Instruction note for the assessment of odour emissions from Intensive Agriculture pig installations

This document does not purport to be and should not be considered a legal interpretation of the provisions and requirements of the Industrial Emissions Directive, the Environmental Protection Agency Act 1992 as amended and supporting regulations.

ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhnú Comhshaoil
PO Box 3000, Johnstown Castle Estate, County Wexford, Y35 W821, Ireland
Telephone: +353 53 9160600 Lo Call: 1890 33 55 99 Fax: +353 53 9160699
Email: info@epa.ie Website: www.epa.ie

ENVIRONMENTAL PROTECTION AGENCY
The EPA is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:
Regulation: *Implementing regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.*
Knowledge: *Providing high quality, targeted and timely environmental data, information and assessment to inform decision making.*
Advocacy: *Working with others to advocate for a clean, productive and well protected environment and for sustainable environmental practices.*

Our responsibilities include:
Licensing
- Large-scale industrial, waste and petrol storage activities;
- Urban waste water discharges;
- The contained use and controlled release of Genetically Modified Organisms;
- Sources of ionising radiation;
- Greenhouse gas emissions from industry and aviation through the EU Emissions Trading Scheme.

National Environmental Enforcement
- Audit and inspection of EPA licensed facilities;
- Drive the implementation of best practice in regulated activities and facilities;
- Oversee local authority responsibilities for environmental protection;
- Regulate the quality of public drinking water and enforce urban waste water discharge authorisations;
- Assess and report on public and private drinking water quality;
- Coordinate a network of public service organisations to support action against environmental crime;
- Prosecute those who flout environmental law and damage the environment.

Waste Management and Chemicals in the Environment
- Implement and enforce waste regulations including national enforcement issues;
- Prepare and publish national waste statistics and the National Hazardous Waste Management Plan;
- Develop and implement the National Waste Prevention Programme;
- Implement and report on legislation on the control of chemicals in the environment.

Water Management
- Engage with national and regional governance and operational structures to implement the Water Framework Directive;
- Monitor, assess and report on the quality of rivers, lakes, transitional and coastal waters, bathing waters and groundwaters, and measurement of water levels and river flows.

Climate Science & Climate Change
- Publish Ireland's greenhouse gas emission inventories and projections;
- Provide the Secretariat to the Climate Change Advisory Council and support to the National Dialogue on Climate Action;
- Support National, EU and UN Climate Science and Policy development activities.

Environmental Monitoring & Assessment

- Design and implement national environmental monitoring systems: technology, data management, analysis and forecasting;
- Produce the State of Ireland's Environment and Indicator Reports;
- Monitor air quality and implement the EU Clean Air for Europe Directive, the Convention on Long Range Transboundary Air Pollution, and the National Emissions Ceiling Directive;
- Oversee the implementation of the Environmental Noise Directive;
- Assess the impact of proposed plans and programmes on the Irish environment.

Environmental Research and Development

- Coordinate and fund national environmental research activity to identify pressures, inform policy and provide solutions;
- Collaborate with national and EU environmental research activity.

Radiological Protection

- Monitoring radiation levels and assess public exposure to ionising radiation and electromagnetic fields;
- Assist in developing national plans for emergencies arising from nuclear accidents;
- Monitor developments abroad relating to nuclear installations and radiological safety;
- Provide, or oversee the provision of, specialist radiation protection services.

Guidance, Awareness Raising, and Accessible Information

- Provide independent evidence-based reporting, advice and guidance to Government, industry and the public on environmental and radiological protection topics;
- Promote the link between health and wellbeing, the economy and a clean environment;
- Promote environmental awareness including supporting behaviours for resource efficiency and climate transition;
- Promote radon testing in homes and workplaces and encourage remediation where necessary.

Partnership and networking

- Work with international and national agencies, regional and local authorities, non-governmental organisations, representative bodies and government departments to deliver environmental and radiological protection, research coordination and science-based decision making.

Management and structure of the EPA

The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by advisory committees who meet regularly to discuss issues of concern and provide advice to the Board.

Instruction note for the assessment of odour emissions from Intensive Agriculture pig installations

Published by
Environmental Protection Agency, Ireland

ISBN Number

Version 05 August 2022

Contents

List of Figures

List of Tables

1. Introduction

1.1. Preamble

This instruction note provides applicants with a methodology on how to screen for and assess odour impacts from the licensable intensive agriculture pig sector, as well as assisting in how applicants can demonstrate compliance with BAT 13 (to reduce odour emissions and / or odour impact) of the Commission Implementing Decision (CID)[1] 2017/302. This instruction note replaces the EPA's 2001[2] '*Odour Impacts and Odour Emission Control Measures for Intensive Agriculture*' guidance document and screening methodology.

The EPA's air guidance notes AG5[3] [EPA TGN AG5] and AG9[4] [EPA TGN AG9] provide general theory, advice, and guidance on odours from licensed sites and odour abatement methodologies for industrial and waste facilities. The 2017 Commission Implementing Decision (CID) and associated BAT Reference (BREF)[5] documents on intensive agriculture include the theory behind the sources of odour and possible odour control techniques available for the intensive agriculture (poultry and pigs) sector. The EPA's air guidance note AG4[6] [EPA TGN AG4] provides guidance on modelling of air emissions from industrial sites, including intensive agriculture installations.

The EU BREF guidance document does not include a list of emission factors specifically for pig rearing in Ireland, nor does it recommend a specific screening procedure to determine potential impacts from piggeries on sensitive receptors. The objective of this document is to bridge this gap.

This instruction note will be amended/updated periodically in line with any sectoral/legislative updates or as new information becomes available.

1.2. Odour Screening Tool

The option to have an odour screening tool is set out in the Commission Implementing Decision (CID) for the intensive rearing of pigs and poultry in 2017 namely:

Ensure adequate distances between the plant/farm and the sensitive receptors.	*At the planning stage of the plant/farm, adequate distances between the plant/farm and the sensitive receptors are ensured by applying minimum standard distances or performing dispersion modelling to predict/simulate odour concentration in surrounding areas.*

[1] COMMISSION IMPLEMENTING DECISION (EU) 2017/302 of 15 February 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D0302&from=EN

[2] Odour impacts and odour emission control measures for intensive agriculture (EPA, 2001). https://www.epa.ie/publications/research/air/Odour-Impacts-Final.pdf

[3] Air guidance note 5 (AG5) odour impact assessment guidance for EPA licensed site (EPA, 2021). https://www.epa.ie/publications/compliance--enforcement/air/air-guidance-notes/AG5-2021.pdf

[4] Odour emissions guidance note (Air guidance note AG9) (EPA, 2019). https://www.epa.ie/publications/compliance--enforcement/air/air-guidance-notes/odour-emissions-guidance-note-air-guidance-note-ag9.php

[5] Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry or Pigs (2017). https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC107189_IRPP_Bref_2017_published.pdf

[6] Air dispersion modelling from Industrial Installations Guidance Note (AG4) (EPA, 2020). https://www.epa.ie/publications/compliance--enforcement/air/air-guidance-notes/epa-air-dispersion-modelling-guidance-note-ag4-2020.php

As part of the development of this instruction note, a review of the relevant literature was undertaken to provide the most up-to-date list of Irish odour emission factors for intensive pig rearing, and to account for recent improvements in pig husbandry. Ideally this would have stemmed from data from Irish pig farms, however there is very limited published data available that is specific to Irish pig farms. Unless an applicant can provide robust evidence that an alternative emission factor should apply, they should use the list of emission factors set out in this document.

Standard practices in pig rearing in Ireland have changed in recent years, which influence the odour emission factors, due in part to the new BAT requirements and improvements in farming practices.

The list of emission factors included in this instruction note should be used:

- In the odour screening procedure/tool included with this instruction note (Chapter 3).
- In detailed air dispersion modelling to give a site-specific assessment of potential odour impacts from intensive piggeries having regard to new technologies and techniques.

The emission factors included have drawn on published data linked to intensive pig farming in several relevant countries.

1.3. Structure of this Instruction Note

The following information is presented in this instruction note:

- Section 2 provides an overview of the odour impacts associated with pig rearing and considers factors such as:
  - An introduction to the screening tool;
  - Siting of farms, and siting of plant within farms;
  - Animal Feed;
  - Animal Housing;
  - External slurry storage;
  - Odour benchmarks; and
  - Odour mitigation (as outlined in the CID).

- Section 3 provides an overview of the odour screening tool and provides:
  - An introduction to the screening tool;
  - A step-by-step guide on how to carry out a screening assessment using the tool;
  - A list of emission factors used in the tool;
  - Guidance on interpreting the results of the tool; and
  - Criteria to determine when a detailed modelling assessment is required.

