

Esholt STF Bioaerosol Risk Assessment

This document discusses the risk associated with bioaerosols that could arise as a result of anaerobic digestion and its directly associated activities

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Esholt STF: Bioaerosol Risk Assessment

1.1 Bioaerosols Introduction

Bioaerosols are defined as micro-organisms suspended in the air and can include bacteria, fungi and viruses, or parts of living organisms, such as spores and plant pollen. Bioaerosols are usually smaller than 10µm in diameter and can cause human health impacts such as allergic responses and inflammation. Bioaerosols are naturally present in the air, but they are also associated with organic waste treatment processes including composting, mechanical biological treatment, and potentially some aspects of anaerobic digestion (AD) which are widely used in the UK.

1.2 Receptors

The most recent guidance¹ requires that biological waste treatment facilities provide a site-specific bioaerosol risk assessment if there are sensitive receptors within 250m of activities, regardless of the specific processes carried out at a site. It is noted that the consensus from various studies is that bioaerosols from composting activities decline rapidly within the first 100 metres from a site and generally decline to background levels within 250m². Technical Guidance Note M9³ states that receptors located more than 250m away should be discounted as they are not likely to be affected.

1.3 Esholt STF

The nearest residential housing is located approximately 160m to the north of the digester area, adjacent to, and within the grounds of YW-owned Esholt Hall. Esholt Hall itself is noted as a potential industrial/commercial receptor location. The building has previously been used as a conference centre and is now being redeveloped for use as a YW staff training academy. Risks associated with industrial/commercial receptors are likely to be less significant due to the relatively shorter duration of exposure (i.e. on the basis of approximately 8 hours/day, 5 days/week working pattern, or less in the case of visitors to these sites). The prevailing wind direction is towards the west, further reducing potential to impact of these locations. The Biowise process operations have not been considered as a receptor, as they form part of the multi-operator installation. In any event, Biowise undertake bioaerosol monitoring in line with TGN M9 monitoring guidance. There are no other residential or industrial/commercial receptors within 250m of the installation boundary.

¹ Environment Agency, consultation draft July 2020, Appropriate measures for the biological treatment of waste.

² Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

³ Environment Agency Technical Guidance Note M9 'Environmental Monitoring of Bioaerosols at Regulated Facilities', July 2018,

Source	Source controls	Pathway	Receptors	Overall risk
Raw sludge intake	Sludge is enclosed throughout; sludge is pumped from tankers or via pipelines to receiving enclosed storage tanks. Displaced air is extracted and dispersed to atmosphere (see separate entry below). Unloading activities occur infrequently. The distance between this source and the nearest residential receptor is >250m.	None	Digester area receptors: Residential housing located approximately 160m to the north of the digester area installation boundary,	No risk present – sludge fully enclosed
Sludge reception – screenings skips	Screenings are not subject to regular disturbance and are stored in relatively small quantities (2 x skips). Screenings are wet, do not produce dust and are not readily susceptible to airborne dispersion. The distance between this source and the nearest residential receptor is >250m	Airborne dispersion	but at greater distance from individual sources. Esholt Hall (currently being redeveloped for use as a YW staff training academy)	Low
Sludge cake reception facility	Unloading activities occur infrequently and are of short duration. Cake is delivered by covered wagon. Cake reception tank is covered when tipping is not taking place. Material disturbance is short lived during tipping operations only. Sludge cake is wet, does not produce dust and is not readily susceptible to airborne dispersion. The distance between this source and the nearest residential receptor is approximately 215m, which combined with the infrequent nature of tipping, makes this source low risk.		located approximately 140m to the north of the digester area installation boundary, but at greater distance from individual sources.	Low

Source	Source controls	Pathway	Receptors	Overall risk
Sludge handling – screening, dewatering, THP and digestion	Sludge is fully enclosed within tanks or pipework at all times. Displaced air is extracted and dispersed to atmosphere (see separate entry below).	None	There are no other residential or industrial/commercial receptors, and no schools or hospitals within 250m of bioaerosol sources.	No risk present – sludge fully enclosed
Consolidation tank 5 (uncovered)	Sludge is liquid in nature, does not produce dust and is not readily susceptible to airborne dispersion. Consolidation tank 5 is located to the south of the digester area and therefore at a greater distance from the receptors identified to the north of the site. The distance between this source and the receptors is >250m and therefore the receptor is unlikely to be affected.	Airborne dispersion		Low
SAS storage and transfer tanks (uncovered)	Sludge is liquid in nature, does not produce dust and is not readily susceptible to airborne dispersion. SAS storage and transfer tanks are located to the southwest of the digester area and therefore at a greater distance from the receptors identified to the north of the site. The distance between this source and the receptors is > 250m and therefore the receptors are unlikely to be affected.			Low
SAS thickeners and thickener OCU (OCU 4)	Sludge is enclosed within thickeners or pipework at all times. Displaced air is extracted and treated by a carbon filter prior to released to atmosphere.			Very low
Proposed OCU's	Sludge is liquid in nature, does not produce dust and is not readily susceptible to airborne dispersion.			Low

Source	Source controls	Pathway	Receptors	Overall risk
	<p>The distance between these sources and the nearest residential receptor is >250m other than OCU3 (THP feed silos) which is approximately 235m. Overall, any effects are likely to be not significant.</p> <p>YW is committed to undertaking improvements to existing OCUs to ensure effective operation (refer to proposed improvement programme). OCUs will be subject to monitoring programme and planned maintenance to ensure effective operation.</p>		<p>Digester area receptors:</p> <p>Residential housing located approximately 160m to the north of the digester area installation boundary, but at greater distance from individual sources.</p> <p>Esholt Hall (currently being redeveloped for use as a YW staff training academy) located approximately 140m to the north of the digester area installation boundary, but at greater distance from individual sources.</p>	
Emergency scenario – bio-gas venting	<p>As the sludge digestion process is a wet process, biogas is unlikely to contain significant concentrations of bioaerosols.</p> <p>Venting events infrequent and short-lived.</p>			Very low
Emergency scenario – Sludge spillage	<p>Sludge is wet, does not produce dust and is not readily susceptible to airborne dispersion.</p> <p>Events occur infrequently and in almost all cases will involve small quantities of sludge. Major/catastrophic loss is highly unlikely to occur.</p> <p>Emergency response procedures are in place to ensure such incidents are responded to promptly and spilt material is cleaned up.</p>			Very low

