Coalition Against Factory Farming

Proposed Poultry Unit, Land at Peartree Hill Road, Whaplode Drove, Spalding

Review of Air Quality and Particulate Matter Assessments

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Review of Particulate Matter and Odour Assessments

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1 Introduction

Michael Bull and Associates Ltd (MBAL) has been commissioned by the Coalition Against Factory Farming to advise on air quality and odour issues concerned with a planning application H23-031-25 to South Holland District Council (SHDC). This application is for "*Provision of new poultry unit & associated works"* at Land At Peartree Hill Road, Whaplode Drove, Spalding PE12 0SL.

The application has been accompanied by an odour impact assessment and an assessment of airborne emissions of particulate matter. Both were prepared by AS Modelling and Data Ltd.

MBAL has been commissioned to undertake the following tasks:

- Review the particulate matter and odour assessment and compare the approach with that suggested by appropriate guidance from the Environment Agency (EA), the Institute of Air Quality Management (IAQM) and other relevant bodies;
- Determine whether the approach taken meets the requirements of the guidance and normal industry custom and practice; and
- Consider whether the results from the assessments suggest that there would be potential significant effects from the proposals.

The Author of this report is Dr Michael Bull; his qualifications and experience are detailed below:

Michael has a BSc in Chemical Engineering from Exeter University and PhD in Public Health Engineering from Imperial College, London. He is a Chartered Engineer, Chartered Scientist and Chartered Environmentalist, a Fellow of the Institute of Air Quality Management, a Member of the Institute of Environmental Sciences and is a corporate member of the Institution of Chemical Engineers. He sat on the council of the Institute of Air Quality Management (IAQM) since its formation until 2018 and was the Vice Chairman of the Institute for 3 years until 2018. Until January 2021, he was a Director of Ove Arup & Partners Ltd and particularly responsible for leading the air quality and odour assessments undertaken by the company over a 24 year period. In January 2021, he set up and became a Director of Michael Bull and Associates Ltd (MBAL), a specialist company providing air quality and odour advice.

He has worked as a professional environmental scientist specialising in air quality and odour for approximately 38 years, having previously conducted research in environmental science for three years. He has contributed to many guidance documents including being a co-author of the RTPI Good Practice Guide on Air Quality and Land Use Planning, a contributing author to the National Society of Clean Air's Panel guidance regarding Air Quality and Planning and a member of the group that produced the IAQM guide on Air Quality Monitoring during Construction. He was the chair of the working group that produced the IAQM Guidance on the Assessment of Odour for Planning in 2014 and updated in 2018 and was a contributing author to the book, Designing with Smells, published by Routledge in 2017. He has also published a paper of particulate matter impacts from poultry housing[1].

Dr Bull has been an advisor on air quality matters on numerous major projects in the UK and overseas, these roles include being HS2's main air quality lead consultant between 2012 and 2021, lead air quality consultant for Gatwick and Stansted airport, acting as an advisor to Highways

[1] Bull, M. (2008) Investigation of the impact of intensive broiler rearing on local fine particulate matter concentrations, Water and Environment Journal, Vol 22(1) p25-31.

England (now National Highways), Transport Scotland and the Welsh Assembly and have provided expert evidence on over 70 occasions for planning appeals, in court and to Parliamentary committees.

2 Air Quality Assessment – Background and Guidance

2.1 European Air Quality Management – Particulate Matter

In 1996, the European Commission published the Air Quality Framework Directive on ambient air quality assessment and management (96/62/EC). This Directive defined the policy framework for twelve air pollutants known to have harmful effects on human health and the environment. Limit values (pollutant concentrations not to be exceeded by a certain date) for each specified pollutant were set through a series of Daughter Directives, including Directive 1999/30/EC (the 1st Daughter Directive) for PM_{10} amongst other pollutants.

In May 2008, the Directive 2008/50/EC on ambient air quality and cleaner air for Europe came into force. This Directive consolidated the Air Quality Framework Directive and most of the Daughter Directives, made provision for extended compliance deadlines for PM_{10} and introduced standards for $PM_{2.5}$ concentrations. The Directive was transposed into national legislation in England by the Air Quality Standards 2010 (amended in 2016). The Secretary of State for the Environment has the duty of ensuring compliance with the air quality limit values.

2.2 Air quality standards

Some pollutants have standards expressed as annual average concentrations due to the chronic way in which they affect health or the natural environment (i.e. effects occur after a prolonged period of exposure to elevated concentrations) and others have standards expressed as 24 hour, 1 hour or 15 minute average concentrations due to the acute way in which they affect health or the natural environment (i.e. after a relatively short period of exposure). Some pollutants have standards expressed in terms of both long term and short term concentrations.

In this assessment, the term ‘air quality standard’ has been used to refer to both the UK objectives and European limit values. Table 1 sets out the air quality standards for particulate matter relevant to this study.

Pollutant	Averaging period	Air quality standard
Human health		
Particulate matter (PM_{10})	Annual mean	40µg/m^3
	24-hour mean	50µg/m^3 [1]
Fine particulate matter ($PM_{2.5}$)	Annual mean	25µg/m^3
[1] not to be exceeded more than 35 times a year (90.4th percentile)		

Table 1 Air Quality Standards

2.3 Environment Act 1995

Part IV of the Environment Act 1995 places a duty on the Secretary of State for the Environment to develop, implement and maintain an Air Quality Strategy with the aim of reducing atmospheric emissions and improving air quality. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland provides the framework for ensuring compliance with the air quality limit values based on a combination of international, national and local measures to reduce emissions and improve air quality. This includes the statutory duty, also under Part IV of the Environment Act 1995, for local authorities to undergo a process of local air quality management and declare Air Quality Management Areas (AQMA) where necessary.

