | 125 | North |
| | Boilers | Biogas combustion | 120 | North |
| | Flare stack | Biogas combustion | 165 | North |
| | Digested sludge storage tanks | Sludge reception and distribution | 175 | North |
| | Centrifuge feed tank | Sludge treatment | 205 | North |
| | Centrifuge | Sludge treatment | 220 | North |
| | Cake storage bays | Sludge treatment | 195 | North |
| | Sludge reception tank | Sludge reception and distribution | 200 | North |
| | Sludge screen | Sludge reception and distribution | 195 | North |
| Industrial area (place of work) to the south of the STC | Digested sludge storage tanks | Sludge reception and distribution | 225 | South |
| | Centrifuge feed tank | Sludge treatment | 215 | South |
| | Centrifuge | Sludge treatment | 200 | South |
| | Cake storage bays | Sludge treatment | 230 | South |
| | Sludge reception tank | Sludge reception and distribution | 220 | South |
| | Sludge screen | Sludge reception and distribution | 215 | South |

Source: (a) Distance from source to receptor is rounded to the nearest 5m

## 3.5 Summary

Table 3.2 below summarises the potential sources of bioaerosol emissions at Queensferry STC, 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 | Distance to nearest receptor (m) |
|---|---|---|---|
| Sludge reception and distribution | Digested sludge storage tanks | Air transport then:<br>• Inhalation (through nose or mouth)<br>• Ingestion (eating or swallowing)<br>• Absorption/contact (through skin or eyes) | 175 |
| | Sludge reception tank | | 145 |
| | Sludge screen | | 155 |
| Sludge treatment | Screened sludge blending tanks | | 140 |
| | Thickened sludge tank | | 135 |
| | Digestors | | 110 |
| | Centrifuge feed tank | | 195 |
| | Centrifuge | | 180 |
| | Cake storage bays | | 150 |
| Biogas combustion | Gas bag holders | | 90 |
| | Boilers | | 120 |
| | CHP | | 125 |
| | Flare | | 90 |

# 4 Control measures

## 4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[11] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at Queensferry STC. These control measures aim to reduce and contain emissions of bioaerosols to prevent the source-pathway-receptor link associated with each of the potential emission sources identified in Section 3.2.5.

## 4.2 Control measures

### 4.2.1 Sludge reception and distribution

Domestic sludge offloads into the inlet channel through an enclosed connection. The inlet is currently uncovered; however, the sludge will only be exposed for a short period of time. Imported sludge is offloaded from an enclosed tanker into the covered imported sludge tank via an enclosed connection, so the potential for release of bioaerosols is minimal.

The processed sludge is transported from the centrifuge to the cake bays via an enclosed pipe. The cake bays are open to air, however once deposited, the cake is not disturbed until loaded into trucks, which are covered before transport, for offsite disposal.

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

Lorry and tanker drivers are required to hose down any spillage after each loading or unloading.

No wheel wash facility is available on site but a standpipe is available and can be utilised to wash spillage from vehicles as required. Vehicles entering public roads are not to enter cake bay areas.

### 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 reception and distribution works and sludge treatment works are kept 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

[11] 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.

minimum periods. If access is required for an extended period of time, such as for maintenance activities, the site would be closed down, in which case, no bioaerosols would be produced.

To further contain bioaerosol emissions, the tanks used for sludge reception and treatment (reception tank, sludge screen, digesters and centrifuge) are covered. The only processes which are not covered are the two digested sludge storage tanks, the centrifuge tank and the cake storage bays, however as the sludge has already been through the digestion process, the concentrations of bioaerosols are lower at these stages. Additionally, the sludge is wet so the likelihood of the resuspension of bioaerosols is minimised.

#### 4.2.2.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down, which primarily occurs during AD. Therefore, at each stage of the sludge treatment process, the quantity of bioaerosols decreases; the concentration of bioaerosols that could potentially be emitted from the cake bays (at the end of the sludge treatment process) is much lower than from the primary settlement tanks (pre-AD).

To further reduce potential bioaerosol emissions, sludge produced on site is processed immediately. This prevents processing of old sludge which is more odorous and difficult to process. Sludge arriving onsite is also processed immediately to help minimise bioaerosol emissions. As discussed above, processes with the greatest potential to release bioaerosols are covered.