Source	Source controls	Pathway	Receptors	Overall risk
			There are no other residential or	
Digested sludge dewatering feed tanks (uncovered) x 4	Sludge is wet, does not produce dust and is not readily susceptible to airborne dispersion. Sludge contained within the dewatering feed tanks has been processed at high temperature via THP and AD achieving high levels of pathogen kill. Bioaerosols generation potential is therefore very low.	Airborne dispersion	Digested sludge area receptors: There are no residential housing, schools or hospitals, or industrial/commercial receptors within 250m of bioaerosol sources associated with the digested sludge area.	Very low
Digested sludge dewatering centrifuges	Digested sludge has been processed at high temperature via THP and AD achieving high levels of pathogen kill. Bioaerosol generation potential is therefore very low. Sludge cake is wet (approximately 25% solids content), does not produce dust and is not readily susceptible to airborne dispersion.			Very low
Digested sludge cake handling – conditioning pad	Digested sludge has been processed at high temperature via THP and AD achieving high levels of pathogen kill. Bioaerosol generation potential is therefore very low. Sludge cake is wet (approximately 25% solids content), does not produce dust and is not readily susceptible to airborne dispersion. The cake is delivered to the cake pad and is then left undisturbed until moving to the cake barn or removal from site.	Airborne dispersion		Very low

Source	Source controls	Pathway	Receptors	Overall risk
Digested sludge cake handling – cake barn	Digested sludge has been processed at high temperature via THP and AD achieving high levels of pathogen kill. Bioaerosol generation potential is therefore very low. Sludge cake is wet (approximately 25% solids content), does not produce dust and is not readily susceptible to airborne dispersion. The cake is delivered to the cake pad and is then left undisturbed until removal from site. The cake barn roof and half height walls further reduce susceptibility to airborne dispersion.			Very low
Vehicle tracking of materials around on the cake pad and roads, which could dry out and disperse	Regular washdown and wetting in order to reduce dust and keep pad area clean.	Airborne dispersion	Digested sludge area receptors: There are no residential housing, schools or hospitals, or industrial/commercial receptors within 250m of bioaerosol sources associated with the digested sludge area.	Low
Emergency scenario – Sludge cake spillage	Sludge is wet (approximately 25% solids content), does not produce dust and is not readily susceptible to airborne dispersion. Events occur infrequently and in almost all cases will involve small quantities of sludge. Major/catastrophic loss is highly unlikely to occur. Emergency response procedures are in place to ensure such incidents are responded to promptly and spilt material is cleaned up.			Very low
				Very low

Table 1: Review of potential bioaerosol sources and associated risk

1.4 Site Operation and monitoring

Although the individual assets at Esholt STF have been deemed a low or very low bioaerosol risk, there will be a requirement to undertake bioaerosol monitoring as part of the site's Industrial Emissions Directive–Anaerobic Digestion (IED–AD) permit. Monitoring frequency will be dictated by the environmental permit.

At Esholt STF, there are a number of sources adjacent to each other, it is therefore not possible to monitor the bioaerosol effect from individual point sources. Bioaerosol monitoring will therefore be considered at the site boundary and sources will be considered a combined single area (fig 1).

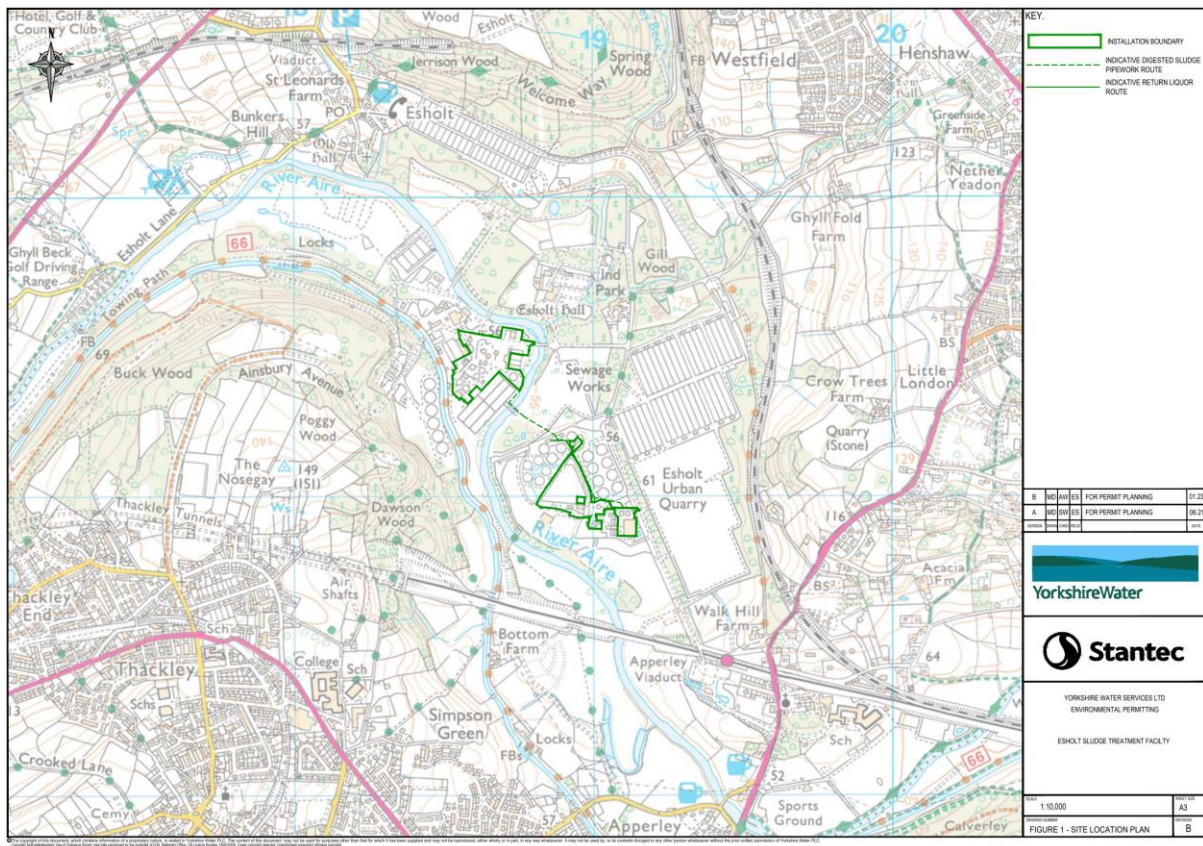


Fig 1 – Esholt STF showing the installation boundary (green) and associated assets some of which may have the potential to cause bioaerosols

1.5 Meteorological Conditions

In the UK, the prevailing wind directions are commonly from the west and south-west. The wind direction and speed will impact the dispersion of odour emissions from site. There is currently no wind station on site to measure meteorological conditions.