2.4 Environment Act 2021

The Environment Act 2021 committed the government to set new targets for $PM_{2.5}$, this has now been set in the Environmental Targets (Fine Particulate Matter) (England) Regulations 2023 which gives a target for annual mean $PM_{2.5}$ of 10µg/m^3 to be met by the year 2040. An interim target is detailed in the Government's Environmental Improvement Plan 2023 of 12µg/m^3 to be met by the end of January 2028.

2.5 DEFRA Interim Planning Guidance

Following the introduction of the Regulations detailed in Section 2.5, Defra released interim planning guidance[2] detailing how the matter should be considered in planning decisions.
These state that:

"***The purpose of the targets is to improve air quality by reducing levels of $PM_{2.5}$ across the country, therefore improving public health. While achievement of the targets will be assessed at relevant monitoring sites, the targets apply to ambient (outdoor) air throughout England. Applicants and Local Planning Authorities should therefore consider the impact of developments on air quality in all ambient air, whether a monitor is present or not.***

These targets require a different approach to that used by applicants and Local Authorities in response to existing air quality legislation.

The new approach moves away from a requirement to assess solely whether a scheme is likely to lead to an exceedance of a legal limit and instead ensures that appropriate mitigation measures are implemented from the design stage, streamlining the process for planning and ensuring the minimum amount of pollution is emitted and that exposure is minimised.

Pending publication of the new guidance, applicants are advised to provide evidence in their planning applications that they have identified key sources of air pollution within their schemes

[2] https://uk-air.defra.gov.uk/pm$_{2.5}$ targets/planning Accessed 13/6/25

and taken appropriate action to minimise emissions of $PM_{2.5}$ and its precursors as far as is reasonably practicable. If quantitative evidence is not available, a qualitative approach can be taken. This applies to all developments which would normally require an air quality assessment. More detailed assessments are expected for developments which are closer to populations, and those which are likely to have higher emissions".

2.6 EPUK/IAQM Land-Use Planning & Development Control

The 2017 Land-Use Planning & Development Control guidance document[3] produced by Environmental Protection UK (EPUK) and the IAQM provides a framework for professionals operating within the planning system to provide a means of reaching sound decisions, having regard to the air quality implications of development proposals.

Where modelling of pollutant concentrations is carried out, the guidance also provides an approach for describing the scale of impact of changes in pollutant levels. The predicted concentration change is assessed as a percentage of the Air Quality Assessment Level (AQAL) which is the relevant air quality standard for the pollutant. This is then considered alongside the total predicted pollutant concentration as a percentage of the AQAL as shown in Table 2.

Long term average concentration at receptor	**% Change in concentration relative to Air Quality Assessment Level (AQAL)**			
	1	**2-5**	**6-10**	**>10**
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-95% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

Table 2 EPUK/IAQM Impact Descriptors

However, it should be noted that the IAQM has recognised that this guidance document is now dated[4] and the focus of air quality assessment is changing (as also indicated in the Defra Interim {Planning Guidance). A full review of the document is now being carried out and specific reference is made to the methodology for defining the impact descriptors (including the approach detailed in Table 2 above). One of the main reasons that Table 2 is no longer valid is that it is recognised that there are no lower thresholds where health impacts are not observed for many pollutants. Therefore, relating the impacts of pollutants to their air quality standard is no longer a logical

[3] EPUK/IAQM, (2017) Land-Use Planning & Development Control: Planning for Air Quality (Version 1.2)
[4] https://iaqm.co.uk/wp-content/uploads/2025/02/IAQM_Briefing_Land-use_Guidance_25.pdf accessed 29 May 2025

approach for assessment (as also stated in the Defra Interim Guidance) and the focus should be on human health effects.

The World Health Organisation[5] provides air quality guidelines but also, they summarises the health impacts resulting from exposure to particulate matter. Figure 1 is taken from Figure 3.5 of the WHO document and shows the association between long-term particulate matter exposure and mortality from 41 studies.

