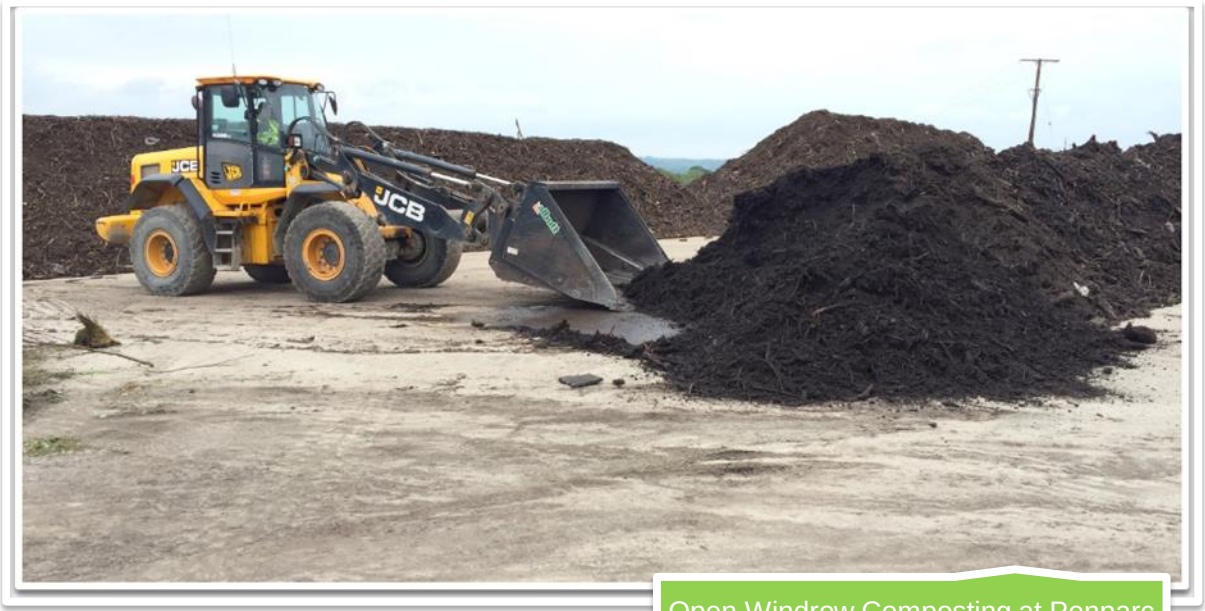
MD Recycling Bioaerosols Report October 2016

Final

Produced for **MD Recycling**

Project Reference **[0637/M15]**



Open Windrow Composting at Penparc

WRM

A Sustainable Future. Today.

www.wrm-ltd.co.uk

01943 468138

QUALITY CONTROL

Document Title:	Bioaerosol Report
Revision:	Final
Date:	08/11/2016
Document Reference:	BAR-MDR
Prepared For:	MD Recycling
Project Reference:	WRM/0637/M15
Copyright:	WRM Ltd © 2016

Quality Control Sign Off		
Document Author	Adam Newman	
Quality Reviewer	Ben Brown	

CONTENTS

1.0 INTRODUCTION

WRM Ltd has been commissioned by MD Recycling to undertake bioaerosol monitoring on the 25th October 2016. Bioaerosol monitoring has been undertaken following the AfOR Standardised Protocol 2009 Edition[1].

Site Address:
Crugmor Farm
Cardigan
Ceredigion
SA43 1QY

The site is located in Cardigan, South Wales (Easting = 219829, Northing = 246850).

Sampling was undertaken by Adam Newman (MSc) of WRM. WRM staff have several years of experience within the industry and have been trained by microbiologists who specialise in the field of bioaerosol monitoring.

1.1 Definitions

1.1.1 Composting

"Composting is a method of waste management based in the biological degradation and stabilization of organic matter under aerobic conditions. It results in a sanitised and stabilised product, rich in humic substances that can be used as fertilizer"[2].

1.1.2 Bioaerosols

"Aerosols are liquid or solid particles suspended in a gaseous medium with size ranges from 0.001 to 100µm. Bioaerosols consists of aerosols containing microorganisms (bacteria, fungi, viruses) or organic compounds derived from microorganisms (endotoxins, metabolites, toxins and other microbial fragments). Bioaerosols vary in size (20nm to 100µm) and composition depending on the source, aerosolisation mechanisms, and environmental conditions prevailing at the site"[3].

