Sutton Veny Farm
Proposed Poultry Unit
Bioaerosol Risk Assessment

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Prepared for:
James Whilding
Acorus Rural Property Services Ltd
Mamhead Castle
Exeter
Devon
EX6 8HD

Site assessed:
Sutton Veny Farm
Sutton Veny
Warminster
Wiltshire
BA12 7BZ

Prepared by:
Laura Donnelly
ADAS UK Ltd
Pendeford House
Pendeford Business Park
Wobaston Road
Wolverhampton
WV9 5AP

Tel: 01902 271278

Verified by:
Ger Parry
ADAS UK Ltd
Pendeford House
Pendeford Business Park
Wobaston Road
Wolverhampton
WV9 5AP

Tel: 01902 271273

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EXECUTIVE SUMMARY

Introduction
ADAS UK Ltd has been commissioned by James Whilding of Acorus Rural Property Services Ltd to undertake a site specific assessment of risks presented by the processes and activities to be carried out at the proposed poultry unit at Sutton Veny Farm, Warminster, Wiltshire.

An application for an Environmental Permit has been made for an intensive farming installation at Sutton Veny Farm, which will be used for the rearing of broiler chickens and associated activities. The proposed completed development at Sutton Veny Farm will comprise five poultry houses with a combined total of 223,900 broiler places.

As there are sensitive receptors within 250 metres of the site, it is a requirement of the Environment Agency that a Site Specific Bioaerosol Risk Assessment (SSBRA) is undertaken. This assessment has been carried out in a logical format, firstly determining the "Critical Control Points", where potential risks are identified and then assessing these risks in the context of *Risk Mitigation* including any *Controls* that may be required to suitably reduce this risk.

The Assessment
The assessment is based on Environment Agency guidelines, which set out that Aspergillus *fumigatus* spp and bacterial levels less than or equivalent to background levels, or otherwise less than 500 and 1,000 cfu/m^3 (colony forming units per cubic metre of air), may be an appropriate measure of low risk to sensitive receptors. In this context, sensitive receptors include any third party dwellings and workplaces (private, public or industrial).

Site and Design
The Sutton Veny Farm poultry unit will consist of five new, "state of the art", poultry houses, with a total capacity of 223,900 broiler chickens, replacing the existing four poultry houses on site, which ceased operation in 2008.

Proposed activities will include delivery of day old chicks to site, rearing to between 34-40 days of age before being exported off-site to a processing plant. The poultry houses will be ventilated by computer controlled, high velocity roof mounted fans. Additional fans will be incorporated into the gable elevations, allowing for tunnel extraction, to be used near to the end of the growing cycle and during hot weather where increased ventilation is required.

Sensitive Receptors and Prevailing Wind Directions
The primary sensitive receptors points within 250 metres of the proposed facility boundary are considered to be as follows:

1. The neighbouring Allotments situated between 180° and 325° of the proposed poultry unit, at approximately 40m from the extents of the poultry buildings.

2. The west-north-west section of the Deverill Road Trading Estate, situated between 235° and 355° of the proposed poultry unit, at approximately 45m from the extents of the poultry buildings.

3. The neighbouring residential property, Java Bungalow, situated between 295° and 355° of the proposed poultry unit, at approximately 85m from the extents of the poultry buildings.

4. Pickle Farm property, situated between 265° and 325° of the proposed poultry unit, at approximately 140m from the extents of the poultry buildings.

5. The northern section of the Deverill Road Trading Estate, situated between 325° and 25° of the proposed poultry unit, at approximately 170m from the extents of the poultry buildings.

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6. The north-north-west section of the Deverill Road Trading Estate, situated between 305° and 5° of the proposed poultry unit, at approximately 190m from the extents of the poultry buildings.

7. The north-west section of the Deverill Road Trading Estate, situated between 285° and 335° of the proposed poultry unit, at approximately 205m from the extents of the poultry buildings.

A review of the probability and consequence of bioaerosol exposure at each of the receptors identified within 250m of the operational boundary has demonstrated either a medium or low magnitude of risk for each critical control point associated with the proposed poultry unit.

Risk Assessment

This risk assessment reveals that the residual risk to sensitive receptors identified within 250m of the of the poultry buildings is **Low** or **Very Low** because there are a number of design and management factors associated with proposed operations at the Sutton Veny Farm poultry unit which help to provide control of potential bioaerosol emissions and off-site impact.

This SSBRA should be reviewed after the first year of operation, or sooner if there are any changes to the proposed site design or activities. It is also recommended that bioaerosol monitoring is undertaken in accordance with the AfOR Standardised Protocol to provide a better understanding of the off-site effects bioaerosol emissions from the site.

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1.0 INTRODUCTION

1.1 Background

ADAS UK Ltd has been commissioned by James Whilding of Acorus Rural Property Services Ltd to undertake a site specific assessment of risks presented by the processes and activities to be carried out at the proposed poultry unit at Sutton Veny Farm, Warminster, Wiltshire.

An application for an Environmental Permit has been made for an intensive farming installation at Sutton Veny Farm, which will be used for the rearing of broiler chickens and associated activities. The proposed completed development at Sutton Veny Farm will comprise five poultry houses with a combined total of 223,900 broiler places.

As part of the Environmental Permit application process, the operator is required to demonstrate that appropriate consideration has been taken of the risks associated with the proposed activities at the application site. The Environment Agency requires a Site Specific Bioaerosol Risk Assessment (SSBRA), for composting facilities, if *there are any workplaces or dwellings within 250 metres of the composting site boundary* (Interim Position Statement 031, 2010) and in lieu of any specific guidance relating to poultry facilities, this has been applied for the purposes of this risk assessment.

ADAS UK Ltd has been instructed to provide an assessment of the potential impact of airborne micro-organisms (bioaerosols) at receptors indentified within 250m of the proposed poultry buildings. The assessment has been carried out in a logical format, firstly to determine the "Critical Control Points" (sources); to assess who is potentially at risk (receptors); to look at how the micro-organisms could travel to those receptors (pathway); and finally where potential risks have been identified to then assess these risks in the context of "Risk mitigation" including any "controls", i.e. separation distances, prevailing weather conditions and the exposure sensitivity of any receptors.

In the absence of poultry specific guidance, the methodology used to carry out the assessment set out in this report is based on the guidance provided by the Environment Agency in their most recently published *Guidance on the evaluation of bioaerosol risk assessments for composting facilities* (2009).

1.2 Bioaerosols

It is recognised that when any agitation of organic material occurs, elevated numbers of micro-organisms may be released into the air to form what is commonly referred to as a 'bioaerosol' – an aerosol that possibly contains biologically active bacteria, spores, viruses, toxins, and other similar material. Once airborne, bioaerosols may be carried away from the site by the action of the wind, and due to their small particle size, they can remain airborne for a sufficient time to travel beyond the boundary of the site, and therefore potentially towards a third party sensitive receptor.

The skin of poultry continuously sheds skin scales, which carry aerobic and anaerobic bacteria (Noble 1975; Benediktsdottir and Hambraeus 1982), therefore, broiler rearing houses are well known to have high levels of bioaerosols (Seedorf and Hartung, 2000). The level of activity within poultry houses is thought to affect internal building concentrations, and bioaerosols emissions generally increase as the flock cycle progresses, although research by Saleh *et al*. (2005) suggests a reduction in internal building concentrations in the final week of growth, due to the reduced activity of the birds at higher stocking densities.

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Animal feed can also be a source of bioaerosols, particularly if agitated during its distribution. Wathes (1987) suggested that feed itself can act as a reservoir for fungi which can become easily aerosolised, particularly if the feed has low moisture content and potentially high concentrations of dust. Research suggests that composition of feed may also affect dust concentrations and therefore the likelihood of particulate matter including microorganisms becoming airborne. Haler *et al*. (2002) found that barley based feed showed elevated levels of dust in comparison to maize based feed. Heber and Matin (1988) also found that wheat based feed had increased levels of dust compared to maize feeds.

Equipment used for distributing feed also has an effect on the levels of particulates produced. Li *et al*. (1993) found that use of a screw auger increased dust levels by 150% compared to a by-hand system, for both meal and pellet feeds. The research also concludes that over administration of feed may also result in dust formation as feed which is spilt onto the floor is crushed by livestock into smaller particles and then aerosolised.

Defra Research Project AC0104 found that there is also potential for diurnal variation in particulate concentrations within poultry houses, which is supported by Nilsson (1982) who found that dust concentrations increased during feeding times for both dry and wet food, as a result of increased animal activity. Higher bioaerosol emissions are therefore likely during the depopulation and removal of birds as a result of increased bird movement.

1.3 Threshold of Risk

The small particle size of bioaerosols means that most bioaerosols are inhalable and some smaller particles may be respirable, as they are not filtered out by the hairs and cells which line the human nose. As a consequence bioaerosols can potentially penetrate deep into the lungs and be deposited in the air sacs where gases are exchanged

There is a limited scientific evidence base on the human health impacts of bioaerosols, and of any potential dose-response relationships. Previous research (CIWEM, 2002 & Enviros, 2004) has identified some associations between bioaerosol exposure and respiratory and gastro-intestinal illness at waste management facilities, in particular inflammation of the respiratory system, coughs, fevers and exacerbation of existing respiratory illnesses. Possible links have also been established between bioaerosols and Organic Dust Toxic Syndrome (ODTS) (Rylander, 1997). Donham (1993) found that approximately 60% of employees working in pig housing had experienced symptoms of chronic bronchitis; 50% experienced symptoms of acute bronchitis and eye, nose and throat irritation; 30% experienced symptoms of ODTS and 20% experienced symptoms of chronic sinusitis.

Aspergillosis caused by Aspergillus *fumigatus* spp, a micro-organism species associated with agricultural practices including poultry production (Defra Project AC0104, 2009), can give rise to a severe infection of the respiratory system and can be fatal.

1.4 Policy Context

The management and control of emissions including bioaerosols released by intensive farming activities is regulated by the Environment Agency under the Integrated Pollution Prevention and Control (IPPC) regime, through the *Environmental Permitting Regulations 2010 (as amended),* to ensure that adverse human health effects are not caused (Environment Agency, 2008). There is little regulatory guidance available for bioaerosol emissions from poultry facilities; therefore, the principles from guidance on the evaluation of bioaerosol risk assessments for composting facilities, which is the best understood sector have been applied to the assessment of risk for the proposed development.

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The Environment Agency advocates a precautionary approach in respect of bioaerosol emissions from composting facilities, which can be applied to the poultry unit development. Their Policy Statement 405 (2007) includes the following guidance:

> *We will take into account the potential effects of bioaerosols on human health when authorising new waste composting facilities or changes to existing facilities. To do this, applicants will have to provide us with a site-specific bioaerosol risk assessment if there is a workplace or dwelling within 250 metres of the composting site boundary.*
>
> *The assessment must be based on clear scientific evidence and show that bioaerosols can and will be maintained at appropriate levels at any workplace or boundary of a dwelling.*

There is currently no clear evidence of dose-response relationships, and therefore no defined 'safe' limits in respect of bioaerosol concentrations have been determined. In the absence of defined limits, appropriate levels are therefore typically determined by reference to background levels as determined by monitoring. Background levels of bacteria and fungal spores are highly variable and can range from 1 to 1,000 cfu/m^3 (colony forming units per cubic metre of air).

The Environment Agency research document *Health Effects of Composting – A Study of Three Compost Sites and Review of Past Data (2001)* assumes appropriate reference levels for total bacteria, total fungi and gram-negative bacteria of 1,000 cfu/m^3, 500 cfu/m^3 and 300 cfu/m^3 respectively. The Environment Agency more recently published *Guidance on the evaluation of bioaerosol risk assessments for composting facilities* (2009), which expanded on these levels and suggested "arbitrary" threshold limits that should not be exceeded downwind of a composting facility. This guidance was later confirmed by the release of the Environment Agency Interim Position Statement 31 on the 1st November 2010 which states:

> *Before granting a permit we need to be satisfied that the SSBRA shows that bioaerosols can, and will, be maintained no higher than <u>acceptable levels at the sensitive receptors.</u> The acceptable levels are 300, 1000 and 500 cfu/m^3 for gram-negative bacteria, total bacteria and Aspergillus fumigatus respectively, as measured by the standardised monitoring protocol.*

Widespread monitoring has not been carried out for poultry farms in the same way that is has for composting; however, the Defra Research Project AC0104 found that in almost all cases, concentrations of bacteria returned to 'background' levels (10^1 to 10^2 cfu/m^3) by 100 m downwind of poultry sheds and for all cases by, or within, 200m downwind of buildings. Fungi concentrations were also found to return to 'background' levels (10 to 10^2 cfu/m^3) by 100m downwind of poultry sheds in almost all cases. In light of this, the Environment Agency's reference levels for composting sites are also considered to be appropriate for poultry housing.