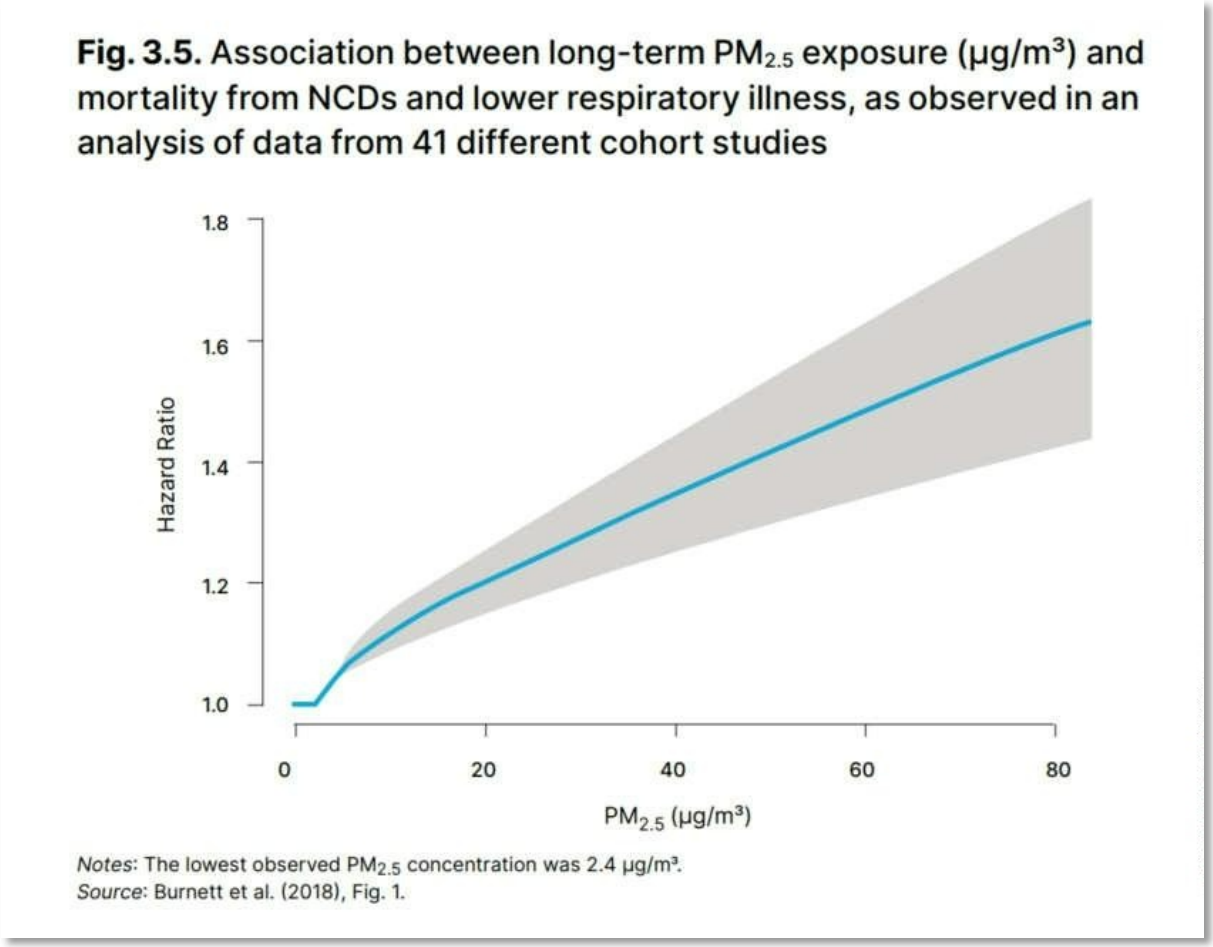

Figure 1 Extract from WHO guideline showing associated between mortality and exposure to $PM_{2.5}$

The WHO estimate an increase in mortality of 1.06-1.09 per 10µg/m^3 increase in exposure to $PM_{2.5}$ and also noted that this increase was higher when $PM_{2.5}$ concentrations were low. It can also be seen from this figure that once concentrations are above around 5µg/m^3, an incremental increase in particulate matter concentrations results in the same increase in mortality whatever the initial concentration. This is the reason why the IAQM guidance is now considered not to be appropriate as this is based around compliance with air quality standards and not human health impacts. To place this in context, it is estimated that the exposure to particulate matter in a moderately polluted city will result in a shortening of life expectancy of around 2.2 years[6].

5 WHO, WHO global air quality guidelines, 2021
6 Pope, C.A. and Dockery, D.W. (2025). Particles of Truth, The MIT Press, Cambridge Massachusetts.

Exposure to particulate matter therefore can result in extremely serious health impacts and, as the Defra Interim planning guidance notes, actions and measures should be taken to reduce exposure to $PM_{2.5}$ and these should be considered in planning decisions.

2.7 Dust deposition

The particulate matter assessment also considers dust deposition. There are no statutory standards for dust deposition in the UK, the IAQM[7] suggest a level of 200mg/m^2/day.

[7] IAQM, Guidance on Monitoring in the Vicinity of Demolition and Construction Sites, October 2018 (version 1.1)

3 Odour Assessment Guidance

3.1 Guidance - Odours

Various guidance documents have been produced in relation to the assessment of odours, the most relevant in terms of planning is guidance from Defra and the Institute of Air Quality Management (IAQM). The Environment Agency also provide guidance in relation to odours which is relevant for an Environmental Permit application, this also contains some useful background information and guidance on good practice for dispersion modelling.

3.1.1 DEFRA Guidance

The Department of Environment, Food and Rural Affairs (Defra) published the document Odour Guidance for Local Authorities in 2010[8]. This document was withdrawn in September 2017 and there is no indication that it will be replaced or updated. Some of the content of this guidance remains useful in providing background information on odours and for providing a framework for the assessment methodology which is discussed below.

The human nose is very sensitive to odour and can detect the presence of some chemicals at very low concentrations that would be difficult for instruments to measure. The environment is rarely "odour free", even in places that are perceived to be clean such as rural areas or by the sea. Our response to odours depends on four interlinked (sensory) characteristics:

- Hedonic tone: this is a judgement of the relative pleasantness or unpleasantness of an odour made by assessors in an odour panel;
- Quality/Characteristics: this is a qualitative attribute which is expressed in terms of "descriptors", e.g. "fruity", "almond", "fishy". This can be of use when establishing an odour source from complainants' descriptions;
- Concentration: is the "amount" of odour present in a sample of air. It can be expressed in terms of parts per million, parts per billion or in mg/m^3 of air for a single odorous compound. More usually a mixture of compounds is present, and the concentration of the mixture can be expressed in odour units per cubic metre (ou_E/m^3) (see definition below); and
- Intensity: is the magnitude (strength) of perception of an odour (from faint to strong). Intensity increases as concentration increases but the relationship is logarithmic. Increases or decreases in concentration of an odour do not always produce a corresponding proportional change in the odour strength as perceived by the human nose.

The most commonly used attribute is the concentration of odours; this is measured in European odour units (ou_E/m^3) using a device known as an olfactometer which presents a sample of odour at different dilutions to a trained panel. The panel is asked whether they are able to detect odour at various concentrations. Once only 50% of the panel can detect the odour it is considered to be at its "Detection Threshold". The odour concentration at the Detection Threshold is defined to be 1 ou_E/m^3. For instance, if an odour sample has been diluted in an olfactometer by a factor of 10,000 to reach the detection threshold, then the concentration of the original sample is 10,000 ou_E/m^3.