### 4.2.3 Biogas combustion

Biogas produced during AD is stored within the gas bag holder before being combusted at high temperatures within the CHP, boilers or flare. The gas bag 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 is conducted of the treatment processes on site to ensure the equipment is working correctly. The parameters measured include: sludge blanket thickness, turbidity and temperature (full list of parameters monitored are found within the operating plan for Queensferry). 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 DCWW staff and specialist contractors if needed. DCWW have also issued generic maintenance task manuals for use across all their sites which include protocols for the maintenance of equipment.

Stocks of chemicals onsite 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 Supervisory Control and Data Acquisition (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, where required, an operator would contact a mechanical or electrical technician, both of whom are on-call 24-hours, to attend site as soon as practicable. Where the on-call technicians are already engaged upon other response work, there is the facility to access staff from other DCWW geographic divisions, coordinated by the Duty Manager. All faults, break-downs and emergencies are logged electronically together with records of the action taken and the solutions reached.

One such emergency event would be failure of the flare stack and/or CHP. Such an event would result in releases of biogas from the Whessoe Valves located on the roofs of the digesters and in the gas holder compound, which would release bioaerosols. This occurs to prevent over pressurisation of the digesters and gas systems. While the problem is rectified, biogas generation is reduced by reducing or inhibiting the digester feed.

## 4.5 Summary

As discussed above, there are a number of control measures in place at Queensferry STC to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure. The greatest risk associated with emissions of bioaerosols from the site is associated with emergency situations such as a failure of the flare or CHP, which could result in uncontrolled emissions of bioaerosols. However, such events would be 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 Queensferry STC to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the EA guidance[12], as summarised in Section 2.3.

## 5.2 Probability of exposure

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

- Sludge reception and distribution
- Sludge treatment (sludge treatment, digestors, centrifuge and cake silo)
- 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, the nearest of which is approximately 90m from the gas bag holder. However, as discussed in Section 4, there are multiple control measures in place at Queensferry STC 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 Queensferry STC is therefore considered to be '**very low**' as exposure of the receptors to bioaerosols is "very unlikely" due to the "effective and multiple barriers" (control measures) in place.

The exception to this are the digested sludge storage tanks, centrifuge tanks and cake storage bays, which are not covered and therefore the probability of exposure is considered to be '**low**' as exposure of the receptors to bioaerosols is "unlikely" as some "barriers exist to mitigate" such as the 'wet' nature of the sludge in the digested sludge storage and centrifuge tanks.

Although the cake bays are uncovered, the cake is at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land and therefore has also been considered to be '**very low**'.

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

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

| Process | Potential source of bioaerosols | Probability of exposure | Justification |
|---|---|---|---|
| Sludge reception and distribution | Sludge reception tank | Very Low | Covered, 'wet' process - exposure to bioaerosol emissions unlikely |
| | Sludge screen | Very Low | Covered, 'wet' process - exposure to bioaerosol emissions unlikely |

[12] 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.

| | | | |
|---|---|---|---|
| | Digested sludge storage tanks | Low | Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely |
| Sludge treatment | Screened sludge blending tanks | Very Low | Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely |
| | Thickened sludge tank | Very Low | Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely |
| | Digesters | Very Low | Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely |
| | Centrifuge building | Very Low | Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely |
| | Centrifuge feed tank | Low | Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely |
| | Cake storage bays | Very Low | Uncovered, however Cake storage at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land –release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis |
| Biogas combustion | Gas holder | Very Low | Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks – uncontrolled release of bioaerosols very unlikely |
| | Boilers | Very Low | Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely |
| | CHPs | Very Low | Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely |
| | Flare | Very Low | Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely |

## 5.3 Consequence of hazard

While the probability of exposure of receptors to bioaerosols is '**very low**' or '**low**' as a result of the control measures in place, there is still a risk that nearby receptors could be exposed bioaerosols, for example if there is a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary as 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) [13,14]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source. Receptors downwind of the prevailing wind direction which are more than 100m from an emission sources will also experience a greater hazard consequence than those upwind of the emission source at these distances.