- Section 4 provides supplementary guidance for undertaking detailed dispersion modelling of odour and provides:
  - A list of emission factors to be used in modelling (including associated reduction where appropriate mitigation is applied);
  - Details on how to calculate reductions where multiple mitigation techniques are being applied; and
  - Details on how to account for cumulative impacts resulting from several farms in close proximity.

2. Odour associated with pig rearing

2.1. Odour Sources

The odours generated in a pig production unit typically originate from:

- Feed;
- Spilled feed;
- Body odour of the animals; and
- Urine and faeces.

The most relevant source of odorants from intensive pig production is animal excreta. The odour from excreta is a product of a complex interaction and mixing of individual odorous and non-odorous components that are produced during anaerobic degradation of organic matter (undigested organic residues including proteins, carbohydrates, and fats) in animal slurry.

The magnitude of odour emissions from an intensive pig installation and the subsequent impact on sensitive receptors[7] will depend on several factors which are set out below. Some of the factors described are incorporated into the screening assessment tool described in this document and all of the factors can be incorporated into detailed odour modelling, if required.

2.1.1. Siting of Farms and Plant within Farms

To protect third-party residents/receptors (i.e., those people not connected to a host installation) it is recommended that an acceptable setback distance between the installation and third-party receptor is adopted when siting new installations.

The acceptable distance is based on the size of the installation, the total number and type of animals being reared, and considers housekeeping factors as well as any mitigating factors which are applied. This distance is calculated using the screening tool and/or air dispersion modelling to compare the site-specific odour emissions from an installation against an applicable odour benchmark (detailed later in this report).

Whilst the option of siting farms with respect to nearby sensitive receptors is more appropriate to new installations, it is also relevant to proposals to extend existing installations or when adding new infrastructure. The option for siting new plant and equipment (e.g., slurry tanks etc.) away from sensitive receptors is appropriate on all installations.

Where the impact of odour on nearby sensitive receptors cannot be minimised through siting of the farm/plant then additional odour mitigation may need to be applied.

2.1.2. Animal Feed

Generally, grower/finisher pigs produce a large quantity of slurry because of feed conversion inefficiencies associated with pigs' digestion and metabolism systems. Using a high protein diet increases the availability of nitrogen and sulphur in the slurry. These substances are the precursors to odorous substances when anaerobic digestion of that slurry occurs. To reduce odours, it is therefore advisable to reduce crude protein levels in the rations, while still providing the essential amino acids in adequate amounts to ensure optimum growth of the animals.

[7] Odour-sensitive locations are areas where human activities are carried out, including but are not limited to dwelling houses (e.g., third-party residential dwellings), visitor accommodation (e.g., hotels and hostels), health buildings (e.g., hospitals and nursing homes), educational establishments (e.g., schools), and places of worship (e.g., churches).

2.1.3. Animal Housing

The typical design of animal housing in Ireland is the traditional fully slatted floor system. The main source of emissions in these houses is from the surface of the slurry contained in the underfloor slurry storage pit. The pit provides an ideal situation for anaerobic degradation to occur, resulting in odour.

The CID and BREF note include techniques to reduce emissions of odour (BAT 13) from the whole farm and to reduce ammonia (BAT 30) from animal housing. Whilst BAT 30 is specific to reducing ammonia emissions, the BREF outlines how odour emissions can also be reduced by implementing various BAT 30 techniques.

The BREF note describes how emissions associated with standard housing with a deep pit can be reduced for existing animal housing through their use in combination with other techniques (e.g., nutritional management, an air cleaning system, pH reduction of slurry, or slurry cooling).

The BREF note also describes several housing types that reduce emissions. These housing systems are primarily applicable to new installations and plant and rely on various mechanisms that avoid or minimise anaerobic degradation occurring. The techniques most relevant to Ireland relate variously to:

- **Vacuum system for frequent slurry removal,** where outlets are placed on the bottom of the pit under a fully slatted floor that are connected to a discharge system moving the slurry to an external covered storage unit. Slurry is discharged by opening a valve in the main slurry pipe. A slight vacuum develops and allows for a thorough slurry removal. The slurry should be removed once or twice a week.
- **Scraper for frequent slurry removal**, where slurry is removed from the pit by the action of a scraper. Slurry should be removed on a daily basis. The system relies on a shorter residence time.
- **Frequent slurry removal by flushing,** where the slurry surface is reduced by means of slurry channels and removal of the slurry by frequent flushing. The channels should be flushed once or twice per day. The system relies on a shorter residence time.
- **Reduced manure volume pit,** where a shallow slurry pit is used with a reduced depth of about 0.6m. The system relies on a shorter residence time and would need to be emptied more frequently.
- **Combination of water and manure channels,** the slurry pit is split up into a wide water channel at the front and a small manure channel at the back with a reduced emitting slurry surface. The manure channel should be designed to be flushed twice every day. The system relies on a limited emitting surface and shorter residence time.
- **Manure pan,** where a prefabricated container (pan) is placed under the slatted floor to collect slurry. The pan slopes towards a central manure channel; the manure discharges when its level reaches around 12 cm. The system relies on a shorter residence time; and
- **Slurry cooling**, where a reduction of the slurry temperature leads to reduced emissions, as at a lower slurry temperature less ammonium is volatilised. The ammonia and odour reduction efficiencies depend on the cooling intensity. The slurry system needs to be emptied frequently to provide continuous heat removal. The frequency of removal will depend on the capacity of the cooling system.

The above list includes housing systems common in Ireland, but may be applicable to specific pig categories only. It is not exhaustive, and further detail on other potential techniques can be found in the CID and BREF documents.

2.1.4. External Slurry Storage

When slurry is stored in a tank or lagoon it can undergo anaerobic degradation giving rise to high concentrations of odorants. These are released from the slurry as wind passes over the surface. More concentrated 'puffs' of odorants can be released when the slurry is being handled. Turbulence, resulting from 'stirring' and pumping, can significantly increase the emissions from the surface.

Various approaches can be used to cover external slurry stores using either rigid covers, flexible covers or floating covers, effectively preventing odours escaping.

2.2. Acceptable Odour Level Benchmarks

This instruction note sets out what the EPA considers to be acceptable odour levels, below which licenced sites can operate without generating unacceptable odour pollution at sensitive receptors.

These odour levels are based on industrial sector categories presented in the EPA Guidance note AG4; Table 4: *Indicative odour standards on offensiveness of odour and adapted for Irish EPA use*. AG4 categorises industrial sectors according to their relative offensiveness of odour. 1.5OU_E/m^3 is the applicable standard for the most offensive odours. Intensive Livestock Rearing is categorised here as Moderately Offensive.

In accordance with the CID published for this sector, a new installation is deemed to be one first licensed following the publication of the CID (February 2017), or a complete replacement of an installation following the publication of the CID. An installation will only be deemed to be an existing installation for the purposes of this document where it was licensed by the EPA prior to 15th February 2017. Any installations undergoing licence reviews after 15th February 2021, are required to be compliant with the CID. Any modelled result that predicts exposures above these levels, after taking uncertainty into account, indicates the likelihood of unacceptable odour pollution. Where applicants propose to operate above these odour levels, further mitigation measures will be required.

For the purposes of this instructional note, the acceptable odour levels[8] specific to intensive agriculture are as follows:

- 3.0 OU_E/m^3 for new pig-production units;
- 5.0 OU_E/m^3 for existing pig-production units (includes sites licensed by the EPA between 2001 and 15th February 2017 only); and
- 6.0 OU_E/m^3 for existing pig-production units (includes sites licensed by the EPA prior to 2001 and not reviewed since this date only).

The applicability of the above levels will be at odour-sensitive locations only. Note, for the purposes of this instruction note, the applicant's dwelling and farmyard are not considered to be odour-sensitive locations. Where there are no third-party odour-sensitive receptors present, a higher odour level may be considered acceptable e.g., at the applicant's dwelling, farmyard, or countryside.

2.3. Mitigation set out in the CID

The CID sets out reference criteria for setting licence conditions for the intensive rearing of pigs (and poultry). The CID sets out what appropriate methods / best available techniques, which under

[8] These odour levels are based on the 98th percentile of hourly mean concentrations of odour modelled over a year at the odour-sensitive locations.

normal operating conditions at the installation, should minimise emission levels and therefore ensure compliance with the odour benchmarks.