In the guidance, it is noted that 5 ou_E/m^3 would be considered to be a 'faint' odour whilst 10 ou_E/m^3 would be considered a 'distinct' odour. Generally, an average person would be able to recognise the source of an odour at about 3 ou_E/m^3, although this can depend on the relative offensiveness of the odour. Background odour levels can be some 5-60 ou_E/m^3 or more.

[8] Defra, Odour Guidance for Local Authorities, March 2010 (withdrawn September 2017).

The guidance considers that the following factors are the main factors to consider when assessing the acceptability of odours:

- Frequency of the odour;
- Intensity of the odour;
- Duration of exposure to the odour;
- Offensiveness of the odour; and
- Tolerance and expectation of the exposed subjects.

These are then placed within a framework known as the FIDOL factors as summarised in Table 1 to assist Environmental Health Practitioners determine if a statutory nuisance exists.

Factor	Factors determining Statutory Nuisance
FREQUENCY (How often an individual is exposed to odour)	Frequency (How often an individual is exposed to odour)
INTENSITY (The perceived strength of the odour, proportional to $\log_{10}$ concentration)	Level of odour
DURATION (The length of a particular odour event or episode. Duration of exposure to the odour)	Duration
OFFENSIVENESS (relative)/character (Offensiveness is a mixture of odour character and hedonic tone at a given odour concentration/intensity)	Type of odour
LOCATION (The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor.)	The characteristics of the neighbourhood where the odour occurs The sensitivity of the complainant

Table 3 DEFRA Odour FIDOL Factors

Some other guidance refers to these as FIDOR factors (where the R relates to “receptors”).

3.1.2 IAQM Guidance

The Institute of Air Quality Management (IAQM) produced guidance in 2014 and was updated in 2018[9] with the specific intention to provide advice for "assessing odour impacts for planning purposes". It provides details of various assessment techniques noting that each has its own strengths and weaknesses.

The guidance states that dispersion modelling is a useful tool for assessments, particularly for assessing future odorous development. However, it also notes that dispersion modelling is not suitable for intermittent and fugitive sources and therefore the model results may not give a complete picture of the odour risk for a site. It suggests that, where possible, odour emissions rates are measured, and this will "*add certainty to the assessment*". Where library data is used the guidance states "Where "*standard" data are used, the source must be clearly noted and it should be demonstrated that the information is likely to be a reasonable representation of odour emission rates on the study site*".

The modelling will provide predicted concentrations (ou_E/m^3) as a 98th percentile of 1-hour means. The guidance recommends that in terms of comparing predicted concentrations with odour assessment criteria, practitioners should observe from the various scientific studies, case law and practical examples of the investigation of odour annoyance cases and then determine an appropriate criterion. This criterion could lie somewhere in the range of 1 to 10 ou_E/m^3 as a 98th percentile of hourly mean odour concentrations.

It is very important to note that the odour benchmarks are based on a modelled statistical value – the 98th percentile of hourly means. This is a very different parameter to the odour levels discussed in section 3.1.1 which refer to how the nose detects odours over short periods (often a few seconds) and the two parameters are not comparable.

3.1.3 Environment Agency H4 Guidance

The Environment Agency H4 odour is the main source of the odour standards generally applied to assess the significance of dispersion modelling results. While the H4 document itself does not detail the justification for the proposed odour standards, these have been published elsewhere[10]. The odour benchmarks proposed were derived from studies that examined the relationship between the percentage of the population reported to be "annoyed" by odours from pig farming with predicted odour concentrations from odour modelling. The percentage of the population reported to be annoyed was derived from community surveys.

The H4 document provides the following odour benchmarks:

- 1.5 ou_E/m^3 for most offensive odours;
- 3 ou_E/m^3 for moderately offensive odours; and
- 6 ou_E/m^3 for less offensive odours.

The guidance states that exposures above these benchmark levels indicates the likelihood of unacceptable odour pollution. H4 provides some guidance on the classification of the offensiveness of odours, odours from pig rearing clearly are defined as moderately offensive.

[9] Bull M, IAQM, Guidance on the assessment of odour for planning, 2018 update

10 Environment Agency, Assessment of Community Response to Odorous Emissions, R&D Technical Report p4-095/TR

However, in the background research on which these benchmarks were based, it is clear that the offensiveness of the odours was not included in the research. What was examined was whether there was an expectation of odours in the area and whether the exposed population had an economic interest in pig farming. The 1.5 ou_E/m^3 benchmark is based on a population where pig odours are not expected in the area (known as non-concentration areas in the research), and the 3 ou_E/m^3 benchmark on the basis that odours would be expected in the area as there are other farms in the area (known as concentration areas). In both cases, the benchmark is set at a level where 10% of the community was reported to be "annoyed" by the odours. This is detailed in the Environment Agency research report[5] which provides the following figure (reproduced as Figure 2) relating reported annoyance with the predicted 98th percentile of hourly means (note that this figure is based on Dutch odour units, 2 Dutch odour units = 1 ou_E/m^3).