1.5 ADAS – an independent assessor

For the purposes of this risk assessment, ADAS UK Ltd is a recognised and appropriately qualified organisation, operating entirely independently of the site operator. ADAS has carried out monitoring of bioaerosols and has undertaken Site Specific Risk Assessments at numerous waste management facilities and poultry installations in the UK. ADAS operates a Quality Management Systems and works in accordance with both *BS EN ISO 14001 (Cert No: LRQ 4001349) and 9001 (Cert No: LRQ 0936648)*.

1.6 Scope and layout of this report

This report documents all the factors relevant to the SSBRA. It is based on the source – pathway – receptor (S-P-R) conceptualisation of risk, accounting for local factors such as site operations, monitoring data, topography and weather conditions.

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Following consideration of each of these determinants, a descriptive assessment of risk is assigned to each activity and each receptor, based on the probability of exposure and the potential consequence caused by that exposure. Definitions are based on those provided by the Environment Agency's 2009 guidance on risk assessment.

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2.0 BACKGROUND TO THE SSBRA

This SSBRA (Site Specific Bioaerosol Risk Assessment) has been prepared in support of an application for an Environmental Permit for the Sutton Veny Farm poultry unit and is focused on the risk associated with the operation of that site only.

2.1 Site Location

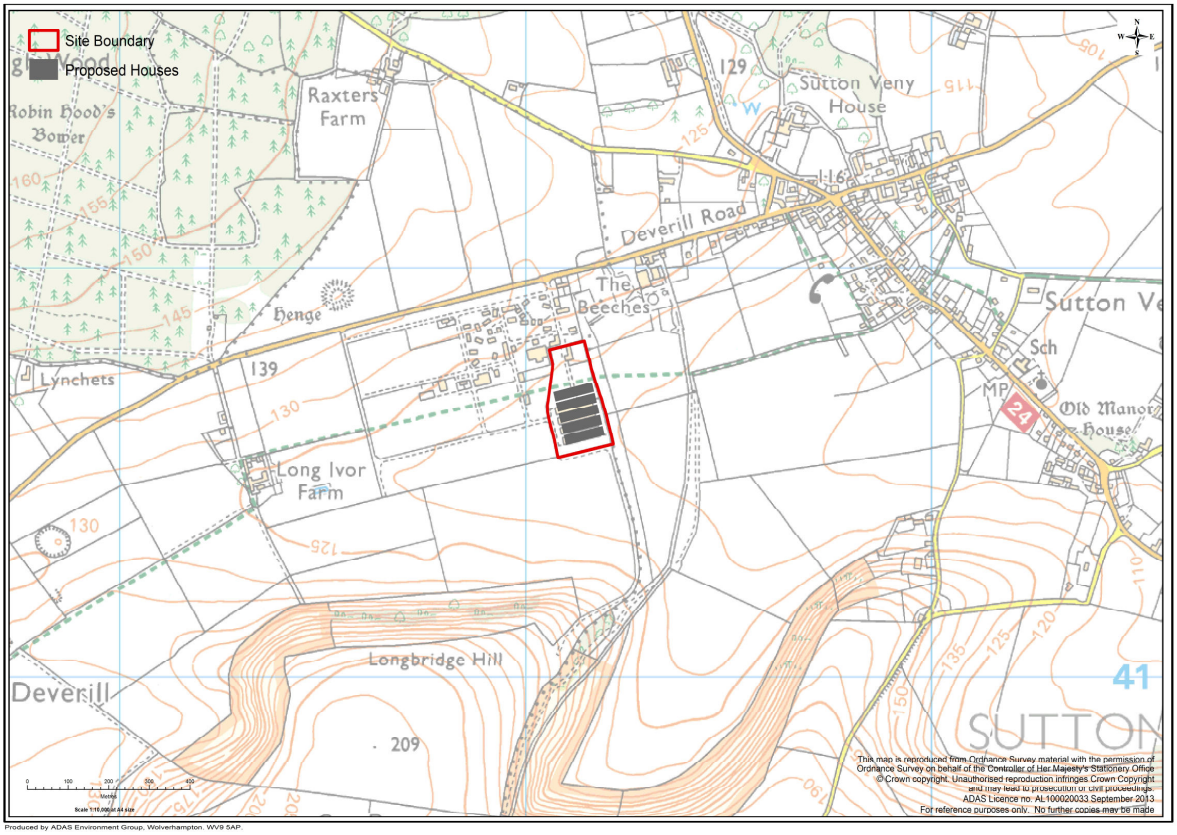
The proposed poultry unit will be located at:

Sutton Veny Farm
Sutton Veny
Warminster
Wiltshire
BA12 7BZ

National Grid Reference: 389132, 141624

A location map is shown in Figure 1.

Figure 1: Proposed Site Location



2.2 Proposed Site

The Sutton Veny Farm poultry unit will comprise five new, "state of the art", poultry houses, with a total capacity of 223,900 broiler chickens. Each poultry house will have a capacity of 55,975 broiler chickens which will be reared from day old chicks to between 34 - 40 days. The poultry

houses will be built of steel, with a steel roof, clad with box profile polyester coated steel sheeting. Ventilation will be provided by ridge fans and gable end fans for use in hot weather.

2.3 Proposed Operation

2.3.1 Pre-production

Prior to the arrival of the day-old birds, the concrete floors in each house will be covered with either wood shavings or chopped straw to a depth of 20mm. Each house will be pre-warmed to 31˚C using a LPG heating system.

2.3.2 Production

Day old chicks will be delivered to site in enclosed transport vehicles and then distributed between the five poultry sheds at the start of each production cycle. The average cycle length will be between 34 and 40 days with thinning of the flock taking place between 34 and 38 days, which will reduce the flock size by approximately 25-50%.

Ventilation will be provided by side air inlets and computer controlled high speed roof mounted fans, extracting internal air and discharging it vertically at high speed and at high level, into the atmosphere to optimise dispersion and dilution of bioaerosols and dust. As the birds grow, the ventilation rate will increase and the house temperature will be gradually reduced until the heating boilers can be switched off. Additional fans will be incorporated into the gable elevations, allowing for tunnel extraction near to the end of the growing cycle and during hot weather when increased ventilation is required.

Litter will be maintained at a moisture content of approximately 35%, through control of ventilation, internal temperature, bedding quantities and relative humidity. This will help control the potential for particulates becoming airborne.

No milling of feed will take place at the proposed poultry site and all feed will be supplied pre-blended by a national or regional supplier as crumbs or pellets, using only high-quality raw materials. Feed will be delivered to site approximately 4 times per week, in fully enclosed transport vehicles and unloaded directly from the transport vehicles to purpose built covered silos located next to the broiler sheds, to minimise the potential for bioaerosol release during transport and reception of feed. Feed will be transferred directly from the silos to the poultry houses using a centreless auger system, to minimise the potential for bioaerosol release during distribution of feed to the poultry unit.

Birds which die during the production cycle will be removed from the houses each day and stored in sealed, vermin proof containers before being collected by a licensed collection agent under the National Fallen Stock Scheme.

At the end of the flock production cycle, all birds will be removed from the houses and loading into crates before transport off-site in open sided lorries for processing.

2.3.3 Clean Out

After depopulation the spent litter will be removed from the buildings and loaded onto trailers which will be sheeted before transport off-site. The empty houses will then be washed and disinfected ready for the next crop.

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2.4 Pollution control

There are a number of design and management factors associated with the proposed operations at Sutton Veny Farm which help to provide control of potential bioaerosol emissions and off-site impact.

Poultry Production

- Day old chicks will be transported to site in enclosed vehicles; therefore the potential for bioaerosol release during transport onto and off site will be limited.
- Doors of the poultry houses will remain shut at all times other than for broiler delivery, pick-up or during clean out. This will minimise the risk of fugitive release during production.
- Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. This will help to reduce the potential for airborne particulates inside the buildings during production.
- Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. The roof mounted fans will provide effective dilution and dispersion of emissions at high level to minimise off-site impact of bioaerosols.

Feed Management

- No milling of feed will take place at the proposed poultry site. All feed will be supplied pre-blended as crumb or pellets. These control measures will help to ensure that only quality feed, with minimum dust potential will be used on-site during production to reduce the potential for particulate release.
- Feed will be delivered to site in fully enclosed transport vehicles and conveyed directly from the vehicles to purpose built covered feed silos located next to the broiler sheds, to minimise the potential for fugitive bioaerosol release during transport and reception of feed.
- Feed storage silos will be regularly checked for signs of damage or wear to minimise the potential for fugitive bioaerosol release.
- Feed will be conveyed directly from the storage silos to the poultry houses using an enclosed conveyor system, to minimise the potential for bioaerosol release during distribution of feed to the poultry units.

Depopulation and Clean-out

- Once started, the clean out operation will be completed in as little time as possible.
- Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for ‘stripping’ of bioaerosols off the surface of litter after removal from the houses following depopulation.
- If an elevator is to be used for loading litter into lorries, the drop height will be minimised and the elevator covered; this will reduce the potential for bioaerosol release. If a loader vehicle is to be used, litter will be carefully tipped into lorry trailers positioned at the entrance to each house.
- All vehicles used for the transport of litter off-site will be sheeted; therefore, the potential for bioaerosol release during transport off-site will be limited.

A site layout plan is included in Figure 2.

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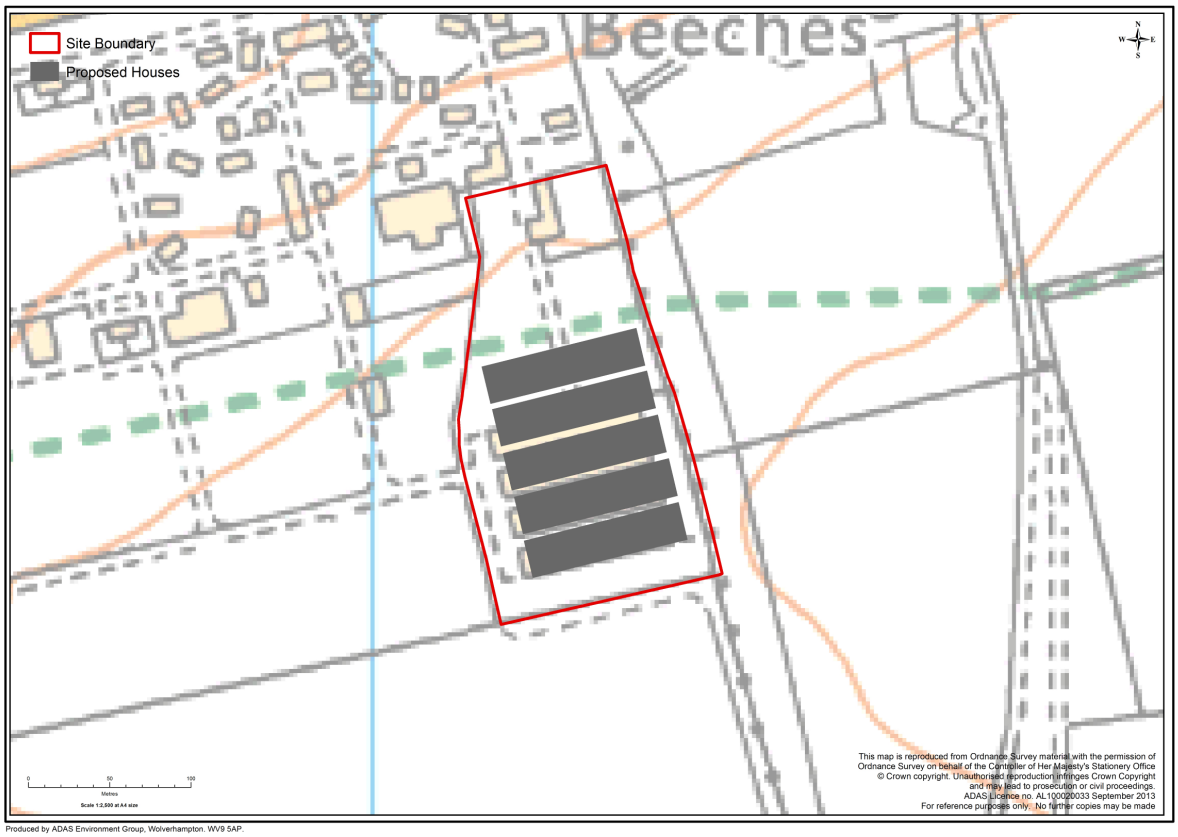
Figure 2: Site layout



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3.0 SOURCE CHARACTERISATION

Source characterisation, the identification of operations likely to give rise to bioaerosol emissions, has been carried out with reference to published scientific reports on bioaerosol emissions from poultry farms and composting facilities (which have been subject to more research than poultry production) and measurements undertaken by ADAS as part of commercial consultancy.