Bioaerosols are defined as aerosols, aeroallergens, or particulate matter of microbiological, plant or animal origin. Bioaerosols can interact with living systems through infective, allergenic and/or toxic mechanisms. The biological agents that have been examined in relation to bioaerosol exposures associated with waste handling and treatment processes include pathogenic and non-pathogenic spores, live (viable) or dead (non-viable) bacteria, fungi,

[1] Association of Organics Recycling (2009) 'A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities' *ed. T. Gladding for the Association of Organics Recycling*

[2] Wery, N. (2014) 'Bioaerosols from composting facilities – a review'. *Frontiers in Cellular and Infection Microbiology.* P1:42.

[3] Mandal, J and Brandl, H. (2011) 'Bioaerosols in Indoor Environment – A review with special reference to residential and occupational locations. *The Open Environmental & Biological Monitoring Journal.* P83:4.

viruses, bacterial endotoxins, mycotoxins, and peptidoglycans. Although other types of biological component may also be present as airborne particles such as algal fragments, protozoa and nematodes, these have not been considered in studies of bioaerosols emitted by the waste industry to date[4].

The potential for particulates to be liberated from organic waste treatment sites does exist. Airborne dusts and so bioaerosols are likely to be aerosolised by the handling of the waste materials accepted on site, their storage and movement and by meteorological conditions (presence or absence of precipitation, wind, etc.). Bioaerosols are aerosolised as clumps, aggregates and attached to larger mineral particles in the TSP size range[5]. Hence they generally settle fairly rapidly, i.e. within a minute or two and within 250m of the point of generation. Weather conditions can also affect generation and aerosolisation. Viability can deteriorate according to temperature, humidity and sunlight. Die off is generally exponential, although non-viable (dead) microorganisms may still be able to cause health effects (allergenic/toxic effects in sufficient concentrations). However, the standard protocol for England and Wales[4] and the majority of data at present utilises counts of viable micro-organisms.

It is important to note other activities and environments can affect local concentrations of bioaerosols. In terms of published scientific literature, a range of authors report natural concentrations of bacteria and fungi routinely range from 1000 to 100,000 (10_3 to 10_5) cfu/m^3 air[6]. An investigation of an open windrow site reported high measurements of fungi off-site in wet woodland comparable to on-site. Additionally, it was reported that mowing a nearby meadow also significantly affected results of viable fungi and bacteria (160 and 480 respectively prior to mowing, 15.0 x 10_3 cfu/m_3 and 17.6 x 10_3 cfu/m_3 after)[7].

[4] Defra (2009) *Exposure response relationships for bioaerosol emissions from waste treatment processes WR0606*.

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

[6] Cox C.S., Wathes C. M. ed. (1995) 'The Bioaerosols Handbook' Lewis Publications Ltd

[7] Frederickson, J.; Boardman, C. P.; Gladding, T. L.; Simpson, A. E.; Howell, G. and Sgouridis, F. (2013). Evidence: Biofilter performance and operation as related to commercial composting. Environment Agency, Bristol.

2.0 SAMPLING SITE

MD Recycling operate an open windrow composting facility with the capacity to receive up 75 tonnes per day. On the day of the monitoring event (25/10/16) there were approximately 480 tonnes of material on site, of which 480 tonnes were being processed and 0 tonnes were finished compost.

The site is based in a rural setting with mainly agricultural fields surrounding the site. Adjacent to the south east boundary is an Anaerobic Digestion Plant which processes food wastes. The Anaerobic Digestion Plant is on MD Recycling's property; however, it is operated by a different company.

There are several sensitive receptors within 250m of the site boundary which is the Environment Agency policy for risk associated with bioaerosols[8]. Table 1 and Figure 1 below show the sensitive receptors and their distance to the nearest site boundary:

Table 1 - Nearest Sensitive Receptor to Operational Boundary

Receptor	Distance
Residential Property	220m from the composting pad
Commercial AD Facility	60m from the composting pad

2.1 Sampling Locations

Bioaerosol monitoring was undertaken at 3 locations across the site at MD Recycling. Sampling was conducted at an upwind and downwind location as well as at a sensitive receptor (the AD Facility), in order to ascertain the level of bioaerosols at each location. These monitoring locations are detailed in Figure 1, with each sampling location superimposed upon a plan of the site. Photographs of each of the monitoring locations are provided (Image 1, 2 and 3).