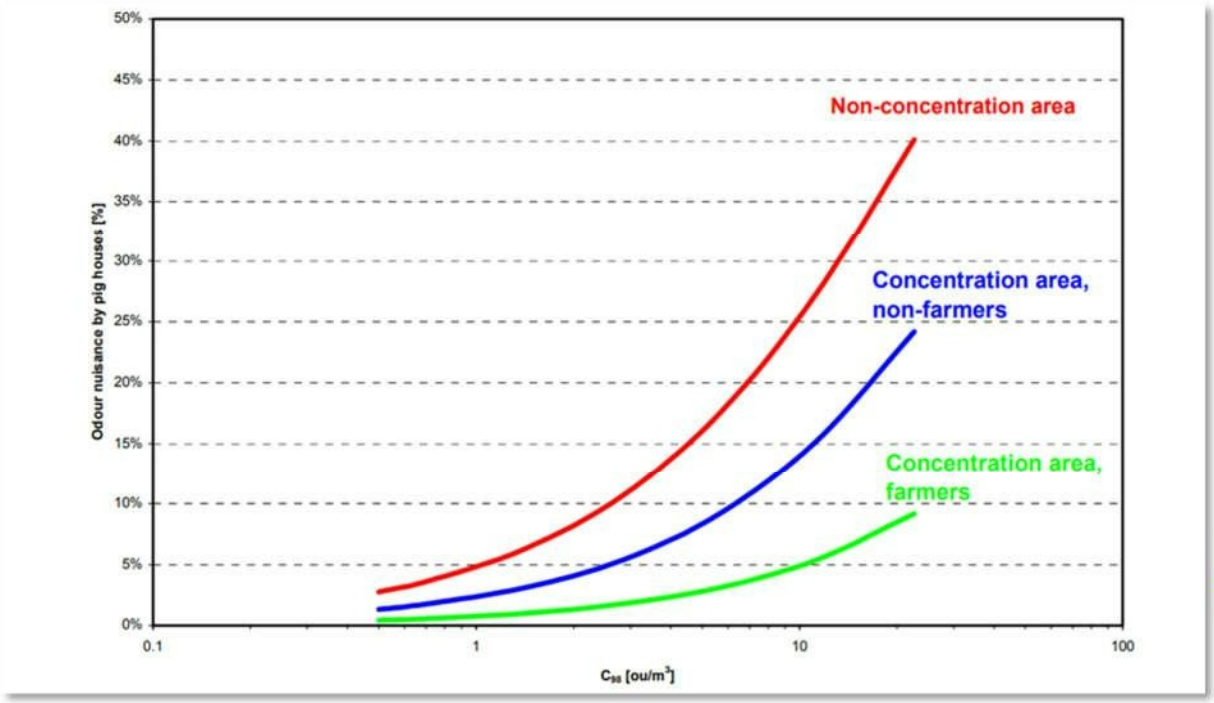

Figure 2 Reported relationship between observed annoyance and predicted odour concentrations

It can be seen from this figure, that even if the 3 ou_E/m^3 was just met (equivalent to 6 Dutch Odour units) then between 10 and 17% of the population would still be annoyed by the odours (depending on its location).

4 The Proposed Development and Surroundings

The application is for provision of 12 poultry houses each measuring 80 by 360 feet and associated infrastructure on land off Pear Tree Hill Road, Whaplode Drove. The sheds will be used for broiler rearing with approximately 552,000 places. However, this stocking level appears to be determined by the customer requirements and the Environmental Statement (ES) (para 1.1.7) states that there will be up to 690,000 bird places. As both the odour and particulate matter assessments are based on the lower bird numbers, it is clearly important to limit the maximum number of birds at the site otherwise the assessments are invalid as they are based on the wrong number of birds.

Chicks would be placed in the sheds at one day old, 35% of the birds would be removed at day 30 and the remainder at day 42. There will then be a period of 7-10 days at the end of the cycle for cleanout and preparation for the next crop.

The sheds will be mainly ventilated by roof mounted fans, the ES (section 5.1.7) states that these will be “higher than 5.5 metres above ground level”. There are also gable end fans for use in warmer weather. The elevations provided for the sheds indicate a ridge height of just over 6m from ground level but the height of the vents does not appear to be stated (although the odour and particulate matter assessment assume 7m above ground level).

Given the number of birds proposed, the site would require an Environmental Permit from the Environment Agency. The ES states in para 2.2 that the EA will only grant a permit if they believe that significant pollution will not be caused. However, it should be noted that in a recent consultation response, the EA has confirmed that they do not review odour impact assessments as part of planning or planning consultations (see Appendix A). Rather they recommend that odour is prevented, or where not possible, minimised through the application of Best Available Techniques and document in an Odour Management Plan. It is therefore wholly appropriate that the planning authority consider whether the odour assessment provided is robust and results in acceptable impacts as clearly this will not be carried out by the EA.

The proposed development is located in a rural area around 5km southeast of Spalding. The closest residential receptors are around 400m from the proposed development

Most of the area appears to be used for agricultural purposes.

5 Review of Particulate Matter Assessment

The air quality assessment was prepared by AS Modelling and Data Ltd and is an Appendix to the ES. The assessment has examined PM_{10} impacts during operation of the proposed development. Given the increasing emphasis on finer particulate matter, the omission of an $PM_{2.5}$ assessment is of concern and without this, the requirements of the Defra interim planning guidance cannot be met.

5.1 Baseline conditions

Information on baseline air quality has been taken from reputable sources that are typically used in air quality assessments. As would be expected, the baseline air quality in this rural area shows that pollutants meet the relevant air quality standards.

5.2 Operational Impacts

The operational impact assessment has been based around dispersion modelling which is the expected approach for this type of assessment. The ADMS model has been used for the assessment which is a widely used model and accepted by all UK regulatory authorities. The model requires input data detailing the mass emission rates of pollutants, the source characteristics (e.g. stack height and diameter), meteorological data, and information on building and terrain heights. These are considered below.

The model has been set up with point sources to represent the roof mounted fans and volume sources to represent the gable end fans, these are both appropriate approaches.

5.2.1 Pollutant Emission Rates

Pollutant emission rates are a key input; the predicted concentrations will be directly proportional to the emission rate selected and consequently any error in the emission rates used will result in an incorrect assessment of the air quality impacts. The emission rate used is 0.1kg/bird/year which has been sourced from an Environment Agency guidance[11] and consequently is a reasonable source for this information. Particle size distribution and mass fraction are stated to have been derived from Defra research – the reference is not directly provided but is assumed to be the Defra document on poultry dust properties listed in the references.