3.1 Review of bioaerosol emissions from organic waste processing operations

There have been a number of scientific reports on the dispersion of bioaerosols from composting sites. Below is a brief review of the main scientific reports.

One of the first main scientific research documents published in the UK was by the Environment Agency *Health Effects of Composting – A Study of Three Compost Sites and Review of Past Data*, 2001 (researcher AEAR). This focussed on three composting sites, including two open air turned windrow sites and one in-vessel plant. Many different emissions were measured from the sites whilst different composting processes were undertaken, with bioaerosols being a leading part of the investigations. The results from the work showed a well-defined decline in concentrations of bioaerosols with increased distance from source. For most of the results, the concentrations had significantly fallen back to the background level or below the appropriate reference level by 250 metres from the source. An extract from this research is shown in Appendix 1A.

A Landfill Tax Credit Scheme (LTCS) funded research project also looked at the rate of decline of bioaerosols from composting sites. The report publish by SWICEB *Bioaerosol Monitoring and Dispersal from Composting Sites*, 2005 (researcher ADAS) focused on three composting sites, including two in-vessel technologies and one open windrow site. Sampling for bioaerosols was conducted on a wide range of composting activities, including shredding, turning, loading, unloading and screening. Sampling also took place while different materials were being composted, including municipal waste, agricultural waste and kitchen waste. The results of this study showed that 91% of all micro-organisms sampled across all three sites were below 1,000 cfu/m^3 at 125 metres downwind from the boundary. Although 125 metres downwind of the facility boundary was the greatest sampling distance in this study, it would appear likely that upwind (background) concentrations would more or less be achieved in the majority of cases at separation distance of 200 metres downwind.

Following this research, SNIFFER/SEPA published a report *Measurement and Modelling of Emissions from Three Composting Sites*, 2007 (researcher Cranfield University). Again, this research included two in-vessel technologies and one open windrow system and it was mainly focused on measuring source bioaerosol concentrations and modelling their dispersion. There was a seasonal variation of *Aspergillus fumigatus* at all the three sites, with concentrations being the highest in the autumn. When composting material was agitated (i.e. shredding, turning, moving, screening), the model predictions of downwind concentrations were within the same order of magnitude as the sampled concentrations, suggesting that the major contribution to downwind emissions was from agitation activities, as has been shown by other researchers. The majority of the sampled concentrations were shown to be reduced to below the suggested threshold limit values by 250 m downwind of the sites.

More recently, another report published by the Environment Agency, *Bioaerosols in waste composting: deriving source terms and characterising profiles*, 2008 (researcher Health & Safety Laboratory) looks at four sites representative of commercial composting activities in the UK. The sites again included both in-vessel composting systems and open windrow composting. The results from the study showed that compost handling operations can release high concentrations of bacteria, fungi and endotoxins into the air in the immediate surroundings. Samples did show, however, that concentrations of bioaerosols tended to decrease as distance from the original

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source increased. At distances of 50m and 100m downwind of composting activities, bioaerosols concentrations were significantly lower than in the immediate vicinity of the composting activity. The report authors also state that there was no evidence that the composting operations visited made major contributions to the overall environmental bioaerosol burden at a distance of >250m from activities, and therefore there was no evidence to suggest that the Environment Agency's 250m trigger limit should be revised.

The most recent report was an extension to the above research, *Bioaerosol emissions from waste composting and the potential for workers' exposure* as published by the Health and Safety Executive, 2010 (researcher Health & Safety Laboratory). The dispersion of bioaerosols from compost handling activities was estimated by collecting bioaerosol samples at several points downwind, at distances increasing from the emission site up to 250m. Upwind background samples were used as a benchmark. This work showed that close to compost handling activities, if workers are not protected from exposure, they may be exposed to concentrations of airborne bacteria and fungi that frequently exceed 100,000 cfu/m^3 and occasionally (28% of bacterial samples and 10% of fungal samples) exceeding 1 million cfu/m^3 in sampled air. At >250m downwind of compost handling activities, at least 93% of bacteria and 98% of *Aspergillus fumigatus* bioaerosol concentrations were less than 5,000 cfu/m^3 air, and could be considered to be within the range of 'typical' background levels. There was therefore little evidence that the composting operations studied made a major contribution to the overall bioaerosol burden at distance >250m from composting activities. Appendix 1C provides a summary diagram of the findings from the research, showing how bioaerosol concentration changes with distance from the source, as denoted by the concentration zones.

Conclusions from the research

The greatest potential for bioaerosol release is when composting material is agitated, which mainly includes shredding, turning, and screening. It is apparent that in many cases very high levels of micro-organisms are released when these activities take place, but that downwind concentrations quickly decline, typically within the range of 50 to 150 metres. Local conditions do however have an impact on the concentrations, whether it is from elevated background levels, process conditions or windbreaks which either reduce the source emission or help disperse the emission. The research indicates that background levels or the EA reference levels are achieved in the majority of cases within separation distance of 250m, although mitigating measures such as enclosure of composting processes and use of mitigation and abatement technologies can be used to reduce this distance.

3.2 Review of bioaerosol emissions from poultry farms

3.2.1 Published research

The Environment Agency report entitled '*PPC bioaerosols (dust and particulates) potentially emanating from intensive agriculture and potential effects on human health'* (2008) provides a review of research on bioaerosol concentrations within and emissions from, different types of poultry production systems. The report suggests that there are a number of factors which can influence bioaerosol emissions from poultry buildings and should be considered when assessing the potential for adverse health effects arising from exposure. These factors may include; type and growth stage of animals, stocking density, building type, ventilation rate and local environmental conditions.

The Environment Agency research report recognises evidence which demonstrates the potential for bioaerosol emissions from intensive agriculture to raise ambient background concentrations, however, the report concludes that extent of this contribution to overall atmospheric bioaerosol burden has not yet been defined and therefore, there is currently insufficient evidence to assess the potential for exposure to cause increased risk of adverse health effects.

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The research project commissioned by Defra, entitled '*Characterising poultry dust properties, assessing human health implications, quantifying emission levels and assessing the potential for abatement'* (2009), represents the single most comprehensive study to date on bioaerosol emissions from poultry housing in the UK. The project included measurement of bioaerosol concentrations upwind of, within, and downwind of broiler and egg layer units during summer and winter months. The research found that concentrations of airborne microorganisms within poultry houses were of similar magnitude to concentrations reported in research by Crook *et al*. (2008) where total bacteria were found to exceed one million cfu/m^3, endotoxin levels were as high as 38,000 cfu/m^3 and total fungal concentrations were measured up to 600,000 cfu/m^3. By comparison to other industries, these levels of bacteria and fungi are similar to concentrations measured in close proximity to compost handling operations.

Off-site bioaerosol sampling undertaken as part of the Defra research project found that in almost all cases, concentrations of bacteria were close to measured upwind levels, or at levels considered to be typical of concentrations in the context of sites within agricultural settings by 100-200m downwind of poultry houses. Concentrations of fungi were also found to return to measured upwind levels or otherwise typical 'background' levels by 100m downwind in almost all cases. These findings are supported by other studies including research work undertaken by Green et al. (2007) which concluded that concentrations of bioaerosols returned to 'background' levels by 150m downwind of poultry houses, and also Hartung (1998) which concluded that 'background' levels were measured at 115m downwind of poultry installations.

3.2.2 ADAS research

As part of this assessment ADAS were commissioned to undertake measurement of bioaerosols at the Galley Hill Farm poultry facility, situated in Huntingdon, Cambridgeshire. The Galley Hill Farm facility comprises 8 poultry houses used for the rearing of broiler chickens with a combined total of 450,000 broiler places. Sampling was undertaken on the 12th September 2013 and the main objectives were to evaluate typical concentrations of bioaerosols within the poultry houses and to quantify ambient downwind concentrations during the final stages of the production cycle, before de-population.

Measurements undertaken within the poultry houses showed high concentrations of mesophilic bacteria which exceeded 37,000 cfu/m^3 at the time of sampling. The measured concentrations of bacteria are within the lower concentration range reported for mesophilic bacteria in the 2009 Defra research project and may reflect the high building ventilation rate at the time of sampling.

Total moulds (at 40˚C) and A. *fumigatus* spp were very low inside the poultry houses at the time of sampling and measured concentrations are within the range that can be expected background air. The concentrations of A. fumigatus spp and total moulds measured within the buildings at Galley Hill Farm are considerably lower than equivalent internal concentrations reported in the 2009 Defra research project and again may reflect the high building ventilation rate at the time of sampling.

Concentrations of mesophilic bacteria were elevated above 'background' levels at 20m and 80m downwind of the poultry houses (5,721 cfu/m^3 and 6,929 cfu/m^3 respectively) and measured concentrations exceeded the 1,000 cfu/m^3 EA reference level at the time of sampling. Sampling undertaken at 150m downwind of the poultry houses showed much lower concentrations of mesophilic bacteria (mean 42 cfu/m^3) which were well within the 1,000 cfu/m^3 EA reference level at the time of sampling. The measured downwind concentrations of mesophilic bacteria support research work undertaken on emissions from poultry facilities summarised in section 3.2.1 and suggest that concentrations of bacteria return to 'background' levels within a separation distance 150m.

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As stated previously in this report ambient atmospheric concentrations of bioaerosols are highly variable and are subject to temporal variability, which may be caused by episodic emissions from on-site activities or off-site fugitive emissions and also the effects of natural variations in dispersion conditions which occur with time. It must be recognised that standard bioaerosol monitoring relies on short duration sampling, i.e. 5-30 minute "snapshots" of air quality during the operational day.

It is possible that there are periods when downwind concentrations at much shorter separation distances are within the respective EA reference limits and other times when these levels may be exceeded, however, in order to obtain a representation of bioaerosol concentrations over a longer period and to relate this to site operations, repeated short duration measurements are needed at various times of the year.

The full report for sampling work undertaken at the Galley Hill Farm poultry facility is provided in Appendix 1.

Conclusions from the research

Concentrations of bioaerosols in and around poultry farms vary depending on time of year, contribution from background sources, farm type, number of animals and management techniques. Measurement data suggests that levels of bacteria and fungi within poultry houses are likely to be elevated and generally concentrations are within the same order of magnitude as levels measured in close proximity to waste handling activities such as waste transfer operations and composting. This may represent a risk to poultry workers in terms of respiratory allergy disease.

Local conditions do however have an impact on the concentrations, whether it is from elevated background levels, process management conditions or windbreaks which either reduce the source emission or help disperse the emission. The research indicates that background levels or the EA reference levels are achieved in the majority of cases within a separation distance of 100-200m, although mitigating measures such as enclosure of processes and use of mitigation and abatement technologies can be used to reduce this distance.

3.3 Other potential bioaerosol sources

Other sources of bioaerosols in the local area around Sutton Veny Farm, other than the proposed poultry unit, could also contribute to local background levels.

The immediate area surrounding the facility is rural, comprising of arable agricultural land with some areas also used for livestock grazing. It is likely that during certain times of the year the rural setting will impact on the level of bioaerosols locally. Arable fields can lead to a high level of bacteria and fungi release (which can include *aspergillus fumigatus* spp) during certain parts of the growing and harvesting cycle, as can vegetated areas amongst arable land which can generate large numbers of spores during certain parts of the spring and summer seasons. Land used for livestock grazing and associated housing is also a potential bioaerosol source, particularly bacteria, deriving directly from livestock in fields and also from activities associated with livestock such as manure stock piling, manure spreading, and winter feed and bedding storage.

