Ammonia Impact Assessment – Integrated Pig Farm at Annakisha, Co. Cork

Prepared for:

Mr Michael Monagle

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Final

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Glossary

Term	Definition
g/s	gram per second
kg	kilogram
kg/m³	Kilogram per cubic meter
km	kilometre
km/hr	kilometre per hour
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
m³/hr	cubic metres per hour
mg	milligram
Z_0	roughness length
µg/m³	micrograms per cubic meter

Abbreviations	Definition
AG4	Air Guidance 4
BAT	Best available techniques
EPA	Environmental Protection Agency
EF	Emission factor
EU	European Union

EXECUTIVE SUMMARY

Mr Michael Monagle commissioned Katestone to complete an ammonia impact assessment (AIA) for a pig farm located at Annakisha North, Doneraile Co. Cork (Site).

The pig farm has an Industrial Emissions Directive (IED) licence (Licence registration number P0446-01) issued by the Environment Protection Agency (EPA) in 1999.

According to its license, total stocking capacity for the Site is 7,462 pigs (131 suckling sows, 649 dry sows, 20 boars, 94 maiden gilts, 2,668 weaners and 3,900 finishers).

The most recent planning application to Cork County Council for the Site was in 2014 (application number 14/5815). Cork County Council issued conditional approval in June 2015 to construct a pig fattening house, associated feed mixing room and a pig walkway. The 14/5815 application was for a stocking capacity of 10,174 pigs (164 suckling sows, 690 dry sows, 120 maiden gilts, 4,400 weaners and 4,800 finishers).

The AIA is required to determine the potential impact of ammonia emissions from the proposed development at the pig farm on ecologically sensitive locations in nearby Natura 2000 sites. The assessment will be submitted as part of a licence review application for the pig farm.

The AIA was conducted in accordance with the stepwise assessment procedure described in EPA's Ammonia and Nitrogen Assessment Guidance (EPA, 2021) for intensive agricultural installation (IAI) and recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4).

The stepwise procedure is designed to evaluate IAIs based on risk of adverse impacts due to ammonia emissions. Low risk projects can be evaluated using simple screening procedures (Step 1, Step 2 or Step 3). If an IAI does not meet the evaluation criteria of Step 1, Step 2 or Step 3, a detailed dispersion modelling assessment as described in Step 4, Step 5 or Step 6 may be required and presented to EPA to consider the application.

Once an assessment meets the requirements of the evaluation criteria for any of the steps, the applicant does not need to consider the requirements of subsequent steps and an application can be made for EPA's consideration. If an assessment does not meet the evaluation criteria of a step, the applicant must undertake assessment described in subsequent steps to determine if the application can be presented for EPA's consideration.

The results of the AIA are presented here:

- The results of the Step 1 assessment indicated that:
    - The approaches using the SCAIL-Agriculture model described in Step 2 and Step 3 of the EPA's Ammonia and Nitrogen Assessment Guidance are not applicable
    - A detailed assessment completed in accordance with Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance is, therefore, required to be completed.
- The results of the Step 4 assessment show that, in relation to the 1% threshold identified in Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance, the PC due to the pig farm:
    - Exceeds for ammonia and nitrogen deposition at a number of modelled discrete receptor locations on:
        - Blackwater River (Cork/Waterford) SAC (Receptors – 1 - 80)
        - Kilcolman Bog SPA (Receptors – 81 - 86).

- The results of the Step 4 assessment indicate that a Step 5 assessment, involving detailed modelling that takes account of in-combination effects, is required for the modelled sensitive locations on the Blackwater River SAC and the Kilcolman Bog SPA.
- The Step 5 assessment requires a review of background IAIs that needed to be included in the in-combination assessment. This review determined there is no requirement for a cumulative assessment of impacts on the Blackwater River SAC and the Kilcolman Bog SPA as no IAI meets the requirements of Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance to be included. Accordingly, the cumulative impact on the Blackwater River SAC and the Kilcolman Bog SPA of all IAI as defined in Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance is equal to the impact of the pig farm in isolation.
- The results of the in-combination Step 5 assessment show that:
    - At the Blackwater River SAC the worst-case cumulative impact due to the pig farm in combination with other IAIs that meet the requirements of Step 5 was well below the in-combination assessment level of 20% with the highest modelled results at any of the modelled sensitive locations being:
    - 13.1% of the critical level for ammonia
    - 12.3% of the critical load for nitrogen deposition.
- At the Kilcolman Bog SPA the worst-case cumulative impact due to the pig farm in combination with other IAIs that meet the requirements of Step 5 was below in-combination assessment level of 20% with the highest modelled results at any of the modelled sensitive locations being:
    - 2.1% of the critical level for ammonia
    - 3.9% of the critical load for nitrogen deposition.

Final Report Findings

The results of the assessment indicate that the cumulative impacts of the proposed pig farm with background IAIs are under EPA limits and, therefore, **complies** with the Step 5 evaluation criteria at all modelled locations on:

- Blackwater River (Cork/Waterford) SAC (Receptors – 1 - 80)
- Kilcolman Bog SPA (Receptors – 81 - 86)

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Mr Michael Monagle to complete an assessment of the impact of ammonia and nitrogen on Natura 2000 sites in the vicinity of a pig farm it operates at Annakisha North, Co. Cork (Site).

The pig farm has an Industrial Emissions Directive (IED) licence (Licence registration number P0446-01) issued by the Environment Protection Agency (EPA) in 1999.

Monagle Pig Farms submitted a planning application to Cork County Council for the pig farm in 2014 (application number 14/5815) to facilitate the construction of a pig fattening house, associated feed mixing room and a pig walkway. Council issued conditional approval in June 2015.

Monagle Pig Farms intends to submit an EPA licence review application to facilitate the increased pig numbers associated with the conditional approval for application number 14/5815.

This ammonia and nitrogen deposition impact assessment will form part of the supporting documentation for the licence review application.

This ammonia and nitrogen impact assessment was undertaken using dispersion modelling techniques. The dispersion modelling has been completed in accordance with the requirements of EPA's Air Dispersion Modelling Guidance Note (AG4). The assessment has also been conducted in accordance with Licence Application guidance issued by EPA titled: Assessment of the impact of ammonia and nitrogen on Natura 2000 sites from intensive agricultural installations (EPA, 2002), which is referred to here as EPA's Ammonia and Nitrogen Assessment Guidance.

2. OVERVIEW OF THE PIG FARM

The pig farm is located approximately 3.6 km south of the village of Doneraile, Co. Cork and approximately 6.7 km northeast of the town of Mallow, Co. Cork. The licence boundary of the Site and its environs are presented in Figure 1. All proposed pig housing units will be located within the proposed licence boundary of the Site.

A site plan illustrating the layout of the proposed housing units is presented in Figure 2.

According to its license, total stocking capacity for the Site is 7,462 pigs (131 suckling sows, 649 dry sows, 20 boars, 94 maiden gilts, 2,668 weaners and 3,900 finishers).

The most recent planning application to Council for the Site was in 2014 (application number 14/5815). Council issued conditional approval in June 2015 to construct a pig fattening house, associated feed mixing room and a pig walkway. Monagle Pig Farms intends to submit an EPA licence review application to facilitate the increased pig numbers associated with the conditional approval for application number 14/5815.

The 14/5815 application indicates a maximum stocking capacity of:

- 164 farrowing sows
- 690 dry sows
- 120 Maiden gilts
- 4,400 weaners
- 4,800 fattener pigs (growers and finishers).

All of the housing units at the Site including those identified in the 14/5815 application are mechanically ventilated.

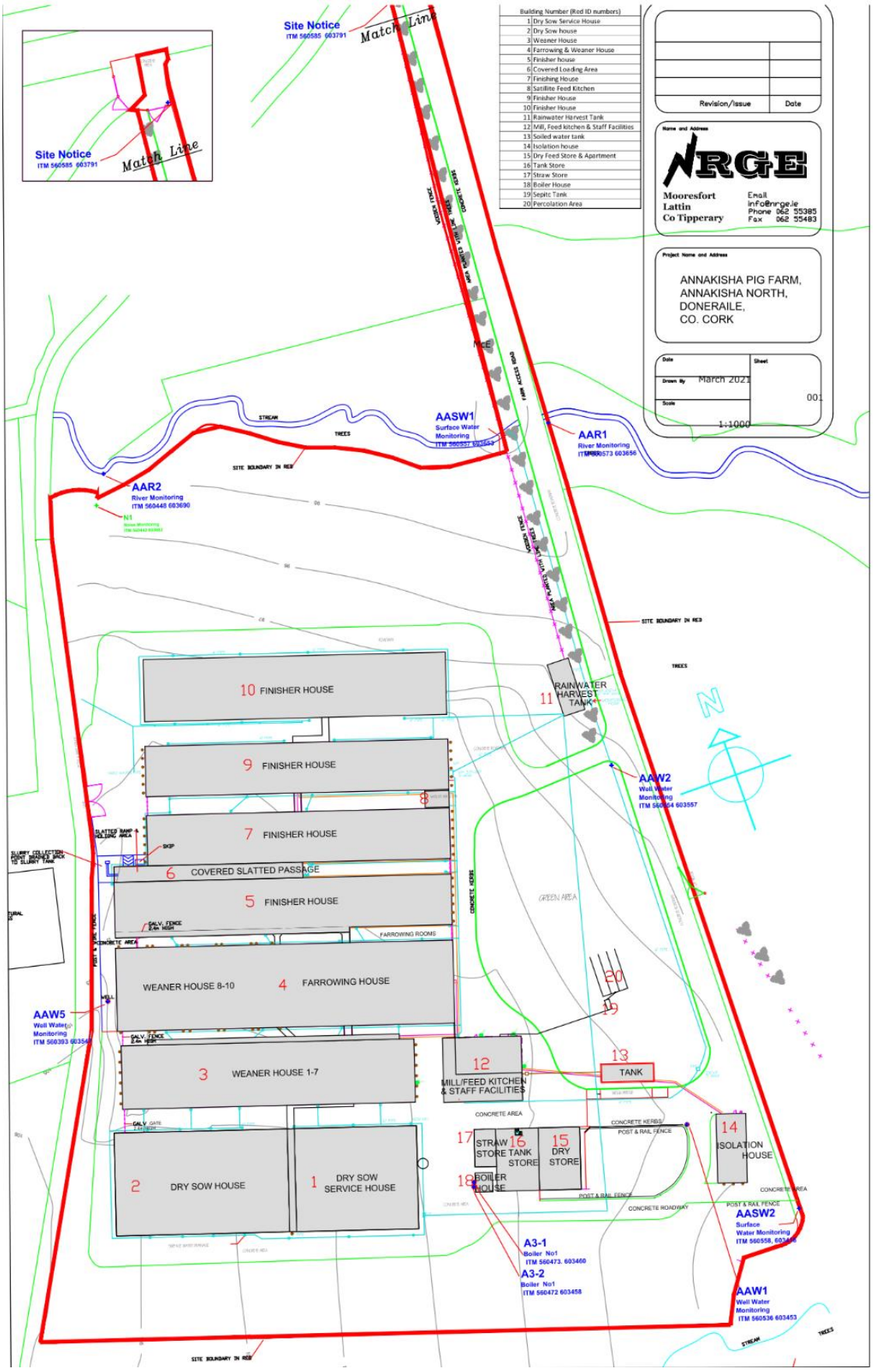

Figure 1 **Monagle pig farm proposed Site boundary (red line) and site layout**

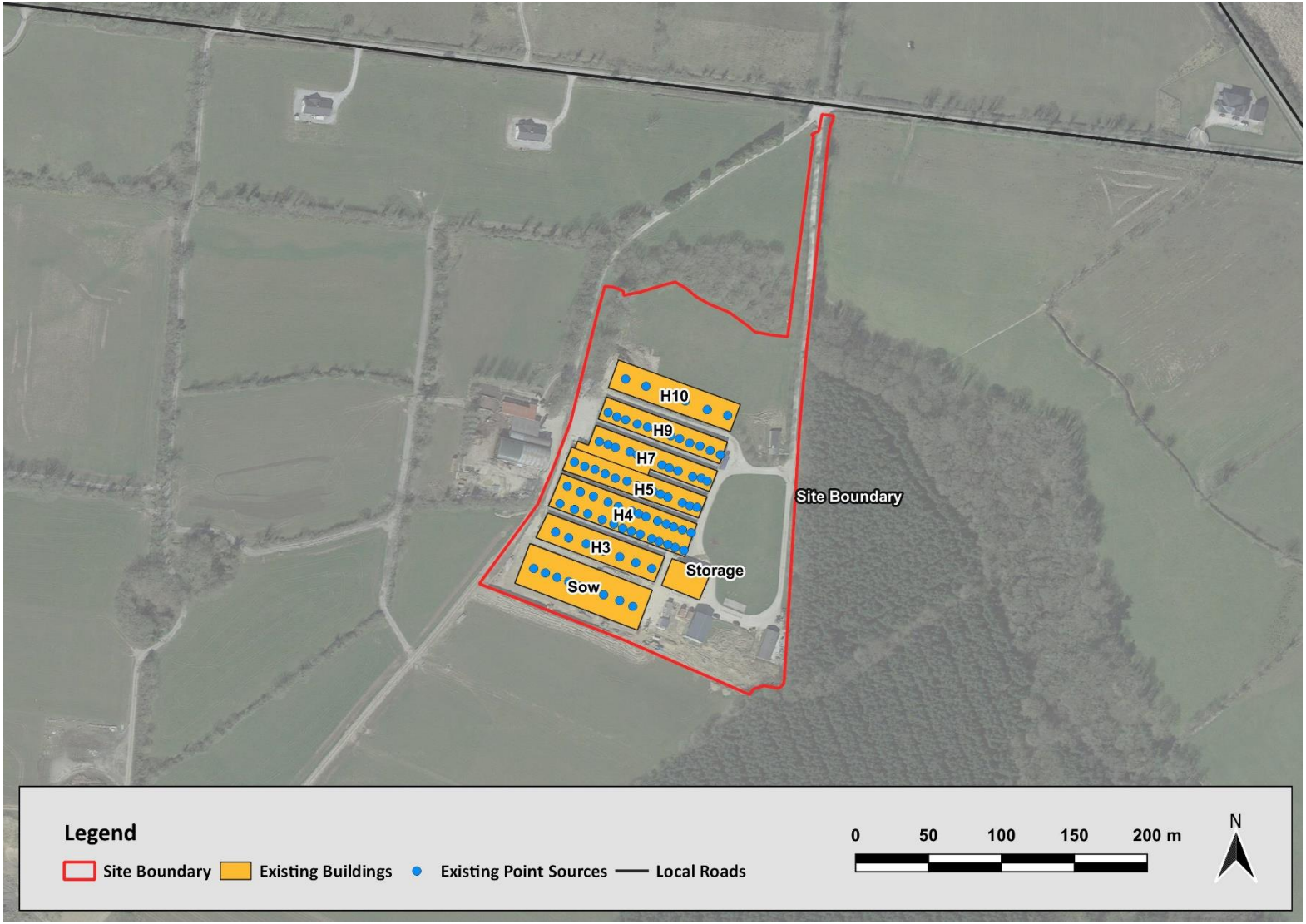

Figure 2 **Monagle pig farm Site plan – existing pig housing units and existing chimney stacks**

3. REGULATORY FRAMEWORK AND ASSESSMENT CRITERIA

3.1 *Environmental Protection Agency Acts 1992 and 2003*

The *Environmental Protection Agency Act 1992 (EPA Act)* and Part 2 of the *Protection of the Environment Act 2003* are collectively referred to as the *Environmental Protection Agency Acts 1992 and 2003*. These Acts provide for the management of air emissions from activities (meaning any process, development or operation) that are listed in the First Schedule of the Acts.