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

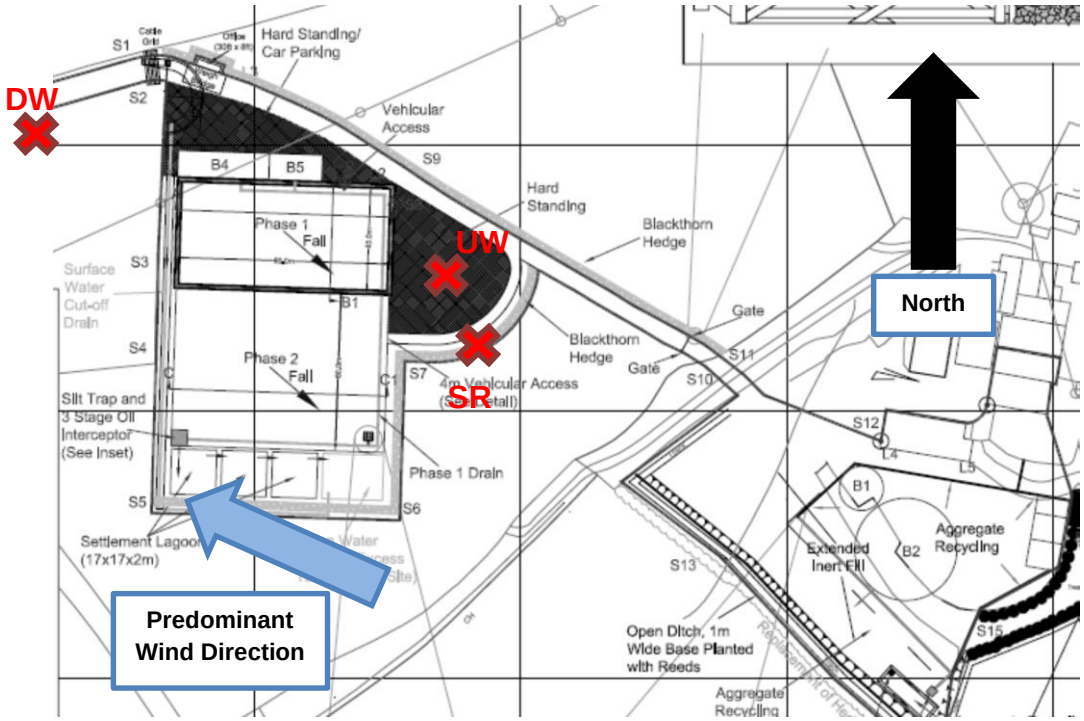


Figure 1 - Wind Direction and Sampling Points on 29/09/2016

2.1.1 Upwind Location (UW)

Monitoring occurred 50m upwind of the composting pad in line with the AfOR protocol. Over the course of the monitoring event the predominant wind direction blew towards a bearing of between 280º and 300º from true North. There was no apparent composting odour (Intensity 0, H4 Guidance) detected during the monitoring event. Site activity during the monitoring event constituted the delivery of green waste to the site and the movement and tipping of green waste by on site machinery.

2.1.2 Downwind Location (DW)

Monitoring took place 60m downwind of the composting pad. The filters were placed adjacent to an access road to the AD facility. Over the course of the monitoring event the predominant wind direction blew towards a bearing of between 280º and 300º from true North. A low composting odour (Intensity 1, H4 Guidance) was detected. Site activity during the monitoring event constituted the delivery of green waste to the site and the movement and tipping of green waste by on site machinery.

2.1.3 Sensitive Receptor (SR)

Monitoring took place 60m from the composting pad. The filters were placed so that they were facing the SR. Over the course of the monitoring event the predominant wind direction blew towards a bearing of between 280º and 300º from true North. Site activity during the monitoring event constituted the delivery of green waste to the site and the movement and tipping of green waste by on site machinery.

.
Image 1- UW Monitoring Location

Image 2- DW Monitoring Location

Image 3- SR Monitoring Location

2.2 Feedstock Accepted at the Site

Table 2 below indicates the types of feedstock accepted on site and which waste type is expected during the different seasons. Feedstock changes throughout the year and changing the feedstock ratios will reduce the amount of bioaerosol release.