3.4 Critical Control Points

The critical control points in respect of bioaerosols for the proposed Sutton Veny Farm poultry development are predicted to be as follows:

Table 1: Identification of Critical Control Points (CCP)

CCP No.	Operation	Description of Operation	Potential for Bioaerosol Emissions
1.	**Poultry house preparation**	Prior to the arrival of the day-old birds, the concrete floors in each house will be covered with either wood shavings or chopped straw to a depth of 20mm. The new houses will be pre-warmed to 31˚C using an LPG heating system.	**Low release potential:** Wood shavings and chopped straw will typically have low levels of micro-organisms within it providing that storage conditions have been adequately controlled prior to delivery. Bedding materials will be delivered onto site using enclosed or sheeted transport vehicles to minimise the potential for bioaerosol release during transport to site. Dust extracted bedding will be used to reduce the potential of fine particulates becoming aerosolised during preparation of the poultry houses.
2.	**Transport of chicks to site & population of houses**	Day old chicks will be delivered to site in enclosed transport vehicles and then distributed between the five poultry sheds at the start of each production cycle.	**Low release potential:** Potential release to atmosphere as delivery vehicles arrive on-site will be limited as chicks will be contained within hatchery boxes and transport vehicles will be fully enclosed or sheeted. This will minimise the potential for fugitive bioaerosol release. Chicks will be gently tipped from hatchery boxes at ground level which will help minimise agitation of bedding material and therefore reduce the potential for bioaerosol release. Building ventilation will be minimal during population of houses to maintain appropriate ambient temperatures; therefore bioaerosol release from the roof mounted fans will be limited.
3.	**Broiler rearing**	The average cycle length will be 34-40 days with thinning of the flock taking place between days 34 – 38, which will reduce the flock size by approximately 25-50%. Ventilation will be provided by side air inlets and high speed roof mounted fans. As the birds grow, the ventilation rate increases and the house temperature will be gradually reduced until the boilers can be switched off. Litter will be maintained at a moisture content of approximately 35%, through control of ventilation, internal temperature, bedding quantities and relative humidity.	**Moderate release potential:** Significant quantities of micro-organisms will be generated by the poultry production process. Primary bioaerosol sources will include feed, bedding and excreta, and the animals themselves as skin of poultry continuously sheds skin scales, some of which carrying aerobic and anaerobic bacteria and excreta. As the flock reaches maturity, the level of animal movement will increase; therefore so will the potential for bioaerosol emissions. Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. The high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols to minimise off-site impact.
4.	**Feed management**	Feed will be delivered to site in fully enclosed transport vehicles and transferred	**Low release potential:** Animal feed can be a source of bioaerosols,

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		directly from the transport to purpose built covered feed silos located next to the broiler sheds. Feed will be conveyed directly from the storage silos to the poultry houses using an enclosed conveyor system.	particularly if the feed has low moisture content and is agitated during its distribution. The use of poor quality ingredients may lead to higher dust concentrations and greater potential for particulates to become airborne. No milling of feed will take place at the proposed poultry site and all feed will be supplied pre-blended. Feed will be delivered to site in fully enclosed transport vehicles and transferred from the transport vehicle to purpose built covered silos located next to the broiler sheds, to minimise the potential for bioaerosol release during transport and reception of feed. Feed storage silos will be regularly checked for signs of damage or wear to minimise the potential for fugitive bioaerosol release. Feed will be piped directly from the storage silos to the poultry houses using an enclosed conveyor system, to minimise the potential for bioaerosol release during distribution of feed to the poultry units.
5.	**De-population**	Thinning of the flock will take place between days 34 – 38, which will reduce the flock size by approximately 25-50%. At the end of the growing period (34-40 days), all birds will be loaded into crates and removed from the houses before transport off-site in open sided lorries.	**Low release potential:** Significant releases of micro-organisms will be generated at various stages of the poultry production process. Primary bioaerosol sources will include feed, bedding and excreta, and the animals themselves as skin of poultry continuously sheds skin scales, some of which carrying aerobic and anaerobic bacteria and excreta. Trained handlers will used to catch birds during thinning and de-population and care will be taken to minimise 'flapping' which can release bioaerosols from the animals. Care will also be taken to minimise disturbance of litter and bedding during thinning and de-population to minimise the potential for bioaerosol release. Doors will remain shut during thinning and de-population to minimise the potential for fugitive bioaerosol emissions. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans, at minimum ventilation required to maintain the correct internal environment for the birds. The high level/velocity release from roof mounted fans will provide dilution and dispersion of bioaerosols to minimise potential off-site impact.
6.	**Clean out**	After depopulation the spent litter will be removed from the buildings using skid steer loaders and loaded directly into the lorries or tractors positioned directly outside the poultry house doors. The houses will then be washed down	**Moderate release potential:** Significant quantities of micro-organisms will be generated by the poultry production process. Agitation of litter and bedding material during clean out may lead to the formation of potentially high bioaerosol emissions.

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		using a pressure washer and disinfected in preparation for the next flock. The process of clearing out and washing down will take approximately 5-7 working days.	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.

The primary bioaerosol emissions points associated with the proposed poultry facility are considered to be as follows:

- Critical control point 3 – broiler rearing
- Critical control point 6 – clean out

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4.0 RECEPTOR CHARACTERISATION

The EA Interim Position Statement defines a sensitive receptor as:

> " *..People likely to be within 250m of the composting operation for prolonged or frequent periods. This term would therefore apply to dwellings (including any associated gardens) and to workplaces where workers would frequently be present. It does not apply to the operators of composting facilities or their staff while carrying out the composting operation, as their health is covered by Health and Safety legislation"*

Seven groups of receptors have been identified within 250m of the poultry sheds. These receptors are termed primary receptors in this SSBRA and are detailed below.

4.1 Primary Sensitive Receptors

In the discussion of primary sensitive receptors and their distances from the proposed poultry unit, distances are measured as the shortest distance between the receptor and the extents of the poultry buildings. The bearing of the receptor from the site is in relation to the maximum extents of the building and the area covered by the receptor.

1. The neighbouring Allotments situated between 180° and 325° of the proposed poultry unit, at approximately 40m from the extents of the poultry buildings.

2. The west-north-west section of the Deverill Road Trading Estate, situated between 235° and 355° of the proposed poultry unit, at approximately 45m from the extents of the poultry buildings.

3. The neighbouring residential property, Java Bungalow, situated between 295° and 355° of the proposed poultry unit, at approximately 85m from the extents of the poultry buildings.

4. Pickle Farm property, situated between 265° and 325° of the proposed poultry unit, at approximately 140m from the extents of the poultry buildings.

5. The northern section of the Deverill Road Trading Estate, situated between 325° and 25° of the proposed poultry unit, at approximately 170m from the extents of the poultry buildings.

6. The north-north-west section of the Deverill Road Trading Estate, situated between 305° and 5° of the proposed poultry unit, at approximately 190m from the extents of the poultry buildings.

7. The north-west section of the Deverill Road Trading Estate, situated between 285° and 335° of the proposed poultry unit, at approximately 205m from the extents of the poultry buildings.

4.2 Secondary Sensitive Receptors

In bioaerosol risk assessments it is also common practice to consider areas to which the public may have regular access. Examples of such receptor areas could include public rights of way, playing fields and parks. Such receptors are termed secondary receptors in this SSBRA.

In the discussion of secondary sensitive receptors and their distances from the proposed poultry unit, distances are measured as the shortest distance between the receptor and the extents of the poultry houses. The bearing of the receptor from the site is taken from the centre point of the proposed poultry unit.

A summary of the site setting and sensitive receptors is detailed by direction below:

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North
- Deverill Road Trading Estate at approximately 170m
- Deverill Road at approximately 245m
- Agricultural land at approximately 280m
- Five Ash Lane at approximately 580m
- Agricultural land at approximately 600m
- Eastleigh Wood at approximately 963m
- Between N and NNE: Oilfields Property at approximately 480m
- Between N and NNE: The Commons Property at approximately 770m
- Between N and NNE: The Commons Farm at approximately 925m

North-North-East
- The Beeches Farm at approximately 282m
- Deverill Road at approximately 330m
- Agricultural land at approximately 356m
- Camp Farm at approximately 480m
- Five Ash Lane at approximately 590m
- Agricultural land at approximately 610m
- Bishopstow Road at approximately 747m
- Public Footpath at approximately 940m
- Between NNE and NE: Raven Hill residential properties at approximately 430m
- Between NNE and NE: Sutton-Veny House Nursing Home at approximately 780m
- Between NNE and NE: Hall Covert at approximately 880m

North East
- Agricultural land at approximately 15m
- Raven Hill residential properties approximately 557m
- Deverill Road at approximately 630m
- Orchard Cottage at approximately 760m
- Hall Covert at approximately 970m

East-North-East
- Agricultural land at approximately 15m
- Track at approximately 240m
- Residential properties on Walnut Close at approximately 685m
- High Street at approximately 800m

East
- Agricultural land at approximately 17m
- Track at approximately 220m
- Agricultural land at approximately 225m
- Hill Road at approximately 885m

East-South-East
- Agricultural land at approximately 17m
- Track at approximately 230m
- Agricultural land at approximately 235m
- Woodcombe Cleve at approximately 840m
- Hill Road at approximately 890m

South East
- Agricultural land at approximately 27m
- Track at approximately 276m
- Agricultural land at approximately 285m

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- Hill Road at approximately 930m

South-South-East
- Track at approximately 20m
- Agricultural land at approximately 254m
- Track at approximately 315m
- Agricultural land at approximately 340m
- Track at approximately 380m
- Agricultural land at approximately 395m

South
- Track at approximately 20m
- Agricultural land at approximately 26m
- Track at approximately 435m
- Deciduous Woodland at approximately 440m
- Track at approximately 475m

South-South-West
- Track at approximately 25m
- Agricultural land at approximately 35m

South West
- Agricultural land at approximately 30m

West-South-West`
- Agricultural land at approximately 25m
- Electricity Sub-Station at approximately 170m
- Track at approximately 760m
- Between WSW and W: Long Ivor Farm at approximately 715m
- Between WSW and W: Allotments at approximately 40m

West
- Agricultural Land at approximately 20m
- Track at approximately 75m
- Track at approximately 185m
- Agricultural land at approximately 190m
- Copperfield Properties at approximately 810m

West-North-West
- Deverill Road Trading Estate situated at approximately 45m
- Pickle Farm property at approximately 140m
- Woodland at approximately 370m
- Deverill Road at approximately 500m
- Henge at approximately 600m
- Southleigh Wood at approximately 735m

North West
- Deverill Road Trading Estate approximately 205m
- Deverill Road at approximately 300m
- Agricultural Land at approximately 325m
- PROW footpath at approximately 700m
- Southleigh Wood at approximately 705m
- Between NW and NNW: Raxters Farm at approximately 840m

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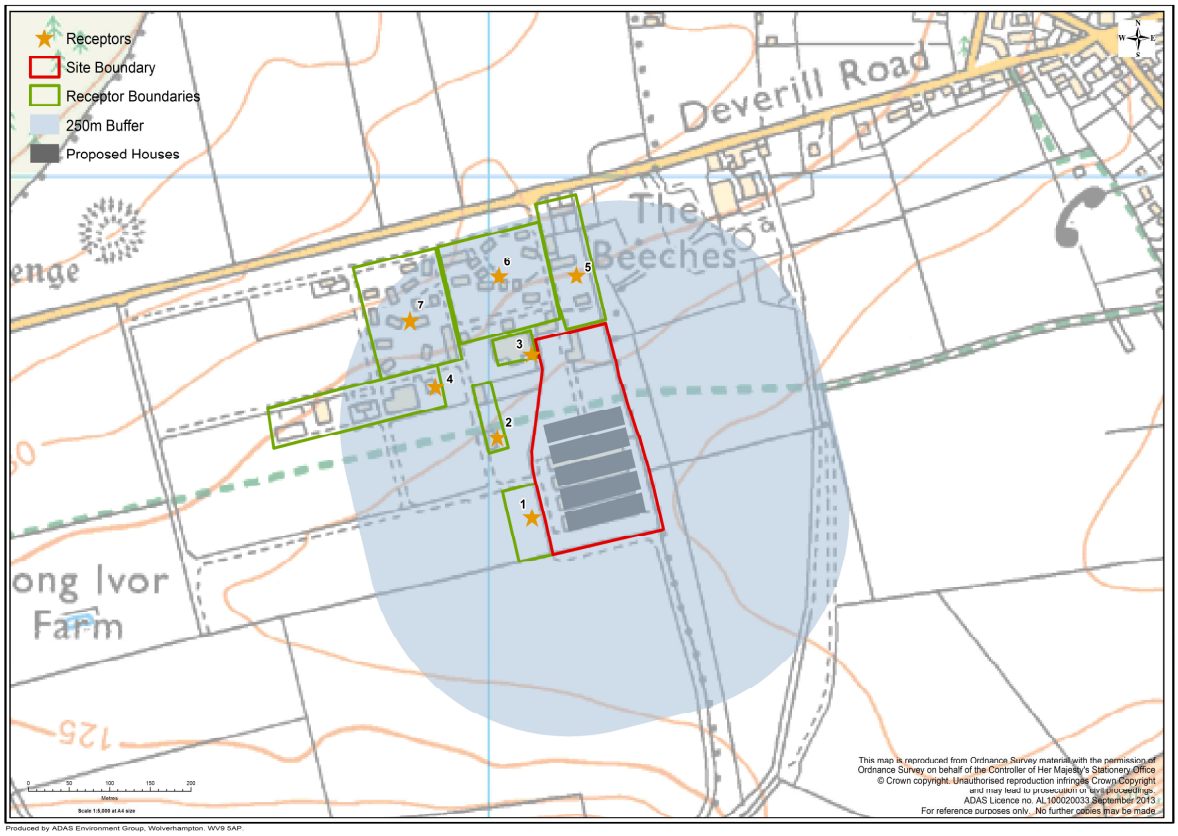
North-North-West

- The neighbouring residential property, Java Bungalow at approximately 85m
- Deverill Road Trading Estate approximately 190m
- Deverill Road at approximately 260m
- Agricultural Land at approximately 280m
- Eastleigh Wood at approximately 970m
- Between NNW and N: Residential property (Bungalow) at approximately 740m

Figure 3 indicates the location of the primary sensitive receptors identified within 250 metres of the proposed poultry houses site.

