Veolia ES (UK) Limited

Ambient Bioaerosol Sampling 2021, Annual Session

Veolia Acton Composting Facility, Trentham Road, Acton, Newcastle under Lyme, ST5 4EE

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RSK GENERAL NOTES

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			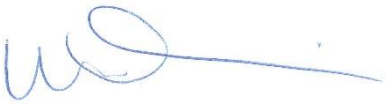
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1 INTRODUCTION

1.1 Background

RSK Environment Limited (RSK) conducted ambient bioaerosol sampling on the 17th August 2021 at the Veolia Acton Composting Facility, Trentham Road, Acton, Newcastle under Lyme, ST5 4EE. This work was undertaken on the instructions of Malcolm Marshall, on behalf of Veolia ES (UK) Ltd ("the client").

1.2 Instructions

Bioaerosol sampling was carried out to the agreed brief as set out in the RSK proposal letter reference T/444477-01 dated the 10th August 2021.

RSK Environment Limited were instructed to sample for bioaerosols once per annum. This report covers the annual sampling session.

1.3 Context

The composting facility at Trentham Road is designed around an open air turned windrow system and processes source separated green waste. Process activities currently include reception of green waste, shredding and feedstock blending operations, turned open windrow composting and screening of finished compost.

All sampling was carried out on a normal day whilst green waste reception and feedstock movement operations were taking place on site.

2 METHODS

2.1 Introduction to Bioaerosol Sampling

The monitoring and assessment of bioaerosol emissions from biowaste facilities may be undertaken using a number of techniques in accordance with Technical Guidance Note "*TGN M9 Environmental Monitoring of Bioaerosols at Regulated Facilities, Version 2, July 2018"* which was issued by the Environment Agency to provide a standardised approach for the monitoring of airborne microorganisms, known as 'bioaerosols'.

Bioaerosols occur naturally within the environment and comprise airborne particles containing living organisms such as plant pollen, fungal spores and bacteria. They may also contain endotoxins from bacterial cells or mycotoxins from fungi. They can typically be found in the size range from approximately 0.02 to 100 micrometres (µm).

As well as many natural sources of bioaerosols in the environment, they also arise from the waste sector including activities such as the composting, anaerobic digestion and mechanical biological treatment of garden waste, food waste and residual household wastes.

These waste treatment technologies rely on large numbers of microorganisms to break down the organic matter in wastes. Composting depends on bacteria and other microbes including spore-forming filamentous actinomycetes and fungi to produce a final organic product that is sanitised and sufficiently stable to be used on land or in horticulture.

As organic matter is broken down during the composting process it goes through a series of temperature dependent stages dominated by certain groups of bacteria and fungi. Bacteria, and in particular mesophilic bacteria, is the most numerous group of microorganisms. *Aspergillus fumigatus* is a mesophilic fungus that can tolerate a broad range of temperatures and is therefore present throughout the various stages of the breakdown process.

This dependence on microorganisms to break down organic matter and the agitation of material (e.g. shredding, screening and windrow turning, both internally and externally) means that biowaste facilities are a potential source of bioaerosols.

2.2 Sampling Locations

For biowaste facilities where open composting operations take place, the approach of the M9 Guidance is to compare the concentration of bioaerosols in ambient air unaffected by activities associated with the waste facility (i.e. background air sampled upwind of the active operational area) with the concentrations of bioaerosols in ambient air downwind of the centre of the active operational area/source.

The M9 Guidance specifies that three downwind sampling locations should be used, set out to form a fan-like shape arrangement to ensure variable wind directions are taken account of, and ensure that measurements are taken within the emission plume.

However, on the day of sampling, the wind was blowing towards the east-south-east of the composting facility, therefore placing the outlying downwind sampling locations within woodland and fields where access was prohibited. M9 recognises that under such circumstances it may not always be practicable or safe to comply with the fan like shape sampling arrangement due to sampling locations falling on land where there may be access restrictions (for example private land, cropped fields, quarries, railway lines or roads) or situations where topographical features impact significantly on meteorological conditions. Under these circumstances the fan-like shape arrangement can be adapted, and M9 allows for a single central traverse to be used downwind, but with an increased number of samples spread over a longer time period to compensate for not using the fan-like shape sampling arrangement. This is the approach that was taken on the day of sampling, with two sampling locations (one upwind and one central traverse downwind position), but with additional samples being taken.

The sampling locations were chosen with reference to the centre of the active operational area on the day of sampling. The centre of the windrows was chosen as the reference point on the day of sampling.

