Appendix 6

Bioaerosols Baseline Monitoring Report

DOCUMENT CONTROL SHEET

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1 INTRODUCTION

1.1 SURVEY BRIEF

In order to determine the air quality and potential health implications of the Organic gold Composting facility currently in operation in Wilkinstown, Co. Meath, RPS Group Ltd, were commissioned to carry out a series of air quality test for Bioaerosols. To this end a suitably qualified consultant from RPS visited the Organic Gold facility to carry out an air quality test for Bioaerosols on the 6th December 2004.

This report outlines the methods employed and results obtained in this air quality survey. The results have been used to determine the potential impact to human inhabitants in the vicinity of the plant as a result of fugitive emissions.

1.2 METHODOLOGY

Samples of ambient air at 7 locations were extracted using an SKC Biostage Impactor operating at a flow rate of 14.15 litres/min for a period of 3 minutes. This is the procedure outlined by the UK National Institute for Occupational Safety and Health (NIOSH) method for Bioaerosol Sampling (Method Reference 0800). All sampling and analytical equipment used in the survey has been specially designed for sampling of workplace air quality for bioaerosols. Samples were extracted from the following locations:

B1: At nearest sensitive receptor to the south west of the facility

B2: At nearest sensitive receptor to the south east of the facility

B3 At nearest sensitive receptor to the north east of the facility

B4: In doors, in the fertiliser shed.

B5: In the middle of the slab, directly down wind of windrow as it was turned (worst case scenario).

B6 Most Northern point on the boundary of the slab (Down wind).

B7 Most Southern point on the boundary of the slab (Up wind).

Samples were extracted onto 2 pre-prepared plates at each monitoring location and analysed for Mesophilic bacteria after 5 days incubation at 37^{0}C and Aspergillus species after 7 days incubation at 25^{0}C. All analysis was carried out at a suitably qualified microbiology laboratory (Cruinn Diagnostics Ltd). In order to determine a broad spectrum of results, the sample plates employed were for general Mesophilic bacteria and Aspergillus species.

2 MICRO-ORGANISMS IN COMPOST

The presence of bacteria and fungi in high concentrations are fundamental to the composting process. Whenever composting materials are moved around, for example during the shredding, turning and screening processes, these micro-organisms can be aerosolised, forming what is termed a Bioaerosol. The handling of large quantities of compost potentially can lead to the release into the air of large quantities of the bacteria, fungi, actinomycetes and their components, found in compost, as a bioaerosol.

2.1 DISPERSION OF BIOAEROSOLS FROM COMPOSTING FACILITIES

As bioaerosol masses are typically small (hence they have small settling velocities), they can be carried long distances by the wind and thermal currents. The pattern of dispersal of bioaerosols around a composting site depends upon a number of factors, including the emission rate (the number of micro-organisms liberated per unit time), prevailing atmospheric conditions (wind speed and direction, solar incidence, temperature gradients and relative humidity) and local topography, which will determine the air flow around the site. The emission rate will depend on the process carried out, the type of machinery used, the moisture content of the compost, the microbial content of the material processed, and whether or not the process is enclosed or carried out in the open air. Concern has been raised by residents in the vicinity of composting sites that composting activities could increase levels of bioaerosols, such as airborne *Aspergillus fumigatus* spores. Research studies have show numbers of *Aspergillus fumigatus* spores to decline to 'background levels' within 200 meters from a compost bioaerosol source.

RR130 - Occupational and environmental exposure to bioaerosols from composts and potential health effects - A critical review of published data

2.2 HEALTH EFFECTS

Residents in Ireland, in the vicinity of composting facilities, have in the past expressed concerns in relation to composting, citing potential adverse health effects resulting from inhalation of bioaerosols from composting sites. Exposure to the microorganisms found in compost could potentially cause ill health in the people exposed to them either by infection, allergy or an adverse response to toxins. In order to understand the potential health hazards associated with exposure to compost bioaerosols, it is first important to examine in detail the microbial components of Bioaerosols generated during the handling of compost.

The bioaerosols typically associated with the composting process are bacteria and fungi (including yeasts and moulds) as these microbes carry out the degradation of organic waste to produce compost. Some of these microbes are recognised allergens such as thermophilic actinomycetes (bacteria) and *Aspergillus fumigatus* (fungi). Thermophillic actinomycetes are fundamental to composting as they break down celluloses and lignins. These bacteria flourish in the heat produced in the composting process. *Aspergillus fumigatus* is a fungus that can tolerate the high temperatures associated with the composting process.

Thermophilic actinonmycetes (*Saccharapolyspora faeni* and *Thermoactinomycetes vulgaris*) and *Aspergillus fumigatus* are associated with occupational allergic lung diseases such as farmer's lung disease and mushroom worker's lung disease (HSE "*Occupational and Environmental exposure to bioaerosols from composts and potential health effects – a critical review of published data*"). Repeated exposure to these microbes stimulates the immune system, causing a series of physical responses including the release of histamines, constricting airways and reduction in lung capacity. These long-term effects may result in chronic bronchitis, asthma or alveolitis.

2.3 REDUCING THE LEVEL OF EXPOSURE TO BIOAEROSOLS FROM COMPOSTING

Several design and operational measures can be taken to reduce exposure to bioaerosols. These included

a) Enclosing the composting system especially during the first stages of waste decomposition

b) Isolation of the screening operation from the composting operations

c) Moisture control of the stock and composting

d) Dust control in dry weather

e) Sweepers and water vehicles to control dust in roadways

f) Air filters in cabins of mobile equipment

g) Adequate ventilation in buildings

h) Use of Personnel Protective Equipment (PPE) for employees

3 RESULTS

The results of the bioaerosol monitoring carried out at the Organic gold facility are presented in Table 3.1.