Section 4 (2) of the *Environmental Protection Agency Acts 1992 and 2003* defines Air Pollution as follows:

> *"…the direct or indirect introduction to an environmental medium, as a result of human activity, of substances, heat or noise which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment, and includes –*
>
> *(a) 'air pollution' for the purposes of the Air Pollution Act 1987,*
>
> *(b) ……..*
>
> *(c) ……..."*

The *Air Pollution Act 1987* (AP Act) provides for the control of air pollution and other matters connected with air pollution. Under the AP Act 'pollutant' means any substance that is specified in the First Schedule or any other substance (including a substance which gives rise to odour) or energy which, when emitted into the atmosphere either by itself or in combination with any other substance, may cause air pollution.

Section 4 of the AP Act defines air pollution as follows:

> *"Air pollution" in this Act means a condition of the atmosphere in which a pollutant is present in such a quantity as to be liable to —*
>
> (1) *be injurious to public health, or*
>
> *(ii) have a deleterious effect on flora or fauna or damage property, or*
>
> *(iii) impair or interfere with amenities or with the environment."*

Section 24 of the AP Act details the obligations of the occupier of a premises in respect to preventing emissions, nuisance and what constitutes defences against prosecution:

> *(1) The occupier of any premises, other than a private dwelling, shall use the best practicable means to limit and, if possible, to prevent an emission from such premises.*
>
> *(2) The occupier of any premises shall not cause or permit an emission from such premises in such a quantity, or in such a manner, as to be a nuisance.*
>
> *(3) In any prosecution for a contravention of this section, it shall be a good defence to establish that—*
>
> *(a) the best practicable means have been used to prevent or limit the emission concerned, or*
>
> *(b) the emission concerned was in accordance with a licence under this Act, or*
>
> *(c) the emission concerned was in accordance with an emission limit value, or*
>
> *(d) the emission concerned was in accordance with a special control area order in operation in relation to the area concerned, or*

in the case of an emission of smoke, the emission concerned was in accordance with regulations under section 25, or

(f) the emission did not cause air pollution.

Section 75 (1) of the *Environmental Protection Agency Acts 1992 and 2003* requires the EPA to publish reasonable and desirable quality objectives to protect the environment, namely:

"The Agency shall, in relation to any environmental medium and without prejudice to its functions under section 103, specify and publish quality objectives which the Agency considers reasonable and desirable for the purposes of environmental protection."

3.2 Birds Directive and Habitats Directive

Concerned with the decline of wild bird species, EU Member States unanimously adopted the Birds Directive (79/409/EEC) in April 1979 that aims to conserve species of wild birds and the habitats that are crucial for their conservation. The Birds Directive was amended in 2009 (2009/147/EC).

The Habitats Directive (92/43/EEC) aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements. It forms the cornerstone of Europe's nature conservation policy with the Birds Directive and establishes the EU wide Natura 2000 ecological network of protected areas.

The Habitats Directive requires EU Member States to take measures to maintain or restore natural habitats and wildlife species at a favourable conservation status. Sites designated under the Birds Directive and the Habitats Directive form the Natura 2000 network. Maintaining or restoring the Natura 2000 network is an obligation that must be considered concurrently with requirements for increased food production and economic growth targets set for agricultural sectors in EU Member States.

The main aim of the Habitats Directive is to contribute towards the conservation of biodiversity by requiring EU Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a favourable conservation status. These annexes list habitats (Annex I) and species (Annexes II, IV and V) that are considered threatened in the EU territory. The listed habitats and species represent a considerable proportion of biodiversity in Ireland and the Habitats Directive itself is one of the most important pieces of legislation governing the conservation of biodiversity in Europe.

The protection and conservation duties of EU Member States for Natura 2000 sites are specified in Article 6 of the Habitats Directive and are summarised below:

- Article 6(1): establish necessary conservation measures, management plans and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitats and species present at the sites
- Article 6(2): take appropriate steps to avoid deterioration of Natura 2000 sites
- Article 6(3) and 6(4): assess the impact of new plans and projects and only agree to the plan or project if it will not adversely affect the integrity of the site unless the plan or project is imperative for reasons of overriding public interest.

The European Communities (Birds and Natural Habitats) Regulations 2011 to 2015, as amended (Birds and Natural Habitats Regulations) give effect to the Habitats Directive in Irish law. The regulations require, inter alia, that a public authority carry out screening for Appropriate Assessment of a plan or project for which an application for consent is received, to assess, in view of best scientific knowledge and in view of the conservation objectives of the site, if that plan or project, individually or in combination with other plans or projects is likely to have a significant effect on the European site. Where it is determined that an Appropriate Assessment is required, the Birds and Natural Habitats Regulations require that the assessment carried out by a public authority include a determination

pursuant to Article 6(3) of the Habitats Directive as to whether or not the plan or project would adversely affect the integrity of a European site.

3.3 Ammonia impact assessment – Guidance

In May 2021, due to a high volume of intensive agriculture applications/reviews and licenses, the Environmental Protection Agency (EPA) published EPA's Ammonia and Nitrogen Assessment Guidance. It describes how applicants should assess, the impact of air emissions, as part of a licence application for the following activities listed under the First Schedule of the Environmental Protection Agency Acts 1992 as amended:

- Class 6.1 (the rearing of poultry in an installation, where the capacity exceeds 40,000 places)
- Class 6.2 (the rearing of pigs in an installation where the capacity exceeds – (a) 750 places for sows, or. (b) 2,000 places for production pigs).

EPA's Ammonia and Nitrogen Assessment Guidance describes a six-step process for the assessment of emissions of ammonia to the atmosphere from intensive agricultural installations (IAIs). Step 1 needs to be completed for all applications to inform the additional steps that need to be completed.

Compliance with the criteria defined in the subsequent steps means that no further steps need to be undertaken and the compliant results can be presented to EPA for review as part of the approvals process.

EPA's Ammonia and Nitrogen Assessment Guidance provides instructions on the steps needed to determine the information required to allow for an AA Stage 1 screening process and where necessary, a Stage 2 AA assessment for Natura 2000 sites (EPA, 2021). The six (6) steps are described in detail and in graphical summary format in EPA's Ammonia and Nitrogen Assessment Guidance.

The graphical summary format of the step-wise approach is reproduced here in Figure 3. Katestone followed the step-wise approach described in EPA's Ammonia and Nitrogen Assessment Guidance in this assessment. The methodology adopted to complete this assessment is described in Section 6.

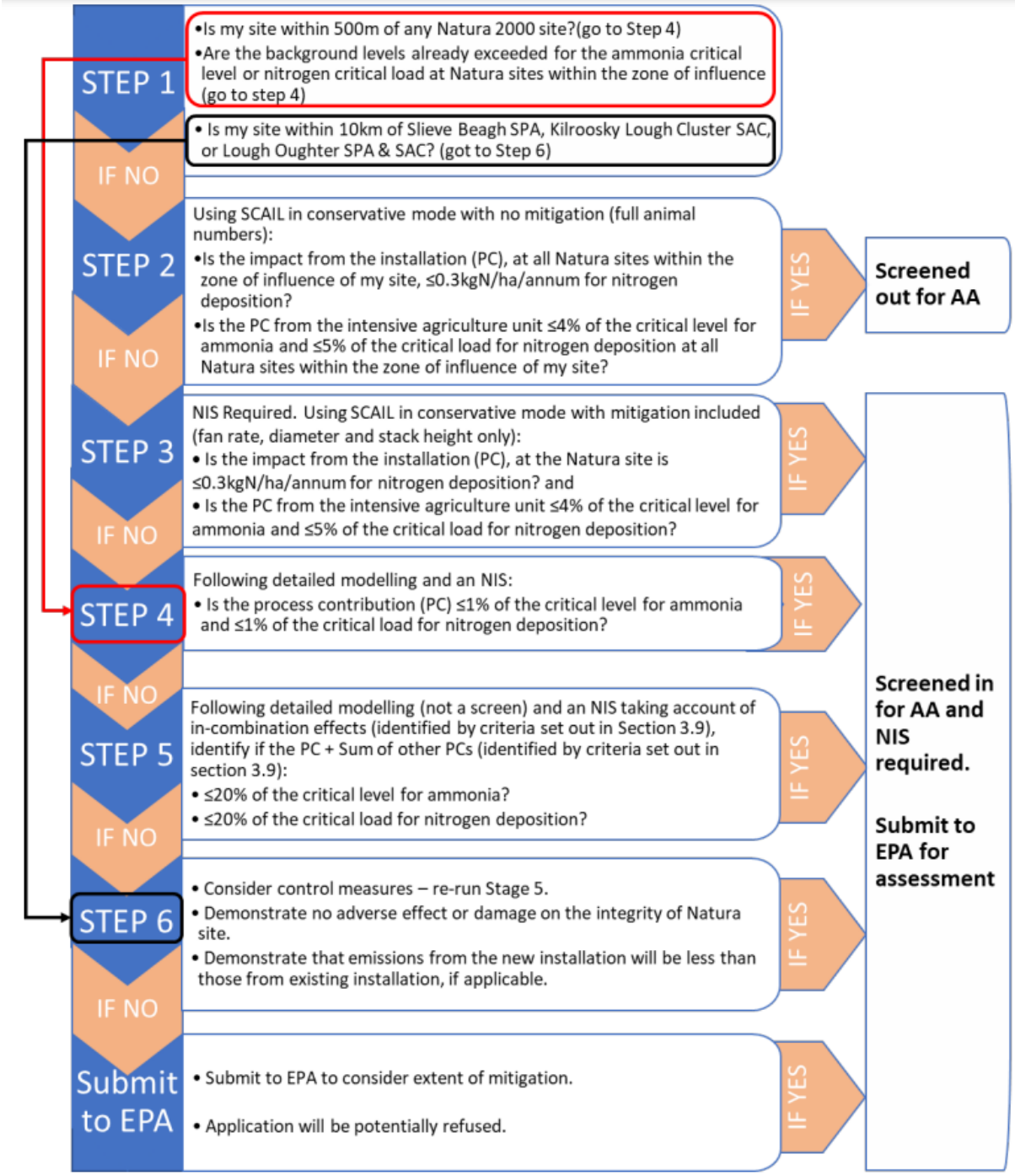

Figure 3 **The steps involved in the assessment process described in EPA's Ammonia and Nitrogen Assessment Guidance (reproduced from EPA, 2023)**

3.4 Assessment Criteria

The compliance criteria adopted in the assessment are based on critical limits. A critical limit, in its simplest form, is a threshold set to indicate when impacts on the terrestrial environment occur from air pollution. These can be used as part of the regulatory process for the assessment of impacts of air quality on terrestrial ecology (Kelleghan *et al.*, 2022). The EPA's Ammonia and Nitrogen Assessment Guidance adopts criteria based on critical limits including:

- Critical levels for ammonia
- Empirical critical loads for nitrogen deposition.

Both critical levels and loads are international guidelines used to protect habitats, primarily across Europe. Critical levels here refer specifically to the threshold for impacts that can occur directly from atmospheric ammonia, allowing for an acute measurement of direct effects. Critical levels are defined as "the concentration in the atmosphere above which direct adverse effects on receptors, such as plants, ecosystems or materials, may occur according to present knowledge" (Posthumus, 1988; Kelleghan *et al.*, 2022).

Empirical critical loads are based on total nitrogen deposition. A critical load is defined as a deposition rate below which significant harmful effects do not occur "according to present knowledge" (Posthumus, 1988).

The critical level for ammonia and the critical load for nitrogen deposition for each of the species and habitat are presented in Section 4.3 for the modelled discrete receptors.

4. EXISTING ENVIRONMENT

This section presents information on the existing environment in the vicinity of the Site, within the dispersion modelling domain and within the meteorological modelling domain. The meteorological modelling domain has been generated using geophysical data (terrain and land use) and meteorological data.

The extents of the dispersion modelling domain were determined based on the locations of the nearest ecological receptors in all directions from the Site.

4.1 Local terrain and land-use

The pig farm is located in a wide valley that runs from west to east that is bound by the Nagles Mountains that rise to over 420 m south of the site and the Ballyhoura Mountains that rise to over 520 m north of the site.

The River Blackwater Runs from southwest to northeast, 3.8 km south of the site. The River Awbeg, a tributary of the River Blackwater, runs from west to east approximately 3.0 km north of the Site. The River Awbeg turns to flow south approximately 7.7 km northwest of the Site and it merges with the River Blackwater at a point approximately 9.3 km southeast of the Site.

The complexities of the Site in terms of local terrain and proximity to river systems are likely to have an important effect on dispersion conditions near the Site and across the modelling domain.

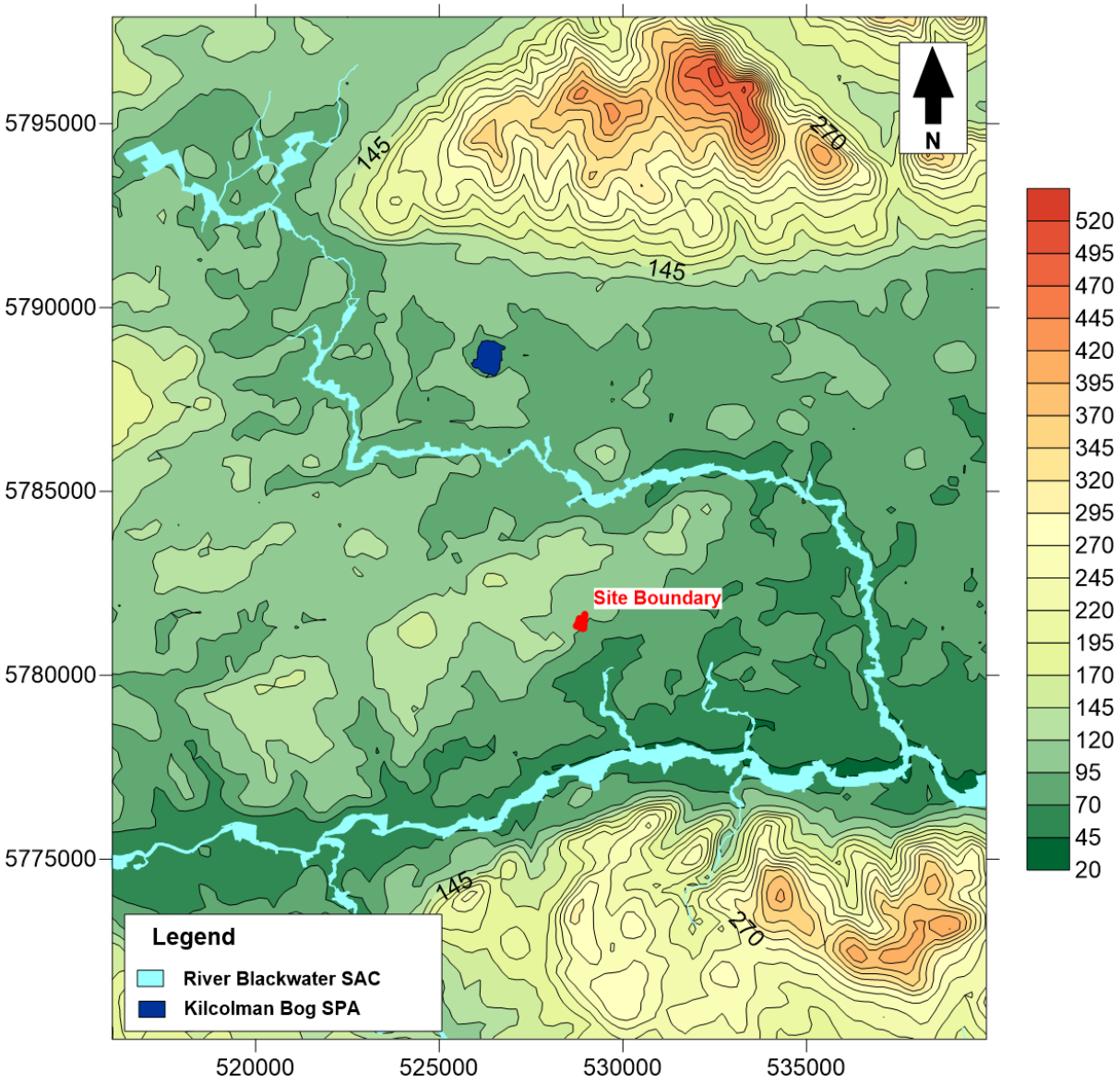

Figure 4 Two-dimensional characterisation of terrain in the modelled domain

4.2 Meteorology

Wind speed and wind direction are important parameters for the transport and dispersion of air pollutants from a source. The winds in the vicinity of the Site have been characterised using a three-dimensional meteorological model called CALMET. The 1-hour average wind speed for the modelling period is 4.97 m/s. This compares to a 1-hour average wind speed of 4.3 m/s at Gurteen between 2008 and 2018 (EPA, 2020). A wind rose representing the annual distribution of 1-hour average winds is presented in Figure 5.