Table 2 - Feedstock Accepted on Site

Waste Source	Seasonal Variation
Kerbside collected green waste.	**April – September:** Increasing grass clippings content (typically peaking at 40%+ in May-June from experience). Short, sharp, tonnage surges possible (e.g. collections around bank holiday weekends) Accordingly, loads increasingly compacted due to material density.
	October - March: Increase in "woody" type materials (branches etc.), resulting in higher C:N ratios.
Civic amenity green waste.	**April – September: I**ncreasing grass clippings content (peaking at 40%+ in May - June). Short, sharp, tonnage surges possible over bank holiday weekends. Accordingly, loads increasingly compacted due to material density, and contractors desire to maximise bin weights / payloads. Potential for waste to be kept in warm conditions prior to delivery (waste exposed to direct sunlight in site bins).

Waste Source	Seasonal Variation
	October - March: Increase in "woody" type materials (branches etc.), resulting in higher C:N ratios. Potential for significant "spike" post-Christmas (disposal of Christmas trees).
Commercial green waste.	**April – September:** Increasing grass clippings content (typically peaking at 40%+ in May – June from experience). Accordingly, loads increasingly compacted due to material density. Potential for waste to be kept in warm conditions prior to delivery (waste exposed to direct sunlight prior to delivery).
	October to March: Increase in "woody" type materials (branches etc.), resulting in higher C:N ratios.

3.0 METHODOLOGY

The method used in this investigation is formed from the Composting Association guidance[9], Association of Organics Recycling standardised protocol guidance[10] and from research undertaken for the Environment Agency on composting sites[11].

This report uses a sampling technique which is comparable throughout the country. IOM sampling was undertaken following the AfOR Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities.

3.1 Calibration of Equipment

Prior to each visit the pumps are calibrated with a certified reference volume meter – 'rotameter' which has an accuracy rating of more than ±2 per cent expressed in operational cubic meters, referenced to ambient air conditions. The rotameter is connected to the filter head and rotameter head, this is then connected to the pump which is set at 2000ml/minute and is run for 10 minutes. The flow rate is adjusted if required.

3.2 Viable Counts – Filters

The sampling was undertaken following the approach set out in the AfOR protocol (2009)[12]. The SKC IOM cassettes were loaded with a 25mm 0.8µm polycarbonate filter. The flow rate of the IOM pump was operated at 2.0 ± 0.1 litre/min. Pumps were charged until full and calibrated to within ±2 per cent of 2l/min (SKC Group). The IOM filter is weighed prior to being loaded and after loading. To provide field blanks, two controls were loaded but not exposed. The filters at all monitoring points sampled for 45 minutes. The start and stop times of each were recorded for accuracy. Each sampling head was mounted on a tripod in a horizontal hanging position at a height of 1.5m as per the protocol, each IOM head was spaced approximately 20cm apart. After the monitoring had taken place the filters were transported to the laboratory at temperatures of 4^{o}C.

3.3 Laboratory Enumeration

The IOM heads containing a polycarbonate filter were used to determine the bioaerosol exposure under the test conditions. Upon arrival at the University of Hertfordshire laboratory located in Hatfield the bioaerosols impacted on each filter were recovered. The target micro-organisms were cultured using appropriate media.

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

[9]Gilbert E. J., Ward C. W., Crook B., Fredrickson J., Garrett A. J., Gladding T. L., Newman A. P., Olsen P., Reynolds S., Stentiford E., Sturdee T., Wheeler P. (1999) 'The Research and Development of a Suitable Monitoring Protocol to Measure the Concentration of Bioaerosols at Distances From Composting Sites" leading to the publication "Standardised Protocol for the Sampling and Enumeration of Airborne Microorganisms at Composting Facilities' ISBN: 0 9532546 2

[10]Association of Organics Recycling (2009) 'A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities' *ed. T. Gladding for the Association of Organics Recycling*

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

[12]Association of Organics Recycling (2009) 'A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities' *ed. T. Gladding for the Association of Organics Recycling*

Samples were incubated for 2 days at 37^0C (total mesophilic bacteria) and 2 days at 40^0C (*Aspergillus fumigatus).* Identification of *Aspergillus fumigatus* was performed by microscopy.