Figure 3: Primary Sensitive Receptors



5.0 PATHWAY CHARACTERISATION

5.1 General Considerations

Once bioaerosols are generated at any of the Critical Control Points described above, then the primary potential pathway for their transport away from the site and potentially towards a sensitive receptor is by wind transit. The main controlling factor of these pathways are the meteorological conditions at the site which will determine the direction, distance and degree of dispersion of any bioaerosols released from the facility at any particular time.

If all other factors are equal, then those sensitive receptors closest to the proposed poultry unit are generally at the highest risk of any impact and the magnitude of any impact will increase or decrease depending on the frequency of wind directions from the proposed development to any particular receptor.

The distance any bioaerosol particle has to travel from the facility to a receptor is deemed to be inversely proportional to the risk it presents i.e. bioaerosol concentrations will decrease rapidly from the source point, and concentrations are expected to return to background levels within 100-200 metres. Surface roughness, or turbulence generated by buildings or vegetation will also increase the favourable dispersion of the bioaerosol relative to a potential receptor. Similarly, winds over a certain velocity will also increase turbulence and increase dispersion, though they may also lead to increased emission rates from certain activities, particularly where outdoor activities are susceptible to wind blow and surface “stripping”.

5.2 Meteorological Conditions for Larkhill Weather Station

The prevailing wind directions in the UK are usually in the segment between south and west. However, the direction of the prevailing winds can be modified by local topography. In general it is the case that the more pronounced the topography, then the greater the potential influence upon local wind directions.

The Met Office maintains a network of observation stations across the UK. Wind speed and direction information is collected and collated as hourly averages. The nearest observation station to the application site is at Larkhill, Wiltshire, which is approximately 25km to the east of the poultry unit. The records from this station are considered to provide an acceptable representation of the weather in the area around the proposed site, which is necessary in the assessment of the potential dispersion of bioaerosols emitted from the facility. The following information is taken from data supplied specifically for this SSBRA by the Met Office.

The meteorological data from Larkhill has been accumulated and summarised for the years 2005 to 2009 inclusive, and based on climatological data collected by the Met Office. The data is summarised in the Wind Rose shown at Figure 4 below.

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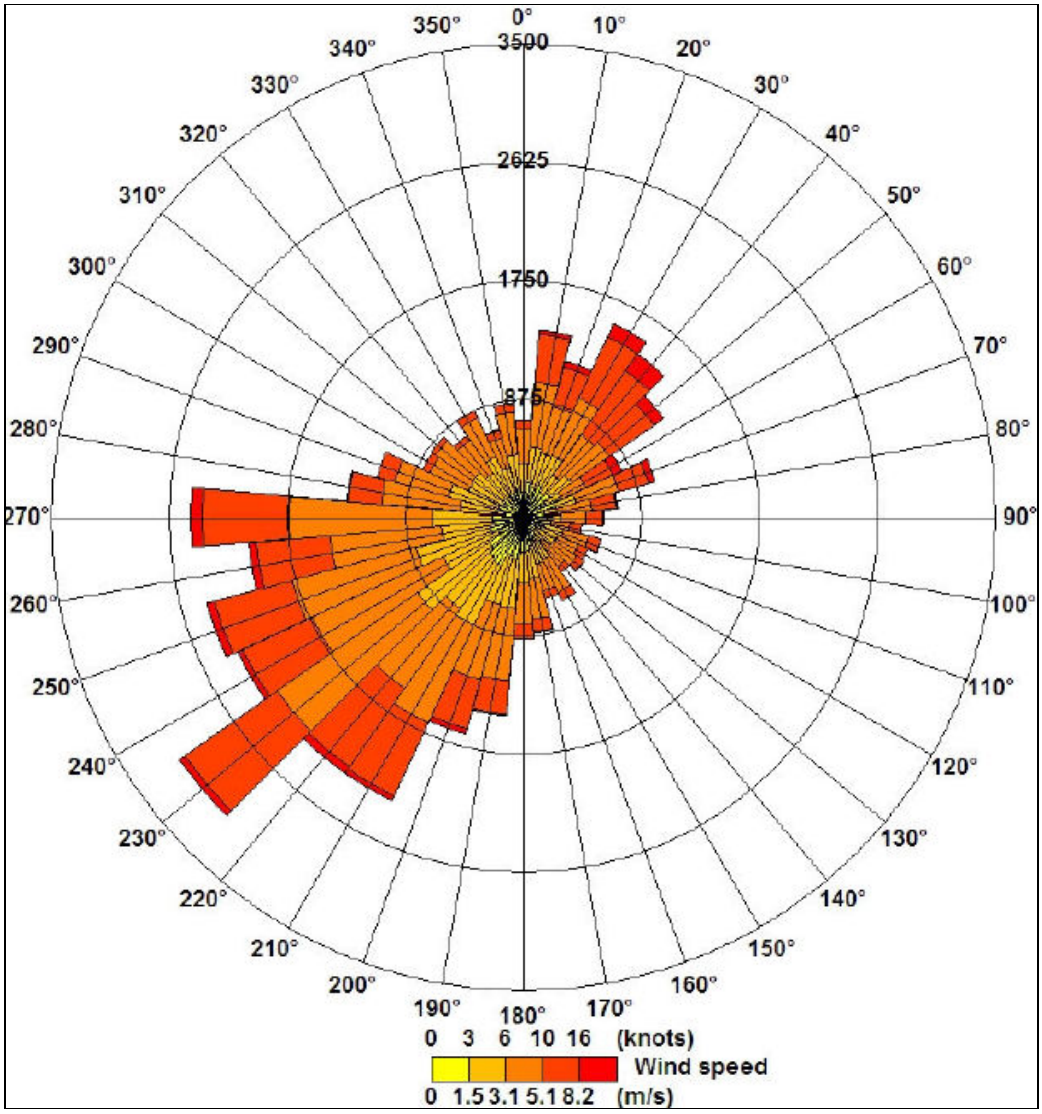
Figure 4: Wind Rose Summary Chart for Larkhill Weather Station (2005 – 2009)
(Illustrating the frequency by percent FROM which the winds blow)



The main features of the wind direction and speed are:

- The prevailing winds blow from between the west (270°) and the southwest (230°) 28% of the time.
- The winds that blow with the least frequency of time are from between the east (90°) and the south-south-east (160°) 10% of the time.

5.3 Wind in relation to sensitive receptor locations

A summary of wind frequencies in relation to the primary sensitive receptors is provided below.

The bearing of the receptor from the site is reported in relation to the maximum extents of the site and the area covered by the receptor; therefore the total wind frequencies reported for each receptor include times when the wind only blows towards the receptor across a proportion of the proposed site. For this reason the calculated frequencies represent the worst case scenario in terms of percentage of time a receptor is potentially downwind of the proposed facility.

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1. Neighbouring Allotments – wind blows towards the receptor 30.6% of the time.

2. The west-north-west section of the Deverill Road Trading Estate – wind blows towards receptor 20.9% of the time.

3. Java Bungalow – wind blows towards the receptor 9.8% of the time.

4. Pickle Farm property – wind blows towards the receptor 9% of the time.

5. The northern section of the Deverill Road Trading Estate – wind blows towards the receptor 15.1% of the time.

6. The north-north-west section of the Deverill Road Trading Estate – wind blows towards the receptor 10.4% of the time.

7. The north-west section of the Deverill Road Trading Estate – wind blows towards the receptor 7.5% of the time.

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6.0 SITE SPECIFIC BIOAEROSOL RISK ASSESSMENT (SSBRA)

A standard risk assessment methodology has been used to develop a conceptual model for the site which characterises the environmental setting and the various source-pathway-receptor (S-P-R) linkages. These have been summarised in the assessment presented below, where each significant S-P-R linkage identified is set out and analysed to give a qualitative assessment of risk.

The level of risk is a combination of the probability or frequency of occurrence of a defined source term hazard, and the magnitude of the consequences of that hazard being realised. In the assessment below, each element contributing to the assessment of risk is assigned a '**Very Low**', '**Low**', '**Medium**' or '**High**' rating to describe its influence on the final determination of risk and also to rank the degree of risk. Definitions are based on those provided by the Environment Agency's 2009 guidance on risk assessment:

6.1 Probability of exposure

The probability of exposure examines the likelihood of the receptor being exposed. This takes into account the frequency that the receptor is downwind of the composting operations and the frequency that release takes place. In line with the *Guidance on the evaluation of bioaerosol risk assessments for composting facilities* (2009), the probability of harm can be described as:

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

For each primary sensitive receptor identified the probability of exposure has been calculated based on the following assumptions:

- As a worst case it has been assumed that all winds blowing towards the receptors are capable of transporting bioaerosols
- Residential premises are permanently occupied
- In commercial premises receptors are present 42 hours per week (25% of the time)
- Primary releases are from:

  a) Broiler production which takes place for 85% of all time based on a flock cycle of 40 days and a clean out / house preparation period of 7 days. Emission will not be constant but will increase progressively through crop cycles from a very low level with day old chicks.
  b) Clean out / house preparation which takes place for 7.4% of all time based on operations taking place for 12 hours per day over a 7 day period. The spent litter removal activity will only occur over a proportion of this time.

The probability of exposure is calculated as the proportion of time that a receptor is downwind of the proposed units multiplied by the potential hours of operational release, multiplied by the proportion of time that the receptor is occupied for.

6.2 Consequence of Exposure

The consequence of exposure examines the nature of the source and the hazard presented to the receptor, with reference to 'acceptable' exposure levels. In line with the *Guidance on the evaluation of bioaerosol risk assessments for composting facilities* (2009), the consequences can be described as:

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

For the identified primary sensitive receptors the consequence of exposure has been defined in line with exposure levels reported in research summarised in section 3.2.1 of this report and physical measurement of ambient levels undertaken by ADAS at the Galley Hill Farm facility.