As stated previously, many of the techniques targeted at one pollutant will have cross media effects of altering the emissions of another pollutant. For example, some techniques targeted at reducing ammonia and / or nitrogen will have impacts on odour emissions. Such consequential odour reductions are detailed throughout the BREF document.

Note, the list given in Table 1 below is not exhaustive and contains the most common techniques in Ireland. The CID and BREF should be consulted for the full list of techniques.

Table 1: Summary of the BAT Conclusions relating to odour control in the CID

Ref	Objective	Range of appropriate measures
BAT 3	In order to reduce total nitrogen excreted and consequently ammonia emissions while meeting the nutritional needs of the animals, use a diet formulation and nutritional strategy	• Reduce the crude protein content by using an N-balanced diet based on the energy needs and digestible amino acids. • Multiphase feeding with a diet formulation adapted to the specific requirements of the production period. • Addition of controlled amounts of essential amino acids to a low crude protein diet. • Use of authorised feed additives which reduce the total nitrogen excreted.
BAT 13	In order to prevent or, where that is not practicable, to reduce odour emissions and/or odour impact from a farm	Ensure adequate distances between the farm/plant and the sensitive receptors.
		Use a housing system which implements one or a combination of the following principles: • Keeping the animals and the surfaces dry and clean (e.g., avoid feed spillages, avoid dung in lying areas of partly slatted floors). • Reducing the emitting surface of manure (e.g., use metal or plastic slats, channels with a reduced exposed manure surface). • Removing manure frequently to an external (covered) manure store. • Reducing the temperature of the manure (e.g., by slurry cooling) and of the indoor environment. • Decreasing the air flow and velocity over the manure surface. • Keeping the litter dry and under aerobic conditions in litter-based systems.
		Optimise the discharge conditions of exhaust air from the animal house by using one or a combination of the following techniques: • Increasing the outlet height (e.g., exhaust air above roof level, stacks, divert air exhaust through the ridge instead of through the low part of the walls). • Increasing the vertical outlet ventilation velocity. • Effective placement of external barriers to create turbulence in the outgoing air flow (e.g., vegetation). • Adding deflector covers in exhaust apertures located in low parts of walls in order to divert exhaust air towards the ground. • Dispersing the exhaust air at the housing side which faces away from the sensitive receptor. • Aligning the ridge axis of a naturally ventilated building aligned transverse to the prevailing wind direction.
		Use an air cleaning system, such as: 1. Bioscrubber (or biotrickling filter). 2. Biofilter. 3. Two-stage or three-stage air cleaning system.

Ref	Objective	Range of appropriate measures
		Use one or a combination of the following techniques for storage of manure: 1. Cover slurry or solid manure during storage. 2. Locate the store taking into account the general wind direction and/or adopt measures to reduce wind speed around and above the store (e.g., trees, natural barriers). 3. Minimise stirring of slurry.
BAT 16 linked to BAT 13e(1) (cover slurry / manure)	In order to reduce ammonia emissions to air from a slurry store	Appropriate design and management of the slurry store by using a combination of the following techniques: 1. Reduce the ratio between the emitting surface area and the volume of the slurry store. 2. Reduce wind velocity and air exchange on the slurry surface by operating the store at a lower level of fill. 3. Minimise stirring of slurry.
		Cover the slurry store. For this purpose, one of the following techniques may be used: 1. Rigid cover. 2. Flexible covers. 3. Floating covers such as: • Plastic pellets. • Light bulk materials. • Floating flexible covers. • Geometrical plastic tiles. • Air-inflated cover. • Natural crust. • Straw.
		Slurry acidification.
BAT 17 linked to BAT 13e(1) (cover slurry / manure)	In order to reduce ammonia emissions to air from an earth-banked slurry store (lagoon)	Cover the earth-banked slurry store (lagoon) with a flexible and/or floating cover such as: • Flexible plastic sheets. • Light bulk materials. • Natural crust. • Straw.

3. Screening tool for odour Assessment

3.1. Assessment Approach

A number of international setback models were examined when writing this instruction note, to determine which method(s) could be adopted for the purpose of delivering initial screening to assess the acceptability of a pig rearing installation located with respect to sensitive receptors.

The following design criteria were key to developing the screening tool, the tool should:

- provide odour predictions in a format that is consistent with EPA odour benchmarks and would also be of suitable standard to be acceptable as part of a licence or planning application;
- be easy for all stakeholders (operators, consultants, planning officers, EPA inspectors and neighbouring communities) to understand and apply;
- give a clear and unambiguous output; and
- not be reliant on an external delivery mechanism outside the EPA's control.

The screening tool provides an initial odour assessment to test the suitability of a pig farm in a particular location. If, with the screening tool, there is headroom between the odour level predicted at a sensitive location and the acceptable odour level benchmark, then odour is not predicted to be an issue and the application can proceed. However, if there is no headroom then the applicant will be asked to carry out a more detailed modelling assessment to demonstrate that the appropriate benchmark will not be exceeded, and further mitigation methods may need to be incorporated into this assessment.

3.2. Using the Screening Tool

The screening tool enables the user to generate a worst-case odour impact with the minimum level of input from the user. To this effect, the tool has been designed to run through Microsoft excel, and can be downloaded from the EPA website at:

https://www.epa.ie/our-services/licensing/industrial/industrial-emissions-licensing-ied/how-to-apply-for-an-ie-licence/ie-licence-application-guidance/.

Note that excel version 2007 or higher, should be used when running the tool to ensure functionality.

The screening tool requires the user to input/select basic parameters. These include pig numbers, pig type and dispersion characteristics of animal houses, as well as basic input parameters for any external slurry storage infrastructure. Those applicable to the subject installation are selected from predetermined dropdown menus and via user input tabs. Once these basic parameters have been selected/inputted, background calculations determine the odour emission rate and provide a recommendation of what dispersion characteristics should apply. The screening tool will then combine the odour emission rate for the installation with the appropriate dispersion profile to give the odour concentration profile away from the installation.

Table 2 lists the EXCEL worksheets in the screening tool.

Table 2: Summary of the various worksheets contained in the screening tool

Sheet	Requires user input	Function
Guide	No	Provides an introduction and guidance to the tool.
Buildings	Yes	Provides • Text entry for building reference • Dropdown menu to select pig types • User input of pig numbers • Dropdown menu to select dispersion character
Slurry storage	Yes	Provides • Text entry for tank reference • User input of tank surface area • Dropdown menu to select mitigation (if any)
Decay curve	No	This sheet displays the results of the screening calculations which feed into the decay curve on the export worksheet.
Export	No	This sheet provides a summary of the input data, the results and includes details of the predicted level of odour emissions (OU/s) from each building and storage tank. This sheet also displays a decay curve which shows the predicted level of odour (OU_E/m^3) at the 98^{th} percentile with respect to distance from the odour source based on a total odour emission rate. This sheet provides guidance for printing the sheet.

Where the tool is being used by an applicant to provide evidence of an odour assessment as part of an IED Intensive Agriculture licence application or licence review application, copies of the input and output parameters (in the form of screenshots / PDF of the tool worksheets) should be attached to the application documentation. These should include as a minimum, a copy of:

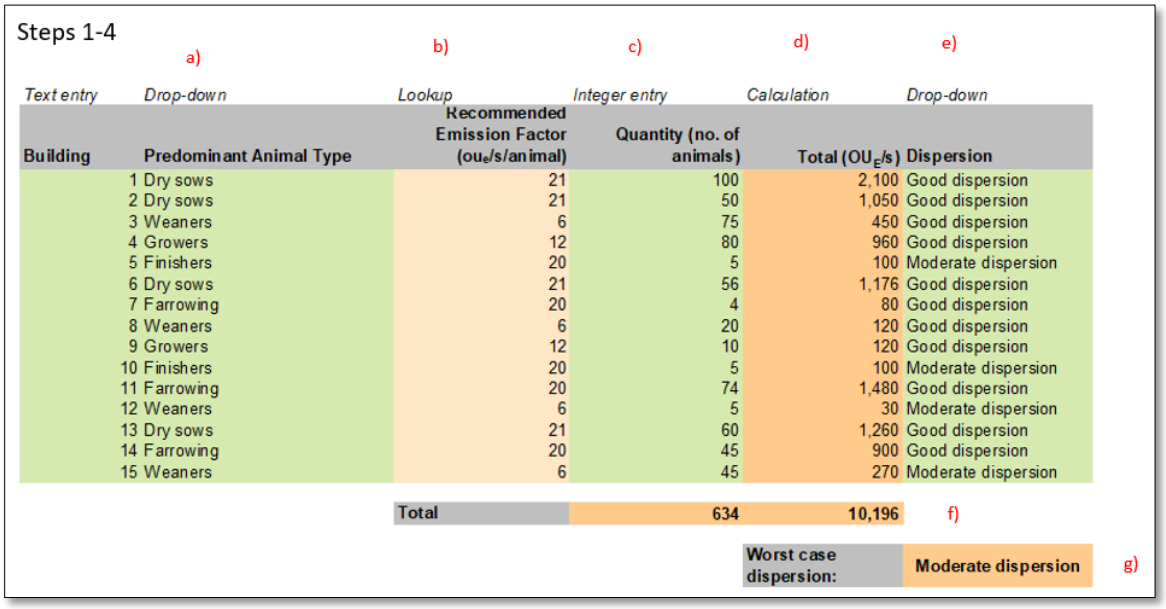
- the 'buildings' worksheet;
- the 'slurry storage' worksheet (where applicable); and
- the 'results export' worksheet including the decay curve.