Location	Mesophilic bacteria (cfu/m^3)	Aspergillus Spp (cfu/m^3)
B1	$2.36x10^2$	$2.36x10^3$
B2	$9.42x10^1$	No Growth
B3	$2.36x10^1$	No Growth
B4	No Growth	No Growth
B5	$3.5x10^3$	$7.07x10^3$
B6	$1.4x10^2$	$2.36x10^3$
B7	$1.9x10^2$	$2.36x10^3$

4 DISCUSSION

4.1 ASSESSMENT CRITERIA

There are no Occupational Exposure Limits (OELs) applicable to exposure to biological parameters in the work place in Irish or International legislation. There are guidelines for minimising exposure to employees in the workplace in the Safety, Health and Welfare at Work (Biological Agents) Regulations, 1994 (S.I. 146 of 1994) and amendments (S.I. 248 of 1998).

The UK Health and Safety Executive has prepared a Research Report (Ref; 130) entitled "*Occupational and Environmental Exposure to Bioaerosols from composts and potential health effects – A critical review of published data*". In this review there are several references to levels of fungi and bacteria as determined by a number of research studies carried out at ambient sites, organic waste sites, municipal bio-waste treatment sites and composting facilities. These reports have been compiled to generate a range of measurement data for various aspects of the domestic waste industry. This information is listed in Table 4.1.

Work Activity	Fungi (*cfu/m^3)	Bacteria (*cfu/m^3)
Handling Domestic Waste	10^4-10^5	10^3-10^4
Domestic Waste Transfer Station	10^6	10^5
Domestic Waste Incineration	10^7	10^7
Domestic Waste Recycling	10^5	10^5
Domestic Waste Landfill Site	10^5	10^6

Table 4.1: Published data for bioaerosol emissions during a number of Waste Treatment Activities

** A cfu is defined as the unit of one or more cells or spores which, when inoculated onto suitable growth medium, grows to form a single colony.*

4.2 INTERPRETATION OF RESULTS

The figures outlined in Table 4.1 provide some perspective to the results determined in this survey at the Organic Gold Composting facility. The fact that airborne particulates were deposited directly onto the agar plates had the advantage of direct inoculation. Fungi were detected at a range of 0–10^3 cfu/m^3. The results suggest that the fungal levels determined at the Organic Gold facility are well below the ranges previously determined at a number of waste activities (Refer to Table 4.1), as outlined in Table 4.1. Mesophilic bacteria were also detected at a range of 0–10^3 cfu/m^3. The results also suggest that bacterial levels determined at the Organic Gold facility are well below the ranges previously determined at a number of waste activities (Refer to Table 4.1).

The levels detected for sample *B5 (*down wind of the windrow, as it is turned) indicate the highest levels of Mesophilic bacteria and Aspergillus species, as expected. This is a worst-case scenario and the elevated concentration of airborne microbes can be attributed to agitation, which occurred during

the mechanical turning of the windrow. It is also reasonable to suggest that short exposure may have sampled the peak of a burst of Bioaerosols and may have shown numbers well above those typically found in the sample area.

Bioaerosol concentrations are known to decline with distance from source due to atmospheric dispersion and dilution. Furthermore, concentrations have been shown to decrease to background levels after site activities cease, suggesting that wind blown aerosolisation is insignificant. Bioaerosol concentrations at the Organic Gold facility show a similar trend, with numbers decreasing with distance from the source and concentrations were found to be insignificant at all of the off-site sensitive receptors.

Bioaerosol concentrations determined in the survey represent the worst-case scenario for exposure to bioaerosols at the Organic Gold facility and typically observed levels outside the site boundary would be expected to be much lower. Routine sampling at a composting facility should be carried out if a 'sensitive receptor' lies within 200 meters of the site boundary. However, the Organic Gold facility is in excess of 260 metres from the nearest receptor and, as such, the potential for bioaerosol dispersion outside the plant is greatly reduced. Samples were extracted at the area of greatest potential for bioaerosol formation (i.e. on and around the composting slab) after the windrows had been turned by a windrow turner.

It is important to associate exposure to a hazardous substance with health effects and to understand the relationship between Host-Agent-Environment and Source-Pathway-Receiver. In considering bioaerosol emissions from the site, the host/receiver is an on-site worker or off-site sensitive receptor, the agent/source is the bioaerosol, the environment is the workplace or surroundings and the pathway is the air. Data that have been reported indicate that workers at compost sites are at risk of regular exposure to bioaerosols between 10 and 1,000 times greater in concentration than may be expected normally in ambient air. Workers at the Organic Gold facility should therefore be encouraged to wear the appropriate Personnel Protective Equipment (PPE) in order to reduce the risk of exposure and contamination. However, the concept of 'control at source', by application of the design and operational measures presented in section 2.3, should be addressed as the first line of defence against bioaerosols.

5 CONCLUSIONS

- Mesophilic bacteria were detected at a range of 10^1 – 10^3 cfu/m^3. These results suggest that bacterial concentrations determined at the Organic Gold facility were well below the ranges previously determined at a number of waste treatment facilities

- Aspergillus Species were detected at a range of 0 – 10^3 cfu/m^3. These results suggest that fungal concentrations determined at the Organic Gold facility were well below the ranges previously determined at a number of waste treatment facilities.

- Bioaerosol concentrations detected at the Organic Gold facility indicate that, the highest levels recorded during the survey were well below the ranges previously determined at a number of waste treatment facilities and were recorded during a worst case scenario (i.e. during windrow turning). Furthermore, concentrations decreased even further with distance from source (i.e. moving away form the windrows) and were found to be insignificant at the nearest off-site receptors.