Leeds Bradford airport meteorological station is 4km north-east of the site. The meteorological data included below consist of 1-hourly average data suitable for use in atmosphere dispersion modelling software.

The meteorological data from Leeds Bradford airport meteorological station has been incorporated into the site's odour risk assessment whereby wind direction and frequency are used to determine the "pathway effectiveness" from source to receptor. Data for 2017 has been adopted for the odour risk assessment as there would be no variability in pathway risk scoring when using a different year. It is more critical for the risk assessment to determine a representative meteorological station location that met. year. The met. year should be updated within every 5 years to ensure the prevailing wind direction and wind speeds are still representative.

Wind direction and speed is also included as part of the on-site sniff testing however, this is based on short-term variations and recorded at the time of assessment (see Section 5.1 Sniff Testing).

The wind rose plot for Leeds Bradford airport is included in Figure 2.

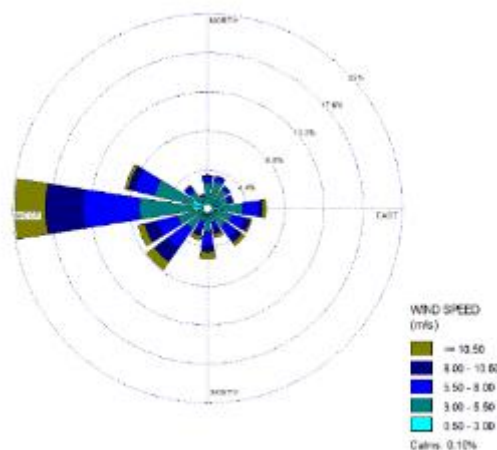


Fig 2 – Leeds Bradford Airport Windrose Plot (2017)

1.6 Site Monitoring Locations

The wind conditions will always be taken into consideration when conducting the bioaerosol monitoring. 1 upwind and 3 downwind samples in a fan shape will be undertaken. As the monitoring will be dictated by onsite wind conditions, the sampling locations may not match the prevailing wind as dictated in figure 2.

All sampling will be undertaken in line with EA M9 sampling guidance.

In August 2022, a one off monitoring assessment was undertaken, the monitoring locations are replicated in figure 3. The wind conditions did not match the expected wind results

(figure 2) on the day of assessment. Wind conditions will always be noted and reported on within the bioaerosol monitoring report.

One upwind sampling location (marked with a blue dot on fig 3) was used to measure upwind concentrations of bioaerosols. Three samples were taken in a fan shape arrangement downwind of STF operations.

Any future monitoring locations will be dictated by the onsite wind conditions at the time of sampling and may or may not match figure 3. Samples will be taken and assessed for the parameters and against the threshold limits given in table 2.

As a one off assessment for the permit application, YW also requested some additional fixed sampling locations. These details and associated results can be found in the bioaerosol monitoring report dated November 2021.

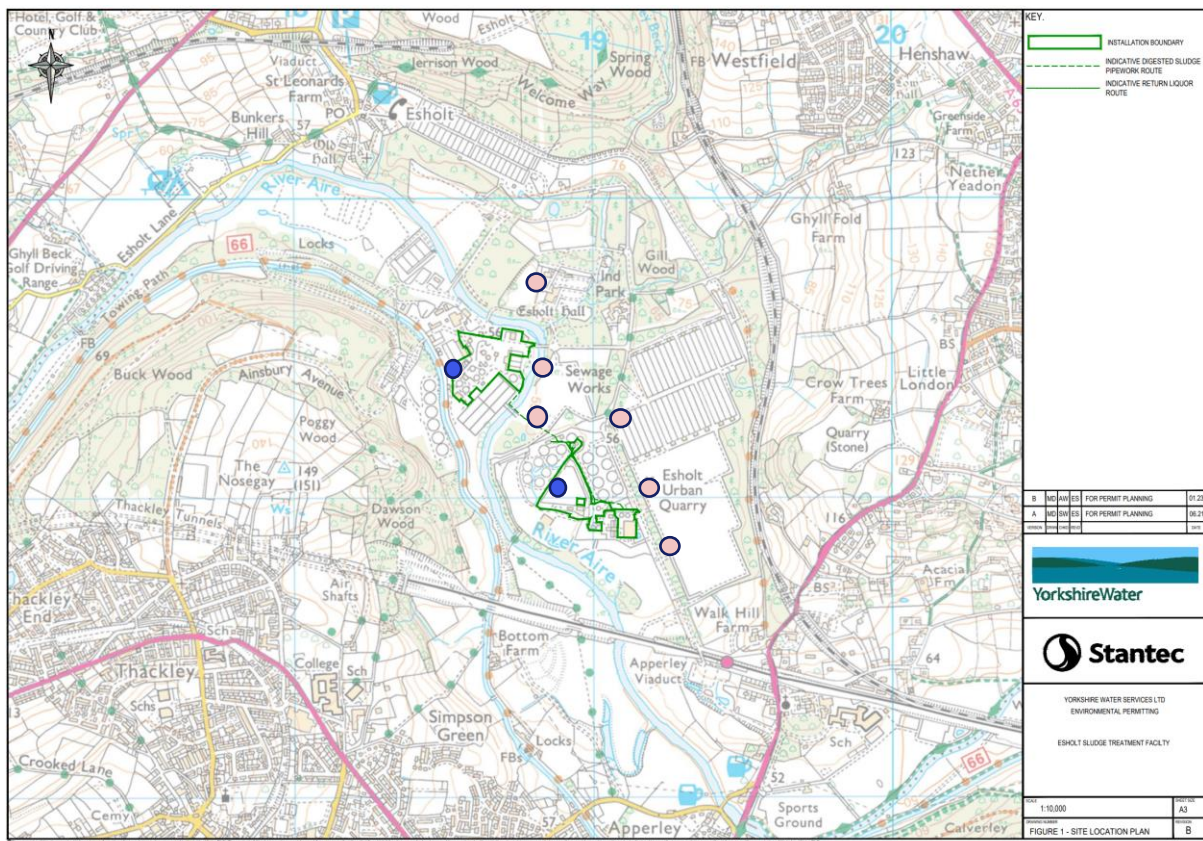


Figure 3 – Esholt STF Site Plan showing the installation boundary (green) with bioaerosol monitoring locations marked (blue dot = upwind, pink dot = downwind)