All filters were extracted from the cassettes (including the two blanks which were retained from the visit) as per the protocol in a controlled and sterilised environment. After the incubation period of 48 hours (see above) the numbers of colonies were counted and the total number of colonies was expressed as colony-forming units (cfu/m^3). Colony-forming units were also counted after 7 days, in line with the AfOR standard protocol[13]. Bioaerosol recovery was conducted in line with the IOM operating instructions, 5ml of recovery solution was utilised to wash the filters in. The blank filters were loaded onto plates in the same way as the filters which had undergone bioaerosol monitoring. The blank filters show any contamination errors which could occur during sampling.

3.4 Sampling Points

All sampling was undertaken during one visit. The sampling points were dependent upon the AfOR protocol and the direction of the wind. This included points upwind of the site, downwind of operations whereby, screening and material was being transported to the external composting pad.

On the day of sampling and one point was chosen at the nearest sensitive receptor. At each point three filters were used as per the AfOR protocol. Pumps were run for five minutes prior to sampling taking place and each pump was checked on a rotameter to ensure each pump was running at the correct flow rate (one unloaded IOM head is used and kept with the calibration equipment). After calibration the pumps are operated for 45 minutes at each location and started within 30 seconds of each other. After sampling had finished at each point the filters were removed from the IOM head, wrapped in tinfoil and marked and stored in a sealed bag within a container overnight. Processing took place within 24 hours of monitoring.

3.5 Meteorological Conditions on the Day of Sampling

A Davis Vantage Pro 2 was used to collect data once a minute over the entire period on site. The data logged included temperatures, relative humidity, wind speed and wind direction. The weather station is situated above the site office, ~6m from the ground. To ensure upwind and downwind locations are correct other physical evidence such as odour are taken into account. Relative humidity and temperature were also recorded using a hand held data logger. Cloud cover and general weather conditions were recorded manually. All meteorological data are presented in Appendix 1.

- Wind speed ranged from 2.4 m/s to 6.7 m/s with an average speed of 3.6m/s.
- The wind direction at the UW, DW and SR locations fluctuated between blowing towards 280º and 300º (W-NW) with average wind speeds of 3.6 m/s.

[13] Association of Organics Recycling (2009) 'A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities' *ed. T. Gladding for the Association of Organics Recycling*

3.6 Site Activities

During the monitoring event material was being delivered to the site and material on the composting pad was being tipped and moved.

3.7 Tonnage on Site

- Active Composting - 480 tonnes
- Finished - 0 tonnes

3.7.1 Other Activities

Upwind: Entry and exit of site, by vehicles, using access road.

Downwind: Entry and exit of site, by vehicles, using access road.

Sensitive Receptor: Entry and exit of site, by vehicles, using access road. The AD Facility was in operation throughout the monitoring event.

3.8 Transportation Conditions

After sampling was concluded, filters were placed into their protective cassettes, wrapped individually in tin foil and placed in a resealable plastic bag. In total 4 of these bags were used, one to store the 3 UW samples, one to store the 3 DW samples, one to store the 3 SR samples (pictured) and one to store the 2 blank controls. All four of these bags containing samples were then place in a Tupperware box, to protect from disturbing impacts. The Tupperware box was placed in a cool box to ensure that the samples were stored in darkness and at a temperature of 4^0C. The cool box containing the samples was stored securely in the car boot during transit. Temperature and humidity conditions in the car boot were recorded using a temperature/humidity probe. These readings were taken twice and are displayed in Table 3. Temperature and humidity readings were also taken in the cool box (Table 4).

Immediately after samples were collected and stored in the aforementioned conditions, they were driven, by Adam Newman, from the MD Recycling to the laboratory (BIODET) in Hatfield, Hertfordshire. The samples were in transit for approximately 5 hours 10 minutes. Sampling concluded at 10.05am. The samples left the site at 10.13am. The samples were delivered to BIODET at 15.30pm. Laboratory analysis began on the same afternoon.

Table 3- Temperature and Humidity conditions of car boot during transit

Time	Temperature (^{0}C)	Humidity (%)	Trip duration
10.10	7	43.2	5 hours 10 minutes
15.20	9	47.6	5 hours 10 minutes

.