The prevailing wind direction in Ireland is between south and west. It is clear from Figure 5 that these winds influence wind patterns at the Site; The modelling indicates that the frequency of southerly winds is lower at the site compared to locations with no elevated terrain to the south. Daytime winds between 6 am and 6 pm are heavily influenced by the prevailing winds. During late evening and early morning, prevailing winds also dominate (Figure 6).

The seasonal distribution of wind speed and wind direction is presented in Figure 7. The strongest winds at the Site occur most frequently from the south during the winter months. The greatest proportion of light winds occur during summer. There is a distinct south-easterly component to the wind rose in spring and summer.

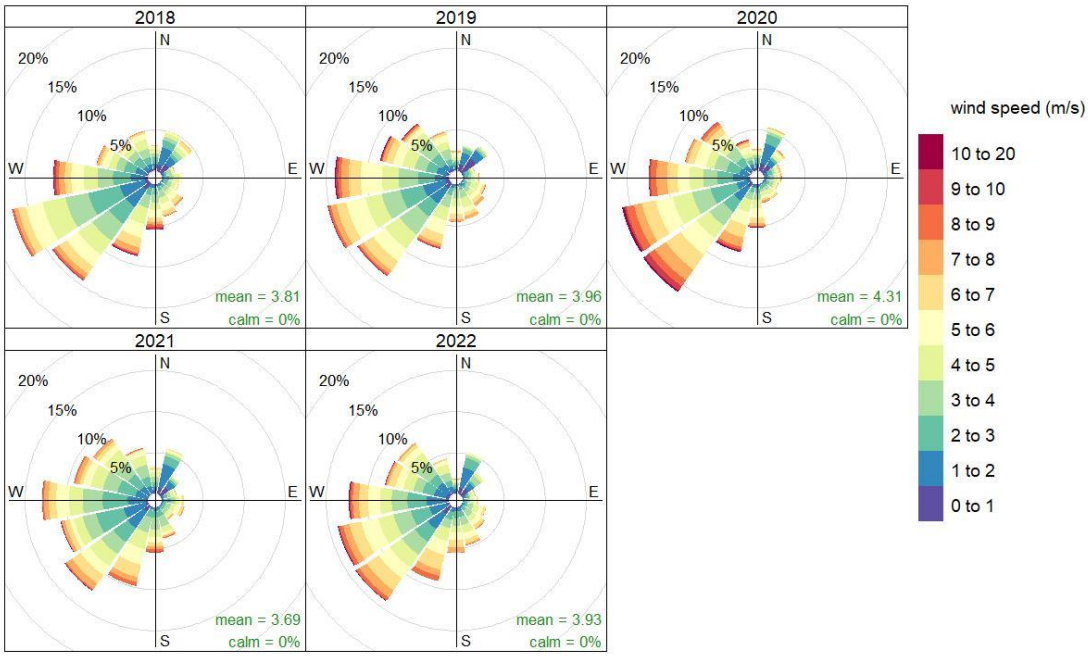

Figure 5 **Annual wind distribution predicted at the Site using CALMET for 2018 (top-left), 2019 (top-middle), 2020 (top-right), 2021 (bottom-left) and 2022 (bottom-right)**

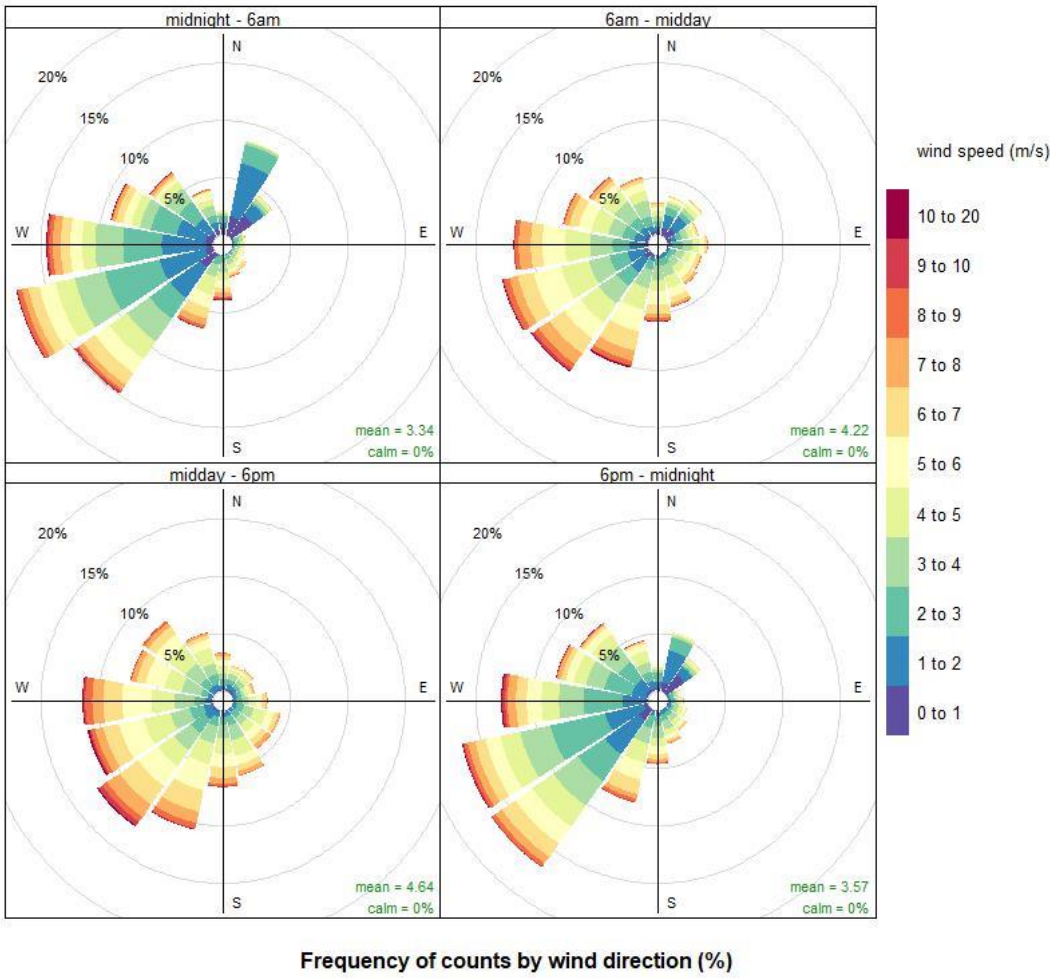

Figure 6 Diurnal wind distribution predicted at the Site using CALMET

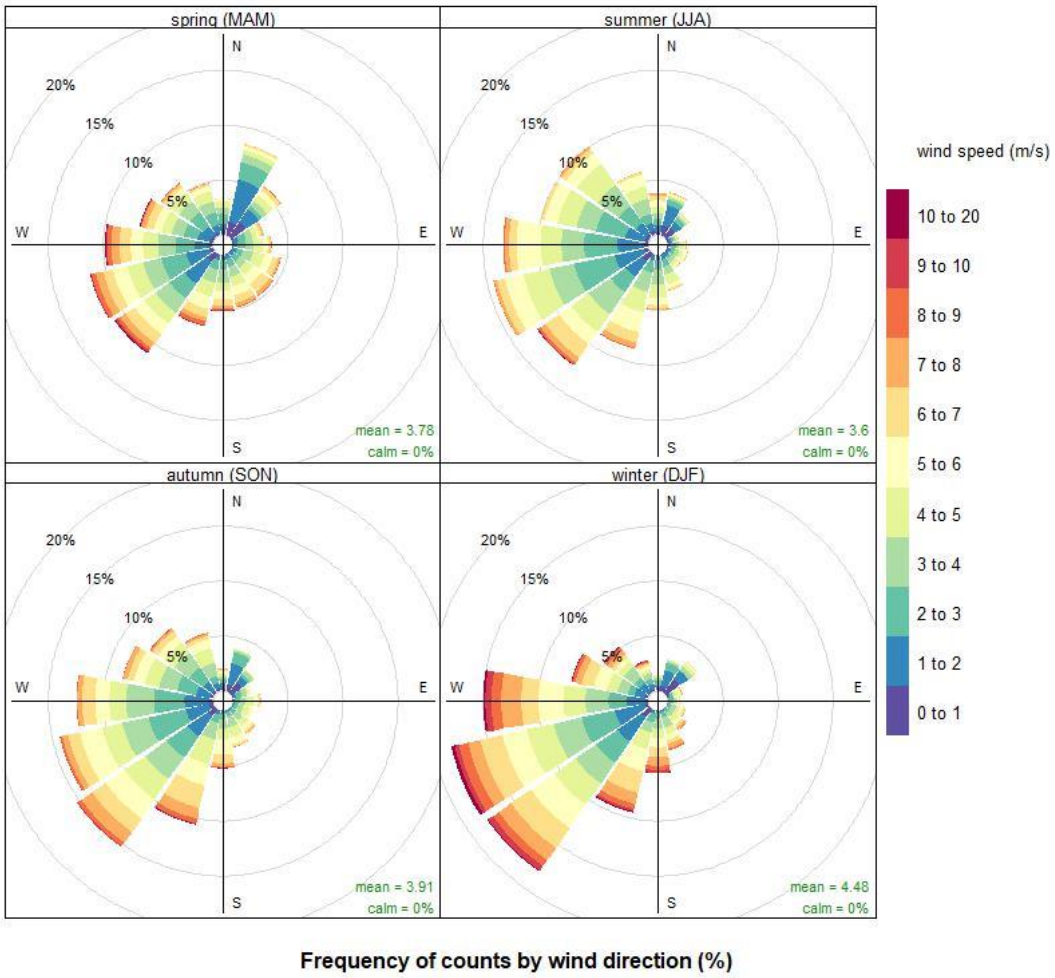

Figure 7 Seasonal wind distribution predicted at the Site using CALMET

4.3 Sensitive receptors

The sensitive receptors that are nearest to the Site are presented in Figure 8. The sensitive receptors included in the dispersion modelling assessment are at locations on Natura 2000 sites in the vicinity of the pig farm. EPA's Ammonia and Nitrogen Assessment Guidance required Natura 2000 sites within 10 km of an intensive agricultural installation to be included in a screening assessment. The Natura 2000 sites within 10 km of the pig farm that were considered in this assessment include:

- Blackwater River (Cork/Waterford) SAC (002170)
- Kilcolman Bog SPA (004095).

A small portion of the Blackwater River (Cork/Waterford) SAC is within 10 km of the pig farm. The entire Kilcolman Bog SPA is within 10 km of the pig farm.

The portion of the Blackwater River (Cork/Waterford) SAC that is within 10 km of the pig farm contains ammonia and nitrogen sensitive habitats that are listed as conservation interests for these sites. The portion of the Blackwater River (Cork/Waterford) SAC within 10 km of the pig farm include:

- A stretch of the Blackwater River that is approximately 14km in length
- A stretch of the Awbeg River (a tributary of the Blackwater River that is approximately 22 km in length. Both rivers flow through agricultural land in the vicinity of the site.

A review of the conservation objectives published by NPWS for the Blackwater River (Cork/Waterford) SAC indicate that the habitats and species listed as conservation objectives with sensitivity to atmospheric ammonia and nitrogen deposition include:

- Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0] (Old sessile oak woods)
- Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion
- albae) [91E0] (Alluvial forests)
- Taxus baccata woods of the British Isles [91J0] (Taxus baccata).

In relation to the Site, the review indicates:

- The Blackwater SAC contains very limited Taxus baccata, with the only location on the SAC mapped in Co. Waterford approximately 50km from the site.
- Alluvial forests have been mapped by NPWS south of the site (at the receptor locations DR16 and DR17)
- No old sessile oak woods have been mapped within 10 km of the site
- Extensive areas of semi natural woodland are located within 10 km of the site however it has not specified if these areas contain habitats that are listed as qualifying interests of the Blackwater River SAC.

Conservatively, the following critical loads and levels were applied to all DR locations with mapped areas of semi-natural woodland:

- A critical level of 1µg/m³ which assumes that all these areas contain the ammonia sensitive habitats
- A critical load of 10 Kg/ha/year) which assumes that all these areas contain Alluvial Forests.

The assumption that the locations contain alluvial forest habitats is conservative as:

- Taxus Bacatta habitat is a woodland habitat that is acknowledged by NPWS to only be located in one area, 50 km from the site on the Blackwater River SAC.
- The lowest critical load for the other types of woodlands which are qualifying interests (alluvial forests and old sessile oak woods) on the Blackwater River SAC was adopted.

Higher default levels were adopted for all modelled locations that do not contain nitrogen sensitive species including:

- A critical level of 3.0 µg/m³ for ammonia
- A critical load of 30 kg/ha/year for nitrogen deposition. The site-specific conservation objectives of a Natura 2000 site aim to define favourable conservation condition for particular habitats or species at that Natura 2000 site.