Parameter	Threshold limit (CFU/m ³)
Total bacteria (TB)	1000
<i>Aspergillus fumigatus</i> (AF)	500

Table 2 – Bioaerosol monitoring parameters and threshold limits

1.7 Bioaerosol Monitoring Results

YW has undertaken quantitative bioaerosols monitoring in accordance with Technical Guidance Note M9 'Environmental Monitoring of Bioaerosols at Regulated Facilities'. This monitoring exercise was carried out by Element Materials Technology Environmental UK Ltd on 22nd and 23rd August 2022 (appendix 1). Sampling was undertaken at 3 downwind and one upwind location on site, with three parallel samples collected per location. Sampling was undertaken at 3 downwind and one upwind location on site, with three parallel samples collected per location. All median concentration results for total bacteria and *Aspergillus fumigatus* were found to be below the guidance limit (1000 and 500 CFU/m³ respectively) at all four sampling locations. Per YW's instruction, Elements had completed additional sampling points for Esholt. The results are inconsequential and monitoring will not be done from these points going forward.

The next bioaerosol monitoring will be carried out in line with permit responsibilities. The results will be updated here.

1.8 Bioaerosol Risk Assessment – conclusions

The bioaerosol risk assessment undertaken concludes that the Esholt STF installation is not considered to be a significant source of bioaerosols and the likelihood of bioaerosols causing negative impacts at nearby receptors is low or very low. This is due to:

- All potential bioaerosol sources at Esholt STF are wet, do not produce dust and are not readily susceptible to airborne dispersion.
- All potential receptors are located greater than 250m from the installation boundary other than the residential housing and training centre, which form part of the YW-owned Esholt Hall complex; these buildings are located approximately 140–160m from the installation boundary. However, this location is at a greater distance from potential bioaerosol sources; in most cases the distance is greater than 250m (where below this, other factors such as frequency of use and forced air dispersion limit the potential for negative effects).
- The consensus of studies is that bioaerosols decline to background levels within 250m and guidance states that receptors located more than 250m away should be discounted as they are not likely to be affected.
- Digested sludge has been processed at high temperature via THP and AD achieving high levels of pathogen kill. Bioaerosol generation potential from digested sludge source is therefore very low.

Notwithstanding the findings of the risk assessment, exceedances of the guidance limit for total bacteria were detected at two out of nine locations sampled during bioaerosol monitoring. Therefore, it is proposed that further monitoring and assessment is undertaken to better understand this data and to assess the likely source(s) and any mitigation measures that may be necessary. This further work will comprise:

- Two further monitoring exercises (6 monthly bioaerosol monitoring over 12 months).

- Data analysis to establish any trends in terms of location and operational activities being undertaken on site.
- Review of site activities to identify appropriate mitigation measures. It is noted that YW already proposes mitigation measures including tank covering and OCU refurbishment, in order to comply with BAT requirements, and that these will contribute to a reduction in bioaerosol risks.

The monitoring data and findings of the data analysis and recommendations for improvements (e.g. mitigation measures and/or further monitoring) will be reported to the Environment Agency within 18 months.

Appendix 1 – Bioaerosol Monitoring Report by Element Materials Technology Environment UK Limited.



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Report: **Bioaerosol Monitoring**
Client: Yorkshire Water Services Ltd
Date of Site Work: 22nd & 23rd August 2022

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Issued by: 

Issue date: 22/09/2022
Report Ref: **113785 V1**

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Executive Summary

Tom Broderick of Yorkshire Water Services Ltd requested that Element Materials Technology Environmental UK Limited undertake monitoring of bioaerosols at its Esholt site. Monitoring was undertaken in accordance with Technical Guidance Note M9 'Environmental Monitoring of Bioaerosols at Regulated Facilities'.

Site work was undertaken by Abigail Pickard on 22nd and 23rd August 2022.

The purpose of the bioaerosol monitoring exercise was to establish the concentration of bioaerosols being dispersed from the site to the nearest sensitive receptor.

Monitoring Findings:

Sampling Location	Analyte	Guidance Limit (CFU/m ³)	Median Concentration of Parallel Samples (CFU/m ³)
Upwind	Total bacteria	1000	125
	<i>Aspergillus fumigatus</i>	500	<125
Downwind	Total bacteria	1000	125
	<i>Aspergillus fumigatus</i>	500	<125
Downwind Left Hand Fan	Total bacteria	1000	<125
	<i>Aspergillus fumigatus</i>	500	<125
Downwind Right Hand Fan	Total bacteria	1000	<125
	<i>Aspergillus fumigatus</i>	500	<125
Sampling Point 1	Total bacteria	1000	<125
	<i>Aspergillus fumigatus</i>	500	<125
Sampling Point 2	Total bacteria	1000	<125
	<i>Aspergillus fumigatus</i>	500	<125
Sampling Point 3	Total bacteria	1000	<125
	<i>Aspergillus fumigatus</i>	500	<125
Sampling Point 4	Total bacteria	1000	<125
	<i>Aspergillus fumigatus</i>	500	<125

< Less than CFU/m³ Colony Forming Units Per Cubic Metre

Below Limit	Exceeds Limit
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1. Introduction

Element Materials Technology Environmental UK Ltd was commissioned by Yorkshire Water Services Ltd to carry out a bioaerosol monitoring exercise at the Waste Water Treatment Works at their site in Esholt.

The purpose of the bioaerosol monitoring exercise was to establish the concentration of bioaerosols being dispersed from the site to the nearest sensitive receptor, as part of a permit application.

Monitoring was undertaken in accordance with Technical Guidance Note M9 'Environmental Monitoring of Bioaerosols at Regulated Facilities'. This report details the survey methodology and results on the monitoring of all locations.

Site work was undertaken by Abigail Pickard of Element Materials Technology Environmental UK Ltd on 22nd and 23rd August 2022.

2. Measurement Methodology

Measurements were carried out in accordance with parameters specified in Technical Guidance Note M9 'Environmental Monitoring of Bioaerosols at Regulated Facilities'. Of the methods suggested in the protocol, the filter method was utilised in this project.

On site calibration checks were performed on the pumps used and were found to be within the permitted tolerance of the standard.

For all measurements the sample head was located 1.5 metres above ground level. The upwind sample was taken further away from the centre of operations than recommended in the guidance. This was to ensure the sample was outside the operational area and represented a true upwind value.