Table 4- Temperature and Humidity conditions of the cool box during transit

Time	Temperature (^{0}C)	Humidity (%)	Trip duration
10.10	4	36.5	5 hours 10 minutes
15.20	5	37.4	5 hours 10 minutes

4.0 RESULTS

4.1 Environmental Conditions

Table 3 below presents the average weather conditions across the whole time on site. Full results are presented in Appendix 1.

Table 4 - Weather Conditions during Bioaerosol Monitoring

Date	Weather/Rain	Cloud Cover (8th)	Temperature (ºC)	Relative Humidity (%)	Windspeed (m/s)
25/10/2016	Dry, Moderate breeze (4, Beaufort scale)	8/8	9.8	46.7	3.6

During monitoring the weather was dry with a moderate breeze and it had been mainly dry for the previous 24 hours – see Appendix 1. The average wind direction blew towards 280 degrees (WNW). Wind speeds were recorded from 2.4 m/s to 6.7 m/s. The detection of odour and other physical characteristics of the wind ensured that the sampling of the downwind location was in the correct place, this will be seen in the results.

4.2 Current Limits

According to the EA[14], acceptable levels of bioaerosols are as follows:

1) Total bacteria 1,000 cfu/m^3
2) Thermophilic fungus *Aspergillus fumigatus* 500 cfu/m^3

4.3 Microbiological Results

Table 5 and Table 6 show all viable counts of micro-organisms on the IOM Filter samples for bacteria and fungi. Table 7 and Table 8 show the amount of micro-organisms per cubic metre (m^3). All samples can be seen in Appendix 2.

To calculate the arithmetic mean, an average of the original colony counts using duplicate spread plates was conducted. Natural viability in a sample size this small will not affect average concentrations to any great degree.

Two controls were loaded and not exposed during the sampling period. There was no contamination found per membrane for bacteria or fungi.

[14]Environment Agency (2009) 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities' *Environment Agency for England and Wales*

Table 5– Bacteria Count, Exposure 45 minutes

Sample No.	Details of Siting	cfu per plate	Time (pm)	Bearing of samplers (°)	Mean direction wind blows to (°)	Difference between wind and bearing
1 2 3	Upwind 50m	0, 0 4, 0 1, no result	8.25-9.10	100	280	180
4 5 6	Downwind 60m	1, 1 0, 0 76, 132	8.25-9.10	280	280	0
7 8 9	Sensitive Receptor 60m	0, 0 1, 0 1, 0	9.20-10.05	110	300	190

Table 6 – Aspergillus Fumigatus Count, Exposure 45 minutes

Sample No.	Details of Siting	cfu per plate	Time	Bearing of samplers (°)	Mean wind direction (°)	Difference bearing and wind direction (°)
1 2 3	Upwind 50m	0, 0 0, 0 0, 0	8.25-9.10	100	280	180
4 5 6	Downwind 60m	0, 0 0, 0 0, 0	8.25-9.10	280	280	0
7 8 9	Sensitive Receptor 60m	0, 0 0, 0 0, 0	9.20-10.05	110	300	190

Table 7. Total amounts of Mesophilic Bacteria (cfu/m^3)

Sample No.	Details of Siting	cfu/m^3	Arithmetic Mean	Time	Bearing of samplers (°)	Mean wind direction (°)	Difference bearing and wind direction (°)
1 2 3	Upwind 50m	<280 1,110 560	556	8.25-9.10	100	280	180
4 5 6	Downwind 60m	560 <280 57,780*	278	8.25-9.10	280	280	0
7 8 9	Sensitive Receptor 60m	<280 280 280	185	9.20-10.05	110	300	190

*- Result for sample 6 (57,780) is considered to be an anomalous result (see discussion). The arithmetic mean for the DW samples was calculated using only sample 4 and 5.