NPWS states the following in relation to the Kilcolman Bog SAC:

> *To acknowledge the importance of Ireland's wetlands to wintering waterbirds, wetland and waterbirds may be included as a Special Conservation Interest for some SPAs that have been designated for wintering waterbirds and that contain a wetland site of significant importance to one or more of the species of Special Conservation Interest. Thus, a second objective is included as follows:*
>
> > *Objective: To maintain or restore the favourable conservation condition of the wetland habitat at Kilcolman Bog SPA as a resource for the regularly-occurring migratory waterbirds that utilise it.*

It was conservatively assumed that lichens and bryophytes are present in the habitats that make up the Kilcolman Bog SPA. Lichens and bryophytes are highly sensitive to ammonia and nitrogen deposition and conservative criteria were adopted for all modelled locations on the Kilcolman Bog SPA including:

- A critical level of 1.0 µg/m³ for ammonia
- A critical load of 5 kg/ha/year for nitrogen deposition.

The sensitive receptor locations included in the dispersion modelling assessment are presented graphically in a map in Figure 8. The sensitive receptors are presented in tabular format in Table 1, which includes for each location:

- The conservation objectives of the habitats or species identified at that point
- The critical level for ammonia adopted in the modelling assessment
- The critical load for nitrogen deposition adopted in the modelling assessment.

Table 1 **Sensitive receptor locations included in the dispersion modelling assessment, the conservation interest at each location, the critical level for ammonia adopted in the modelling assessment and the critical load for nitrogen deposition at each location**

Receptor	Species or Habitat				Relevant Criteria	
	Old sessile oak woods (91A0)	Alluvial forests (91E0)	Taxus bacatta woods of the British Isles (91J0)	Semi-natural Woodland	Ammonia Concentration	Nitrogen Deposition
					µg/m³	kg/ha/yr
DR1				✓	1	10
DR2					3	30
DR3				✓	1	10
DR4					3	30
DR5					3	30
DR6				✓	1	10
DR7				✓	1	10
DR8				✓	1	10
DR9				✓	1	10
DR10				✓	1	10
DR11				✓	1	10
DR12				✓	1	10
DR13					3	30
DR14					3	30
DR15					3	30
DR16		✓			1	15.3
DR17		✓		✓	1	15.3
DR18				✓	3	30
DR19					3	30
DR20				✓	1	10
DR21				✓	1	10

Receptor	Species or Habitat				Relevant Criteria	
	Old sessile oak woods (91A0)	Alluvial forests (91E0)	Taxus bacatta woods of the British Isles (91J0)	Semi-natural Woodland	Ammonia Concentration	Nitrogen Deposition
					µg/m³	kg/ha/yr
DR22					3	30
DR23					3	30
DR24					3	30
DR25				✓	1	10
DR26				✓	1	10
DR27					3	30
DR28					3	30
DR29				✓	1	10
DR30				✓	1	10
DR31					3	30
DR32					3	30
DR33					3	30
DR34					3	30
DR35					3	30
DR36					3	30
DR37				✓	1	10
DR38				✓	1	10
DR39				✓	1	10
DR40				✓	1	10
DR41				✓	1	10
DR42				✓	1	10
DR43				✓	1	10
DR44				✓	1	10
DR45				✓	1	10

Receptor	Species or Habitat				Relevant Criteria	
	Old sessile oak woods (91A0)	Alluvial forests (91E0)	Taxus bacatta woods of the British Isles (91J0)	Semi-natural Woodland	Ammonia Concentration	Nitrogen Deposition
					µg/m³	kg/ha/yr
DR46				✓	1	10
DR47				✓	1	10
DR48				✓	1	10
DR49				✓	1	10
DR50				✓	1	10
DR51				✓	1	10
DR52				✓	1	10
DR53					3	30
DR54					3	30
DR55					3	30
DR56				✓	1	30
DR57					3	30
DR58				✓	1	10
DR59				✓	1	10
DR60				✓	1	10
DR61				✓	1	10
DR62				✓	1	10
DR63				✓	1	10
DR64				✓	1	10
DR65				✓	1	10
DR66				✓	1	10
DR67				✓	1	10
DR68				✓	1	10
DR69				✓	1	10

Receptor	Species or Habitat				Relevant Criteria	
	Old sessile oak woods (91A0)	Alluvial forests (91E0)	Taxus bacatta woods of the British Isles (91J0)	Semi-natural Woodland	Ammonia Concentration	Nitrogen Deposition
					µg/m³	kg/ha/yr
DR70				✓	1	10
DR71				✓	1	10
DR72				✓	1	10
DR73				✓	1	10
DR74				✓	1	10
DR75				✓	1	10
DR76				✓	1	10
DR77				✓	1	30
DR78				✓	1	30
DR79				✓	1	10
DR80				✓	1	5
DR81					1	5
DR82					1	5
DR83					1	5
DR84					1	5
DR85					1	5
DR86					1	5

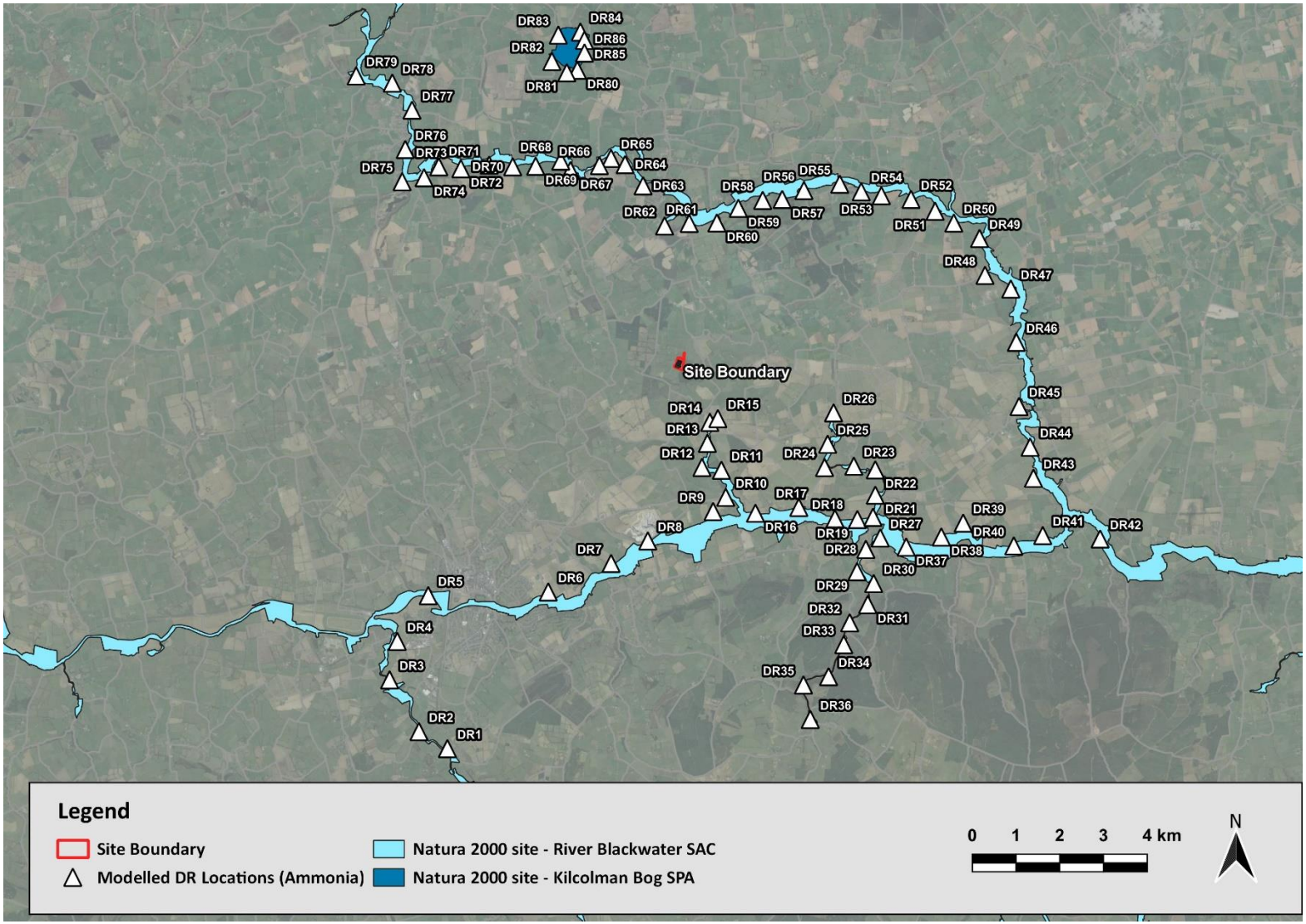

Figure 8 **The sensitive receptors included in the dispersion modelling assessment to represent locations on Natura 2000 sites**

4.4 Background concentrations of ammonia and nitrogen deposition

The background ammonia concentration and nitrogen deposition flux rates at each modelled sensitive receptor were obtained from the Simple Calculation of Atmospheric Impacts Limits (SCAIL) online tool as recommended in EPA's Ammonia and Nitrogen Assessment Guidance (EPA, 2021). The background concentrations of ammonia and nitrogen deposition levels adopted in the assessment are presented in Table 2.

Background ammonia concentration and nitrogen deposition flux rates adopted in the assessment were included in the assessment methodology defined in EPA's Ammonia and Nitrogen Assessment Guidance.

Table 2 **The background concentrations of ammonia and nitrogen deposition levels adopted in the assessment (based on SCAIL)**

NAME	NH_3 Background (ug m^{-3})	Criteria	NDEP Background (kg/ha/yr)	Criteria
DR1	2.7	1	7.74	10
DR2	2.71	3	7.52	30
DR3	2.66	1	7.29	10
DR4	2.66	3	7.05	30
DR5	2.69	3	7.1	30
DR6	2.73	1	7.04	10
DR7	2.76	1	7.08	10
DR8	2.88	1	7.19	10
DR9	2.82	1	7.1	10
DR10	2.93	1	7.05	10
DR11	3.02	1	7.19	10
DR12	2.97	1	7.3	10
DR13	3.02	3	7.19	30
DR14	3.2	3	7.6	30
DR15	3.2	3	7.6	30
DR16	3.05	1	7.06	15.3
DR17	3.1	1	7.19	15.3
DR18	2.8	3	7.23	30
DR19	2.8	3	7.23	30
DR20	2.8	1	7.23	10
DR21	3.04	1	7.21	10
DR22	3.1	3	7.21	30
DR23	3.1	3	7.21	30
DR24	3.12	3	7.2	30
DR25	3.12	1	7.2	10
DR26	3.22	1	7.28	10
DR27	2.78	3	7.19	30
DR28	2.8	3	7.23	30
DR29	2.51	1	7.4	10
DR30	2.51	1	7.4	10
DR31	2.26	3	7.58	30
DR32	2.26	3	7.58	30
DR33	2.26	3	7.58	30
DR34	2.22	3	7.64	30
DR35	2.22	3	7.64	30
DR36	2.18	3	7.7	30
DR37	2.78	1	7.19	10
DR38	2.85	1	7.26	10
DR39	2.85	1	7.25	10
DR40	2.83	1	7.18	10
DR41	2.83	1	7.18	10

NAME	NH_3 Background (ug m^{-3})	Criteria	NDEP Background (kg/ha/yr)	Criteria
DR42	2.94	1	7.22	10
DR43	3.03	1	7.18	10
DR44	3.16	1	7.18	10
DR45	3.16	1	7.11	10
DR46	3.18	1	7.16	10
DR47	3.22	1	7.45	10
DR48	3.42	1	7.52	10
DR49	3.31	1	7.47	10
DR50	3.57	1	7.83	10
DR51	3.57	1	7.83	10
DR52	3.22	1	7.64	10
DR53	3.22	3	7.64	30
DR54	2.98	3	7.56	30
DR55	2.98	3	7.56	30
DR56	2.79	1	7.31	30
DR57	2.76	3	6.98	30
DR58	2.76	1	6.98	10
DR59	2.8	1	6.8	10
DR60	2.77	1	6.93	10
DR61	2.81	1	6.87	10
DR62	2.81	1	6.87	10
DR63	2.88	1	6.85	10
DR64	2.88	1	6.94	10
DR65	2.88	1	6.94	10
DR66	2.85	1	7.08	10
DR67	2.89	1	7.07	10
DR68	2.82	1	7.24	10
DR69	2.82	1	7.24	10
DR70	2.83	1	7.33	10
DR71	2.83	1	7.33	10
DR72	2.88	1	7.25	10
DR73	2.88	1	7.25	10
DR74	2.91	1	7.3	10
DR75	2.91	1	7.3	10
DR76	2.83	1	7.2	10
DR77	2.84	1	7.22	30
DR78	2.86	1	7.36	30
DR79	2.8	1	7.37	10
DR80	2.92	1	7.28	10
DR81	2.92	1	7.28	5
DR82	2.99	1	7.44	5
DR83	2.96	1	7.23	5
DR84	2.91	1	7.13	5
DR85	2.92	1	7.28	5

NAME	NH_3 Background (ug m^{-3})	Criteria	NDEP Background (kg/ha/yr)	Criteria
DR86	2.92	1	7.28	5

5. ASSESSMENT

5.1 Dispersion modelling methodology

The following section describes the dispersion modelling methodology that was adopted to determine concentrations of ammonia and deposition rates of nitrogen from the pig farm in combination with background levels at ecologically sensitive locations near the Site. The methodology is based on a dispersion modelling study incorporating source characteristics and operational activity data of the pig farm with meteorological data that is representative of the Site and surrounding region. The dispersion modelling assessment has been prepared in accordance with industry standards, regulatory requirements and best practice approaches.

The assessment methodology has included:

- Determination of the locations and emission characteristics at the pig farm.
- Derivation of an emissions inventory based on its design and data from the literature for the pig farm.
- Generation of a representative meteorological dataset using prognostic meteorological modelling techniques.
- Characterisation of meteorological conditions in the region using prognostic meteorological data.
- Dispersion modelling using the regulatory dispersion model, CALPUFF, to predict ground-level concentrations of ammonia and nitrogen deposition:
    - At sensitive receptor locations
    - Across a cartesian grid that covers the modelling domain.

5.2 SCAIL-Agriculture

The baseline levels of ammonia and flux rates of nitrogen deposition at the sensitive ecological receptor locations were determined using SCAIL- Agriculture for Step 1 of EPA's Ammonia and Nitrogen Assessment Guidance.

SCAIL-Agriculture is a tool for assessing impacts of atmospheric nitrogen from agricultural installations in the UK and Ireland. It is a model underpinned by a detailed air dispersion model, AERMOD (Kelleghan *et al.*, 2022).

SCAIL-Agriculture includes estimates of baseline levels of ammonia and flux rates of nitrogen deposition across Ireland. The SCAIL-Agriculture ambient concentration model (1 x 1 km grid) has been updated to include modelled 2018 emissions by the UKCEH on behalf of the EPA. Similarly, the coarser international 2018 European Monitoring and Evaluation Programme (EMEP) national concentration and deposition models for Ireland have been made available through the AmmoniaN2K website (AmmoniaN2K, 2021). Both these models currently rely on the MapEire emissions model, which utilises cattle and sheep distribution from 2010 and locations of pig and poultry farms from 2015 according to the Irish Wildlife Manual 135 (Kelleghan *et al.*, 2022).