Triplicate samples were carried out at each selected sampling location. Once completed, filters were transferred in a refrigerated container to the laboratory within 24 hours.

The IOM heads containing a polycarbonate filter were used to determine the bioaerosol exposure under the test conditions. Upon arrival at the laboratory the bioaerosols impacted on each filter were recovered in 2 ml maximum recovery diluent. The target micro-organisms were cultured using appropriate dilutions on the following media.

Half-strength nutrient agar (1/2NA) plates were used for total mesophilic bacteria. Malt extract agar (MEA) plates were used for *Aspergillus fumigatus*.

Samples were incubated for up to seven days at 37°C (total mesophilic bacteria), and for two days at 45°C (*Aspergillus fumigatus*).

The laboratory retained information regarding each sample. Dates and times of preparation, incubation times, batch numbers, personnel responsible, storage medium and incubator temperature were all recorded.

3. Site Information

Yorkshire Water Services Ltd operates a Waste Water Treatment Works at their site in Esholt, Yorkshire. The site currently is not required to undertake ambient air monitoring but has done so to support a permit application.

The site is not currently permitted, with an application being submitted in the near future. As such the limits used are the standard limits used by the Environment Agency (EA).

Parameter	Threshold limit (CFU/m ³)
Total bacteria (TB)	1000
<i>Aspergillus fumigatus</i> (AF)	500

Table 1. Environmental Parameters - Bioaerosol monitoring

Location	Bearing of samplers from boundary of operational area (degrees °)	Mean direction the wind blows to during the sampling period (degrees °)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Site Operator		Job Number 113785	
				Commissioning Laboratory	Types of materials processed on site	Yorkshire Water Services Ltd	EIMT Environmental
Date:		23/08/22		Esholt, Yorkshire		Waste Water	
				Mean wind speed (mph)	Arithmetic mean of air temperature °C	Arithmetic mean of relative humidity (%)	Prevailing weather conditions including cloud cover
Upwind	200	20	180	7	21	65	Cloudy. 4/8
Downwind	20	20	0	7	21	65	Cloudy. 4/8
Downwind Left Hand Fan	350	20	30	7	21	65	Cloudy. 4/8
Downwind Right Hand Fan	50	20	30	7	21	65	Cloudy. 4/8

4. Measurement Results

The results for measurements undertaken at all locations are shown within a number of standardised tables on the following pages:

Table 2. Upwind: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:		Esholt, Yorkshire		Site Operator:		Commissioning Laboratory:		Job Number 113785 Yorkshire Water Services Ltd	
Date:		23/08/22		Types of materials processed on site:		Waste Water		EMT Environmental	
Activities affecting Bioaerosol Conc ⁿ		None		Sampling duration (mins)		Microbial Type		Calculated concentration of airborne microorganisms (CFU/m ³)*	
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated concentration of airborne microorganisms (CFU/m ³)*	Median of parallel samples (CFU/m ³)	Comments
Upwind	UW1	60	180			TB	<125		
	UW2	60	180	12:50 – 13:50	60	TB	500	TB: 125	-
	UW3	60	180			TB	125		
Upwind	UW1	60	180			AF	<125		
	UW2	60	180	12:50 – 13:50	60	AF	125	AF: <125	-
	UW3	60	180			AF	<125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 3. Downwind: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:		Esholt, Yorkshire			Site Operator:			Yorkshire Water Services Ltd	
Date:		23/08/22			Commissioning Laboratory:			EMT Environmental	
Activities affecting Bioaerosol Conc ⁿ		None			Types of materials processed on site:			Waste Water	
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated concentration of airborne microorganisms (CFU/m ³)*	Median of parallel samples (CFU/m ³)	Comments
Downwind	DW1	80	0			TB	125		
	DW2	80	0	12:51 – 13:51	60	TB	3250	TB: 125	-
	DW3	80	0			TB	125		
Downwind	DW1	80	0			AF	<125		
	DW2	80	0	12:51 – 13:51	60	AF	<125	AF: <125	-
	DW3	80	0			AF	<125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 4. Downwind Left Hand Fan: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms							Job Number 113785
Site: Estholt, Yorkshire							Yorkshire Water Services Ltd
Date: 23/08/22							EMT Environmental
Activities affecting Bioaerosol Conc ⁿ : None							Waste Water
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Commissioning Laboratory:		Comments
					Types of materials processed on site:	Microbial Type	
					Sampling duration (mins)	Calculated concentration of airborne microorganisms (CFU/m ³)*	Median of parallel samples (CFU/m ³)
Downwind Left Hand Fan	LHS1	90	30			875	
	LHS2	90	30	12:59 – 13:59	60	<125	TB: <125
	LHS3	90	30			<125	
Downwind Left Hand Fan	LHS1	90	30			<125	
	LHS2	90	30	12:59 – 13:59	60	<125	AF: <125
	LHS3	90	30			<125	

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 5. Downwind Right Hand Fan: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:		23/08/22		Esholt, Yorkshire		Commissioning Laboratory:		Job Number 113785	
Activities affecting Bioaerosol Conc ⁿ		None		Types of materials processed on site:		Waste Water		Yorkshire Water Services Ltd	
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated concentration of airborne microorganisms (CFU/m ³)	Median of parallel samples (CFU/m ³)	Comments
Downwind Right Hand Fan	RHS1	70	30	13:00 – 14:00	60	TB	<125	TB: <125	-
	RHS2	70	30			TB	<125		
	RHS3	70	30			TB	125		
Downwind Right Hand Fan	RHS1	70	30	13:00 – 14:00	60	AF	<125	AF: <125	-
	RHS2	70	30			AF	<125		
	RHS3	70	30			AF	<125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 6. Sample Point 1: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:		Esholt, Yorkshire		Site Operator:		Yorkshire Water Services Ltd		Job Number 113785	
Date:		22/08/22		Commissioning Laboratory:		EMT Environmental		Waste Water	
Activities affecting Bioaerosol Conc ⁿ		None		Types of materials processed on site:		Calculated concentration of airborne microorganisms (CFU/m ³)*		Median of parallel samples (CFU/m ³)	
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated concentration of airborne microorganisms (CFU/m ³)*	Median of parallel samples (CFU/m ³)	Comments
Sample Point 1	S1A	670	20			TB	500		
	S1B	670	20	10:44 – 11:44	60	TB	<125	TB: <125	-
	S1C	670	20			TB	<125		
Sample Point 1	S1A	670	20			AF	<125		
	S1B	670	20	10:44 – 11:44	60	AF	125	AF: <125	-
	S1C	670	20			AF	<125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ *Aspergillus fumigatus* (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 7. Sampling Point 2: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:		Esholt, Yorkshire		Site Operator:		Yorkshire Water Services Ltd			
Date:		22/08/22		Commissioning Laboratory:		EMT Environmental			
Activities affecting Bioaerosol Conc ⁿ		None		Types of materials processed on site:		Waste Water			
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated concentration of airborne microorganisms (CFU/m ³)*	Median of parallel samples (CFU/m ³)	Comments
Sample Point 2	S2A	800	10	11:04 – 12:04	60	TB	1375	TB: 250	-
	S2B	800	10			TB	<125		
	S2C	800	10			TB	250		
Sample Point 2	S2A	800	10	11:04 – 12:04	60	AF	<125	AF: <125	-
	S2B	800	10			AF	<125		
	S2C	800	10			AF	250		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ *Aspergillus fumigatus* (AF) = 500 CFU/m³