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Table 2: Site Specific Risk Assessment – Neighbouring Allotments

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry Houses	Bioaerosols	Neighbouring Allotments – Situated between 180° and 325° of poultry unit. Approximately 40m from the extents of the poultry buildings. Wind blows towards the receptor 30.6% of the time	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (6.5%)	**High** Concentrations of bioaerosols may exceed the EA reference levels within 100m of a poultry facility.	**Medium**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. The high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Low**
2. Clean-out	Used litter	Bioaerosols	Neighbouring Allotments – Situated between 180° and 325° of the poultry unit. Approximately 40m from the extents of the poultry buildings. Wind blows towards the receptor 30.6% of the time	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.6%)	**High** Concentrations of bioaerosols may exceed the EA reference levels within 100m of a poultry facility	**Medium**	Clean out will be postponed when the wind is blowing towards the receptor. This will minimise the potential for off-site impact as spent litter is removed from the buildings Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation.	**Low**

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Table 3: Site Specific Risk Assessment – West-north-west section of the Deverill Road Trading Estate

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry Houses	Bioaerosols	West-north-west section of the Deverill Road Trading Estate. Situated between 235° and 355° of the proposed poultry unit Approximately 45m from the extents of the poultry buildings. Wind blows towards the receptor 20.9% of the time.	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (4.4%)	High Concentrations of bioaerosols may exceed the EA reference levels within 100m of a poultry facility	**Medium**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. It is anticipated that the high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Low**
2. Clean-out	Used litter	Bioaerosols	West-north-west section of the Deverill Road Trading Estate. Situated between 235° and 355° of the proposed poultry unit Approximately 45m from the extents of the poultry buildings. Wind blows towards the receptor 20.9% of the time.	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.3%)	**High** Concentrations of bioaerosols may exceed the EA reference levels within 100m of a poultry facility	**Medium**	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.	**Low**

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Table 4: Site Specific Risk Assessment – Java Bungalow

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry Houses	Bioaerosols	Java Bungalow Situated between 295° and 355° of the proposed poultry unit. Approximately 85m from the extents of the poultry buildings. Wind blows towards the receptor 9.8% of the time.	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (8.3%)	**High** Concentrations of bioaerosols may exceed the EA reference levels within 100m of a poultry facility	**Medium**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. It is anticipated that the high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Low**
2. Clean-out	Used litter	Bioaerosols	Java Bungalow Situated between 295° and 355° of the proposed poultry unit. Approximately 85m from the extents of the poultry buildings. Wind blows towards the receptor 9.8% of the time.	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.7%)	**High** Concentrations of bioaerosols may exceed the EA reference levels within 100m of a poultry facility	**Medium**	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.	**Low**

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Table 5: Site Specific Risk Assessment – Pickle Farm

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry Houses	Bioaerosols	Pickle Farm Properties Situated between 265° and 325° of the proposed poultry unit. Approximately 140m from the extents of the poultry buildings. Wind blows towards the receptor 9.0% of the time.	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (7.7%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**low**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. It is anticipated that the high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Very low**
2. Clean-out	Used litter	Bioaerosols	Pickle Farm Properties Situated between 265° and 325° of the proposed poultry unit. Approximately 140m from the extents of the poultry buildings. Wind blows towards the receptor 9.0% of the time.	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.7%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.	**Very Low**

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Table 6: Site Specific Risk Assessment – Northern section of the Deverill Road Trading Estate

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry	Bioaerosols	Northern section of the Deverill Road Trading Estate Situated between 325° and 25° of the proposed poultry unit. Approximately 170m from the extents of the poultry buildings. Wind blows towards the receptor 15.1% of the time.	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (3.2%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. It is anticipated that the high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Very Low**
2. Clean-out	Used litter	Bioaerosols	Northern section of the Deverill Road Trading Estate Situated between 325° and 25° of the proposed poultry unit. Approximately 170m from the extents of the poultry buildings. Wind blows towards the receptor 15.1% of the time.	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.3%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.	**Very Low**

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Table 7: Site Specific Risk Assessment – North-north-west section of the Deverill Road Trading Estate

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry Houses	Bioaerosols	North-north-west section of the Deverill Road Trading Estate Situated between 305° and 5° of the proposed poultry unit. Approximately 190m from the extents of the poultry houses. Wind blows towards the receptor 10.4% of the time.	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (2.2%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. It is anticipated that the high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Very Low**
2. Clean-out	Used litter	Bioaerosols	North-north-west section of the Deverill Road Trading Estate Situated between 305° and 5° of the proposed poultry unit. Approximately 190m from the extents of the poultry houses. Wind blows towards the receptor 10.4% of the time.	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.2%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.	**Very Low**

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Table 8: Site Specific Risk Assessment – North-west section of the Deverill Road Trading Estate

Process	Source	Hazard	Receptor	Transport Mechanism	Pathway	Probability	Consequence	Magnitude of Risk	Risk Management Procedures & References	Residual risk
1. Broiler rearing	Poultry Houses	Bioaerosols	North-west section of the Deverill Road Trading Estate Situated between 285° and 335° of the proposed poultry unit. Approximately 205m from the extents of the poultry buildings. Wind blows towards the receptor 7.5% of the time.	Airborne from agitation and animal movement	Release to atmosphere through ridge fans	**Low** Probability of exposure (1.6%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Doors will remain shut at all times other than for broiler delivery, pick-up or during clean out to minimise the potential for fugitive bioaerosol emissions. Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. It is anticipated that the high level/velocity release from roof mounted fans will provide sufficient dilution and dispersion of bioaerosols which will minimise off-site impact.	**Very Low**
2. Clean-out	Used litter	Bioaerosols	North-west section of the Deverill Road Trading Estate Situated between 285° and 335° of the proposed poultry unit. Approximately 205m from the extents of the poultry buildings. Wind blows towards the receptor 7.5% of the time.	Agitation during material removal	Wind blown during litter removal	**Very Low** Probability of exposure (0.1%)	**Low** Concentrations of bioaerosols are likely to return to within EA reference levels at distances > 100m downwind of a poultry facility	**Low**	Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions. Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter that is removed from the houses following depopulation. Litter will be carefully tipped into lorry trailers positioned at the entrance to each house.	**Very Low**

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7.0 CONCLUSIONS

ADAS UK Ltd has been commissioned by James Whilding of Acorus Rural Property Services Ltd to undertake a site specific assessment of risks presented by the processes and activities to be carried out at the proposed poultry unit at Sutton Veny Farm, Warminster, Wiltshire.

An application for an Environmental Permit has been made for an intensive farming installation, which will be used for the rearing of broiler chickens and associated activities. The proposed completed development at Sutton Veny Farm will comprise five poultry houses with a combined total of 223,900 broiler places.

As there are sensitive receptors within 250 metres of the site, it is a requirement of the Environment Agency that a Site Specific Bioaerosol Risk Assessment (SSBRA) is undertaken. This assessment has been carried out in a logical format, firstly determining the "Critical Control Points", where potential risks may be identified and then assessing these risks in the context of *Risk Mitigation* including any *Controls* that may be required to suitably reduce this risk.

This risk assessment reveals that the residual risk to sensitive receptors identified within 250m of the foot print of the poultry units is **Low** or **Very Low** because there are a number of design and management factors associated with proposed operations at the Sutton Veny Farm poultry unit which help to provide control of potential bioaerosol emissions and off-site impact. These include:

Poultry Production

- Day old chicks will be transported to site in enclosed vehicles; therefore the potential for bioaerosol release during transport onto and off site will be limited.
- Doors of the poultry houses will remain shut at all times other than for broiler delivery, pick-up or during clean out. This will minimise the risk of fugitive release during production.
- Litter will be maintained at a moisture content of approximately 35%, through control of the ventilation system, internal temperature, bedding quantities and relative humidity. This will help to reduce the potential for airborne particulates inside the buildings during production.
- Air will be extracted from the poultry houses and exhausted to the atmosphere by roof mounted fans. The roof mounted fans will provide effective dilution and dispersion of emissions at high level to minimise off-site impact of bioaerosols.

Feed Management

- No milling of feed will take place at the proposed poultry site. All feed will be supplied pre-blended as crumb or pellets. These control measures will help to ensure that only quality feed, with minimum dust potential will be used on-site during production to reduce the potential for particulate release.
- Feed will be delivered to site in fully enclosed transport vehicles and conveyed directly from the transport to purpose built covered feed silos located next to the broiler sheds, to minimise the potential for fugitive bioaerosol release during transport and reception of feed.
- Feed storage silos will be regularly checked for signs of damage or wear to minimise the potential for fugitive bioaerosol release.
- Feed will be conveyed directly from the storage silos to the poultry houses using an enclosed conveyor system, to minimise the potential for bioaerosol release during distribution of feed to the poultry units.

Depopulation and Clean-out

- Once started, the clean out operation will be completed in as little time as possible whilst taking account of the above recommended restrictions.
- Spent litter will not be stored on site; instead litter removed from the poultry houses will be loaded onto vehicles and transported off site. This will reduce the potential for 'stripping' of bioaerosols off the surface of litter after removal from the houses following depopulation.

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- If an elevator is to be used for loading litter into lorries, the drop height will be minimised and the elevator covered; this will reduce the potential for bioaerosol release. If a loader vehicle is to be used, litter will be carefully tipped into lorry trailers positioned at the entrance to each house.
- All vehicles used for the transport of litter off-site will be sheeted; therefore, the potential for bioaerosol release during transport off-site will be limited.

This SSBRA should be reviewed after the first year of operation, or sooner if there are any changes to the proposed site design or activities. It is also recommended that bioaerosol monitoring is undertaken in accordance with the AfOR Standardised Protocol to provide a better understanding of the off-site effects bioaerosol emissions from the site.

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Annex 1. Galley Hill Farm Bioaerosol Monitoring Report

Bioaerosol Sampling at Galley Hill Farm Poultry Unit

(12th September 2013)

Prepared for:
James Whilding
Acorus Rural Property Services Ltd
Mamhead Castle
Exeter
Devon
EX6 8HD

Prepared by:
Laura Donnelly
ADAS UK Ltd
Pendeford House
Pendeford Business Park
Wobaston Road
Wolverhampton
WV9 5AP

Environment Group

Tel: 0845 766 0085

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1.0 INTRODUCTION

Sampling for the enumeration of airborne micro-organisms at the Galley Hill Farm Poultry facility was undertaken by ADAS UK Ltd on 12th September 2013.

The Galley Hill Farm facility comprises 8 poultry houses used for the rearing of broiler chickens with a combined total of 450,000 broiler places. The sampling was carried out on a normal working day approximately two days before the end of the flock cycle and start of the cleanout period.

The main objectives of the sampling were to:

a. Evaluate typical concentrations of bioaerosols within the poultry houses during the final stages of the production cycle.

b. Quantify typical ambient downwind concentrations during the final stages of the production cycle.

In lieu of any specific guidance relating to the sampling of bioaerosols from poultry facilities, the sampling was carried out, following so far as reasonably practicable, the *Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities* (Association for Organics Recycling (AfOR), 2009), or as specified in the report.

2.0 SAMPLING POINTS

Off-site

Sampling points were carefully chosen to correspond with the criteria of the AfOR Standardised Protocol and the requirements of the Site Specific Bioaerosol Risk Assessment for the proposed poultry unit at Sutton Veny. (see Appendix 3: Plan of Site, for further details on the positions):

1. **Upwind** of the poultry unit, at approximately 20 metres from the poultry buildings, west (270° from north) of the centre of the unit. The sampling position was located on an area of rough ground, adjacent to the fence line which forms the western site boundary.

2. **Downwind (1)** of the poultry unit, at approximately 20 metres from the poultry buildings, east (90° from north) of the centre of the unit. The sampling position was situated on an area of rough ground.

3. **Downwind (2)** of the poultry unit, at approximately 80 metres from the poultry buildings, east (90° from north) of the centre of the unit. The sampling position was situated on a grass verge adjacent to the A1096.

4. **Downwind (3)** of the poultry unit, at approximately 150 metres from the poultry buildings, east-south-east (105° from north) of the centre of the unit. The sampling position was situated on a grass verge adjacent to the junction of Huntingdon Road and the A1096.

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Internal

Sampling was also undertaken within one of the poultry houses to evaluate typical concentrations of bioaerosols at source. The sampling position was located centrally within 'shed 3' which was housing approximately 42,000 broilers at the time of sampling.

3.0 EQUIPMENT & METHODS

Sampling was carried out in accordance with the AfOR Protocol using single stage 400 hole Andersen type impact samplers, with micro-organisms being collected on duplicate agar plates. For each downwind sampling position and upwind equivalent sample was taken simultaneously to provide an appreciation of 'background' concentrations of bioaerosols at the time of sampling. Sampling at the upwind and downwind positions was undertaken using 10 minute sampling periods. Internal sampling was carried out using shorter 5 minute and 2 minute sampling periods to reduce the risk over population of sample plates.

At the downwind sampling positions and the internal position, a third plate was exposed in a sampler with no pump attached to act as a control. In addition, a separate unexposed control plates of each media were kept at the upwind sampling station to assess if there was any plate contamination during transportation and whilst the sampling was being undertaken.

A Davis Vantage Pro weather station was used to record the wind and weather conditions during sampling, as set out in the AfOR Protocol.

4.0 MICRO-ORGANISMS

The micro-organisms that were evaluated were:

- A. *fumigatus* spp
- Total moulds at 40°C
- Mesophilic bacteria (Total Viable Count)

Sciantec Analytical Services at Cawood (North Yorkshire) undertook the enumeration of these micro-organisms. The microbiology facility at Sciantec is UKAS accredited and also runs its own internal Quality Management System. All medium preparation, storage and analysis were undertaken in accordance with the AfOR Protocol and defined Standard Operating Procedures for the enumeration of these micro-organisms as part of the Sciantec Quality Management System.