3.3. Step by Step Guide to using the Screening Tool

3.3.1. The 'buildings' input worksheet

Figure 1 provides a screenshot of the "*buildings"* worksheet found within the screening tool. The illustration has been annotated with red letters to explain what is on the worksheet and how the worksheet is to be used.

Figure 1: Emissions entry page for "buildings"



Steps 1-4

	a)	b)	c)	d)	e)
	Text entry	*Drop-down*	*Lookup*	*Integer entry*	*Calculation*	*Drop-down*
	Building	**Predominant Animal Type**	**Recommended Emission Factor (ou_E/s/animal)**	**Quantity (no. of animals)**	**Total (OU_E/s)**	**Dispersion**
	1	Dry sows	21	100	2,100	Good dispersion
	2	Dry sows	21	50	1,050	Good dispersion
	3	Weaners	6	75	450	Good dispersion
	4	Growers	12	80	960	Good dispersion
	5	Finishers	20	5	100	Moderate dispersion
	6	Dry sows	21	56	1,176	Good dispersion
	7	Farrowing	20	4	80	Good dispersion
	8	Weaners	6	20	120	Good dispersion
	9	Growers	12	10	120	Good dispersion
	10	Finishers	20	5	100	Moderate dispersion
	11	Farrowing	20	74	1,480	Good dispersion
	12	Weaners	6	5	30	Moderate dispersion
	13	Dry sows	21	60	1,260	Good dispersion
	14	Farrowing	20	45	900	Good dispersion
	15	Weaners	6	45	270	Moderate dispersion
			Total	**634**	**10,196**	f)
					Worst case dispersion:	**Moderate dispersion** g)

Step 1 - Open the "Buildings" worksheet, and for each building used to rear pigs:

a) In the column below the label "a)", the user must specify the type of pigs reared within the building using the dropdown menu (e.g., sows, farrowers, weaners, growers, finishers). Where more than one animal type is to be reared in a building, then more than one entry will be required for that building as each pig type should be inputted separately.

b) In the column below the label "b)", the screening tool automatically selects the recommended odour emission factor for that type of pig.

The screening tool calculates the odour emission rate for pig rearing based on the odour emission factors set out in Table 3 below.

Table 3: Odour emission factors for the different pig types used in the screening tool.

	Recommended odour emission factor (OU_E/s/pig)
Sows	21
Farrowing Sows	20
Boars	20
Weaners	6
Growers	12
Finishers	20
Maiden Gilts	20

According to the BREF note, live weights for each type of pig and typical growth rates are shown in Table 4. For the purpose of the screening tool, it should be assumed that the

odour emission factor for a given pig type are linked to the weight of the animal at the end of a particular growth phase.

Table 4: Typical pig weight by animal category in an intensive production unit

	typical weight range (kg)	typical growth rate (kg/day)
Sows	--	--
Farrowers	--	--
Boars	--	--
Weaners	8 to 30kg	0.3
Growers	>30 kg to 60 kg	0.6
Finishers	> 60 kg to ~120kg	0.6
Maiden gilts	--	--

c) In the column below the label "c)", the user specifies the maximum number of pigs that could be reared within the building when at full capacity.

d) In the column below the label "d)", the screening tool will calculate the total odour emission rate for the building.

e) In the column below the label "e)", the user specifies the dispersion characteristics for the building where:

   a. **Poor dispersion** applies if the building integrity is poor: dispersion from the building is uncontrolled with air passing out through the building fabric and not through stacks.

   b. **Moderate dispersion** applies if the building integrity is good: dispersion from the building is controlled with air passing out through a short stack (<3m) above the roof ridge at an efflux velocity below 15m/s.

   c. **Good dispersion** applies if the building integrity is good: dispersion from the building is controlled with air passing out through a short stack (<3m) above the roof ridge at an efflux velocity of 15m/s or more.

   Note: Where the applicant is inputting moderate or good dispersion, then evidence should be provided to demonstrate the efflux velocity. If this cannot be provided, then poor dispersion should be selected.

Step 2 - Repeat Step 1 for each building used on site.

Step 3 - The screening tool will calculate the total odour emission rate as the sum of the odour emission rates for each building on site, this is given in the cell to the left of the label marked "f)".

Step 4 – The screening tool will automatically select the appropriate dispersion characteristics for the installation based on the performance of the worst building dispersion characteristics, this is given in the cell labelled "g)". This selection becomes the recommended dispersion characteristic for the installation.

3.3.2. The 'slurry storage' input worksheet

Figure 2 provides an illustration of the "*Slurry Storage"* worksheet found within the screening tool. The illustration has been annotated with red letters to explain what is on the sheet and how the worksheet is to be used.

Figure 2: Emissions entry page for "slurry storage"

Steps 5-7

	h)	i)	j)	k)
Tank/Lagoon	Surface Area (m^2)	Mitigation	Emission Factor ($OU_E/m^2/s$)	Total (OU_E/s)
Tank 1	200	Straw or natural crust	10	2000
Tank 2	400	Rigid or floating cover	2	800
Tank 3	80	None	20	1600
Tank 4	20	Straw or natural crust	10	200
Tank 5	350	Rigid or floating cover	2	700
Tank 6	351	Straw or natural crust	10	3510
Tank 7	352	None	20	7040
Tank 8	54	None	20	1080
Tank 9	456	Straw or natural crust	10	4560
Tank 10	56	None	20	1120
Tank 11	87	Straw or natural crust	10	870
Tank 12	86	None	20	1720
Tank 13	23	Rigid or floating cover	2	46
Tank 14	15	None	20	300
Tank 15	46	Rigid or floating cover	2	92
		Total		25,638 l)

Step 5 – Open the "*Slurry Storage"* worksheet located next to the "*buildings"* worksheet identified for steps 1-4.

a) In the column below the label "h)", the user specifies the surface area of each tank or lagoon.

b) In the column below the label "i)", the user specifies the type of covering (if any) on each tank or lagoon.

c) In the column below the label "j)", the screening tool selects the recommended odour emission factor for slurry storage.

The screening tool calculates the odour emission rate for slurry storage based on a surface emission factor of 20 $OU_E/m^2/s$. The screening tool allows the user to take account of surface covering and automatically applies the following levels of mitigation:

- A reduction of 90% of the surface emission can be achieved using rigid or floating cover.
- A reduction of 50% of the surface emission can be achieved using low tech operations (e.g., floating covers such as straw etc.).

d) In the column below the label "k)", the screening tool calculates the total odour emission rate for each tank or lagoon.

Step 6 - Repeat Step 5 for each tank or lagoon used on site.

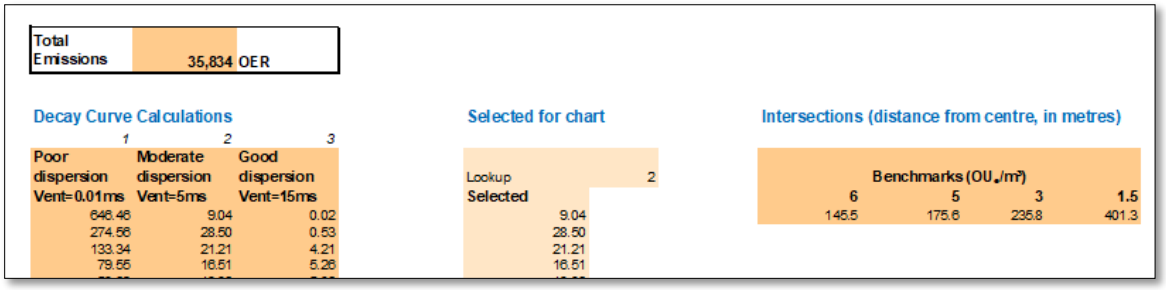
Step 7 – The screening tool calculates the total odour emission rate as the sum of the odour emission rates for each tank/lagoon on site, this is given in the cell to the left of the label marked "l)".