Below permit limit	Exceeds permit limit
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Table 8. Sample Point 3: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:		Esholt, Yorkshire		Site Operator:		Yorkshire Water Services Ltd		Job Number 113785	
Date:		22/08/22		Commissioning Laboratory:		EMT Environmental		Waste Water	
Activities affecting Bioaerosol Conc ¹		None		Types of materials processed on site:		Calculated concentration of airborne microorganisms (CFU/m ³) ^a		Median of parallel samples (CFU/m ³)	
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated concentration of airborne microorganisms (CFU/m ³) ^a	Median of parallel samples (CFU/m ³)	Comments
Sample Point 3	S3A	600	10			TB	1125		Activities of site operative laying cake in the area.
	S3B	600	10	11:17 – 12:17	60	TB	<125	TB: 1125	
	S3C	600	10			TB	1375		
Sample Point 3	S3A	600	10			AF	<125		-
	S3B	600	10	11:17 – 12:17	60	AF	<125	AF: <125	
	S3C	600	10			AF	<125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 9. Sample Point 4: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms										
Site:		Esholt, Yorkshire				Site Operator:		Yorkshire Water Services Ltd		Job Number 113785
Date:		23/08/22		Commissioning Laboratory:		Waste Water		EMT Environmental		
Activities affecting Bioaerosol Conc ⁿ		None		Types of materials processed on site:		Waste Water		Comments		
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated airborne microorganisms (CFU/m ³)	Median of parallel samples (CFU/m ³)		
Sample Point 4	S4A	40	10			TB	125			
	S4B	40	10	10:07 – 11:07	60	TB	750	TB: 625	-	
	S4C	40	10			TB	625			
Sample Point 4	S4A	40	10			AF	<125			
	S4B	40	10	10:07 – 11:07	60	AF	250	AF: <125	-	
	S4C	40	10			AF	125			

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ *Aspergillus fumigatus* (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 10. Sample Point 5: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms									
Site:			Site Operator:		Job Number: 113785				
Esholt, Yorkshire			Yorkshire Water Services Ltd		EMT Environmental				
Date:			Commissioning Laboratory:						
23/08/22			Waste Water						
Activities affecting Bioaerosol Conc ⁿ			Types of materials processed on site:						
None			Calculated concentration of airborne microorganisms (CFU/m ³)*						
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Median of parallel samples (CFU/m ³)	Comments	
Sample Point 5	S5A	150	160	10:51 – 11:51	60	TB	3250	Construction was happening close by sample location.	
	S5B	150	160			TB	1325		TB: 1500
	S5C	150	160			TB	1500		
Sample Point 5	S5A	150	160	10:51 – 11:51	60	AF	125	-	
	S5B	150	160			AF	<125		AF: <125
	S5C	150	160			AF	<125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 11. Sample Point 6: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms							
Site:			Esholt, Yorkshire		Job Number 113785		
Date:			23/08/22		Yorkshire Water Services Ltd		
Activities affecting Bioaerosol Conc ⁿ			None		EMT Environmental		
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Commissioning Laboratory:		
					Sampling duration (mins)	Microbial Type	
					Calculated concentration of airborne microorganisms (CFU/m ³)*	Median of parallel samples (CFU/m ³)	
Sample Point 6	S6A	400	120		TB	125	TB: <125
	S6B	400	120	11:00 – 12:00	TB	100	
	S6C	400	120		TB	875	
Sample Point 6	S6A	400	120		AF	<125	AF: <125
	S6B	400	120	11:00 – 12:00	AF	125	
	S6C	400	120		AF	<125	

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ *Aspergillus fumigatus* (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 12. Sample Point 7: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms

Site:		Esholt, Yorkshire		Job Number 113785			
Date:		23/08/22		Yorkshire Water Services Ltd			
Activities affecting Bioaerosol Conc ⁿ		None		EMT Environmental			
Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Commissioning Laboratory:		Comments
					Sampling duration (mins)	Microbial Type	
				Types of materials processed on site:		Median of parallel samples (CFU/m ³)	
				Calculated concentration of airborne microorganisms (CFU/m ³)*	Waste Water		
Sample Point 7	S7A	800	170		TB	1750	
	S7B	800	170	11:11 – 12:11	TB	500	TB: 1750
	S7C	800	170		TB	4500	
Sample Point 7	S7A	800	170		AF	<125	
	S7B	800	170	11:11 – 12:11	AF	<125	AF: <125
	S7C	800	170		AF	<125	

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ Aspergillus fumigatus (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 13. Sample Point 8: Bioaerosol monitoring – Estimated Concentrations of Airborne Micro-organisms
Esholt, Yorkshire

Location	Sample REF	Distance from centre of operational area (m)	Difference in bearing between location of samplers from boundary and mean direction wind blows to (degrees °)	Sampling Times	Sampling duration (mins)	Microbial Type	Calculated airborne microorganisms (CFU/m ³)	Median of parallel samples (CFU/m ³)	Comments
Sample Point 8	S8A	450	180	11:21 – 12:21	60	TB	125	TB: 125	-
	S8B	450	180			TB	125		
	S8C	450	180			TB	<125		
Sample Point 8	S8A	450	180	11:21 – 12:21	60	AF	<125	AF: <125	-
	S8B	450	180			AF	<125		
	S8C	450	180			AF	125		

* Site permit limits: Total Bacteria (TB) = 1000 CFU/m³ *Aspergillus fumigatus* (AF) = 500 CFU/m³