5.0 PERSONNEL

The bioaerosol sampling was undertaken by Ger Parry and Laura Donnelly of ADAS. These persons have received training for undertaking this work, in accordance with both *BS EN ISO 14001 (Cert No: LRQ 4001349) and 9001 (Cert No: LRQ 0936648)* Quality Management Systems.

6.0 RESULTS

6.1 Concentration of airborne micro-organisms

Results (individual plate counts) obtained from the various sampling points can be seen in Appendix 1 and are summarised below in Table 1 and Table 2. The results have been

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calculated on a concentration (total viable count) per cubic metre (cfu/m^3) of air so are directly comparable.

Table 1: Results for off-site bioaerosol measurement on 12th September 2013

Location	Average cfu/m^3 (colony forming units per cubic metre of air)		
	Aspergillus fumigatus spp	Total Moulds @ 40°C	Mesophilic bacteria
Upwind 1	0	4	78
Downwind (20m)	4	7	5721
Upwind 2	0	25	18
Downwind (80m)	0	4	6929
Upwind 3	0	11	7
Downwind (150m)	7	74	42

Table 2: Results for internal bioaerosol measurement on 12th September 2013

Location	Average cfu/m^3 (colony forming units per cubic metre of air)		
	Aspergillus fumigatus spp	Total Moulds @ 40°C	Mesophilic bacteria
Internal (5 min)	0	0	TNTC* (>15,032)
Internal (2 min)	0	18	TNTC* (>37,580)

*The 'Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities' (Association for Organic Recycling (AfOR), 2009), states that "if 399 or more colonies are counted on any single plate, this result should be reported as 'too numerous to count' (TNTC)". To provide a meaningful result an indicative plate count of 398 colony forming units has been applied to the above results for mesophilic bacteria to provide a concentration which is reported as 'greater than'.

6.2 Weather conditions

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

- Dry and an average of 7/8 cloud cover.
- Temperature ranged from 13.9°C to 17.6°C, the average was 16.5°C.
- Relative humidity ranged from 77.0% to 93.0%, the average was 84.8%.
- Wind speeds ranged from 0.0 m/s to 1.8 m/s, the average was 0.4 m/s.
- Wind direction was on average from the west-south-west (248° from the north).

7.0 OBSERVATIONS AND DISCUSSION

Bacteria and fungi occur naturally in many different environments and are therefore commonly present in the air. Concentrations are highly variable, but background levels of mesophilic bacteria or moulds (which include *A. fumigatus* spp) 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 1,000 cfu/m^3 for mesophilic bacteria and 500 cfu/m^3 for total moulds have been used within this report, when assessing the concentrations of bioaerosols. These threshold values are stated in the latest Environment Agency position statement on bioaerosols (2010).

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7.1 Off-Site

Upwind position

A.fumigatus spp were not detected at the upwind position during any of the sampling periods undertaken and therefore all measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant influence from off-site upwind sources of A. *fumigatu*s spp at the time of sampling.

Total moulds (at 40˚C) were also low at the upwind position during all sampling periods (mean 13 cfu/m^3) and therefore all measured concentrations were therefore well within the 500 cfu/m^3 EA reference level for moulds at the time of sampling. The results suggest that there was no significant influence from off-site upwind sources of moulds capable of culture at 40˚C at the time of sampling.

Mesophilic bacteria were low at the upwind position during all sampling periods (mean 34 cfu/m^3) and therefore all measured concentrations were therefore well within the 1,000 cfu/m^3 EA reference level for bacteria at the time of sampling. The measured concentrations of are considered to be representative of 'background' levels in the context of sites within rural surroundings and suggest that there was no significant influence from off-site upwind sources of bacteria at the time of sampling.

Downwind Positions

Downwind (20m)

A. fumigatus spp were low at the downwind 20m position (4 cfu/m3) and measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant increase in 'background' levels of A. *fumigatus* spp at 20m downwind of the poultry unit at the time of sampling.

Total moulds were also low at the downwind 80m position (7 cfu/m3) and measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant increase in 'background' levels of total moulds at 20m downwind of the poultry unit at the time of sampling.

Mesophilic bacteria were elevated at the downwind 20m position (5,721 cfu/m^3) in comparison to levels measured concurrently at the upwind sampling position (78 cfu/m^3) and downwind concentrations exceeded the 1,000 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was a significant increase in 'background' concentrations of mesophilic bacteria at 20m downwind of the poultry unit at the time of sampling.

Downwind (80m)

A. fumigatus spp were not detected at the downwind 20m position and therefore measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant increase in 'background' levels of A. *fumigatus* spp at 80m downwind of the poultry unit at the time of sampling.

Total moulds were low at the downwind 80m position (4 cfu/m3) and measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant increase in 'background' levels of total moulds at 80m downwind of the poultry unit at the time of sampling.

Mesophilic bacteria were elevated at the downwind 80m position (6,929 cfu/m^3) in comparison to levels measured concurrently at the upwind sampling position (18 cfu/m^3) and downwind concentrations exceeded the 1,000 cfu/m^3 EA reference level at the time of

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sampling. The results suggest that there was a significant increase in 'background' concentrations of mesophilic bacteria at 80m downwind of the poultry unit at the time of sampling.

Downwind (150m)
A. fumigatus spp were low at the downwind 150m position (7 cfu/m3) and measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant increase in 'background' levels of A. *fumigatus* spp at 150m downwind of the poultry unit at the time of sampling.

Total moulds were low at the downwind 150m position (74 cfu/m3) and measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that there was no significant increase in 'background' levels of total moulds at 150m downwind of the poultry unit at the time of sampling.

Mesophilic bacteria were low at the downwind 150m position (42 cfu/m^3) and measured concentrations were well within the 1,000 cfu/m^3 EA reference level at the time of sampling. The measured concentrations of mesophilic bacteria are within the range that can be expected in background air in the context of sites within rural surroundings.

7.1 Internal

A. *fumigatus* spp were not detected within 'shed 3' during any internal sampling periods and therefore all measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that sources of A. *fumigatus* spp were not contributing to internal atmospheric concentrations of bioaerosols in close proximity to the sampling station, at the time of sampling.

Total moulds were low within 'shed 3' during both internal sampling periods (mean 9 cfu/m^3) and measured concentrations were well within the 500 cfu/m^3 EA reference level at the time of sampling. The results suggest that sources of total moulds were not making significant contributions to internal atmospheric concentrations of moulds in close proximity to the sampling station, at the time of sampling.

Duplicate sample plates for mesophilic bacteria were saturated with colonies of bacteria for both sampling periods. The 'Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities' (Association for Organic Recycling (AfOR), 2009), states that "if 399 or more colonies are counted on any single plate, this result should be reported as 'too numerous to count' (TNTC)". To provide a meaningful result a plate count of 398 colony forming units was applied to the results for mesophilic bacteria to provide an indicative concentration which is reported as 'greater than'.

Indicative concentrations of mesophilic bacteria were elevated during both sampling periods (15,032 cfu/m^3 and 37,580 cfu/m^3) and the results suggest that sources of mesophilic bacteria were contributing to high internal atmospheric concentrations of bacteria at the time of sampling.

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8.0 CONCLUSIONS & RECOMMENDATIONS

Measurements undertaken within the poultry houses showed high concentrations of mesophilic bacteria which exceeded 37,000 cfu/m^3 at the time of sampling. The measured concentrations of bacteria are within the lower concentration range reported for mesophilic bacteria in the 2009 Defra research project and may reflect the high building ventilation rate at the time of sampling due to ambient temperature and the final stages of the flock cycle.

Total moulds (at 40˚C) and A. *fumigatus* spp were very low inside the poultry houses at the time of sampling and measured concentrations are within the range that can be expected background air. The concentrations of A. fumigatus spp and total moulds measured within the buildings at Galley Hill Farm are considerably lower than equivalent internal concentrations reported in the 2009 Defra research project and again may reflect the high building ventilation rate at the time of sampling.

Concentrations of mesophilic bacteria were elevated above 'background' levels at 20m and 80m downwind of the poultry houses (5,721 cfu/m^3 and 6,929 cfu/m^3 respectively) and measured concentrations exceeded the 1,000 cfu/m^3 EA reference level at the time of sampling. Sampling undertaken at 150m downwind of the poultry houses showed much lower concentrations of mesophilic bacteria (mean 42 cfu/m^3) which were well within the 1,000 cfu/m^3 EA reference level at the time of sampling. The measured downwind concentrations of mesophilic bacteria support research work undertaken on emissions from poultry facilities summarised in section 3.2.1 and suggest that concentrations of bacteria return to 'background' levels within a separation distance 150m.

As stated previously in this report ambient atmospheric concentrations of bioaerosols are highly variable and are subject to temporal variability, which may be caused by episodic emissions from on-site activities or off-site fugitive emissions and also the effects of natural variations in dispersion conditions which occur with time. It must be recognised that standard bioaerosol monitoring relies on short duration sampling, i.e. 5-30 minute "snapshots" of air quality during the operational day.

It is possible that there are periods when downwind concentrations at much shorter separation distances are within the respective EA reference limits and other times when these levels may be exceeded, however, in order to obtain a representation of bioaerosol concentrations over a longer period and to relate this to site operations, repeated short duration measurements are needed at various times of the year.

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Appendix 1a: Site data during off-site Aspergillus fumigatus *spp sampling*

Location	**Sample Ref.**	**Distance from boundary** (metres)	**Bearing of sampling point from operation** (° from north)	**Sampling times** (from-to)	**Sampling duration** (mins)	**Sample pump ID**	**Pump flow rate** (l/min)	**Micro plate type**	**Uncorrected Result** (cfu /plate)	**Mean** (cfu /plate)	**Corrected mean** (cfu /plate)	**Concentration** (cfu/m^3)	**Activities/notes**
Upwind 1	19	20	270	13:18-13:28	10	5	28.3	MEA	0				cloud cover 7/8
Upwind 1	20	20	270	13:18-13:28	10	6	28.3	MEA	0	0	0	0	cloud cover 7/8
Downwind 1 (20m)	27	20	90	13:18-13:28	10	1	28.3	MEA	0				cloud cover 7/8
Downwind 1 (20m)	28	20	90	13:18-13:28	10	2	28.3	MEA	1	1	1	4	cloud cover 7/8
DW 1 Control (20m)	29	20	90	13:18-13:28	10	-	-	MEA	0			Control	cloud cover 7/8
Upwind 2 (80m)	37	80	270	13:53-14:03	10	5	28.3	MEA	0				cloud cover 8/8
Upwind 2 (80m)	38	80	270	13:53-14:03	10	6	28.3	MEA	0	0	0	0	cloud cover 8/8
Downwind 2 (80m)	45	80	90	13:53-14:03	10	1	28.3	MEA	0				cloud cover 8/8
Downwind 2 (80m)	46	80	90	13:53-14:03	10	2	28.3	MEA	0	0	0	0	cloud cover 8/8
DW 2 Control (80m)	47	80	90	13:53-14:03	10	-	-	MEA	0			Control	cloud cover 8/8
Upwind 3 (150m)	55	150	270	14:26-14:36	10	5	28.3	MEA	0				cloud cover 8/8
Upwind 3 (150m)	56	150	270	14:26-14:36	10	6	28.3	MEA	0	0	0	0	cloud cover 8/8
Downwind 3 (150m)	63	150	105	14:26-14:36	10	1	28.3	MEA	2				cloud cover 8/8
Downwind 3 (150m)	64	150	105	14:26-14:36	10	2	28.3	MEA	1	2	2	7	cloud cover 8/8
DW3 Control (150m)	65	150	105	14:26-14:36	10	-	-	MEA	0			Control	cloud cover 8/8
Workstation Control	73	-	-	-	-	-	-	MEA	<0	-	-	Control	-