5.3 Meteorological modelling

5.3.1 Overview

EPA's Air Dispersion Modelling Guidance Note (AG4) states that the dispersion process is dependent on the underlying meteorological conditions and ensuring that the air dispersion model includes representative meteorological data is critical. In the absence of Site-specific meteorological data, AG4 requires the use of representative data observed at a Met Eireann monitoring location. AG4 states:

> *The USEPA (24) has defined meteorological representativeness as:*

> *"the extent to which a set of {meteorological} measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application"*

and has expanded on this definition by outlining the factors to consider in the selection of appropriate meteorological data:

- *Proximity of the meteorological station to the modelling domain;*
- *The complexity of the terrain;*
- *The exposure of the meteorological monitoring Site;*
- *The period of time during which data is collected."*

The modelling domain includes areas of complex terrain. The meteorological parameters that affect dispersion are likely to vary spatially and temporally across the modelling domain due to the complexity of the terrain.

The closest Met Eireann monitoring location to the Site is at Moore Park, Co. Cork, which is 22 km east of the pig farm. This monitoring station is in a narrow valley. It sits at a low point in the local terrain and is close to the Blackwater River. Meteorological data at Moore Park is characterised by frequent easterly and westerly winds that occur due to the east-west orientation of the valley in which the monitoring station is located. The meteorological station at Moore Park is not likely to be representative of meteorological conditions at the Site as the narrow valley results in a high level of wind channelling that is not likely to be observed at the site.

A review by Katestone indicates that there are no other meteorological observation stations on the Met Eireann Network that meet the requirements specified in AG4 to be considered representative of the modelling domain.

Where site-specific or representative meteorological data is not available, AG4 provides the following alternatives:

> *Prognostic meteorological data should be considered in locations where there is no comparable representative Met Eireann station particularly in areas of complex terrain or at a land / sea interface.*

and

> *Prognostic meteorological data may be useful in locations where there is no comparable representative Met Eireann station. Locations where prognostic meteorological data may be required include regions of complex terrain and at a land/sea interface in circumstances where the nearest meteorological stations are outside of the modelling domain. As outlined by the USEPA, meteorological data should be spatially representative of the modelling domain and in particular of the pathway from the source to the most impacted receptor.*

Accordingly, prognostic meteorological data was generated for the Site due to the complexity of the terrain. The approach adopted to generate representative site-specific data used a numerical model to generate a 3-dimensional grid of spatially varying meteorological parameters to represent conditions surrounding the Site. The approach is described in Appendix A1.

5.3.2 Meteorology

The prognostic model TAPM (developed in Australia by the Commonwealth Scientific and Industrial Research Organisation [CSIRO], version 4.0.5) and the diagnostic meteorological model CALMET (developed by EarthTec, version 6.5) were used to generate the three-dimensional meteorological dataset for the region.

The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the innermost nest. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

The three-dimensional wind field produced by TAPM/CALMET was then used to create a meteorological file suitable for use with the CALPUFF dispersion model.

Details of the model configuration and evaluation are presented in Appendix A.

The TAPM/CALMET approach has been used in jurisdictions like Australia to generate suitable meteorological data for modelling impacts for over 15 years. It has been adopted in the assessment of a number proposed projects in Ireland in the last 5 years. There is significant experience using these approaches in jurisdictions such as Australia. Industry specific guidance on modelling odour dispersion from sources such as intensive poultry farms and cattle feedlots recommend the use of TAPM/CALMET to generate representative site-specific data. Research in Europe indicates that meteorological data generated using a numerical model provided a better indication of locations where odour nuisance occurred (Feliubadaló et al, 2008). In that study, locations of likely odour nuisance were determined using the German VDI grid assessment approach. The correlation between observed and modelled odour concentrations was significantly better using the TAPM/CALMET approach compared to traditional steady state gaussian models such as AERMOD.

5.4 Emissions

The derivation of the ammonia emissions inventory adopted for the dispersion modelling assessment is presented in this section. Ammonia emission inventories were derived for the old housing units and the new housing units at the pig farm.

There are no emissions monitoring data available for the pig farm. Ammonia emission rates from the pig housing units at pig farms vary considerably depending on factors such as:

- The ventilation rate which is heavily influenced by:
    - The target temperature of the pigs in the unit, which is influenced by:
        - Type of pig (sow, weaner, fattener).
        - The age of the pigs
    - The ambient temperature outside the pig unit.
- The design of the housing system including but not limited to the following:
    - Depth of manure holding pits
    - Frequency on manure removal
    - Ventilation design
    - Surface area of manure exposed beneath the slats.
- The depth of manure in the house, which varies considerably with season.

The ammonia emission inventory derived for the pig farm is based on:

- The design and operation of the old housing units and the new housing units at the pig farm.
- Ammonia emission rates for housing units presented in the latest Best Reference (BREF) document for the intensive rearing of poultry or pigs (IRPP) (EC, 2017).

The existing housing units are operated as traditional deep pit housing units. The pig diets at the existing housing units are formulated with reduced protein content to limit emissions. The pig diets at the existing housing units will continue to be formulated with reduced protein content to limit emissions.

The ammonia emission rates adopted in the dispersion modelling assessment are based on the emission rates of BAT compliant pig farms presented in the BREF for IRPP including the following based on data from Table 5.4 of the BAT conclusions, which presents the BAT Acceptable Emission limits (AELs) for piggeries that are designed

and operated in accordance with BAT. The BAT-AELs for various BAT techniques are presented in the BAT conclusions as ranges. The upper limit of the ranges for pig housing units that adopt BAT are as follows:

- 2.7 kg.animal^{-1}.year^{-1} for dry sows
- 2.7 kg.animal^{-1}.year^{-1} for gilts
- 5.6 kg.animal^{-1}.year^{-1} for farrowing sows
- 0.53 kg.animal^{-1}.year^{-1} for weaners
- 2.6 kg.animal^{-1}.year^{-1} for fatteners.

The BREF document for the intensive rearing of poultry or pigs also presents AELs for pig housing units that were approved and built before the BAT conclusions were published and therefore do not have a requirement to be operated in accordance with BAT (referred to in this document as pre-BAT housing units). The upper limit of the ranges for pig housing units that adopt BAT are as follows:

- 4.0 kg.animal^{-1}.year^{-1} for dry sows
- 4.0 kg.animal^{-1}.year^{-1} for gilts
- 7.5 kg.animal^{-1}.year^{-1} for farrowing sows
- 0.7 kg.animal^{-1}.year^{-1} for weaners
- 3.6 kg.animal^{-1}.year^{-1} for fatteners.

If dietary crude protein exceeds the dietary requirements of a pig it will be excreted resulting in higher levels of nitrogen in slurry. It is therefore desirable to optimise the level of crude protein in diets to meet the pig's nutritional requirements for growth while minimising nitrogen levels in excrement. For weaner and finisher pigs, the level of crude protein required in the diet declines with age and as growth slows. Younger pigs therefore require more crude protein than older pigs in each of the weaner (8kg to 30kg) and finisher (30kg to 120kg) categories.

The site will adopt low protein diets as a BAT technique to reduce ammonia emissions to the atmosphere. The level of protein in diets at the pig farm will be limited (as a weighted average) to:

- 14.5% for sows
- 17.5% for weaners
- 15% for fatteners.

The crude protein levels stated here are weighted average levels across the diets fed to sows, weaners and finishers because the overall level of nitrogen that ends up in the slurry tanks of pig housing units is correlated with the average level of crude protein in the diets fed to pigs in the housing unit.

The diets of younger pigs in each of the weaner and fattener categories will be above the levels specified and the diets of older pigs in each of these categories will be below the levels specified overall. However, the weighted average crude protein levels for the categories of pigs will be maintained below the levels specified above.

Ammonia emissions from the existing pre-BAT housing units are considered conservative as the upper end of the range of ammonia emissions from pre-BAT housing units was adopted to derive the emissions inventory for the existing pre-BAT pig housing units at the site.

5.5 Dispersion modelling

The assessment was conducted in accordance with recognized techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4). CALPUFF was used to predict ground-level concentrations

of ammonia and nitrogen deposition rates across the modelling domain and at sensitive ecological receptor locations on nearby Natura 2000 site due to sources at the pig farm.

The details of source characterization utilized for the pig farm in the modelling assessment are provided in Section 5.9.

5.6 Deposition

Deposition flux rates of nitrogen at sensitive receptors were estimated based on the predicted concentrations of ammonia across the modelled domain and using the following calculation methodology that is described in AG4:

> *The critical loads in ecologically sensitive areas such as SPAs, SACs and NHAs can be determined using the methodology outlined in the UK publication "AQTAG06 – Technical Guidance on Detailed Modelling Approach For An Appropriate Assessment For Emissions To Air" (Environment Agency, 2014)(64) . The approach is based on using the maximum annual average ground level concentration within the ecologically sensitive area and converting this concentration into a deposition flux based on a chemical species specific deposition velocity (m/s) as outlined in Table A3.*

The recommended dry deposition velocities for ammonia in Table A3 of AG4 are:

- 0.02 m/s for grassland
- 0.03 m/s for woodland/forest.

Dry deposition flux (µg m^{-2} s^{-1}) is calculated as the product of the ground-level process contribution (µg/m^3) and the deposition velocity (m/s).

The dry deposition velocities adopted in the modelling assessment was conservatively assumed to be 0.03 m/s for all modelled sensitive locations as the modelled locations as a number of the modelled locations are forest or woodland.

5.7 Building downwash

When modelling emissions from an industrial installation it should be borne in mind that stacks that are relatively short can be subjected to additional turbulence due to the presence of nearby buildings. Buildings are considered nearby if they are within five times the lesser of the building height or maximum projected building width (but not greater than 800m) (EPA, 2020).

A plume of a short stack is likely to be downwashed if its height is less than two and a half times the height of nearby buildings within a distance of 10 x L from each source, where L is the lesser of the height or width of the building. A Building Profile Input Program (BPIP) was used to determine the effects of buildings on the point sources of emissions at the pig farm. The Plume Rise Model Enhancements (PRIME) algorithm is recommended in EPA Guidance for use with AERMOD. PRIME was used in the dispersion modelling assessment to determine the effect of building induced turbulence on plumes from point sources at the pig farm.

The PRIME algorithm takes into account the position of each stack relative to each relevant building and the projected shape of each building for 36 wind directions (at 10º intervals). The model determines the change in plume centreline location with downwind distance based on the slope of the mean streamlines and coupled to a numerical plume rise model.

Eight onsite buildings/structures have been included in the BPIP program to represent pig housing units and other onsite buildings. The coordinates used in the configuration of the pig housing units and onsite buildings in the PRIME BPIP model for this assessment are presented in Table 3.

Table 3 Pig housing units included and configuration of the pig housing units in BPIP

Building	Easting	Northing	Height (m)
	UTM (m)	UTM (m)	
H10	528899.8	5781444	4.884
	528906.7	5781463	
	528823.1	5781493	
	528816.3	5781474	
H9	528897.8	5781437	4.31
	528815	5781468	
	528809.3	5781453	
	528892.6	5781422	
H5	528784.8	5781418	4.31
	528878	5781385	
	528883.7	5781399	
	528791.1	5781433	
H4	528775.2	5781393	5.331
	528868.5	5781358	
	528877	5781381	
	528784.3	5781415	
H3	528766.5	5781371	4.7
	528847.6	5781341	
	528854.7	5781358	
	528774.6	5781388	
Sow	528836.1	5781308	4.766
	528846.3	5781335	
	528762.4	5781367	
	528752.1	5781340	
Store	528852.7	5781339	8
	528878.5	5781328	
	528886.4	5781347	
	528859.9	5781357	
H7	528795.1	5781437	4.31
	528793.3	5781432	
	528843.2	5781414	
	528844.7	5781418	
	528807.7	5781448	
	528802.6	5781434	
	528795.1	5781437	
	528795.1	5781437	

5.8 Sources of Emissions

The pig housing units included in the dispersion modelling assessment are presented in Table 4, which specifies:

- The housing unit at the pig farm after the proposed development
- The type of pigs housed (development as modelled)
- The type of ventilation (development as modelled)
- The number of pigs housed in the building (development as modelled)
- The number of sources used to represent the mechanical ventilation points in the modelling assessment.

The pig housing units at the Site are mechanically ventilated sheds as indicated in Table 4 and were configured point sources (mechanically ventilated housing units) in the modelling assessment.

The point sources representing mechanically ventilated housing units included in the modelling assessment, the number of pigs per source and the ammonia emission rate per source included in the modeling assessment are presented in Table 5.

Table 4 Pig housing units included in the dispersion modelling assessment

Building	Type of Ventilation	Type of Pig	Number of Pigs	Sources per shed
House 1/2	Mechanical	Dry Sow (Maiden Gilts)	670 (120)	8
House 3	Mechanical	2nd	2933	6
House 3	Mechanical	1st	567	1
House 4	Mechanical	1st	900	6
House 4	Mechanical	Farrowing	164	19
House 4	Mechanical	Dry Sow	20	1
House 5	Mechanical	Fattener	1120	13
House 7	Mechanical	Fattener	1120	12
House 9	Mechanical	Fattener	1120	12
House 10	Mechanical	Fattener	1440	6

Table 5 Sources and odour emission rate of point sources representing mechanically ventilated housing units included in the modelling assessment

Housing Unit	Source Number	Number of pigs per source	Ammonia Emission rate (g/s)
House 1/2	S_DS_1	99	1.25E-02
	S_DS_2	99	1.25E-02
	S_DS_3	99	1.25E-02
	S_DS_4	99	1.25E-02
	S_DS_5	99	1.25E-02
	S_SS_1	99	1.25E-02
	S_SS_2	99	1.25E-02
	S_SS_3	99	1.25E-02
House 3	H3_W1	489	1.09E-02
	H3_W2	489	1.09E-02

Housing Unit	Source Number	Number of pigs per source	Ammonia Emission rate (g/s)
	H3_W3	489	1.09E-02
	H3_W4	489	1.09E-02
	H3_W5	489	1.09E-02
	H3_W6	489	1.09E-02
	H3_W7	567	1.26E-02
	H4_W1	150	3.33E-03
House 4	H4_W2	150	3.33E-03
	H4_W3	150	3.33E-03
	H4_W4	150	3.33E-03
	H4_W5	150	3.33E-03
	H4_W6	150	3.33E-03
	H4_Far1	9	2.05E-03
	H4_Far2	9	2.05E-03
	H4_Far3	9	2.05E-03
	H4_Far4	9	2.05E-03
	H4_Far5	9	2.05E-03
	H4_Far6	9	2.05E-03
	H4_Far7	9	2.05E-03
	H4_Far8	9	2.05E-03
	H4_Far9	9	2.05E-03
	H4_Sow10	20	2.54E-03
	H4_Far11	9	2.05E-03
	H4_Far12	9	2.05E-03
	H4_Far13	9	2.05E-03
	H4_Far14	9	2.05E-03
	H4_Far15	9	2.05E-03
	H4_Far16	9	2.05E-03
	H4_Far17	9	2.05E-03
	H4_Far18	9	2.05E-03
	H4_Far19	9	2.05E-03
	H4_Far20	9	2.05E-03
House 5	H5_F1	86	7.82E-03
	H5_F10	86	7.82E-03
	H5_F11	86	7.82E-03
	H5_F12	86	7.82E-03
	H5_F13	86	7.82E-03
	H5_F2	86	7.82E-03
	H5_F3	86	7.82E-03
	H5_F4	86	7.82E-03
	H5_F5	86	7.82E-03

Housing Unit	Source Number	Number of pigs per source	Ammonia Emission rate (g/s)
	H5_F6	86	7.82E-03
	H5_F7	86	7.82E-03
	H5_F8	86	7.82E-03
	H5_F9	86	7.82E-03
House 7	H7_F1	93	8.47E-03
	H7_F2	93	8.47E-03
	H7_F3	93	8.47E-03
	H7_F4	93	8.47E-03
	H7_F5	93	8.47E-03
	H7_F6	93	8.47E-03
	H7_F7	93	8.47E-03
	H7_F8	93	8.47E-03
	H7_F9	93	8.47E-03
	H7_F10	93	8.47E-03
	H7_F11	93	8.47E-03
	H7_F12	93	8.47E-03
House 9	H9_F1	93	8.47E-03
	H9_F10	93	8.47E-03
	H9_F11	93	8.47E-03
	H9_F12	93	8.47E-03
	H9_F2	93	8.47E-03
	H9_F3	93	8.47E-03
	H9_F4	93	8.47E-03
	H9_F5	93	8.47E-03
	H9_F6	93	8.47E-03
	H9_F7	93	8.47E-03
	H9_F8	93	8.47E-03
	H9_F9	93	8.47E-03
House 10	H10_F1	240	2.18E-02
	H10_F2	240	2.18E-02
	H10_F3	240	2.18E-02
	H10_F4	240	2.18E-02
	H10_F5	240	2.18E-02
	H10_F6	240	2.18E-02

5.9 Source configuration

The pig housing units at the pig farm are mechanically ventilated and were, therefore, modelled as point sources in the modelling assessment. This section describes the configuration of the sources included in the CALPUFF modelling assessment.