3.3.3. The 'decay curve' worksheet

Once steps 1 – 7 have been completed, the user should select the "*decay curve"* worksheet.

Figure 3 shows an example of what the sheet looks like. This data is used in calculating the decay curve graph in the next worksheet ("*Results export" worksheet).* This worksheet doesn't require user input. It is for information / calculation purposes only.

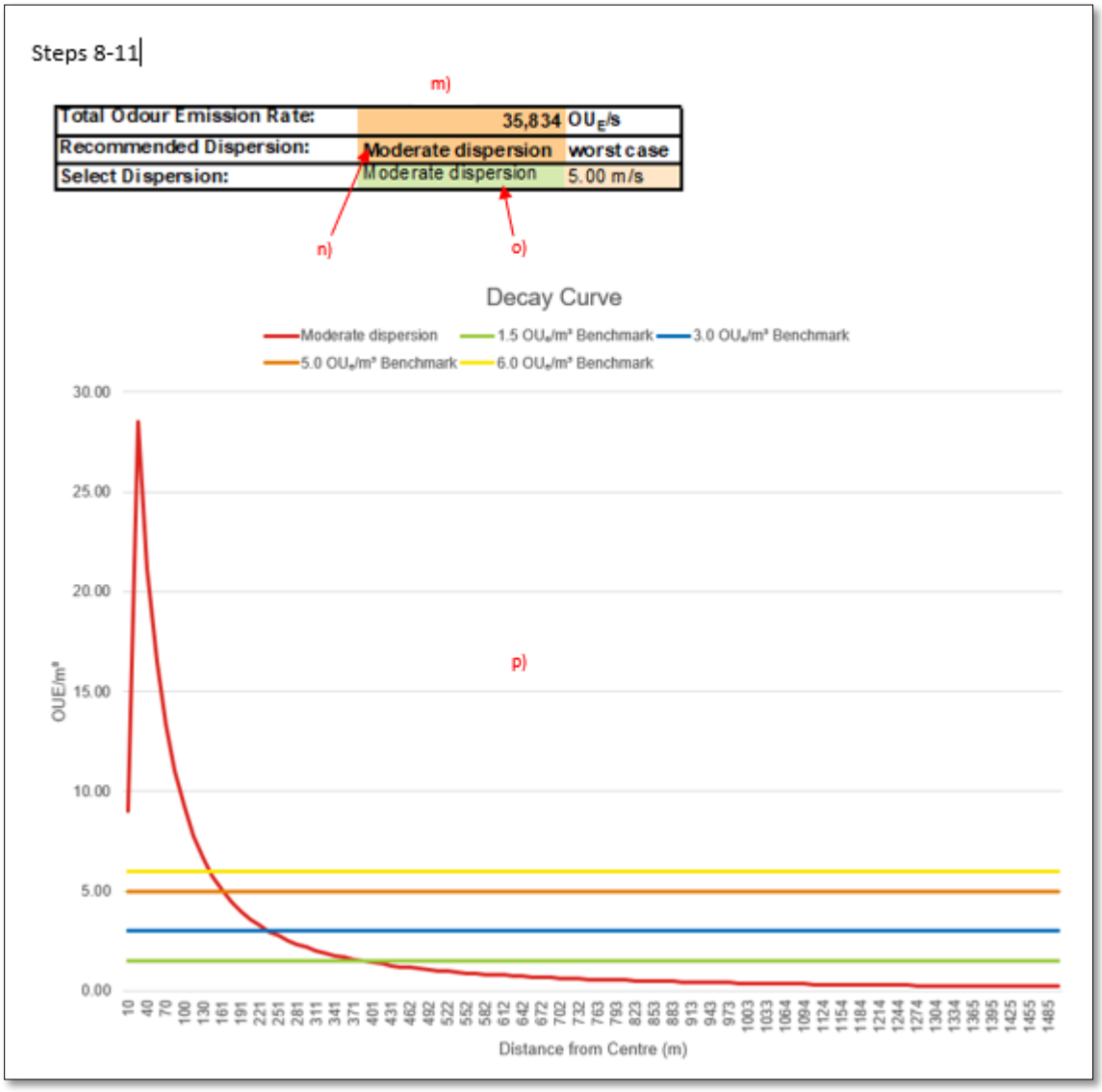
Figure 3: Decay curve calculations page



3.3.4. The 'Results Export' worksheet

Once steps 1 – 7 have been completed, the user should select the *"Results Export"* worksheet which includes steps 8 – 13. Figure 4 shows an example of what the sheet looks like, and the illustration has been annotated with red letters to explain what is on the sheet and how the sheet is to be used.

Figure 4: '*Results Export'* output page



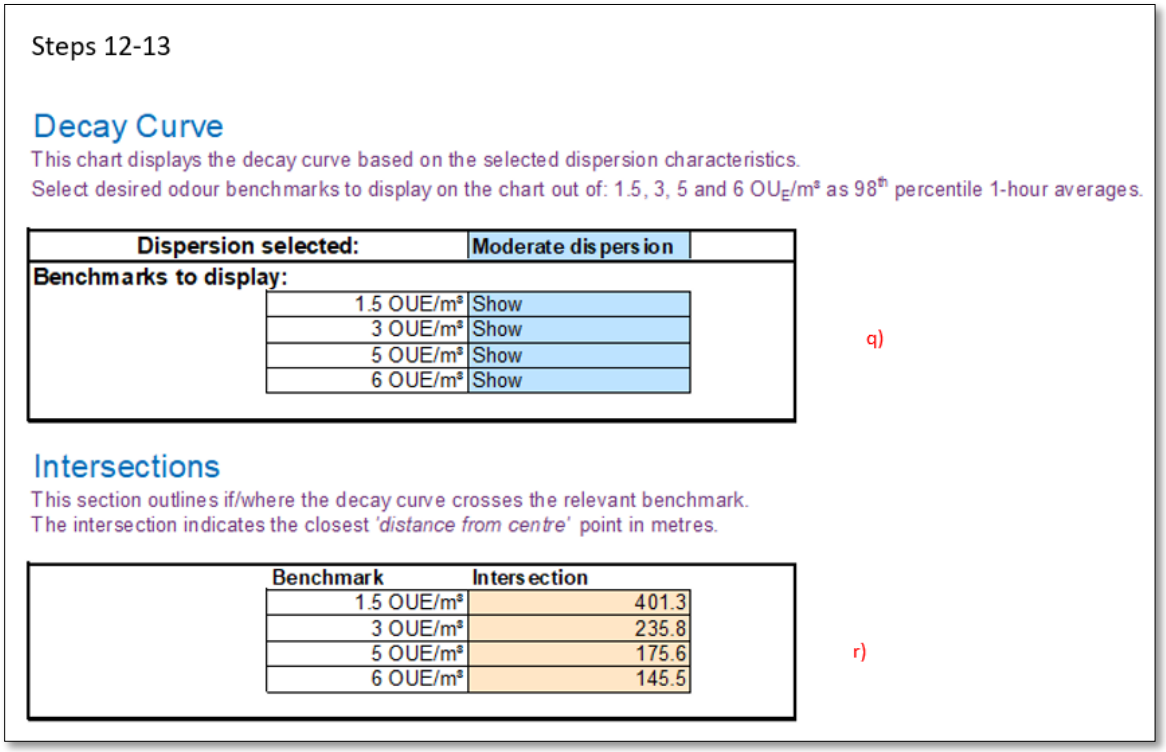
Step 8 – In the box labelled "m)", the screening tool calculates the total odour emission rate for the site as the sum of building emissions (label "f)") and slurry storage emissions (label "l)").

Step 9 – In the box labelled "n)" the screening tool restates the recommended dispersion characteristic selected. This will be the same as label "g)".

Step 10 – In the box labelled "o)" the user can use the drop-down menu to select the dispersion characteristic to be applied. This allows the user to select dispersion characteristics different to the recommended characteristic, if required.

Step 11 – In '*Decay Curve'* graph labelled "p)" the screening tool presents the 'decay curve' profile based on the total emission rate and selected dispersion characteristic. The profile shows how the odour concentration from the centre of the farm is predicted to change over distance from source.

> To aid interpretation the 'decay curve' profile includes the 3 benchmark levels (3.0, 5.0 and 6 OU_E/m^3 as a 98th%ile 1-hour average). The benchmark 1.5 OU_E/m^3 is also included in the graph.