The single central downwind sampling location was chosen at a distance that was equivalent to the separation distance between the centre of the active operational area and the nearest sensitive receptor. The nearest sensitive receptor to the active operational area on the day of sampling was an isolated residential property located on Acton Lane approximately 300 m to the east-north-east of the centre point of operations.

Appendix 1: “Bioaerosol Concentrations”, sets out the activities that were being undertaken during each sampling period and Appendix 3: “Site Details”, provides details of the layout of the sampling positions and the centre of the active operational activity.

The sampling locations selected were as follows:

1. **Upwind** of composting activities, at approximately 50 m from the centre point of the operations. The bearing of the upwind sampling location was west-north-west (280° from true north) of the centre point of the windrows.

2. **Downwind** of composting activities, at approximately 130 m from the centre point of operations. The bearing of the single downwind sampling location was east-south-east (110° from true north) of the centre point of operations and was taken as a representative point on the central traverse line to the mean wind direction on the day of sampling. This sampling position was located along Acton Lane and was used because it represented a distance that was approximately equivalent to the separation distance between the centre of the active operational area and the isolated residential receptor on Acton Lane as marked in Appendix 3.

2.3 Assessment & Measurement of Meteorological Conditions

Meteorological conditions on the day of any sampling assessment can have a significant influence on the concentrations of bioaerosols. The wind direction and wind speed influence both the dispersion and dilution of bioaerosols in ambient air, and elevated temperatures and relative humidities greater than 80% may enhance their viability in the atmosphere.

An automatic weather station was used to record the weather conditions during sampling, and it was positioned adjacent to the site car park.

2.4 Sampling Equipment & Procedures

Sampling was carried out in accordance with the M9 Guidance, Version 2, July 2018 using single stage 400 hole Andersen type impact samplers at a height of 1.5 metres to the top of the inlet cone for each sampler, with microorganisms collected on single or duplicate agar plates. Each Anderson sampler was fitted with a hemi-cylindrical wind baffle to ensure stagnation point sampling.

Sampling at the upwind and single central downwind monitoring positions was undertaken simultaneously for two 10-minute sampling periods for each microorganism evaluated.

Two, shorter, 5-minute sampling periods were also undertaken at the same upwind and single downwind monitoring positions as a contingency measure against the possibility of plate saturation during the 10-minute periods.

An additional plate was also exposed in a sampler with no pump attached at the single central downwind position during the first two sampling periods to act as non-aspirated controls for all microorganisms. In addition, separate unexposed control plates were kept at the upwind position throughout sampling to indicate if there was any plate contamination during transportation and whilst the sampling was being undertaken. These samples are known as workstation controls.

2.5 Microorganisms

The microorganisms that were evaluated were as follows:

- *Aspergillus fumigatus*
- Mesophilic bacteria

Enumeration of these microorganisms was carried out by Biodet at the University of Hertfordshire. Biodet is UKAS accredited. All medium preparation, storage and analysis were undertaken in accordance with the M9 Guidance and defined Standard Operating Procedures for the enumeration of these microorganisms as part of the laboratory's Quality Management System.

2.6 Personnel

The bioaerosol sampling was undertaken by Annie Trevis and MacKenzie Russell of RSK Environment. These persons have received training for undertaking this work, in accordance with RSK's accredited Quality Management System.

3 RESULTS

3.1 Concentration of Airborne Microorganisms

Results (individual petri dish plate counts) obtained from the various sampling points are shown in Appendix 1.

In line with the requirements of the M9 Guidance, the counted number of colonies on each petri dish, as reported by the laboratory, was adjusted with reference to correction tables provided in the '*Positive-Hole Correction of Mulitple-Jet Impactors for Collecting Viable Microorganisms'* (Macher, 1989), based on the probability that more than one viable particle may be collected through a single sampling hole on the impactor to produce a single colony.

Airborne populations (cfu/m^3) of culturable microorganisms were estimated based on the corrected plate count (cfu) and the volume of air sampled (m^3).

M9 states that due to the broad scatter that is inherent in the measurement of bioaerosol concentrations, the median value should be calculated when characterising both upwind and downwind concentrations of bioaerosols as shown in Table 1, for each sampling position, and each monitoring period. Use of the median value reduces the effect of any extreme values and means that any statistical/measurement outlier counts will have much less influence on the final measurement result. Also, in line with the updated M9 guidance the median value of replicated downwind samples has been reported here as shown in Table 1.