5.2.2 Building Effects

Building structures can affect the initial dispersion of pollutants and the model used can take this into account. Building dimensions are included as model input to allow for modelling of building downwash for the poultry houses. The data used in the model is provided in line with good practice.

5.2.3 Meteorological and Terrain Data

The meteorological data used for the modelling is so-called NWP data which is good quality data for this type of assessment. This is the closest site and has good data capture and would be suitable for this assessment. Four years of data are used and this is consistent with the IAQM guidance that suggests between 3-5 years of data are used.

Terrain data has not been used but given the nature of the area, this is not necessary.

[11] https://www.gov.uk/government/publications/pollution-inventory-reporting-guidance-notes/intensive-farming-pollution-inventory-reporting - accessed 13/6/25

5.2.4 Other Model Options

The predicted concentrations are dependent on the selected surface roughness, the effect of surface roughness on the predicted concentrations depends on the type of source being modelled. For elevated point sources, increasing the surface roughness would generally be expected to result in higher predicted concentrations closer to the source as the plume will expand more quickly bringing pollutants to ground level nearer to the source although this effect will be related to the distance from the source. For the volume sources used, increasing the surface roughness will result in a decrease in predicted concentrations.

In this assessment, a surface terrain file has been created based on information in the Defra Living Landscapes land use database. This is an unusual approach frequently applied by AS Modelling and Data Ltd but it could result in a reasonable definition of the surface roughness of the area if appropriately applied.

Further explanation of the approach is needed as the database does not directly contain surface roughness information, rather it contains a habitat classification based on those in UK Biodiversity Action Plan (UKBAP) habitat classification framework[12]. An explanation is needed to detail how each of the habitat classifications is used to determine the surface roughness. The report details that the resulting average surface roughness over the modelling domain is 0.161, this is a relatively low value for an agricultural area and potentially results in lower predicted concentrations. As such, this would be an appropriate factor to examine in sensitivity testing (see following section).

The model has been set up to produce the 98th percentile of hourly means and the model run for each of the five years of data which is consistent with guidance.

5.2.5 Sensitivity Testing

The EA guidance on dispersion modelling[13] details requirements for sensitivity testing, this states that

"***You must show how the model is affected by:***

- ***meteorological data, such as different observed data, NWP data, data sources, inter-annual variation and surface characteristics;***
- ***emission parameters, such as stack parameters, substance release rates and different plant operating scenarios;***
- ***the receptor grid resolution;***
- ***treatment of terrain and buildings;***
- ***special model treatments;***
- ***alternative modelling software, if appropriate".***

The assessment does not provide a specific response to this requirement. There is consideration of inter-year variation with the met data.

[12] https://publications.naturalengland.org.uk/publication/5260859937652736 accessed 16/6/25
[13] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports#carry-out-sensitivity-analysis Accessed 2 June 2025

This type of sensitivity study is important as it allows an assessment of the uncertainties in the assessment. If it is found that the impacts are acceptable for most options examined in a sensitivity test, then there can be more confidence in the conclusion that the development is acceptable. If, however, acceptable impacts are only found under a narrow range of input options, then there can be less confidence in the conclusions.

5.2.6 Results – Air Quality

The results of the modelling of PM_{10} are produced in Tabes 7 and 8 of the assessment and the results for dust deposition in Table 9.

The predicted increases in PM_{10} levels are very high, indeed the increase of 5.5µg/m^3 predicted at Receptor 1 is one of the highest predicted increases ever seen by the author in an assessment report where typical increases are in the range 0.1–0.2µg/m^3 at worse. The scale of the predicted increases can be compared with those from major transport applications such as the Gatwick Northern runway DCO application (maximum increase in annual mean concentrations of 0.3µg/m^3). The scale of impact predicted at nearby residential properties is similar to those seen from extremely large transport infrastructure applications. The predicted increase near to the site and at the workers' residences are likely to result in health impacts that are very significant and highlight the deficiencies in the now out of date IAQM approach. The predicted increase of 5.5 µg/m^3 as an annual mean would result in an increase in mortality rates of around 3% when allied to the overall population (based on the information in Figure 1 and taking the $PM_{2.5}$ fraction of 67%). The predicted increase of 3.16µg/m^3 at the proposed workers' accommodation would result in an increase in mortality of approximately 1.7% to the general population.

Examining the impacts of existing residential receptors, the potential increase in mortality would be around 0.2%.

These levels of impact cannot be dismissed as insignificant and highlight the need to follow the advice in the Defra interim planning guidance for $PM_{2.5}$ that states: "***applicants are advised to provide evidence in their planning applications that they have identified key sources of air pollution within their schemes and taken appropriate action to minimise emissions of $PM_{2.5}$ and its precursors as far as is reasonably practicable".*** In this application, no mitigation is proposed and no attempts have been made to minimise the impacts. Given the potential health impacts, this is a significant omission and results in quantifiable health impacts at nearby receptors.

6 Operational Impacts – Process Emissions – Odour

Odour impacts during operation have been assessed using dispersion modelling using the same dispersion model and approach as discussed in Section 5.4. Therefore, all the general comments made for the modelling approach made in Section 5.4 apply to the odour assessment with the exception of the calculation of emission rates.

It should be reiterated that the EA does not generally review odour modelling reports and therefore it is completely appropriate that the planning authority scrutinise the report during the planning application process.

6.1 Model Selection and Set Up

The odour assessment report has used the ADMS 6 model and would have been the current version at the time of the assessment. This is a well-established model which is widely used for odour assessments in the UK and is considered to be a suitable tool for this study. The model requires information on the odour emission sources, meteorological data, terrain data (where complex terrain is an issue) and selection of general model options. As the model has been set up in generally the same manner as the odour assessment, the same comments made in Section 5 on general model options would also apply to the odour assessment and these comments have not been repeated in this section.