Step 12 – In the aforementioned '*Decay Curve'* graph, the different benchmarks can be turned on or off in the graph by selecting "show" or "do not show" in the dropdowns within the box "q)" above.

Step 13 – In the aforementioned '*Decay Curve'* graph, the point (distance from the installation) where the curve crosses each of the benchmarks in the graph can be seen in the box "r)" above.

Step 14 - Once the odour assessment is complete the user can export the assessment results using the '*export'* sheet either to a printer or as a PDF file.

To access the printer function, the user must be connected to a functioning printer.

To save the export sheet as a PDF the user should:

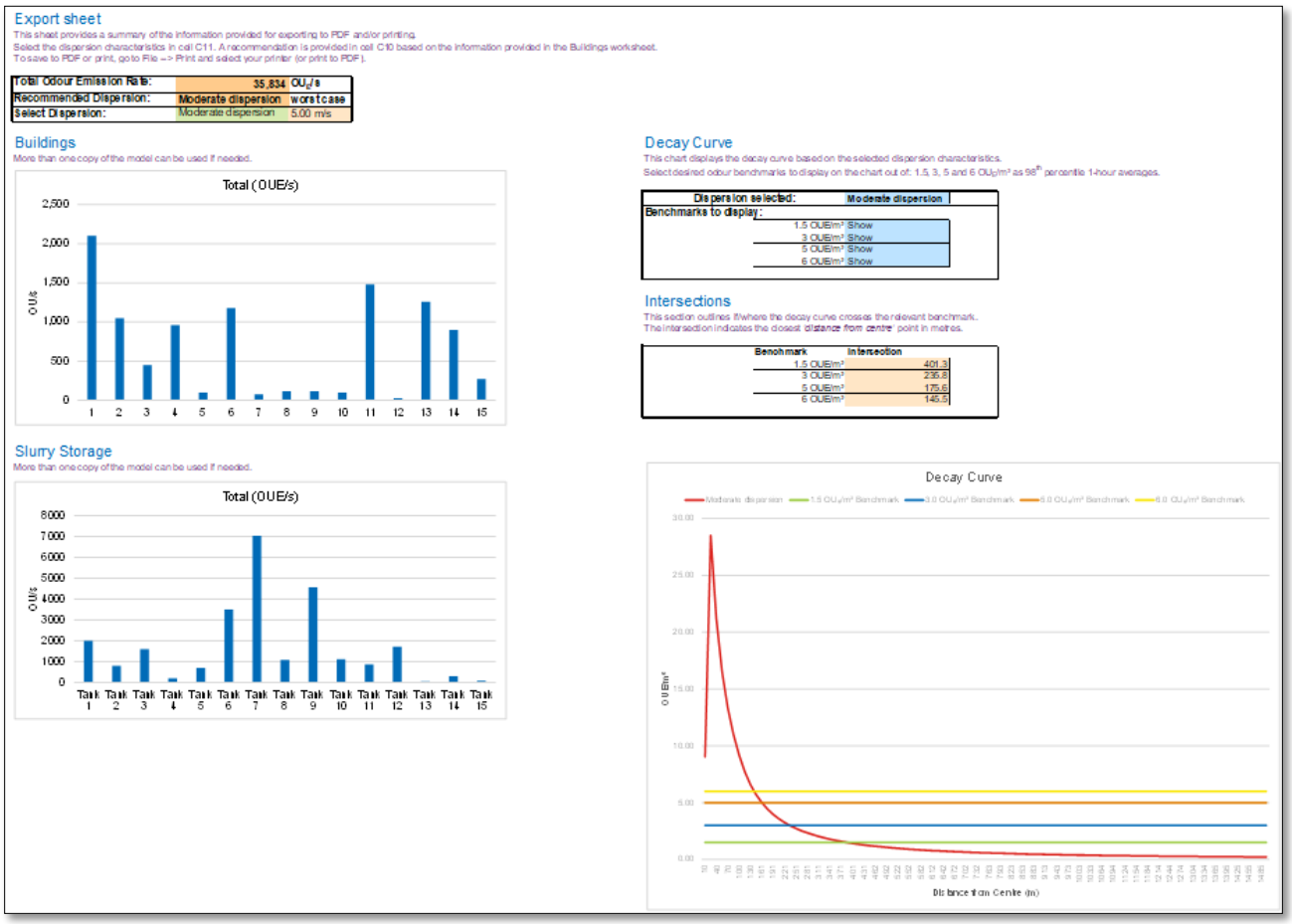
- Select the 'file' tab on excel.
- Select the 'save as' option.
- Give the output file a name as shown in Figure 5.
- Select pdf.* from the dropdown menu as shown in Figure 5.

Figure 5: Saving the results of an assessment

An example of the results is shown in Figure 6. The sheet shows:

- How the odour emissions have been assigned by buildings and by slurry storage tanks;
- What dispersion characteristic has been used, as well as what the recommended dispersion characteristic was; and
- The decay profile for the input data used.

Figure 6: Example of '*results export*' sheet

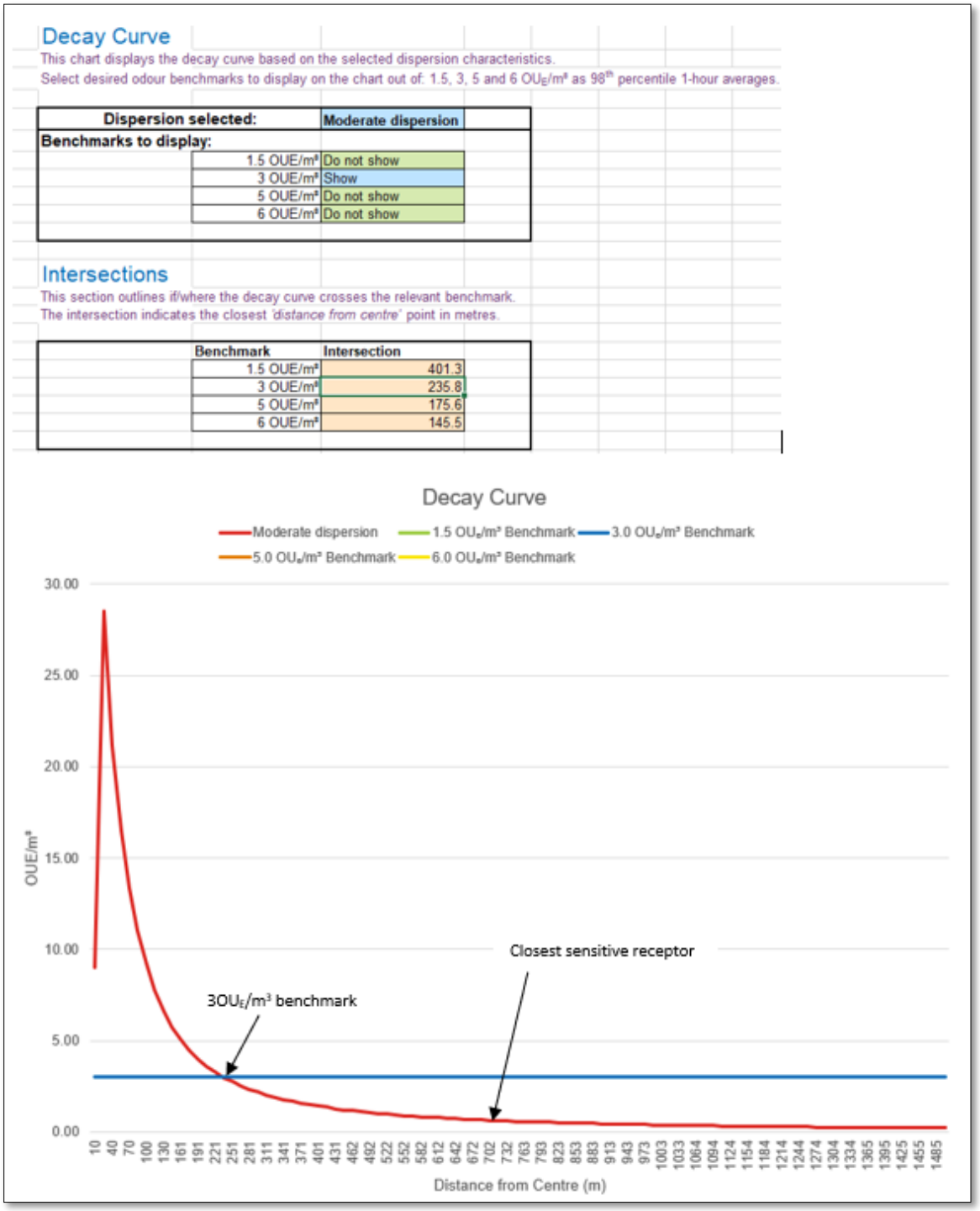


3.3.5. Interpretation of the Decay Curve

Step 15: For Interpretation the user can read the decay curve to:

- Predict odour levels at a particular distance (e.g., where sensitive receptors such as residential houses are).
- Predict the distances where the acceptable odour levels are not exceeded e.g., taking the example in Figure 7 below, the benchmark of $3OU_E/m^3$ is not predicted to be exceeded at a distance of 235.8m. This can be read from both the decay curve graph itself and the intersection table.