Below permit limit

Exceeds permit limit

Table 6. Controls and Filter Counts - Bioaerosol monitoring

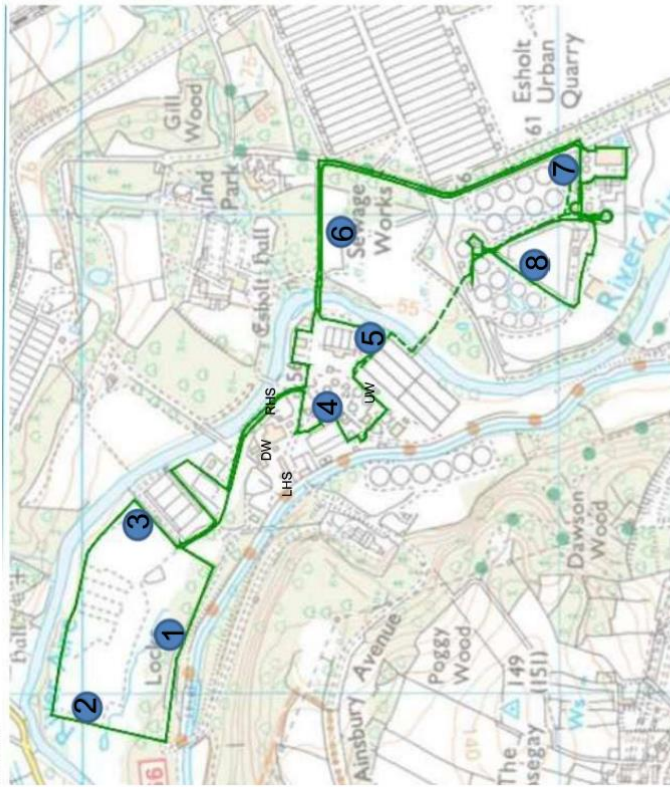
Site: Esholt, Yorkshire		Date: 23/08/22	Site Operator : Yorkshire Water Services Ltd		Commissioning Laboratory : EMT Environmental	Job Number: 113785
Location	Sample Ref Number	Microbial Type	Average Count of microorganisms (CFU/filter)	Types of materials processed on site : Waste Water		
Upwind	UW1	TB	20			None received
		AF	0			
Upwind	UW2	TB	4			None received
		AF	1			
Upwind	UW3	TB	1			None received
		AF	0			
Downwind	DW1	TB	1			None received
		AF	0			
Downwind	DW2	TB	26			None received
		AF	0			
Downwind	DW3	TB	1			None received
		AF	0			
Downwind Left Hand Fan	LHS1	TB	7			None received
		AF	0			
Downwind Left Hand Fan	LHS2	TB	0			None received
		AF	0			
Downwind Left Hand Fan	LHS3	TB	0			None received
		AF	0			
Downwind Right Hand Fan	RHS1	TB	0			None received
		AF	0			
Downwind Right Hand Fan	RHS2	TB	0			None received
		AF	0			
Downwind Right Hand Fan	RHS3	TB	1			None received
		AF	0			

5. Plan

A standard map is shown on the next page. The operational boundary of the site is shown in red and the sample points are shown and labelled.

Bioaerosol Monitoring – Estimated Concentrations of Airborne Micro Organisms		Job Number 113785
Site	Esholt, Yorkshire	Site Operator Yorkshire Water Services Ltd
Date	23/08/22	Commissioning Laboratory EMT Environmental
Types of materials processed on site	Municipal solid waste	

Site boundary marked on in Green.



6. Discussion

Samples for this monitoring were collected using the filter option of the guidance document M9.

It is important to continue to monitor the site. It would be particularly useful to monitor on a day when the prevailing wind is in a different direction.

Whilst it is possible to replicate the sampling points, many other variables will have changed such as temperature, wind speed and wind direction. As such this monitoring is only a snapshot of the situation on site, not a complete picture. The sampling should be carried out at least quarterly to build up an idea of the characteristics of the site.

There were no nearby activities observed which could adversely impact the upwind results.

All up wind and downwind results for total bacteria and *Aspergillus fumigatus* (AF) were below the limits. Some individual filter results were above the 1000 cfu/m³ limit for total bacteria but the median result at all locations was below.

Fixed points 3, 5 and 7 were all above the limit for total bacteria and below the limit for *Aspergillus fumigatus* (AF). Fixed point 3 results are considered to be influenced by site activities of operatives adding to cake piles close to the fixed sample location and fixed point 5 results are considered to be influenced by construction activities occurring close by the location. No significant activities were observed near fixed point 7.

All other fixed point were below the limit for total bacteria and *Aspergillus fumigatus* (AF). Some individual filter results were above the 1000 cfu/m³ limit for total bacteria but the median result at all locations was below.

It should be noted that the fixed points were undertaken in addition to the required sampling locations at the request of Yorkshire Water.

7. Conclusions

Element Materials Technology Environmental UK Limited was commissioned by Yorkshire Water Services Ltd to carry out a bioaerosol monitoring exercise at the Waste Water Treatment Works at their site in Esholt, Yorkshire.

Measurements were carried out in accordance with parameters specified in Technical Guidance Note M9 'Environmental monitoring of bioaerosols at regulated facilities'. Of the methods suggested in the protocol, the filter method was utilised in this project.

All upwind and downwind sampling results for total bacteria and *Aspergillus fumigatus* (AF) were below the limits.

Fixed points 3, 5 and 7 were all above the limit for total bacteria and below the limit for *Aspergillus fumigatus* (AF). All other fixed point were below the limit for total bacteria and *Aspergillus fumigatus* (AF).

The site would be due to be re-assessed in November 2022 assuming the standard frequency requested by the Environment Agency.