6.1.1 Odour Emission Rates

The odour emissions have been calculated by assuming that odour concentrations in the houses are 300 ou_E/m^3 at day 1, increase to 700 ou_E/m^3 at day 16, 1800 ou_E/m^3 at day 30 and "approximately" 2,300 ou_E/m^3 at day 34. This figures were obtained by a paper published by Robertson[14] for a poultry house with 34,000 birds. However, the Robertson only reports odour concentrations "around day 16" as 600-800 ou_E/m^3 and 1300-2300 ou_E/m^3 around day 30. The assessment has used the average of the range quoted, not the worse case and the figures used for the start of the cycle (300 ou_E/m^3) and day 34 (2,300 ou_E/m^3) are not quoted in the paper.

It should be noted that, higher odour concentrations have been measured in an operational chicken house housing 44,700 birds (i.e. nearly the same size as this proposal) in an Environment Agency (EA) research study[15]. They measured odour concentrations from just under 3,000 – 4,179 ou_E/m^3 (in one test) and from just over 3,000-3,641 ou_E/m^3 (in a second test) at day 29 of the rearing cycle. The aim of this study was to "*to inform modelling studies that will be undertaken by the Air Quality Modelling and Assessment Unit (AQMAU)".* The figures in the Environment Agency study are in some cases more than 100% higher than those reported in the Robertson study. However, other odour monitoring studies reported in poultry house odour assessments indicate that concentrations are in a similar range to those detailed in the Robertson paper[16].

This illustrates the potential range in values that can be found in poultry houses, all studies have reputable authors and no study could be considered to be "better" than another. However, if the EA study figures were used in the same manner to calculate the odour emission rates, the resulting predicted odour concentrations would be more than double those predicted in the report and would

[14] Robertson, A.P. et al, (2002), Commercial-scale Studies of the Effect of Broiler-protein Intake on Aerial Pollutant Emissions, Biosystems Engineering, 82 (2), 217–225.
15 Environment Agency, (2012), Odour Assessment of an Intensive Livestock Facility, ISBN: 978-1-84911-268-0
16 Air Spectrum Environmental Limited (October 2022). Odour & ammonia emissions monitoring assessment. Hollins lane Poultry facility. International energy crops Limited. Report reference: JL 24242 v1.0

result in a predicted exceedance of the adopted standard of 3.0 ou_E/m^3 at several of the receptors (although the 3 ou_E/m^3 is exceed at two receptors).

This uncertainty can be addressed by providing a full review of information available. For instance, MBAL maintain a database of odour emission rates that includes many values for emissions from various processes. Our current practice, when carrying out modelling assessments, is to use a 70th percentile value for the emissions rate taken from the available information.

The odour emission rates are calculated in the applicant's report for each hour of the year by multiplying the ventilation rate by the internal odour concentration. The ventilation rate is based on the day of the crop cycle and the external temperature. Lower ventilation rates will occur at the beginning of the rearing cycle and/or in cooler weather. At high ventilation rates an adjustment is made to the assumed concentrations, it is stated that "*if the calculated ventilation rate exceeds that required to replace the volume of air in the house every 5 minutes, internal concentrations are reduced (by a factor of the square root of 7.5 times the shed volume/divided by the ventilation rate as an hourly figure)".* This adjustment reduces the odour emission rate (and hence the odour impact) at higher ventilation rates. There is no supporting justification for the manner in which this adjustment is made in the applicant's report. MBAL has frequently noted this in similar reviews of AS Modelling and Data Ltd.'s reports and the data to support this adjustment has not been made publicly available.

6.2 Guidance and Standards

Two sources for odour standards are quoted, the Environment Agency H4 guidance and a study carried out by UK Water Industry Research (UKWIR) on the relationship between complaints and predicted odour concentrations. While the UKWIR study is described as "in depth" in the dispersion modelling reports, the information provided in the UKWIR report amounts to less than one page of a 260 page report and gives no detail regarding the methodology used or the sites studied. In any event, complaints are not the same as annoyance and a far smaller proportion of the population exposed to annoying levels of odours will complain compared with those who are annoyed.

The H4 document is the main source of odour standards (known as benchmarks) used in assessments and the value of 3 ou_E/m^3 quoted (as a 98th percentile) is the most relevant for poultry house odours. The H4 standards are based on annoyance as measured by social surveys and the 3 ou_E/m^3 standard is the level where 10% of a population where odours are a common feature of the local environment will report being "annoyed" by the odours (although see earlier explanation that the proportion could be higher depending on the observers' expectations of the area).

H4 also sets other requirements for modelling studies:

"***Irrespective of the model applied, sufficient information should be supplied to enable the model to be audited.***

A sensitivity analysis, to enable the overall uncertainties to be understood, should also be provided including:

- ***likely uncertainties in the source term, including a consideration of fugitive emissions;***
- ***the degree to which the emissions are likely to be steady or fluctuating and the impact of this on the model chosen;***
- ***likely uncertainties associated with the meteorological data;***
- ***plausible worst case scenarios;***

These uncertainties should be acknowledged in consideration of the isopleths".

The need for a sensitivity analysis and acknowledgement of the uncertainties in the source term have been noted earlier but this has not been provided.

The report has not used the IAQM guidance for the assessment of odours for planning. This provides a framework for determining whether there is a significant effect. This is important as the assessment has only considered whether the predicted odour concentrations exceed the Environment Agency benchmarks. However, the IAQM guidance notes that a significant effect can occur for concentrations lower than the benchmark for some types of odours – this is a significant omission from the ES. It is also a surprising omission given that the particulate matter assessment by the same authors does provide an assessment of significance based on IAQM guidance.