Table 6 lists the point sources included in the modelling assessment and relevant modelling parameters including:

- The source coordinates
- The base elevations
- Stack height
- Stack diameter
- Exhaust temperature
- Exhaust velocity.

The building locations, configuration and heights were determined from Site plans provided by Monagle Pig Farms, correspondence between Katestone and Monagle Pig Farms and from satellite imagery.

Table 6 Source parameters for the point sources at the pig farm

Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
S_DS_1	528.765	5781.352	101.2	6.046	0.71	21	6.0
S_DS_2	528.773	5781.349	101.0	6.046	0.71	21	6.0
S_DS_3	528.781	5781.346	100.7	6.046	0.71	21	6.0
S_DS_4	528.789	5781.343	100.4	6.046	0.71	21	6.0
S_DS_5	528.797	5781.34	100.1	6.046	0.71	21	6.0
S_SS_1	528.813	5781.334	99.6	6.046	0.71	21	6.0
S_SS_2	528.824	5781.33	99.2	6.046	0.71	21	6.0
S_SS_3	528.833	5781.326	98.9	6.046	0.71	21	6.0
H3_W1	528.78	5781.377	101.3	6.03	0.91	25	5.1
H3_W2	528.789	5781.373	101.0	6.03	0.91	25	5.1
H3_W3	528.801	5781.369	100.5	6.03	0.91	25	5.1
H3_W4	528.813	5781.364	100.1	6.03	0.91	25	5.1
H3_W5	528.824	5781.36	99.7	6.03	0.91	25	5.1
H3_W6	528.835	5781.356	99.3	6.03	0.91	25	5.1
H3_W7	528.846	5781.352	98.9	6.03	0.91	25	5.1
H4_W1	528.783	5781.397	101.6	5.131	0.56	25	5.4
H4_W2	528.793	5781.393	101.2	5.131	0.56	25	5.4
H4_W3	528.802	5781.39	100.9	5.131	0.56	25	5.4
H4_W4	528.788	5781.409	101.7	5.131	0.56	25	5.4
H4_W5	528.812	5781.386	100.5	5.131	0.56	25	5.4
H4_W6	528.816	5781.398	100.6	5.131	0.56	25	5.4
H4_Far1	528.797	5781.405	101.3	5.131	0.45	25	4.7
H4_Far2	528.862	5781.367	98.7	5.131	0.45	25	4.7
H4_Far3	528.857	5781.369	98.9	5.131	0.45	25	4.7
H4_Far4	528.851	5781.371	99.1	5.131	0.45	25	4.7
H4_Far5	528.846	5781.373	99.3	5.131	0.45	25	4.7
H4_Far6	528.838	5781.376	99.5	5.131	0.45	25	4.7
H4_Far7	528.832	5781.378	99.8	5.131	0.45	25	4.7
H4_Far8	528.826	5781.38	100.0	5.131	0.45	25	4.7
H4_Far9	528.82	5781.383	100.2	5.131	0.45	25	4.7
H4_Sow10	528.806	5781.402	101.0	5.131	0.45	21	4.7
H4_Far11	528.856	5781.383	99.1	5.131	0.45	25	4.7
H4_Far12	528.868	5781.365	98.5	5.131	0.45	25	4.7
H4_Far13	528.823	5781.395	100.3	5.131	0.45	25	4.7
H4_Far14	528.832	5781.392	100.0	5.131	0.45	25	4.7
H4_Far15	528.837	5781.39	99.8	5.131	0.45	25	4.7
H4_Far16	528.842	5781.388	99.6	5.131	0.45	25	4.7

Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
H4_Far17	528.85	5781.385	99.3	5.131	0.45	25	4.7
H4_Far18	528.861	5781.381	98.9	5.131	0.45	25	4.7
H4_Far19	528.867	5781.379	98.7	5.131	0.45	25	4.7
H4_Far20	528.873	5781.377	98.5	5.131	0.45	25	4.7
H5_F1	528.793	5781.425	101.8	5.14	0.56	21	5.4
H5_F10	528.857	5781.401	99.4	5.14	0.56	21	5.4
H5_F11	528.867	5781.397	99.0	5.14	0.56	21	5.4
H5_F12	528.872	5781.395	98.8	5.14	0.56	21	5.4
H5_F13	528.877	5781.394	98.6	5.14	0.56	21	5.4
H5_F2	528.8	5781.422	101.5	5.14	0.56	21	5.4
H5_F3	528.807	5781.42	101.3	5.14	0.56	21	5.4
H5_F4	528.814	5781.417	101.0	5.14	0.56	21	5.4
H5_F5	528.821	5781.414	100.7	5.14	0.56	21	5.4
H5_F6	528.829	5781.412	100.4	5.14	0.56	21	5.4
H5_F7	528.836	5781.409	100.1	5.14	0.56	21	5.4
H5_F8	528.847	5781.405	99.7	5.14	0.56	21	5.4
H5_F9	528.852	5781.403	99.5	5.14	0.56	21	5.4
H7_F1	528.81	5781.439	101.5	5.14	0.56	21	5.4
H7_F2	528.816	5781.437	101.3	5.14	0.56	21	5.4
H7_F3	528.821	5781.435	101.1	5.14	0.56	21	5.4
H7_F4	528.831	5781.432	100.7	5.14	0.56	21	5.4
H7_F5	528.836	5781.43	100.5	5.14	0.56	21	5.4
H7_F6	528.842	5781.428	100.3	5.14	0.56	21	5.4
H7_F7	528.853	5781.423	99.8	5.14	0.56	21	5.4
H7_F8	528.858	5781.421	99.6	5.14	0.56	21	5.4
H7_F9	528.864	5781.419	99.4	5.14	0.56	21	5.4
H7_F10	528.874	5781.415	99.0	5.14	0.56	21	5.4
H7_F11	528.88	5781.414	98.8	5.14	0.56	21	5.4
H7_F12	528.884	5781.412	98.7	5.14	0.56	21	5.4
H9_F1	528.816	5781.459	101.6	5.14	0.56	21	5.4
H9_F10	528.879	5781.436	99.2	5.14	0.56	21	5.4
H9_F11	528.886	5781.433	98.9	5.14	0.56	21	5.4
H9_F12	528.893	5781.43	98.6	5.14	0.56	21	5.4
H9_F2	528.822	5781.456	101.4	5.14	0.56	21	5.4
H9_F3	528.828	5781.454	101.1	5.14	0.56	21	5.4
H9_F4	528.836	5781.451	100.8	5.14	0.56	21	5.4
H9_F5	528.843	5781.449	100.6	5.14	0.56	21	5.4
H9_F6	528.849	5781.447	100.3	5.14	0.56	21	5.4
H9_F7	528.859	5781.443	99.9	5.14	0.56	21	5.4

Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
H9_F8	528.865	5781.441	99.7	5.14	0.56	21	5.4
H9_F9	528.872	5781.438	99.4	5.14	0.56	21	5.4
H10_F1	528.828	5781.482	101.6	6.124	0.91	21	5.1
H10_F2	528.842	5781.477	101.0	6.124	0.91	21	5.1
H10_F3	528.856	5781.472	100.5	6.124	0.91	21	5.1
H10_F4	528.869	5781.467	99.9	6.124	0.91	21	5.1
H10_F5	528.884	5781.461	99.3	6.124	0.91	21	5.1
H10_F6	528.898	5781.457	98.8	6.124	0.91	21	5.1

5.10 In-combination modelling assessment

An in-combination assessment is a requirement of Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance.

The in-combination modelling assessment needs to include other sources that may act in-combination with the application/review installation. The other sources that need to be included in the in-combination modelling assessment are defined in Section 3.9 of EPA's Ammonia and Nitrogen Assessment Guidance, which is reproduced here:

> *Other sources of nitrogen and ammonia (other PCs) to the Natura 2000 site(s), which could act in combination with emissions from the proposed/expanded installation, to impact the protected habitat, must be accounted for at relevant stages of the appropriate assessment process (screening stage details are set in Section 4 of this document). The in-combination assessment which needs to be conducted, is dependent on the size of the activity and the distance from the Natura site.*
>
> *At the target Natura 2000 site(s) (i.e. that/those identified, as possibly impacted by emissions from the applicant/review installation), all IAIs, which meet the following two criteria and which (with abatement in place), have a PC of ≥4% of the critical level for ammonia and/or ≥5% of the critical load for nitrogen deposition at the relevant Natura site must be included:*
>
> 1) *Developments that have planning permission and/or licences but are not yet (fully) operating; including those both above and below licensing thresholds that may contribute to ammonia and nitrogen emissions; and*
> 2) *Developments that started operating/increased their numbers, after the most recent update of background levels; including those both above and below licensing thresholds, that may contribute to ammonia and nitrogen emissions*
>
> *The criteria to use in order to determine the geographical range of the installations, which meet the above criteria, to include in the in-combination assessment is outlined below. (see Figure 1):*
>
> - *All below threshold installations within 5km of the Natura site*
> - *All licensed installations within 10km of the Natura site*

6. AMMONIA AND NITROGEN ASSESSMENT RESULTS

The results of the assessment are presented in this section. Katestone followed the step-wise approach described in EPA's Ammonia and Nitrogen Assessment Guidance in this assessment. The results of each step considered in the modelling assessment are presented in this section.

In summary, following the step-wise approach described in EPA's Ammonia and Nitrogen Assessment Guidance required the following steps to be completed:

- Step 1
- Step 4
- Step 5.

6.1 Results of Step 1

Question 2 of Step 1 in the EPA's Ammonia and Nitrogen Assessment Guidance asks:

> *Are the background levels already exceeded for the ammonia critical level or nitrogen critical load at Natura sites within the zone of influence of my site (as reported by SCAIL)?*

The background concentrations of ammonia and the background nitrogen deposition flux as determined using the SCAIL screening tool are presented along with the appropriate critical level for ammonia and critical load for nitrogen deposition fluxes in Table 7.

The results show that the background concentrations of ammonia and the background nitrogen deposition flux exceed the relevant critical level for ammonia and critical load for nitrogen deposition fluxes at a number of the modelled discrete receptor locations on each of the Natura 2000 including:

- Blackwater River (Cork/Waterford) SAC (Receptors – 1 - 80)
- Kilcolman Bog SPA (Receptors – 81 - 86).

According to Step 1 of EPA's Ammonia and Nitrogen Assessment Guidance:

- The approaches using the SCAIL-Agriculture model described in Step 2 and Step 3 of the EPA's Ammonia and Nitrogen Assessment Guidance are not applicable.
- A detailed assessment completed in accordance with Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance is, therefore, required to be completed. The results of the Step 4 assessment are presented in Section 6.2.

Table 7 Background concentrations of ammonia and the background nitrogen deposition flux as determined using the SCAIL screening tool are presented along with the appropriate critical level for ammonia and critical load for nitrogen deposition fluxes

NAME	NH_3 Background (ug m^{-3})	Criteria	NDEP Background (kg/ha/yr)	Criteria
DR1	2.7	1	7.74	10
DR2	2.71	3	7.52	30
DR3	2.66	1	7.29	10
DR4	2.66	3	7.05	30
DR5	2.69	3	7.1	30
DR6	2.73	1	7.04	10

NAME	NH_3 Background (ug m^{-3})	Criteria	NDEP Background (kg/ha/yr)	Criteria
DR7	2.76	1	7.08	10
DR8	2.88	1	7.19	10
DR9	2.82	1	7.1	10
DR10	2.93	1	7.05	10
DR11	3.02	1	7.19	10
DR12	2.97	1	7.3	10
DR13	3.02	3	7.19	30
DR14	3.2	3	7.6	30
DR15	3.2	3	7.6	30
DR16	3.05	1	7.06	15.3
DR17	3.1	1	7.19	15.3
DR18	2.8	3	7.23	30
DR19	2.8	3	7.23	30
DR20	2.8	1	7.23	10
DR21	3.04	1	7.21	10
DR22	3.1	3	7.21	30
DR23	3.1	3	7.21	30
DR24	3.12	3	7.2	30
DR25	3.12	1	7.2	10
DR26	3.22	1	7.28	10
DR27	2.78	3	7.19	30
DR28	2.8	3	7.23	30
DR29	2.51	1	7.4	10
DR30	2.51	1	7.4	10
DR31	2.26	3	7.58	30
DR32	2.26	3	7.58	30
DR33	2.26	3	7.58	30
DR34	2.22	3	7.64	30
DR35	2.22	3	7.64	30
DR36	2.18	3	7.7	30
DR37	2.78	1	7.19	10
DR38	2.85	1	7.26	10
DR39	2.85	1	7.25	10
DR40	2.83	1	7.18	10
DR41	2.83	1	7.18	10
DR42	2.94	1	7.22	10
DR43	3.03	1	7.18	10
DR44	3.16	1	7.18	10
DR45	3.16	1	7.11	10
DR46	3.18	1	7.16	10
DR47	3.22	1	7.45	10
DR48	3.42	1	7.52	10
DR49	3.31	1	7.47	10
DR50	3.57	1	7.83	10

NAME	NH_3 Background (ug m^{-3})	Criteria	NDEP Background (kg/ha/yr)	Criteria
DR51	3.57	1	7.83	10
DR52	3.22	1	7.64	10
DR53	3.22	3	7.64	30
DR54	2.98	3	7.56	30
DR55	2.98	3	7.56	30
DR56	2.79	1	7.31	30
DR57	2.76	3	6.98	30
DR58	2.76	1	6.98	10
DR59	2.8	1	6.8	10
DR60	2.77	1	6.93	10
DR61	2.81	1	6.87	10
DR62	2.81	1	6.87	10
DR63	2.88	1	6.85	10
DR64	2.88	1	6.94	10
DR65	2.88	1	6.94	10
DR66	2.85	1	7.08	10
DR67	2.89	1	7.07	10
DR68	2.82	1	7.24	10
DR69	2.82	1	7.24	10
DR70	2.83	1	7.33	10
DR71	2.83	1	7.33	10
DR72	2.88	1	7.25	10
DR73	2.88	1	7.25	10
DR74	2.91	1	7.3	10
DR75	2.91	1	7.3	10
DR76	2.83	1	7.2	10
DR77	2.84	1	7.22	30
DR78	2.86	1	7.36	30
DR79	2.8	1	7.37	10
DR80	2.92	1	7.28	10
DR81	2.92	1	7.28	5
DR82	2.99	1	7.44	5
DR83	2.96	1	7.23	5
DR84	2.91	1	7.13	5
DR85	2.92	1	7.28	5
DR86	2.92	1	7.28	5

6.2 Results of Step 4

Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance requires a licensee/applicant to complete a detailed dispersion modelling assessment.