Figure 7: Illustration of how to interpret the decay curve



Where the screening tool predicts that:

- The appropriate benchmark will not be exceeded at any sensitive receptors, the applicant should submit the licence application for assessment including a copy of the input and output from the screening tool.
- The appropriate benchmark will be exceeded then the applicant will need to carry out a detailed dispersion modelling assessment to demonstrate that the appropriate benchmark will not be exceeded at any of the sensitive receptors.

3.3.6. Example of Using the Screening Tool

Background

This case study is for an integrated pig rearing installation which comprises of:

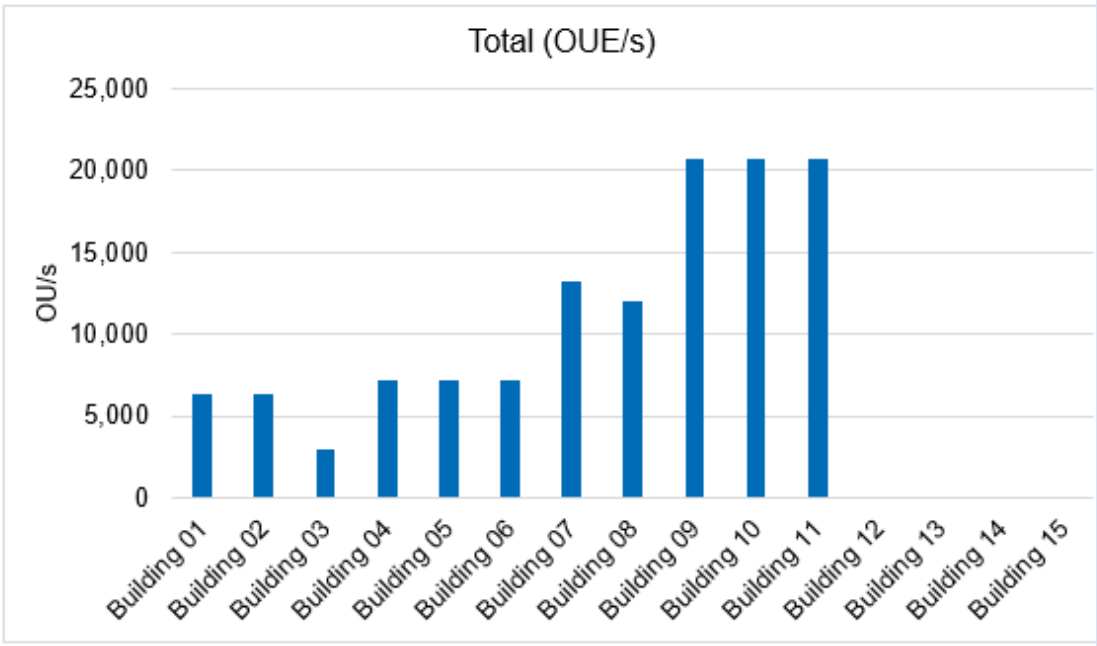
- 600 dry sows in two buildings fitted with ridge mounted vents discharging at a high velocity.
- 150 farrowing sows in one building operating under natural ventilation.
- 3,600 weaners in three buildings (1,200 in each house), operating under natural ventilation in one house and high velocity in two houses.
- 2,100 growers in two buildings fitted with ridge mounted vents discharging at a high velocity.
- 3,099 finishers in three buildings (1,033 in each) fitted with ridge mounted vents discharging from one house at a moderate velocity, and from two houses at high velocity.

The site also has 3 large round slurry storage tanks used to store slurry removed from the deep slurry pits under the animal houses. Each tank is 30m in diameter (706m^2 each) with floating covers.

The closest residential receptor lies 370m to the northwest. The area is a rural setting with some farming activity in the general vicinity.

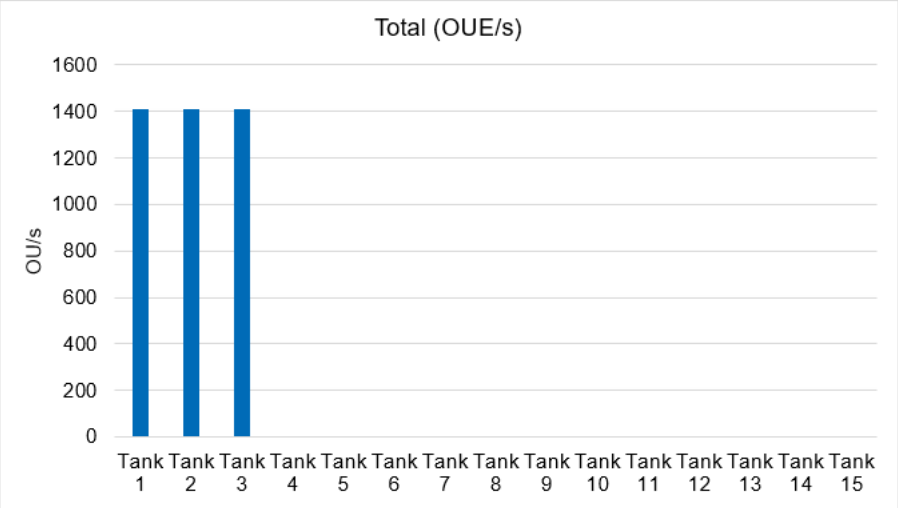
Step 1 – Building input sheet

Text entry	*Drop-down*	*Lookup*	*Integer entry*	*Calculation*	*Drop-down*
Building	**Predominant Animal Type**	**Recommended Emission Factor (ou_E/s/animal)**	**Quantity (no. of animals)**	**Total (OU_E/s)**	**Dispersion**
Building 01	Dry sows	21	300	6,300	Good dispersion
Building 02	Dry sows	21	300	6,300	Good dispersion
Building 03	Farrowing	20	150	3,000	Poor dispersion
Building 04	Weaners	6	1200	7,200	Good dispersion
Building 05	Weaners	6	1200	7,200	Poor dispersion
Building 06	Weaners	6	1200	7,200	Good dispersion
Building 07	Growers	12	1100	13,200	Good dispersion
Building 08	Growers	12	1000	12,000	Good dispersion
Building 09	Finishers	20	1033	20,660	Good dispersion
Building 10	Finishers	20	1033	20,660	Moderate dispersion
Building 11	Finishers	20	1033	20,660	Good dispersion
Building 12	Not used	0	0	0	Moderate dispersion
Building 13	Not used	0	0	0	Good dispersion
Building 14	Not used	0	0	0	Good dispersion
Building 15	Not used	0	0	0	Poor dispersion
		Total	**9,549**	**124,380**	
				Worst case dispersion:	**Poor dispersion**



Step 2 – Slurry Storage input sheet

Tank/Lagoon	Surface Area (m²)	Mitigation	Emission Factor ($OU_E/m^2/s$)	Total (OU_E/s)
Tank 1	706	Rigid or floating cover	2	1412
Tank 2	706	Rigid or floating cover	2	1412
Tank 3	706	Rigid or floating cover	2	1412
Tank 4		None	20	0
Tank 5		None	20	0
Tank 6		None	20	0
Tank 7		None	20	0
Tank 8		None	20	0
Tank 9		None	20	0
Tank 10		None	20	0
Tank 11		None	20	0
Tank 12		None	20	0
Tank 13		None	20	0
Tank 14		None	20	0
Tank 15		None	20	0
			Total	**4,236**



Step 3 – Calculations Sheet

Total Emissions	128,616	OER

Decay Curve Calculations

1	2	3
Poor dispersion	Moderate dispersion	Good dispersion
Vent=0.01ms	Vent=5ms	Vent=15ms
2320.27	32.44	0.08
985.47	102.28	1.92
478.57	76.12	15.12
285.52	59.26	18.89
192.70	47.94	18.18
143.42	39.59	15.92
113.03	32.97	14.09
91.93	27.75	12.62
76.73	23.69	11.32

Selected for chart

Lookup	1
Selected	
2320.27	
985.47	
478.57	
285.52	
192.70	
143.42	
113.03	
91.93	
76.73	

Intersections (distance from ce

	Benchmarks (OU
6	5
627.1	702.3

Step 4 – Decay Curve results

Decay Curve

This chart displays the decay curve based on the selected dispersion characteristics.
Select desired odour benchmarks to display on the chart out of: 1.5, 3, 5 and 6 OU_E/m^3 as 98th percentile 1-hour averages.