6.3 Compliance with Guidance

The assessment provided does not meet the full requirements of either the Environment Agency H4 guidance nor the IAQM guidance on the assessment of odours for planning. Sensitivity testing is not provided nor are full details of the input data provided; this is not compliant with the EA requirements for dispersion modelling. The main areas of non-compliance with H4 and the IAQM guidance are:

- The derivation of odour emissions is limited and based on a single study of odour concentrations in poultry houses. The use of another dataset detailed in an Environment Agency research report would result in concentrations that are more than double those predicted. Further justification of the emission rates is therefore required;
- No justification or supporting evidence is provided for adjustments made to odour emission rates at high ventilation rates. Without such evidence this has to be considered an arbitrary adjustment that has reduced the overall impact of the proposals;
- No sensitivity testing has been carried out to establish the likely uncertainties in the assessment as required by the H4 guidance; and
- No assessment of significance following an established framework such as in the IAQM guidance.

6.4 Results

The results of the assessment are provided in Table 2 of the report and as a contour plot in Figure 7. The results show that the predicted concentration exceed the level of 3 ou_E/m^3 suggested in the EA H4 guidance where “unacceptable odour “ would be present at Pear Tree Hill Farm and are in the range of 2.4 – 2.9 ou_E/m^3 at four other receptors. Pear Tree Farm would be unlikely to be considered to be a highly sensitive receptor given its connection with the proposal development. However, the other receptors nearby would be considered to be highly sensitive. This illustrates the value of undertaking sensitivity testing to understand the range in plausible values that could be predicted and consequently how much confidence there would be that unacceptable odours would not occur. Note that should the number of birds increase to 690,000 (the capacity stated in the ES), then the assessment would predict an exceedance of the 3 ou_E/m^3 benchmark at nearby receptors.

Note that the concentrations of 2.4-2.9 ou_E/m^3 would result in around 15% of the population exposed being “annoyed” by odours with a resulting risk of complaint.

Given the predicted values being close to the standard, the lack of a sensitivity study further mitigation should be considered. As the same conclusion was reached in the review of the particulate matter assessment, one solution would be a scrubber that would both reduce particulate matter and odour emissions from the proposals.

7 Summary and Conclusions

MBAL has reviewed the assessments of odour and particulate matter submitted with the ES for the proposed development at Pear Tree Hill. The assessment of particulate matter predicts increases in concentrations of PM_{10} that are surprisingly high and up to fifteen times greater than those predicted in assessments of very large transport infrastructure at airports. The highest predicted PM_{10} concentrations (when corrected for $PM_{2.5}$) would result in an increase in exposure that would be associated with a 3% increase in mortality at the worst affected receptor and around 1.7% at the proposed workers accommodation. This level of impact is not considered to be insignificant.

The proposed development contains no measures designed to reduce the emissions of $PM_{2.5}$ and results in increased exposure to this pollutant for the local population. It is therefore not considered to have complied with the requirements of the Defra interim planning guidance relating to $PM_{2.5}$.

The odour assessment predicts concentrations that are close to the benchmark in the Environment Agency H4 guidance where unacceptable odour levels would arise. The report has also not met some of the requirements of the H4 guidance for modelling particularly as it has not provided a sensitivity study nor acknowledged the potential uncertainties. Given that the predicted concentrations at residential properties are within 0.1 ou_E/m^3 of the standard of 3.0 ou_E/m^3 and given the uncertainties in the modelling that have not been appropriately tested in a sensitivity study provided by the applicant. Such a study would provide more information on the level of confidence that the appropriate benchmarks would not be breached. However, given the very marginal compliance with standards reported, there is a need for further mitigation to reduce the risk of unacceptable odour exposure.

As currently planned, the proposed development results in increases in concentrations of fine particulate matter that would have significant impacts on human health at nearby receptors and odour levels that would potentially exceed Environment Agency thresholds.

Appendix A – Extract from Environment Agency Consultation Response

Simon Wood
Breckland Council
Development Control
Elizabeth House Walpole Loke
Dereham
Norfolk
NR19 1EE

Our ref: AC/2025/132665/01-L01
Your ref: 3PL/2021/0932/VAR

Date: 15 April 2025

Dear Simon,

VARIATION OF CONDITION NO2 ON 3PL/2017/0878/F : VARIATION TO REFLECT THE AS-BUILT APPEARANCE AND LAYOUT OF THE PIG SHEDS, FEED SILOS AND MANURE STORE COVER AND PROPOSED AMENDMENTS INCLUDING REVISED EXTERNAL MATERIALS AND THE ADDITION OF CHIMNEYS

CHERRY TREE FARM CHERRY TREE LANE, STOW BEDON, ATTLEBOROUGH, NORFOLK, NR17 1BY

Thank you for your consultation dated 17 March 2025. We have reviewed the documents as submitted and we have no objection to the variation of condition 2. Firther information on odour can be found below.

Odour

Our National Air Quality Monitoring Assessment Unit (AQMAU) have reviewed the report (Review of Ammonia and Odour Assessments, Michael Bull & Associates, 13/1/25, Version 2) and have the following comments to make:

We do not normally review odour impact assessments as part of permitting or planning consultations. We are rarely able to use odour modelling to definitively confirm whether or not odour complaints are likely. The uncertainties in the derivation of emission rates, the short time duration of received odour compared to modelled averaging times and also uncertainties in dispersion modelling algorithms are often too high for numerical predictions to be used. Although modelling can be useful for comparing sources or site configurations (*i.e*. to determine if one configuration or source type is likely to be better or worse than another). We would recommend odour is prevented, or where not possible, minimised through application of Best Available Techniques (BAT) and fully documented in a robust odour management plan.

For the ammonia impact assessment, the consultant has not reviewed this document and has made several assumptions based on the odour impact assessment which are not correct. A review of the ammonia impact assessment (from 2022) suggests