Dispersion modelling has been conducted for five years of meteorological data. The following sections present the highest concentrations across the five-year modelled period as required by EPA dispersion modelling guidance.

The predicted ground-level concentrations of ammonia and annual average flux rate of nitrogen deposition at the nearest ecologically sensitive locations due to the pig farm are presented in Table 8.

The results in Table 8 are compared against the Step 4 criteria identified in EPA's Ammonia and Nitrogen Assessment Guidance, which require the process contribution of the pig farm (PC) to be:

- ≤1% of the critical level for ammonia
- ≤1% of the critical load for nitrogen deposition?

The results presented in Table 8 show that, in relation to the 1% threshold identified in Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance, the PC due to the pig farm exceeds the 1% PC threshold defined in Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance for ammonia and nitrogen deposition at a number of modelled discrete receptor locations on:

- Blackwater River (Cork/Waterford) SAC (Receptors – 1 - 80)
- Kilcolman Bog SPA (Receptors – 81 - 86)

If the criteria identified in Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance are exceeded, the licensee/applicant is required to undertake the assessment defined in Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance. Step 5 requires detailed modelling that takes account of in-combination effects. The results of the assessment undertaken to consider the impacts of the proposed development in the context of Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance is presented in Section 6.3 for the modelled sensitive locations on the Blackwater River SAC and the Kilcolman Bog SPA.

Table 8 **The predicted ground-level concentrations of ammonia and annual average flux rate of nitrogen deposition at the nearest ecologically sensitive locations due to the pig farm**

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR1*	0.008	1	0.8%	0.08	10	0.8%
DR2	0.012	3	0.4%	0.11	30	0.4%
DR3*	0.019	1	1.9%	0.18	10	1.8%
DR4	0.025	3	0.8%	0.24	30	0.8%
DR5	0.035	3	1.2%	0.33	30	1.1%
DR6*	0.038	1	3.8%	0.36	10	3.6%
DR7*	0.048	1	4.8%	0.45	10	4.5%
DR8*	0.043	1	4.3%	0.40	10	4.0%
DR9*	0.056	1	5.6%	0.53	10	5.3%
DR10*	0.070	1	7.0%	0.66	10	6.6%
DR11*	0.111	1	11.1%	1.05	10	10.5%
DR12*	0.131	1	13.1%	1.23	10	12.3%
DR13	0.213	3	7.1%	2.01	30	6.7%
DR14	0.269	3	9.0%	2.54	30	8.5%
DR15	0.300	3	10.0%	2.83	30	9.4%
DR16*	0.053	1	5.3%	0.50	15.3	3.3%
DR17*	0.048	1	4.8%	0.45	15.3	3.0%
DR18	0.047	3	1.6%	0.45	30	1.5%
DR19	0.041	3	1.4%	0.39	30	1.3%
DR20*	0.038	1	3.8%	0.36	10	3.6%
DR21*	0.037	1	3.7%	0.35	10	3.5%
DR22	0.051	3	1.7%	0.48	30	1.6%

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR23	0.052	3	1.7%	0.49	30	1.6%
DR24	0.053	3	1.8%	0.50	30	1.7%
DR25*	0.069	1	6.9%	0.65	10	6.5%
DR26*	0.095	1	9.5%	0.89	10	8.9%
DR27	0.040	3	1.3%	0.37	30	1.2%
DR28	0.035	3	1.2%	0.33	30	1.1%
DR29*	0.025	1	2.5%	0.23	10	2.3%
DR30*	0.021	1	2.1%	0.19	10	1.9%
DR31	0.016	3	0.5%	0.15	30	0.5%
DR32	0.012	3	0.4%	0.11	30	0.4%
DR33	0.011	3	0.4%	0.10	30	0.3%
DR34	0.009	3	0.3%	0.08	30	0.3%
DR35	0.009	3	0.3%	0.08	30	0.3%
DR36	0.007	3	0.2%	0.07	30	0.2%
DR37*	0.035	1	3.5%	0.33	10	3.3%
DR38*	0.032	1	3.2%	0.30	10	3.0%
DR39*	0.031	1	3.1%	0.29	10	2.9%
DR40*	0.028	1	2.8%	0.27	10	2.7%
DR41*	0.033	1	3.3%	0.31	10	3.1%
DR42*	0.026	1	2.6%	0.25	10	2.5%
DR43*	0.032	1	3.2%	0.30	10	3.0%
DR44*	0.025	1	2.5%	0.24	10	2.4%
DR45*	0.019	1	1.9%	0.18	10	1.8%
DR46*	0.045	1	4.5%	0.42	10	4.2%

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR47*	0.061	1	6.1%	0.57	10	5.7%
DR48*	0.072	1	7.2%	0.68	10	6.8%
DR49*	0.068	1	6.8%	0.64	10	6.4%
DR50*	0.069	1	6.9%	0.65	10	6.5%
DR51*	0.071	1	7.1%	0.67	10	6.7%
DR52*	0.081	1	8.1%	0.76	10	7.6%
DR53	0.088	3	2.9%	0.83	30	2.8%
DR54	0.104	3	3.5%	0.98	30	3.3%
DR55	0.107	3	3.6%	1.01	30	3.4%
DR56*	0.114	1	11.4%	1.08	30	3.6%
DR57	0.105	3	3.5%	0.99	30	3.3%
DR58*	0.112	1	11.2%	1.05	10	10.5%
DR59*	0.109	1	10.9%	1.03	10	10.3%
DR60*	0.110	1	11.0%	1.04	10	10.4%
DR61*	0.095	1	9.5%	0.90	10	9.0%
DR62*	0.076	1	7.6%	0.72	10	7.2%
DR63*	0.053	1	5.3%	0.50	10	5.0%
DR64*	0.046	1	4.6%	0.44	10	4.4%
DR65*	0.049	1	4.9%	0.46	10	4.6%
DR66*	0.053	1	5.3%	0.50	10	5.0%
DR67*	0.049	1	4.9%	0.46	10	4.6%
DR68*	0.047	1	4.7%	0.44	10	4.4%
DR69*	0.033	1	3.3%	0.31	10	3.1%
DR70*	0.035	1	3.5%	0.33	10	3.3%

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR71*	0.032	1	3.2%	0.30	10	3.0%
DR72*	0.023	1	2.3%	0.22	10	2.2%
DR73*	0.021	1	2.1%	0.20	10	2.0%
DR74*	0.017	1	1.7%	0.16	10	1.6%
DR75*	0.015	1	1.5%	0.14	10	1.4%
DR76*	0.018	1	1.8%	0.17	10	1.7%
DR77	0.019	1	1.9%	0.18	30	0.6%
DR78	0.018	1	1.8%	0.17	30	0.6%
DR79*	0.013	1	1.3%	0.12	10	1.2%
DR80	0.019	1	1.9%	0.18	5	3.6%
DR81	0.019	1	1.9%	0.18	5	3.5%
DR82	0.018	1	1.8%	0.17	5	3.3%
DR83	0.017	1	1.7%	0.16	5	3.3%
DR84	0.020	1	2.0%	0.19	5	3.8%
DR85	0.021	1	2.1%	0.19	5	3.9%
DR86	0.020	1	2.0%	0.18	5	3.7%

6.3 Results of Step 5

Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance requires detailed modelling to determine the in-combination effects of:

- The pig farm
- Intensive agricultural installations (AIA) built or approved since the most recent update of background levels (determined using SCAIL-Agriculture).

The results of the in-combination assessment are assessed against the criteria identified in Step 5.

The most recent update to background levels of ammonia and nitrogen deposition was in 2018 with data used based on the locations of pig and poultry farms up to 2015 (Kelleghan *et al.*, 2022).

A review of nearby IAIs (IAI Review) was undertaken to identify all IAI developments that received licence/planning approval since 2015 or IAI developments that were built since 2015 within the following set-back distances identified in Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance:

- Licensed IAI within 10 km of the closest point of 1) The Blackwater River SAC and 2) Kilcolman Bog SPA to the pig farm.
- Sub-threshold Licensed IAI within 5 km of the closest point of 1) The Blackwater River SAC and 2) Kilcolman Bog SPA to the pig farm.

The IAI Review included detailed searches of satellite imagery, the EPA licence database and the planning systems of:

- Limerick County Council
- Cork County Council.

The areas searched were determined using the methodology defined in EPA's Ammonia and Nitrogen Assessment Guidance and are presented in Figure 9.

The IAI Review identified:

- There are a small number of IAI in the areas searched
- There have been no new EPA licence approvals for IAI within the search areas since 2015
- EPA has not approved any increases in stocking numbers at any EPA licensed IAI in the search areas after 2015
- EPA has not approved any licence amendments/reviews for any EPA licensed IAI in the search areas after 2015
- No planning approvals for sub-threshold IAI within a 5 km setback distance from the Blackwater River SAC or the Kilcolman Bog SPA have been issued after 2015.

The results of the IAI Review identified there is no requirement for a cumulative assessment of impacts on the Blackwater River SAC or Kilcolman Bog SPA as no IAI meet the requirements of Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance. Accordingly, the cumulative impact on the Blackwater River SAC or Kilcolman Bog SPA of all IAI as defined in Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance is equal to the impact of the pig farm in isolation.

The results have been assessed against the Step 5 criteria identified in EPA's Ammonia and Nitrogen Assessment Guidance that require the cumulative impact to be less than:

- 20% of the critical level for ammonia

- 20% of the critical load for nitrogen deposition.

The results of the Step 5 cumulative assessment on ecologically sensitive receptors on the Blackwater River SAC and the Kilcolman Bog SPA are presented in Table 9.

At the Blackwater River SAC the worst-case cumulative impact due to the pig farm in combination with other IAIs that meet the requirements of Step 5 was well below the in-combination assessment level of 20% with the highest modelled results at any of the modelled sensitive locations being:

- 13.1% of the critical level for ammonia
- 12.3% of the critical load for nitrogen deposition.

At the Kilcolman Bog SPA the worst-case cumulative impact due to the pig farm in combination with other IAIs that meet the requirements of Step 5 was below in-combination assessment level of 20% with the highest modelled results at any of the modelled sensitive locations being:

- 2.1% of the critical level for ammonia
- 3.9% of the critical load for nitrogen deposition.

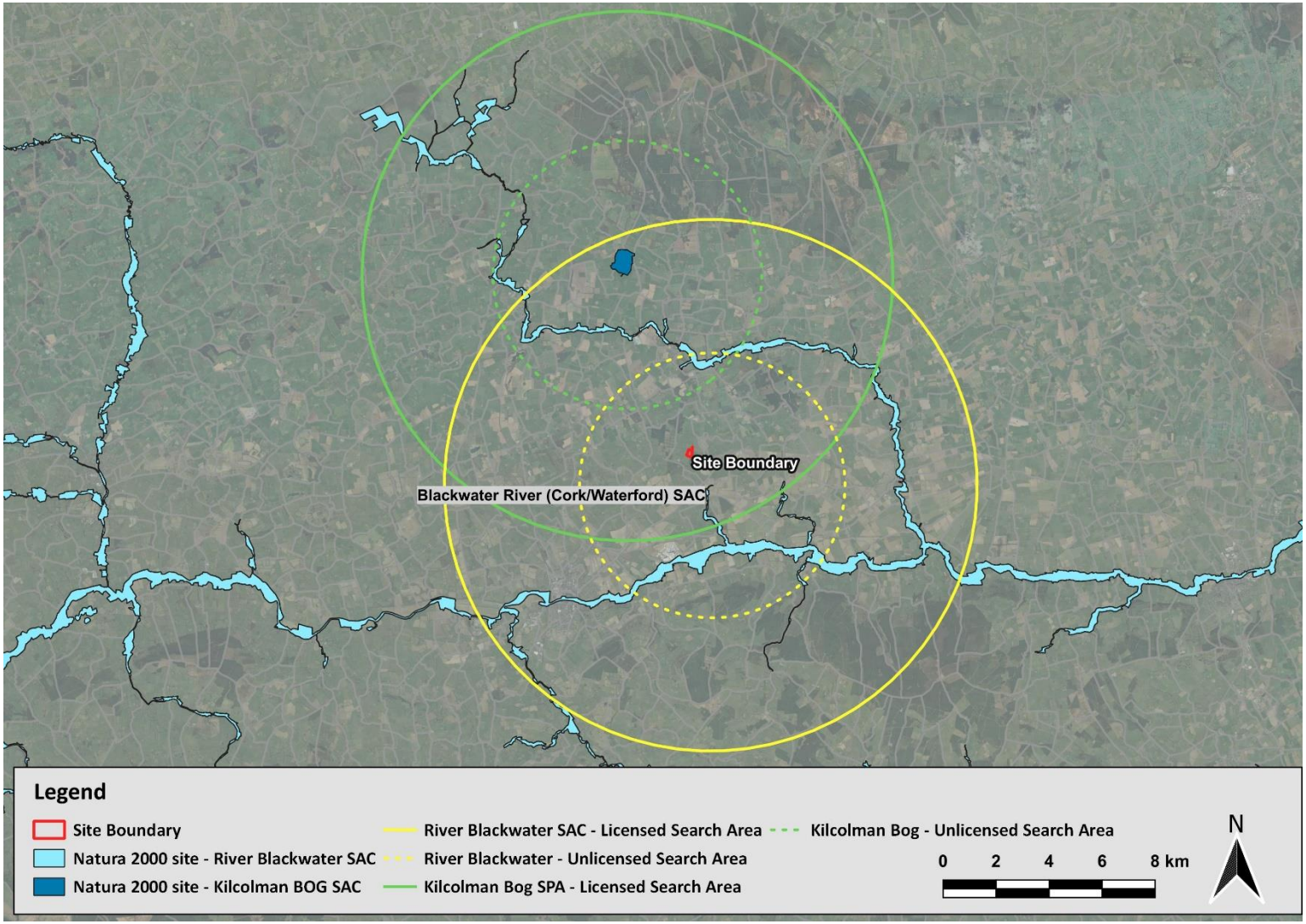

Figure 9 **Areas searched for background IAIs and background IAIs that were included in the cumulative assessment using the methodology defined in EPA's Ammonia and Nitrogen Assessment Guidance**

Table 9 **The predicted cumulative ground-level concentrations of ammonia and annual average flux rate of nitrogen deposition at the ecologically sensitive locations on the Galtee Mountain SAC due to the pig farm in combination with background facilities that meet the requirements of Step 5**