Appendix 1b: Site data during off-site total moulds @ 40°C sampling

Location	**Sample Ref.**	**Distance from boundary** (metres)	**Bearing of sampling point from operation** (° from north)	**Sampling times** (from-to)	**Sampling duration** (mins)	**Sample pump ID**	**Pump flow rate** (l/min)	**Micro plate type**	**Uncorrected Result** (cfu /plate)	**Mean** (cfu /plate)	**Corrected mean** (cfu /plate)	**Concentration** (cfu/m^3)	**Activities/notes**
Upwind 1	19	20	270	13:18-13:28	10	5	28.3	MEA	0				cloud cover 7/8
Upwind 1	20	20	270	13:18-13:28	10	6	28.3	MEA	1	1	1	4	cloud cover 7/8
Downwind 1 (20m)	27	20	90	13:18-13:28	10	1	28.3	MEA	0				cloud cover 7/8
Downwind 1 (20m)	28	20	90	13:18-13:28	10	2	28.3	MEA	3	2	2	7	cloud cover 7/8
DW 1 Control (20m)	29	20	90	13:18-13:28	10	-	-	MEA	0			Control	cloud cover 7/8
Upwind 2 (80m)	37	80	270	13:53-14:03	10	5	28.3	MEA	5				cloud cover 8/8
Upwind 2 (80m)	38	80	270	13:53-14:03	10	6	28.3	MEA	9	7	7	25	cloud cover 8/8
Downwind 2 (80m)	45	80	90	13:53-14:03	10	1	28.3	MEA	1				cloud cover 8/8
Downwind 2 (80m)	46	80	90	13:53-14:03	10	2	28.3	MEA	1	1	1	4	cloud cover 8/8
DW 2 Control (80m)	47	80	90	13:53-14:03	10	-	-	MEA	0			Control	cloud cover 8/8
Upwind 3 (150m)	55	150	270	14:26-14:36	10	5	28.3	MEA	4				cloud cover 8/8
Upwind 3 (150m)	56	150	270	14:26-14:36	10	6	28.3	MEA	1	3	3	11	cloud cover 8/8
Downwind 3 (150m)	63	150	105	14:26-14:36	10	1	28.3	MEA	18				cloud cover 8/8
Downwind 3 (150m)	64	150	105	14:26-14:36	10	2	28.3	MEA	22	20	21	74	cloud cover 8/8
DW3 Control (150m)	65	150	105	14:26-14:36	10	-	-	MEA	0			Control	cloud cover 8/8
Workstation Control	73	-	-	-	-	-	-	MEA	<0	-	-	Control	-

Appendix 1c: Site data during off-site mesophilic bacteria sampling

Location	**Sample Ref.**	**Distance from boundary** (metres)	**Bearing of sampling point from operation** (° from north)	**Sampling times** (from-to)	**Sampling duration** (mins)	**Sample pump ID**	**Pump flow rate** (l/min)	**Micro plate type**	**Uncorrected Result** (cfu /plate)	**Mean** (cfu /plate)	**Corrected mean** (cfu /plate)	**Concentration** (cfu/m^3)	**Activities/notes**
Upwind 1	21	20	270	13:18-13:28	10	7	28.3	TBC	8				cloud cover 7/8
Upwind 1	22	20	270	13:18-13:28	10	8	28.3	TBC	34	21	22	78	cloud cover 7/8
Downwind 1 (20m)	30	20	90	13:18-13:28	10	3	28.3	TBC	400				cloud cover 7/8
Downwind 1 (20m)	31	20	90	13:18-13:28	10	4	28.3	TBC	386	393	1619	5721	cloud cover 7/8
DW 1 Control (20m)	32	20	90	13:18-13:28	10	-	-	TBC	0			Control	cloud cover 7/8
Upwind 2 (80m)	39	80	270	13:53-14:03	10	7	28.3	TBC	6				cloud cover 8/8
Upwind 2 (80m)	40	80	270	13:53-14:03	10	8	28.3	TBC	4	5	5	18	cloud cover 8/8
Downwind 2 (80m)	48	80	90	13:53-14:03	10	3	28.3	TBC	398				cloud cover 8/8
Downwind 2 (80m)	49	80	90	13:53-14:03	10	4	28.3	TBC	396	397	1961	6929	cloud cover 8/8
DW 2 Control (80m)	50	80	90	13:53-14:03	10	-	-	TBC	0			Control	cloud cover 8/8
Upwind 3 (150m)	57	150	270	14:26-14:36	10	7	28.3	TBC	3				cloud cover 8/8
Upwind 3 (150m)	58	150	270	14:26-14:36	10	8	28.3	TBC	0	2	2	7	cloud cover 8/8
Downwind 3 (150m)	66	150	105	14:26-14:36	10	3	28.3	TBC	11				cloud cover 8/8
Downwind 3 (150m)	67	150	105	14:26-14:36	10	4	28.3	TBC	13	12	12	42	cloud cover 8/8
DW3 Control (150m)	68	150	105	14:26-14:36	10	-	-	TBC	0			Control	cloud cover 8/8
Workstation Control	75	-	-	-	-	-	-	TBC	<0	-	-	Control	-

Appendix 2a: Site data during internal Aspergillus fumigatus *spp sampling*

Location	**Sample Ref.**	**Distance from boundary** (metres)	**Bearing of sampling point from operation** (^{o} from north)	**Sampling times** (from-to)	**Sampling duration** (mins)	**Sample pump ID**	**Pump flow rate** (l/min)	**Micro plate type**	**Uncorrected Result** (cfu /plate)	**Mean** (cfu /plate)	**Corrected mean** (cfu /plate)	**Concentration** (cfu/m^3)	**Activities/notes**
Internal (5 min)	9	-	-	11:25-11:30	5	5	28.3	MEA	0				
Internal (5 min)	10	-	-	11:25-11:30	5	6	28.3	MEA	0	0	0	0	
Internal Control (5 min)	11	-	-	11:25-11:30	5	-	-	MEA	0			Control	
Internal (2 min)	15	-	-	11:37-11:39	2	5	28.3	MEA	0				
Internal (2 min)	16	-	-	11:37-11:39	2	6	28.3	MEA	0	0	0	0	

Appendix 2b: Site data during internal total moulds @ 40°C sampling

Location	**Sample Ref.**	**Distance from boundary** (metres)	**Bearing of sampling point from operation** (^{o} from north)	**Sampling times** (from-to)	**Sampling duration** (mins)	**Sample pump ID**	**Pump flow rate** (l/min)	**Micro plate type**	**Uncorrected Result** (cfu /plate)	**Mean** (cfu /plate)	**Corrected mean** (cfu /plate)	**Concentration** (cfu/m^3)	**Activities/notes**
Internal (5 min)	9	-	-	11:25-11:30	5	5	28.3	MEA	0				
Internal (5 min)	10	-	-	11:25-11:30	5	6	28.3	MEA	0	0	0	0	
Internal Control (5 min)	11	-	-	11:25-11:30	5	-	-	MEA	0			Control	
Internal (2 min)	15	-	-	11:37-11:39	2	5	28.3	MEA	0				
Internal (2 min)	16	-	-	11:37-11:39	2	6	28.3	MEA	1	1	1	18	

Appendix 2c: Site data during internal mesophilic bacteria sampling

Location	**Sample Ref.**	**Distance from boundary** (metres)	**Bearing of sampling point from operation** (^{o} from north)	**Sampling times** (from-to)	**Sampling duration** (mins)	**Sample pump ID**	**Pump flow rate** (l/min)	**Micro plate type**	**Uncorrected Result** (cfu /plate)	**Mean** (cfu /plate)	**Corrected mean** (cfu /plate)	**Concentration** (cfu/m^3)	**Activities/notes**
Internal (5 min)	12	-	-	11:31-11:36	5	5	28.3	TBC	400				
Internal (5 min)	13	-	-	11:31-11:36	5	6	28.3	TBC	400	400	TNTC	TNTC	
Internal Control (5 min)	14	-	-	11:31-11:36	5	-	-	TBC	360			Control	
Internal (2 min)	17	-	-	11:40-11:42	2	5	28.3	TBC	400				
Internal (2 min)	18	-	-	11:40-11:42	2	6	28.3	TBC	400	400	TNTC	TNTC	

Appendix 3a: Weather data during Aspergillus fumigatus *spp/Total moulds @ 40°C sampling*

Location	**Sample Ref.**	**Time taken**	**Bearing of sampling point from operation** (° from north)	**Mean bearing of wind [blowing from]** (° from north)	**Difference in bearing between sampling point and mean wind direction** (°)	**Mean wind speed during sampling** (m/s)	**Mean temperature** (°C)	**Mean relative humidity** (%)	**Other comments, including cloud cover** (n/8)
Upwind 1	19	13:18-13:28	270	105	-165	0.3	17.4	82.4	cloud cover 7/8
Upwind 1	20	13:18-13:28	270	105	-165	0.3	17.4	82.4	cloud cover 7/8
Downwind 1 (20m)	27	13:18-13:28	90	105	15	0.3	17.4	82.4	cloud cover 7/8
Downwind 1 (20m)	28	13:18-13:28	90	105	15	0.3	17.4	82.4	cloud cover 7/8
DW 1 Control (20m)	29	13:18-13:28	90	105	15	0.3	17.4	82.4	cloud cover 7/8
Upwind 2 (80m)	37	13:53-14:03	270	99	-171	0.7	17.4	80.2	cloud cover 8/8
Upwind 2 (80m)	38	13:53-14:03	270	99	-171	0.7	17.4	80.2	cloud cover 8/8
Downwind 2 (80m)	45	13:53-14:03	90	99	9	0.7	17.4	80.2	cloud cover 8/8
Downwind 2 (80m)	46	13:53-14:03	90	99	9	0.7	17.4	80.2	cloud cover 8/8
DW 2 Control (80m)	47	13:53-14:03	90	99	9	0.7	17.4	80.2	cloud cover 8/8
Upwind 3 (150m)	55	14:26-14:36	270	104	-166	0.6	17.3	81.2	cloud cover 8/8
Upwind 3 (150m)	56	14:26-14:36	270	104	-166	0.6	17.3	81.2	cloud cover 8/8
Downwind 3 (150m)	63	14:26-14:36	105	104	-1	0.6	17.3	81.2	cloud cover 8/8
Downwind 3 (150m)	64	14:26-14:36	105	104	-1	0.6	17.3	81.2	cloud cover 8/8
DW3 Control (150m)	65	14:26-14:36	105	104	-1	0.6	17.3	81.2	cloud cover 8/8

Appendix 3b: Weather data during Mesophilic Bacteria sampling

Location	**Sample Ref.**	**Time taken**	**Bearing of sampling point from operation** (^{o} from north)	**Mean bearing of wind [blowing from]** (^{o} from north)	**Difference in bearing between sampling point and mean wind direction** (^{o})	**Mean wind speed during sampling** (m/s)	**Mean temperature** (^{o}C)	**Mean relative humidity** (%)	**Other comments, including cloud cover** (n/8)
Upwind 1	21	13:18-13:28	270	105	-165	0.3	17.4	82.4	cloud cover 7/8
Upwind 1	22	13:18-13:28	270	105	-165	0.3	17.4	82.4	cloud cover 7/8
Downwind 1 (20m)	30	13:18-13:28	90	105	15	0.3	17.4	82.4	cloud cover 7/8
Downwind 1 (20m)	31	13:18-13:28	90	105	15	0.3	17.4	82.4	cloud cover 7/8
DW 1 Control (20m)	32	13:18-13:28	90	105	15	0.3	17.4	82.4	cloud cover 7/8
Upwind 2 (80m)	39	13:53-14:03	270	99	-171	0.7	17.4	80.2	cloud cover 8/8
Upwind 2 (80m)	40	13:53-14:03	270	99	-171	0.7	17.4	80.2	cloud cover 8/8
Downwind 2 (80m)	48	13:53-14:03	90	99	9	0.7	17.4	80.2	cloud cover 8/8
Downwind 2 (80m)	49	13:53-14:03	90	99	9	0.7	17.4	80.2	cloud cover 8/8
DW 2 Control (80m)	50	13:53-14:03	90	99	9	0.7	17.4	80.2	cloud cover 8/8
Upwind 3 (150m)	57	14:26-14:36	270	104	-166	0.6	17.3	81.2	cloud cover 8/8
Upwind 3 (150m)	58	14:26-14:36	270	104	-166	0.6	17.3	81.2	cloud cover 8/8
Downwind 3 (150m)	66	14:26-14:36	105	104	-1	0.6	17.3	81.2	cloud cover 8/8
Downwind 3 (150m)	67	14:26-14:36	105	104	-1	0.6	17.3	81.2	cloud cover 8/8
DW3 Control (150m)	68	14:26-14:36	105	104	-1	0.6	17.3	81.2	cloud cover 8/8

Plan of Site

Produced by ADAS Environment Group, Wolverhampton. WV9 5AP.