Table 1: Summary of Results

Sampling Location	Airborne concentrations, cfu/m^3 (colony forming units per cubic metre of air)	
	Aspergillus fumigatus CFU/m^3	Mesophilic bacteria CFU/m^3
Upwind 1 (5 mins)	3	2
Downwind 1 (5 mins)	14	34
Downwind 1 control (5 mins)	0	2
Upwind 2 (10 mins)	2	20
Downwind 2 (10 mins)	4	8

Downwind 2 control (10 mins)	0	5
Upwind 3 (5 mins)	4	7
Downwind 3 (5 mins)	9	0
Upwind 4 (10 mins)	6	12
Downwind 4 (10 mins)	18	3
Median concentration, cfu/m^3, of all upwind sampling results	**21**	**46**
Median concentration, cfu/m^3, of all downwind sampling results	**64**	**37**

Notes: 'CFU' denotes Colony Forming Units

3.2 Weather Conditions

During the period of sampling, weather conditions varied as follows (see Appendix 2 for a detailed summary of weather data):

- Wet and overcast (10/10 cloud cover).
- The temperature was 14°C.
- Relative humidity was 94%.
- Wind speeds ranged from 0.5m/s to 0.9m/s.
- Wind direction was on average from the west-north-west (280° from true north).

4 DISCUSSION OF RESULTS

Bacteria and fungi occur naturally in many different environments and are therefore commonly present in the air. Populations are highly variable, but background levels of mesophilic bacteria and moulds (which include *A. fumigatus*) do not normally exceed 1,000 cfu/m^3 (colony forming units per cubic metre).

In line with guidance from the Environment Agency (based on R&D Report *Health effects of composting - a study of three compost sites and review of past data*), threshold values or reference levels of 500 cfu/m^3 for fungi and moulds, and 1,000 cfu/m^3 for mesophilic bacteria, are used in this report to assess the concentrations of bioaerosols. These threshold values were set out in the 2010 Environment Agency position statement on bioaerosols and are still appropriate.

4.1 Results at the Upwind Sampling Position

A. fumigatus

Concentrations of *A. fumigatus* were low at the upwind sampling position, with measured concentrations ranging between 7 cfu/m^3 and 28 cfu/m^3 and an overall calculated median concentration of 21 cfu/m^3. The results from the upwind sampling position are well within the 500 cfu/m^3 EA reference level, as would be expected upwind of the facility.

Mesophilic Bacteria

Concentrations of mesophilic bacteria were mostly low at the upwind sampling position, with measured concentrations ranging between 14 cfu/m^3 and 74 cfu/m^3 and an overall calculated median concentration of 46 cfu/m^3. The results from the upwind sampling position are well within the 1,000 cfu/m^3 EA reference level, suggesting limited contributions from fugitive upwind sources of mesophilic bacteria.

4.1 Results at the Downwind Sampling Position

A. fumigatus

Concentrations of *A. fumigatus* were very low at the single central downwind sampling position and roughly comparable with equivalent 'background' concentrations measured concurrently at the upwind sampling position as shown in Table 1.

In line with the updated M9 Guidance, the median concentration from all four downwind sampling results is 64 cfu/m^3, which is well within the 500 cfu/m^3 EA reference level. The results suggest no significant increase above upwind 'background' levels of *A. fumigatus* at 130 metres downwind of operations.

Mesophilic Bacteria

Concentrations of mesophilic bacteria were very low at the single central downwind sampling position and roughly comparable with equivalent 'background' concentrations measured concurrently at the upwind sampling position as shown in Table 1.

In line with the updated M9 Guidance, the median concentration from all four downwind sampling results is 37 cfu/m^3, which is well within the 1,000 cfu/m^3 EA reference level. The results suggest no increase above upwind 'background' levels of mesophilic bacteria at 130 metres downwind of operations.

5 CONCLUSIONS

A comparison of concentrations of A. *fumigatus* and mesophilic bacteria measured at the upwind position with those at the single downwind sampling position over four separate sampling periods suggests no significant increase above 'background' levels of both microorganisms at the downwind location.

Measured concentrations of all microorganisms evaluated as part of this assessment were within the respective EA reference levels at all sampling positions.

It is recommended that annual sampling continues to be undertaken. This future sampling will help to provide a better understanding of bioaerosol emissions from the site and the influence of factors affecting long term temporal and spatial variation in ambient concentrations.