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR1*	0.008	1	0.8%	0.08	10	0.8%
DR2	0.012	3	0.4%	0.11	30	0.4%
DR3*	0.019	1	1.9%	0.18	10	1.8%
DR4	0.025	3	0.8%	0.24	30	0.8%
DR5	0.035	3	1.2%	0.33	30	1.1%
DR6*	0.038	1	3.8%	0.36	10	3.6%
DR7*	0.048	1	4.8%	0.45	10	4.5%
DR8*	0.043	1	4.3%	0.40	10	4.0%
DR9*	0.056	1	5.6%	0.53	10	5.3%
DR10*	0.070	1	7.0%	0.66	10	6.6%
DR11*	0.111	1	11.1%	1.05	10	10.5%
DR12*	0.131	1	13.1%	1.23	10	12.3%
DR13	0.213	3	7.1%	2.01	30	6.7%
DR14	0.269	3	9.0%	2.54	30	8.5%
DR15	0.300	3	10.0%	2.83	30	9.4%
DR16*	0.053	1	5.3%	0.50	15.3	3.3%
DR17*	0.048	1	4.8%	0.45	15.3	3.0%
DR18	0.047	3	1.6%	0.45	30	1.5%
DR19	0.041	3	1.4%	0.39	30	1.3%
DR20*	0.038	1	3.8%	0.36	10	3.6%

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR21*	0.037	1	3.7%	0.35	10	3.5%
DR22	0.051	3	1.7%	0.48	30	1.6%
DR23	0.052	3	1.7%	0.49	30	1.6%
DR24	0.053	3	1.8%	0.50	30	1.7%
DR25*	0.069	1	6.9%	0.65	10	6.5%
DR26*	0.095	1	9.5%	0.89	10	8.9%
DR27	0.040	3	1.3%	0.37	30	1.2%
DR28	0.035	3	1.2%	0.33	30	1.1%
DR29*	0.025	1	2.5%	0.23	10	2.3%
DR30*	0.021	1	2.1%	0.19	10	1.9%
DR31	0.016	3	0.5%	0.15	30	0.5%
DR32	0.012	3	0.4%	0.11	30	0.4%
DR33	0.011	3	0.4%	0.10	30	0.3%
DR34	0.009	3	0.3%	0.08	30	0.3%
DR35	0.009	3	0.3%	0.08	30	0.3%
DR36	0.007	3	0.2%	0.07	30	0.2%
DR37*	0.035	1	3.5%	0.33	10	3.3%
DR38*	0.032	1	3.2%	0.30	10	3.0%
DR39*	0.031	1	3.1%	0.29	10	2.9%
DR40*	0.028	1	2.8%	0.27	10	2.7%
DR41*	0.033	1	3.3%	0.31	10	3.1%
DR42*	0.026	1	2.6%	0.25	10	2.5%
DR43*	0.032	1	3.2%	0.30	10	3.0%
DR44*	0.025	1	2.5%	0.24	10	2.4%

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR45*	0.019	1	1.9%	0.18	10	1.8%
DR46*	0.045	1	4.5%	0.42	10	4.2%
DR47*	0.061	1	6.1%	0.57	10	5.7%
DR48*	0.072	1	7.2%	0.68	10	6.8%
DR49*	0.068	1	6.8%	0.64	10	6.4%
DR50*	0.069	1	6.9%	0.65	10	6.5%
DR51*	0.071	1	7.1%	0.67	10	6.7%
DR52*	0.081	1	8.1%	0.76	10	7.6%
DR53	0.088	3	2.9%	0.83	30	2.8%
DR54	0.104	3	3.5%	0.98	30	3.3%
DR55	0.107	3	3.6%	1.01	30	3.4%
DR56*	0.114	1	11.4%	1.08	30	3.6%
DR57	0.105	3	3.5%	0.99	30	3.3%
DR58*	0.112	1	11.2%	1.05	10	10.5%
DR59*	0.109	1	10.9%	1.03	10	10.3%
DR60*	0.110	1	11.0%	1.04	10	10.4%
DR61*	0.095	1	9.5%	0.90	10	9.0%
DR62*	0.076	1	7.6%	0.72	10	7.2%
DR63*	0.053	1	5.3%	0.50	10	5.0%
DR64*	0.046	1	4.6%	0.44	10	4.4%
DR65*	0.049	1	4.9%	0.46	10	4.6%
DR66*	0.053	1	5.3%	0.50	10	5.0%
DR67*	0.049	1	4.9%	0.46	10	4.6%
DR68*	0.047	1	4.7%	0.44	10	4.4%

DR	Ammonia			Nitrogen Deposition		
	Concentration	Criteria	% of criteria	Rate	Criteria	% of criteria
	µg/m³	µg/m³		kg/ha/yr	µg/m³	
DR69*	0.033	1	3.3%	0.31	10	3.1%
DR70*	0.035	1	3.5%	0.33	10	3.3%
DR71*	0.032	1	3.2%	0.30	10	3.0%
DR72*	0.023	1	2.3%	0.22	10	2.2%
DR73*	0.021	1	2.1%	0.20	10	2.0%
DR74*	0.017	1	1.7%	0.16	10	1.6%
DR75*	0.015	1	1.5%	0.14	10	1.4%
DR76*	0.018	1	1.8%	0.17	10	1.7%
DR77	0.019	1	1.9%	0.18	30	0.6%
DR78	0.018	1	1.8%	0.17	30	0.6%
DR79*	0.013	1	1.3%	0.12	10	1.2%
DR80	0.019	1	1.9%	0.18	5	3.6%
DR81	0.019	1	1.9%	0.18	5	3.5%
DR82	0.018	1	1.8%	0.17	5	3.3%
DR83	0.017	1	1.7%	0.16	5	3.3%
DR84	0.020	1	2.0%	0.19	5	3.8%
DR85	0.021	1	2.1%	0.19	5	3.9%
DR86	0.020	1	2.0%	0.18	5	3.7%

7. CONCLUSIONS

Mr Michael Monagle commissioned Katestone to complete an ammonia impact assessment (AIA) for a pig farm located at Annakisha North, Doneraile Co. Cork (Site).

The pig farm has an Industrial Emissions Directive (IED) licence (Licence registration number P0446-01) issued by the Environment Protection Agency (EPA) in 1999.

According to its license, total stocking capacity for the Site is 7,462 pigs (131 suckling sows, 649 dry sows, 20 boars, 94 maiden gilts, 2,668 weaners and 3,900 finishers).

The most recent planning application to Cork County Council for the Site was in 2014 (application number 14/5815). Cork County Council issued conditional approval in June 2015 to construct a pig fattening house, associated feed mixing room and a pig walk-way. The 14/5815 application was for a stocking capacity of 10,174 pigs (164 suckling sows, 690 dry sows, 120 maiden gilts, 4,400 weaners and 4,800 finishers).

The AIA is required to determine the potential impact of ammonia emissions from the proposed development at the pig farm on ecologically sensitive locations in nearby Natura 2000 sites. The assessment will be submitted as part of a license review applications for the pig farm.

The AIA was conducted in accordance with the stepwise assessment procedure described in EPA's Ammonia and Nitrogen Assessment Guidance (EPA, 2021) for intensive agricultural installation (IAI) and recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4).

The results of the AIA are presented here:

- The results of the Step 1 assessment indicated that:
    - The approaches using the SCAIL-Agriculture model described in Step 2 and Step 3 of the EPA's Ammonia and Nitrogen Assessment Guidance are not applicable
    - A detailed assessment completed in accordance with Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance is, therefore, required to be completed.
- The results of the Step 4 assessment show that, in relation to the 1% threshold identified in Step 4 of EPA's Ammonia and Nitrogen Assessment Guidance, the PC due to the pig farm:
    - Exceeds for ammonia and nitrogen deposition at a number of modelled discrete receptor locations on:
        - Blackwater River (Cork/Waterford) SAC (Receptors – 1 - 80)
        - Kilcolman Bog SPA (Receptors – 81 - 86).
- The results of the Step 4 assessment indicate that a Step 5 assessment, involving detailed modelling that takes account of in-combination effects, is required for the modelled sensitive locations on the Blackwater River SAC and the Kilcolman Bog SPA.
- The Step 5 assessment requires a review of background IAIs that needed to be included in the in-combination assessment. This review determined there is no requirement for a cumulative assessment of impacts on the Blackwater River SAC and the Kilcolman Bog SPA as no IAI meets the requirements of Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance to be included. Accordingly, the cumulative impact on the Blackwater River SAC and the Kilcolman Bog SPA of all IAI as defined in Step 5 of EPA's Ammonia and Nitrogen Assessment Guidance is equal to the impact of the pig farm in isolation.
- The results of the in-combination Step 5 assessment show that:
    - At the Blackwater River SAC the worst-case cumulative impact due to the pig farm in combination with other IAIs that meet the requirements of Step 5 was well below the in-combination

assessment level of 20% with the highest modelled results at any of the modelled sensitive locations being:

  - 13.1% of the critical level for ammonia
  - 12.3% of the critical load for nitrogen deposition.

- At the Kilcolman Bog SPA the worst-case cumulative impact due to the pig farm in combination with other IAIs that meet the requirements of Step 5 was below in-combination assessment level of 20% with the highest modelled results at any of the modelled sensitive locations being:
  - 2.1% of the critical level for ammonia
  - 3.9% of the critical load for nitrogen deposition.

Final Report Findings

The results of the assessment indicate that the cumulative impacts of the proposed pig farm with background IAIs are under EPA limits and therefore **complies** with the Step 5 evaluation criteria at all modelled locations on:

- Blackwater River (Cork/Waterford) SAC (Receptors – 1 - 80)
- Kilcolman Bog SPA (Receptors – 81 - 86).

8. REFERENCES

EPA, 1999, Integrated Pollution Control Licence. Licensee: Michael Monagle. Location of Activity: Annakisha North, Doneraile, Co. Cork. Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland. https://epawebapp.epa.ie/licences/lic_eDMS/090151b2804e2280.pdf

EPA (2017) Guidelines on the information to be contained in environmental impact assessment reports Draft. August 2017. Environmental Protection Agency. An Ghníomhaireacht um Chaomhnú Comhshaoil PO Box 3000, Johnstown Castle, Co. Wexford, Ireland. http://www.epa.ie/pubs/advice/ea/EPA%20EIAR%20Guidelines.pdf

EPA (2020) Air Dispersion Modelling from Industrial Installations Guidance Note (AG4). Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland. https://www.epa.ie/pubs/advice/air/emissions/AG4%20Guidance%20note%20for%20web.pdf

EPA (2021) Licence Application Guidance Assessment of the impact of ammonia and nitrogen on Natura 2000 Sites from intensive agricultural installations. Version 1.0 May 2021. Environmental Protection Agency. An Ghníomhaireacht um Chaomhnú Comhshaoil PO Box 3000, Johnstown Castle, Co. Wexford, Ireland. https://www.epa.ie/publications/licensing--permitting/industrial/ied/Assessment-of-Impact-of--Ammonia-and-Nitrogen-on-Natura-Sites-from-Intensive-Agericulture-Installations.pdf

EPA, 2022, Instruction note for the assessment of odour emissions from Intensive Agriculture pig installations. PO Box 3000, Johnstown Castle Estate, County Wexford, Y35 W821, Ireland. 05 August 2022 https://www.epa.ie/publications/licensing--permitting/industrial/ied/EPA-Instruction-note-for-the-assessment-of-odour-emissions-from-Intensive-Agriculture-pig-installations.pdf

Hayes, E.T., Curran, T.P., Dodd, V.A. 2006. Odour and ammonia emissions from intensive pig units in Ireland. Bioresource technology 97 (7), 940-948

Hayes, E.T. (2004). Odour and ammonia emissions from intensive pig and poultry units in Ireland. PhD Thesis. University College Dublin, Belfield, Dublin 4

Kelleghan, D.B., Fogarty, M., Welchman, S., Cummins, T., & Curran, T.P. (2022) Agricultural atmospheric ammonia: identification & assessment of potential impacts. Irish Wildlife Manuals, No. 135. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland

NPWS (2012) Conservation Objectives: Blackwater River (Cork/Waterford) SAC 002170. Version 1.0. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002170.pdf

NPWS (2022) Conservation objectives for Kilcolman Bog SPA [004095]. First Order Site specific Conservation Objectives Version 1.0. Department of Housing, Local Government and Heritage. https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004095.pdf

Teagasc (2018) Pig Farmers' Conference 2018 Conference Proceedings Cavan Crystal Hotel, 23rd October 2018 & Horse & Jockey Hotel, 24th October 2018. https://www.teagasc.ie/media/webSite/publications/2018/Pig-Farmers-Conference-2018.pdf

APPENDIX A MODELLING METHODOLOGY

A1 METEOROLOGICAL MODELLING

A1.1 TAPM

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.5, was developed by the CSIRO and has been validated by the CSIRO, Katestone and others for many locations in Australia, southeast Asia, North America and Ireland. Katestone has used the TAPM model throughout Australia and has performed well for simulating regional winds patterns. Katestone has recently used the TAPM model to generate gridded data over Cork city and Harbour. The data generated correlated well with observed data at Cork Airport. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM requires synoptic meteorological information for the region surrounding the project. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 metres to five kilometres above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM resolves local terrain and land-use features that may influence local meteorology and generates a meteorological dataset that is representative of Site-specific geographic conditions. A year of synoptic data must be selected as input for TAPM. The selection of this year should be such that the year is representative of typical meteorological conditions (and therefore is not necessarily the most recent year of available data) and whether monitoring data is available for the time period to validate the output dataset. In addition, Katestone's experience elsewhere suggests that variability of dispersion meteorological conditions from year to year are unlikely to change the outcome of the air quality assessment.

TAPM was configured as follows:

- 41 x 41 grid point domain with an outer grid resolution of 30 kilometres and nesting grids of 10, 3.0 and 1.0 kilometres.
- 5 modelled years (1 January 2018 to 31 December 2022)
- Grid centered near the Project Site at latitude 52°12’30 and longitude -8°35’0
- US Geological Survey EROS global terrain height database
- TAPM default land use database, modified to be consistent with aerial imagery in the innermost grid
- 25 vertical grid levels
- No data assimilation.

A1.2 CALMET meteorological modelling

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple Sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.5.0) was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 1 km grid. CALMET treats the prognostic model

output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

CALMET was configured with twelve vertical levels with heights at 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600 and 4600 metres at each grid point.

All options and factors were selected in accordance with NSW EPA CALPUFF Guidance released by TRC Environmental in 2011 except where noted below.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 120 x 140 grid cells at 200m spacing
- 5 years modelled (1 January 2018 to 31 December 2022)
- Prognostic wind fields input as MM5/3D.dat for “initial guess” field (as generated by TAPM)
- Gridded cloud cover from prognostic relative humidity at all levels
- No extrapolation of surface wind observations to upper layers (not used in no-obs mode)
- Terrain radius of influence set to 5 km
- Maximum search radius of 10 grid cells in averaging process
- Use prognostic relative humidity
- Land use data modified to be consistent with aerial imagery.

All other options set to default.

A2 CALPUFF DISPERSION MODELLING

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 20 x 20 grid cells at 200m spacing, which is a sub-set of the CALMET domain centred on the Site
- 5 years modelled (1 January 2018 to 31 December 2022)
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables.

All other options set to default.