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

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

**Table 5.2: Consequence of hazard from bioaerosols at Queensferry STC**

| Process | Potential source of bioaerosols | Nearest receptor | Consequence of exposure | Justification |
|---|---|---|---|---|
| Sludge reception and distribution | Sludge reception tank | 145m north east, industrial area | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Sludge screen | 155m north east, industrial area | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Digested sludge storage tanks | 175m north, residential area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |
| Sludge treatment | Screened sludge blending tanks | 140m north, residential area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |
| | Thickened sludge tank | 135m north, residential area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |
| | Digesters | 110m east, industrial area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |
| | Centrifuge | 180m north west, business park | Medium | Nearest receptor >100m from potential source, downwind of prevailing wind direction |
| | Centrifuge feed tanks | 195m north east, industrial area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |

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

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

| Process | Potential source of bioaerosols | Nearest receptor | Consequence of exposure | Justification |
|---|---|---|---|---|
| | Cake storage bays | 150m north west, business park | Medium | Nearest receptor >100m from potential source, downwind of prevailing wind direction |
| Biogas combustion | Gas bag holders | 90m east, industrial area | Medium | Nearest receptor <100m from potential source, not downwind of prevailing wind direction |
| | Boilers | 120m north, residential area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |
| | CHP | 125m north, residential area | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction |
| | Flare | 90m north east, industrial area | Medium | Nearest receptor <100m from potential source, not downwind of prevailing wind direction |

## 5.4 Magnitude of risk

Table 5.3 below summarises the probability of exposure, consequence of hazard and resulting magnitude of risk for each potential bioaerosol emission source at Queensferry STC. Across all sources, there is a '**very low**' or '**low**' probability of exposure due to the nature of the processes and control measures in place which would prevent uncontrolled releases of bioaerosols. The consequence of exposure is described as '**low**' to '**medium**' depending on the potential emission source due to their proximity to sensitive receptors and the location of the receptor relative to the prevailing wind direction and potential emission source.

In accordance with EA guidance[15], across all potential bioaerosol emission sources, the magnitude of risk is described as '**low**' or '**medium**' and therefore operation of the Queensferry STC 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 Queensferry STC[16]. The requirements for bioaerosol monitoring at Queensferry STC will need to be agreed with NRW 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 exposure | Magnitude of risk | Justification |
|---|---|---|---|---|---|
| Sludge reception and distribution | Sludge reception tank | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction<br>Covered, 'wet' process - exposure to bioaerosol emissions unlikely |

[15] 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.

[16] Natural Resource Wales (2014) Technical Guidance Note M17 (Monitoring) – Monitoring Particulate Matter in Ambient Air around Waste Facilities. Available online at: https://naturalresources.wales/media/2129/technical-guidance-note-m17-monitoring-monitoring-particulate-matter-in-ambient-air-around-waste-facillities.pdf

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|---|---|---|---|---|---|
| | Sludge screen | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction<br>Covered, 'wet' process - exposure to bioaerosol emissions unlikely |
| | Digested sludge storage tanks | Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely |
| Sludge treatment | Screened sludge blending tanks | Very Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely |
| | Thickened sludge tank | Very Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely |
| | Digesters | Very Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely |
| | Centrifuge | Very Low | Medium | Low | Nearest receptor >100m from potential source, downwind of prevailing wind direction<br>Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely |
| | Centrifuge feed tanks | Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely |
| | Cake storage bays | Very Low | Medium | Low | Nearest receptor >100m from potential source, downwind of prevailing wind direction<br>Uncovered, however Cake storage at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land –release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis |
| Biogas combustion | Gas holder | Very Low | Medium | Low | Nearest receptor <100m from potential source, not downwind of prevailing wind direction<br>Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks -uncontrolled release of bioaerosols very unlikely |

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|---|---|---|---|---|---|
| | Boilers | Very Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Combustion of biogas at very high temperatures which would destroy bioaerosols - uncontrolled release of bioaerosols very unlikely |
| | CHPs | Very Low | Low | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Combustion of biogas at very high temperatures which would destroy bioaerosols - uncontrolled release of bioaerosols very unlikely |
| | Flare | Very Low | Medium | Low | Nearest receptor >100m from potential source, not downwind of prevailing wind direction<br>Combustion of biogas at very high temperatures which would destroy bioaerosols- uncontrolled release of bioaerosols very unlikely |

# 6 Summary

At Queensferry STC, there is the potential for bioaerosol emissions from:

- Sludge reception and distribution
- Sludge treatment (sludge treatment, digestors, centrifuge 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 Queensferry STC, a bioaerosol risk assessment has been undertaken in accordance with NRW and EA guidance.

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

Based on the ‘very low’ and ‘low’ probability of exposure and ‘low’ to ‘medium’ consequence of hazards associated with different processes at the STC, the overall magnitude of the risk associated with bioaerosols emissions from Queensferry STC is considered to be ‘low’. This is primarily due to the ‘wet’ nature of several processes undertaken at Queensferry STC 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.