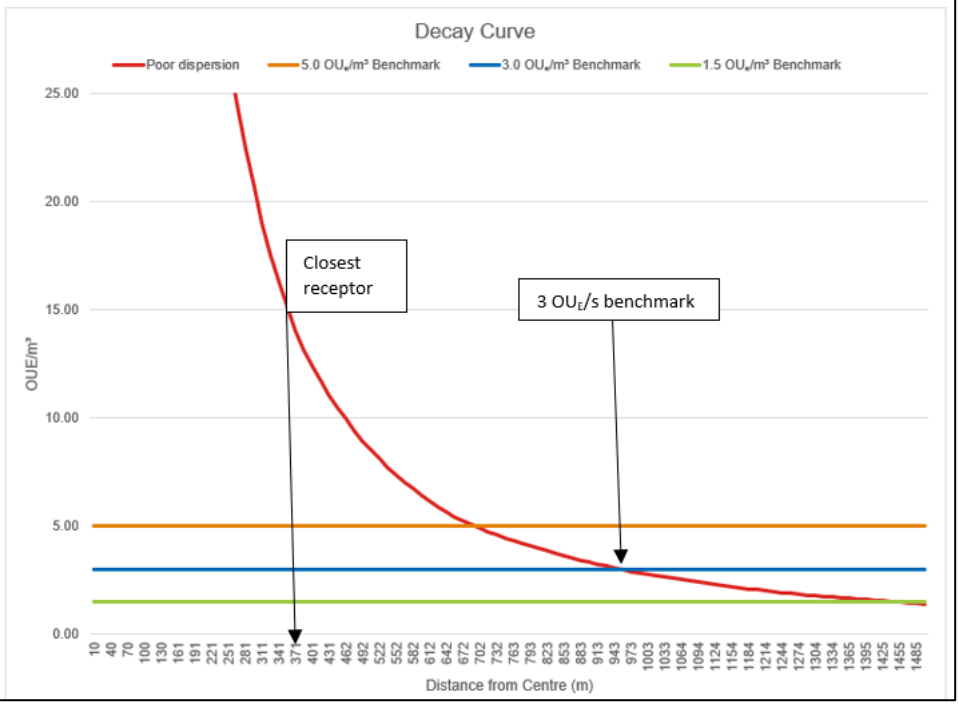
Dispersion selected:	Poor dispersion
Benchmarks to display:	
1.5 OUE/m³	Show
3 OUE/m³	Show
5 OUE/m³	Show
6 OUE/m³	Show

Intersections

This section outlines if/where the decay curve crosses the relevant benchmark.
The intersection indicates the closest *'distance from centre'* point in metres.

Benchmark	Intersection
1.5 OUE/m³	1454.9
3 OUE/m³	958.2
5 OUE/m³	702.3
6 OUE/m³	627.1

Dispersion selected:	Poor dispersion



Model results

Screening tool indicated that at approximately 370m from the centre of the farm the concentrations would be:

- ca. 15 OU_E/m^3 as a 98^{th}%ile with poor dispersion.

Conclusion

The calculated concentration at the closest receptor for this farm's dispersion characteristics is above the benchmark of 3 OU_E/m^3 as a 98^{th}%ile benchmark. A more detailed odour assessment is required to evaluate odours fully and determine the level of abatement/mitigation that will need to be applied.

4. Detailed modelling for Odour Assessment

The results of the screening odour assessment may indicate that a more detailed odour impact assessment will need to be carried out. This section provides supplementary information on odour emission factors and the levels of abatement that should be considered alongside the EPA's other more general guidance on carrying out a detailed modelling assessment [3,4].

4.1. Recommended Approach

To provide consistency between all modelling practitioners the approach for detailed modelling is as follows:

- Pig Housing:
    - The applicant shall calculate the 'baseline' odour emission rate by pig type using the emission factors set out in Table 3. This ensures that the assessment provides a worst-case illustration of the odour impact.
    - Lower emission factors for other alternative techniques are given in the Section 4.9 of the BREF document. Where an applicable technique is employed onsite (e.g., bioscrubbers are detailed in Section 4.9.3 of the BREF document), these emission factors may be used in the detailed modelling.
    - In the event that the applicant applies mitigation to abate odour at their installation then the 'baseline' odour emission factor shall be:
        - Reduced by the recommended odour reduction level for the first mitigation technique.
        - Where an additional mitigation technique is utilised, it can be further reduced by the proportion of the recommended odour reduction level for the second mitigation technique as set out in section 4.2.3 below. This adjustment avoids odour reductions being double counted but also gives some credit where an applicant has invested in additional mitigation.
- Slurry storage
    - In the event that external slurry storage is present, the appropriate odour emission factor set out in section 3.3.2 shall be applied, which may incorporate mitigation by covering the store. Any reduction applied to the external slurry storage is separate to, and should not be included, as part of the adjustment applied to multiple mitigation techniques associated with animal housing above.

4.2. Recommended Levels of Mitigation

4.2.1. Manipulating Dietary Protein & Supplements

Manipulating animal feed by reducing dietary protein will reduce the amount of unused protein that passes through a pig's digestive system. Fewer precursor compounds present in the slurry will reduce potential odour.

For detailed modelling, it would be reasonable to apply a reduction factor of 10% on the basis of a reduction of 1% crude protein in the diet. The maximum reduction factor that can be applied is 30% linked to a reduction of 3% crude protein in the diet.

4.2.2. Improved slurry management offered by integrated housing techniques

Various integrated housing techniques (see Section 2.1.3) are available that will minimise the decomposition of protein and other constituents. A range of published odour emission factors are available for such systems however the breadth of data on any technique is small. For carrying out detailed modelling it would be reasonable to apply a reduction factor of 25% irrespective of the technique being employed (e.g., frequent slurry removal / slurry cooling).

4.2.3. Mitigation offered by more than one mitigation technique

The main focus of odour mitigation used to abate odour from a pig rearing activity seeks to either prevent the amount of precursor compounds present which will degrade or to manipulate the anaerobic environment to avoid any precursors degrading, and odorous compounds being released. It can therefore be seen that when dietary manipulation is used in conjunction with a system integrated housing technique, there would be a degree of 'double counting' if the applicant were to add the individual reductions set out above.

Until further scientific evidence is available to the contrary, where two mitigation techniques are operated on the same pig rearing installation, the applicant should be limited to:

- 100% of the odour reduction offered by the first mitigation technique; and
- no more than 50% of the odour reduction offered by the second mitigation technique.

Examples:

Examples below are for demonstrative purposes only, actual percentage reductions for particular techniques should be obtained from the BREF document.

Example 1:

Technique	Individual Reduction	Combined reduction
Low protein feed (3% drop in Crude Protein)	30%	30%
Frequent Slurry removal	25%	12.5%
Total allowable reduction		**42.5%**

Example 2:

Technique	Individual Reduction	Combined reduction
Bioscrubber (45-76% reduction)	50%	50%
Low protein feed (3% drop in Crude Protein)	30%	15%
Total allowable reduction		**65%**

4.3. In-Combination effects of multiple farms

If detailed odour dispersion modelling is carried out and shows that the odour contribution from the application farm at the closest sensitive receptors is <10% of the applicable EPA odour benchmark (e.g.,3 OU_E/m^3 as a 98th%ile), then it is considered insignificant and can be screened out and an in-combination impact is not required.

Where the odour contribution is >10 % of the applicable odour benchmark (e.g., > 10% of 3 OU_E/m^3 as a 98th%ile), the odour contribution from the application farm should be combined and modelled with that for any other intensive pig farms (above and below licensable thresholds) currently proposed or operational within 2km of the application farm.

The in-combination effect is predicted using detailed modelling as the modelled sum of all odour contributions impacting at each relevant residential property within 2km of the application farm. Odour contribution from other farms of <10% of the applicable odour benchmark (e.g., 3 OU_E/m^3 as a 98th%ile) do not need to be included.