Appendix 1. Analysis Certificates

ELE/22/12
Issue no.1University of
Hertfordshire
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AL10 9AB**Biodet**Direct line 01707 284545
Laboratory 01707 284522
Fax 01707 285046Abi Pickard
Element Materials Technology,
Lawton Square,
Delph,
Oldham,
OL3 5DT

Our Ref: ELE/22/12

Date: 7th September 2022**BIOAEROSOL EXPOSURE REPORT**Log No. 2942
Sample date: 23rd August 2022
Engineer: Abigail Pickard
Job no.: 113785Thirty-eight IOM bioaerosol exposure heads were received on 24th August 2022.
Occupational exposure events were monitored:

Sample no.	Sample ID	Date	Volume (litres)
Bio1	S1A	23/08/2022	120
Bio2	S1B	23/08/2022	120
Bio3	S1C	23/08/2022	120
Bio4	S2A	23/08/2022	120
Bio5	S2B	23/08/2022	120
Bio6	S2C	23/08/2022	120
Bio7	S3A	23/08/2022	120
Bio8	S3B	23/08/2022	120
Bio9	S3C	23/08/2022	120
Bio10	S4A	23/08/2022	120
Bio11	S4B	23/08/2022	120
Bio12	S4C	23/08/2022	120
Bio13	S5A	23/08/2022	120
Bio14	S5B	23/08/2022	120
Bio15	S5C	23/08/2022	120
Bio16	S6A	23/08/2022	120
Bio17	S6B	23/08/2022	120
Bio18	S6C	23/08/2022	120
Bio19	S7A	23/08/2022	120
Bio20	S7B	23/08/2022	120
Bio21	S7C	23/08/2022	120
Bio22	S8A	23/08/2022	120

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Bio23	S8B	23/08/2022	120
Bio24	S8C	23/08/2022	120
Bio25	UW1	23/08/2022	120
Bio26	UW2	23/08/2022	120
Bio27	UW3	23/08/2022	120
Bio28	RHS1	23/08/2022	120
Bio29	RHS2	23/08/2022	120
Bio30	RHS3	23/08/2022	120
Bio31	DW1	23/08/2022	120
Bio32	DW2	23/08/2022	120
Bio33	DW3	23/08/2022	120
Bio34	LHS1	23/08/2022	120
Bio35	LHS2	23/08/2022	120
Bio36	LHS3	23/08/2022	120
Bio37	Blank 1	23/08/2022	n/a
Bio38	Blank 2	23/08/2022	n/a

The IOM heads containing a polycarbonate filter were used to determine the bioaerosol exposure under the test conditions. Upon arrival at the laboratory the bioaerosols impacted on each filter were recovered in 3 ml maximum recovery diluent. The target micro-organisms were cultured using appropriate dilutions on the following media.

Nutrient agar (NA) agar plates were used for total bacteria.
Malt extract agar (MEA) agar plates were used for *Aspergillus fumigatus*.

The samples were incubated for 2 days at 37C (total bacteria) and for 2 days at 44C (*Aspergillus fumigatus*).



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Results:

Job number 113785
Date 23rd August 2022
Comments: All polycarbonate filters and filter heads were in good condition.

Table 1. Microbiological Culture Plate Data:

Sample no.	Sample ID	Volume (litres)	Total Bacteria (cfu per plate)	Total <i>Aspergillus fumigatus</i> (cfu per plate)
Bio1	S1A	120	2, 2	0, 0
Bio2	S1B	120	0, 0	0, 1
Bio3	S1C	120	0, 0	0, 0
Bio4	S2A	120	7, 4	0, 0
Bio5	S2B	120	0, 0	0, 0
Bio6	S2C	120	2, 0	1, 1
Bio7	S3A	120	5, 4	0, 0
Bio8	S3B	120	0, 0	0, 0
Bio9	S3C	120	5, 6	0, 0
Bio10	S4A	120	1, 0	0, 0
Bio11	S4B	120	4, 2	2, 0
Bio12	S4C	120	3, 2	0, 0
Bio13	S5A	120	13, 13	1, 0
Bio14	S5B	120	6, 5	0, 0
Bio15	S5C	120	6, 6	0, 0
Bio16	S6A	120	1, 0	0, 0
Bio17	S6B	120	5, 3	1, 0
Bio18	S6C	120	5, 2	0, 0
Bio19	S7A	120	8, 6	0, 0
Bio20	S7B	120	2, 2	0, 0
Bio21	S7C	120	19, 17	0, 0
Bio22	S8A	120	1, 0	0, 0
Bio23	S8B	120	1, 0	0, 0
Bio24	S8C	120	0, 0	0, 0
Bio25	UW1	120	0, 0	0, 0



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Bio26	UW2	120	3, 1	1, 0
Bio27	UW3	120	1, 0	0, 0
Bio28	RHS1	120	0, 0	0, 0
Bio29	RHS2	120	0, 0	0, 0
Bio30	RHS3	120	1, 0	0, 0
Bio31	DW1	120	1, 0	0, 0
Bio32	DW2	120	14, 12	0, 0
Bio33	DW3	120	1, 0	0, 0
Bio34	LHS1	120	7, 0	0, 0
Bio35	LHS2	120	0, 0	0, 0
Bio36	LHS3	120	0, 0	0, 0
Bio37	Blank 1	n/a	0, 0	0, 0
Bio38	Blank 2	n/a	0, 0	0, 0

Table 2. Microbiological Results:

Sample no.	Sample ID	Volume (litres)	Total Bacteria (cfu per m ³)	Total <i>Aspergillus fumigatus</i> (cfu per m ³)
Bio1	S1A	120	500	<125
Bio2	S1B	120	<125	125
Bio3	S1C	120	<125	<125
Bio4	S2A	120	1375	<125
Bio5	S2B	120	<125	<125
Bio6	S2C	120	250	250
Bio7	S3A	120	1125	<125
Bio8	S3B	120	<125	<125
Bio9	S3C	120	1375	<125
Bio10	S4A	120	125	<125
Bio11	S4B	120	750	250
Bio12	S4C	120	625	125
Bio13	S5A	120	3250	125
Bio14	S5B	120	1325	<125
Bio15	S5C	120	1500	<125



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Bio16	S6A	120	125	<125
Bio17	S6B	120	1000	125
Bio18	S6C	120	875	<125
Bio19	S7A	120	1750	<125
Bio20	S7B	120	500	<125
Bio21	S7C	120	4500	<125
Bio22	S8A	120	125	<125
Bio23	S8B	120	125	<125
Bio24	S8C	120	<125	<125
Bio25	UW1	120	<125	<125
Bio26	UW2	120	500	125
Bio27	UW3	120	125	<125
Bio28	RHS1	120	<125	<125
Bio29	RHS2	120	<125	<125
Bio30	RHS3	120	125	<125
Bio31	DW1	120	125	<125
Bio32	DW2	120	3250	<125
Bio33	DW3	120	125	<125
Bio34	LHS1	120	875	<125
Bio35	LHS2	120	<125	<125
Bio36	LHS3	120	<125	<125
Bio37	Blank 1	Per membrane	<15	<15
Bio38	Blank 2	Per membrane	<15	<15

Exposure results are expressed as total micro-organisms per cubic metre collected during the exposure time.



BIODET

7th September 2022