Table 8. Total amounts of Fungi (cfu/m^3)

Sample No.	Details of Siting	cfu/m^3	Arithmetic Mean	Time	Bearing of samplers (°)	Mean wind direction (°)	Difference bearing and wind direction (°)
1 2 3	Upwind 50m	<280 <280 <280	0	8.25-9.10	100	280	180
4 5 6	Downwind 60m	<280 <280 <280	0	8.25-9.10	280	280	0
7 8 9	Sensitive Receptor 60m	<280 <280 <280	0	9.20-10.05	110	300	190

5.0 DISCUSSION

Table 9 – EA Guideline Limits against on site bioaerosol levels[15]

	EA Guideline Limits (cfu/m^3)	Upwind/SR (cfu/m^3)	Downwind (cfu/m^3)	Sensitive Receptor (cfu/m^3)
Bacteria	1,000	556	278	185
Fungi	500	0	0	0

As shown in Table 9, bacteria and fungi levels were below EA Guideline limits[13] at all sampling locations. The results were below the limit of detection at both the downwind and sensitive receptor locations.

The result for sample 6 of 57,780 cfu/m^3 is considered to be anomalous and was therefore excluded from the calculation of the arithmetic mean for the DW location. The result for sample 6 is likely to have been cause by aggregation of bioaerosols. This result is considered to be anomalous because the it is approximately 57 orders of magnitude greater than the results for samples 4 and 5, which were both collected at the same location as sample 6. Furthermore, comparison of the results for this monitoring event with previous monitoring events at MD Recycling, demonstrates that this result is considerably greater than anything else that has been recorded. Table 10 presents previous bacteria levels at MD Recycling.

Table 10- Mean Bacteria levels recorded at previous monitoring events (cfu/m^3)

Date of Sampling	Upwind (cfu/m^3)	Downwind (cfu/m^3)	Sensitive Receptor (cfu/m^3)
26/11/2015	111	222	111
26/05/2016	0	37	37
11/08/2016	592	481	1,258

The highest level of bacteria recorded during previous monitoring events was 1,258 cfu/m^3 at the SR on 11/08/16. Consideration of previous monitoring events in addition to the similar levels recorded on samples 4 and 5 (Table 7) during the current monitoring event strengthens the claim the sample 6 is an anomalous result.

The total results have been plotted to demonstrate the minimum and maximum counts per filter at each upwind, downwind and sensitive receptor location for each monitoring event combined. Each filter result per monitoring location (i.e. 3 filter results per upwind, downwind and sensitive receptor) have been analysed for min, max and mean results across all of the monitoring events to date. The results are plotted in Figure 2 below demonstrating that the combined mean and max for downwind monitored concentrations per filter are below the threshold limit. Therefore, it can be concluded that the levels of bioaerosols being produced by site activity are low and under control.

[15] Environment Agency (2009) 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities' Environment Agency for England and Wales