APPENDIX 1: BIOAEROSOL CONCENTRATIONS

Table A.1.1: Results of *Aspergillus fumigatus* sampling

Location	Distance from centre of active area (metres)	Difference in bearing between sampling point and mean direction wind blows to (°)	Sampling times (from-to)	Sampling duration (mins)	Pump flow rate (l/min)	Micro plate type	Uncorrected Result (cfu /plate)	Corrected Result (cfu /plate)	Concentration, Colony forming units per cubic metre of air (cfu/m^3)	Calculated median of downwind replicate field samples (cfu/m^3)	Calculated median of upwind field samples (cfu/m^3)
Upwind 1	50	31	10:49-10:53	5	28.3	MEA	3	3	21	**64**	**21**
Downwind 1	130	201			28.3	MEA	14	14	99		
Downwind 1 Control	130	201			28.3	MEA	0	0	0		
Upwind 2	50	7	10:57-11:06	10	28.3	MEA	2	2	7		
Downwind 2	130	163			28.3	MEA	4	4	14		
Downwind 2 Control	130	163			28.3	MEA	0	0	0		
Upwind 3	50	1	11:09-11:13	5	28.3	MEA	4	4	28		
Downwind 3	130	169			28.3	MEA	9	9	64		
Upwind 4	50	31	11:16-11:25	10	28.3	MEA	6	6	21		
Downwind 4	130	201			28.3	MEA	18	18	64		

Table A.1.2: Results of mesophilic bacteria sampling

Location	Distance from centre of active area (metres)	Difference in bearing between sampling point and mean direction wind blows to (°)	Sampling times (from-to)	Sampling duration (mins)	Pump flow rate (l/min)	Micro plate type	Uncorrected Result (cfu /plate)	Corrected Result (cfu /plate)	Concentration, Colony forming units per cubic metre of air (cfu/m^3)	Calculated median of downwind replicate field samples (cfu/m^3)	Calculated median of upwind field samples (cfu/m^3)
Upwind 1	50	31	10:49-10:53	5	28.3	TBC	2	2	14	**37**	**46**
Downwind 1	130	201			28.3	TBC	34	37	261		
Downwind 1 Control	130	201			28.3	TBC	2	2	14		
Upwind 2	50	7	10:57-11:06	10	28.3	TBC	20	21	74		
Downwind 2	130	163			28.3	TBC	8	8	28		
Downwind 2 Control	130	163			28.3	TBC	5	5	18		
Upwind 3	50	1	11:09-11:13	5	28.3	TBC	7	7	49		
Downwind 3	130	169			28.3	TBC	0	0	0		
Upwind 4	50	31	11:16-11:25	10	28.3	TBC	12	12	42		
Downwind 4	130	201			28.3	TBC	13	13	46		

APPENDIX 2: METEOROLOGICAL DATA

Table A.2.1: Meteorological data during *Aspergillus fumigatus* sampling

Location	Bearing of sampling point from centre of active operational area (° from true north)	Mean direction the wind blows to during the sampling period (each individual sample) (° from true north)	Difference in bearing between sampling point and mean direction wind blows to (°)	Mean wind speed during sampling (m/s)	Arithmetic mean air temperature (°C)	Arithmetic mean relative humidity (%)	Prevailing weather conditions, cloud cover (n/10)
Upwind 1	280	311	31	0.9	13.7	95.1	10
Downwind 1	110		201				
Downwind 1 Control	110		201				
Upwind 2	280	273	7	0.7	13.9	94.2	10
Downwind 2	110		163				
Downwind 2 Control	110		163				
Upwind 3	280	279	1	0.5	14.3	92.9	10
Downwind 3	110		169				
Upwind 4	280	311	31	0.8	14.1	93.1	10
Downwind 4	110		201				

Table A.2.2: Meteorological data during mesophilic bacteria sampling

Location	Bearing of sampling point from centre of active operational area (° from true north)	Mean direction the wind blows to during the sampling period (each individual sample) (° from true north)	Difference in bearing between sampling point and mean direction wind blows to (°)	Mean wind speed during sampling (m/s)	Arithmetic mean air temperature (°C)	Arithmetic mean relative humidity (%)	Prevailing weather conditions, cloud cover (n/10)
Upwind 1	280	311	31	0.9	13.7	95.1	10
Downwind 1	110		201				
Downwind 1 Control	110		201				
Upwind 2	280	273	7	0.7	13.9	94.2	10
Downwind 2	110		163				
Downwind 2 Control	110		163				
Upwind 3	280	279	1	0.5	14.3	92.9	10
Downwind 3	110		169				
Upwind 4	280	311	31	0.8	14.1	93.1	10
Downwind 4	110		201				

APPENDIX 3: SITE DETAILS

Figure A.3.1: Plan of Site and Sampling Locations