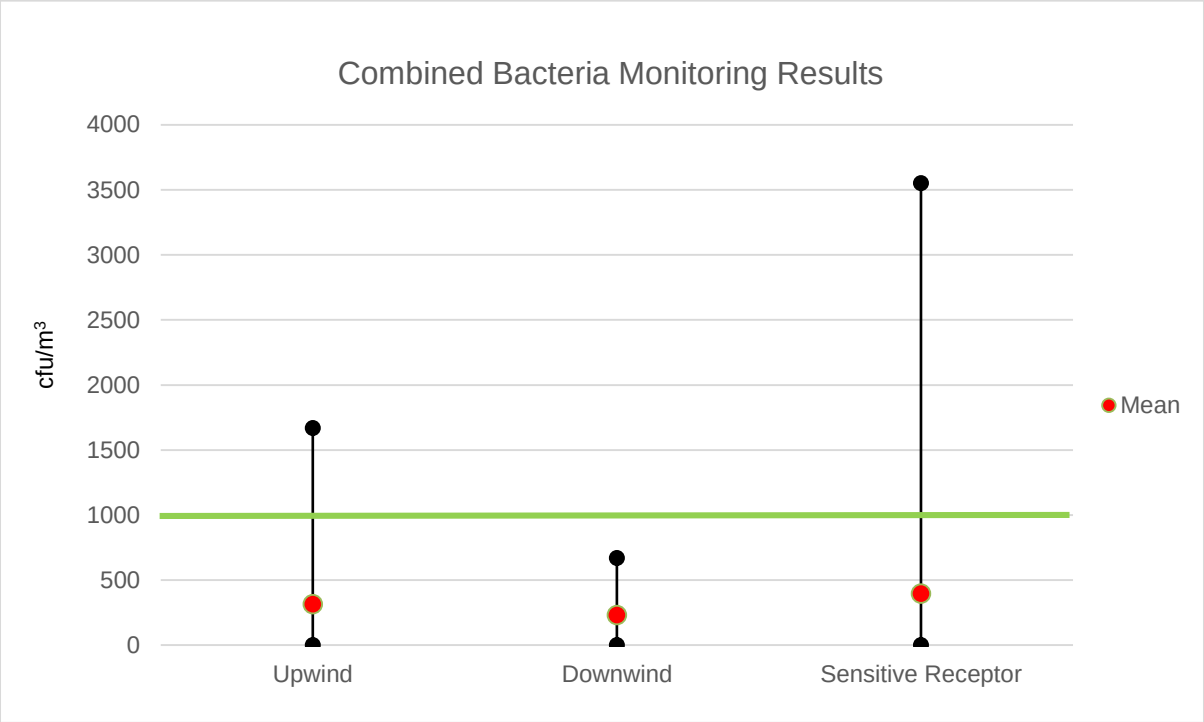


Figure 2 – Combined bacteria monitoring results per filter

5.1 Replication of Sampling

It is possible to replicate the sampling points at the site however the variables will change due to weather, wind patterns, activity on site and seasonal variations of feedstock. As such sampling for bioaerosols can only tell you what is present at the time of sampling. The longer the sampling is undertaken for the greater response the filters will take and will therefore give us a better understanding of how activities are dispersing bioaerosols.

WRM undertake sampling for 45 minutes and at a minimum of three points, this increases to 4+ points where required. Sampling was undertaken during a minimum 45-minute period with three replicates and one blank used per sampling point

APPENDIX 1 – METEOROLOGICAL SAMPLING CONDITIONS

Weather Conditions on Day of Sampling

Sample	Time	Mean wind direction (°)	Mean wind speed (m/s)	Air temperature (°C)	Relative humidity (%)	Cloud Cover
1 2 3	8.25-9.10	280	3.6	9.8	39.6	8/8
4 5 6	8.25-9.10	280	3.6	9.8	40.4	8/8
7 8 9	9.20-10.05	300	4.2	10.2	41.7	8/8

Weather Conditions 24 Hours Earlier

Temp Max (°C)	Temp Min (°C)	Temp Mean (°C)	Humidity Max (%)	Humidity Min (%)	Humidity Mean (%)	Precipitation (mm)	Average Wind speed (m/s)
10	8	9	84	67	76	0.0	4.7

APPENDIX 2 – LABORATORY TEST RESULTS

Site MD Recycling
Site Operator: Marc Davies
Date 25th October 2016
Comments: All polycarbonate filters and filter heads were in good condition.

Table 1. Microbiological Results from MD Recycling green waste site:

Sample no.	Sample Head no.	Volume (litres)	Total Mesophilic Bacteria (cfu per plate)	*Aspergillus Fumigatus* (cfu per plate)	Total Mesophilic Bacteria (cfu per m^3)	*Aspergillus Fumigatus* (cfu per m^3)
1	No.1	90	0, 0	0, 0	<280	<280
2	No.2	90	4, 0	0, 0	1110	<280
3	No.3	90	1, no result	0, 0	560	<280
	Mean				**556**	**0**
4	No.4	90	1, 1	0, 0	560	<280
5	No.5	90	0, 0	0, 0	<280	<280
6	No.6	90	76, 132	0, 0	57 780*	<280
	Mean				**278**	**0**
7	No.7	90	0, 0	0, 0	<280	<280
8	No.8	90	1, 0	0, 0	280	<280
9	No.9	90	1, 0	0, 0	280	<280
	Mean				**185**	**0**
10	No.10	Blank control	0 per membrane)	0 per membrane)	<25 (per membrane)	<25 (per membrane)
11	No.11	Blank control	0 per membrane)	0 per membrane)	<25 (per membrane)	<25 (per membrane)

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

The anomalous result in head no.6 – possibly caused by aggregation - creates a considerable standard deviation. Therefore this result has been ignored in the calculation of the mean.

7th November 2016
R. SMITH DATE
BIODET

WRM Limited
Courtyard South, Wharfebank House, Wharfebank Business Centre,
Ilkley Road, Otley, LS21 3JP

Tel: 01943 468138

Email: info@wrm-ltd.co.uk Web: www.wrm-ltd.co.uk