A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Poultry Houses at Brynthomas, Penybont, near to Llandrindod Wells in Powys

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Steve Raasch, on behalf of Ben Owens, the applicant, to use computer modelling to assess the impact of ammonia emissions from the existing free range egg-laying poultry house and the proposed broiler chicken rearing houses at Brynthomas, Penybont, near to Llandrindod Wells in Powys. LD1 5SP.

Ammonia emission rates from the existing and proposed poultry houses have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. The ammonia emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

This report is arranged in the following manner:

- Section 2 provides relevant details of the farm and potentially sensitive receptors in the area.

- Section 3 provides some general information on ammonia; details of the method used to estimate ammonia emissions, relevant guidelines and legislation on exposure limits and where relevant, details of likely background levels of ammonia.

- Section 4 provides some information about ADMS, the dispersion model used for this study and details the modelling procedure.

- Section 5 contains the results of the modelling.

- Section 6 provides a discussion of the results and conclusions.

2. Background Details

Brynthomas is in a rural area approximately 2.3 km to the south of the village of Penybont, near to Llandrindod Wells in Powys. The surrounding land is used largely for grazing, but there is some arable farming nearby. The farm is located on level ground on the banks of the River Ithon, a tributary of the River Wye, at an elevation of around 230 m, with the land rising to the east and south.

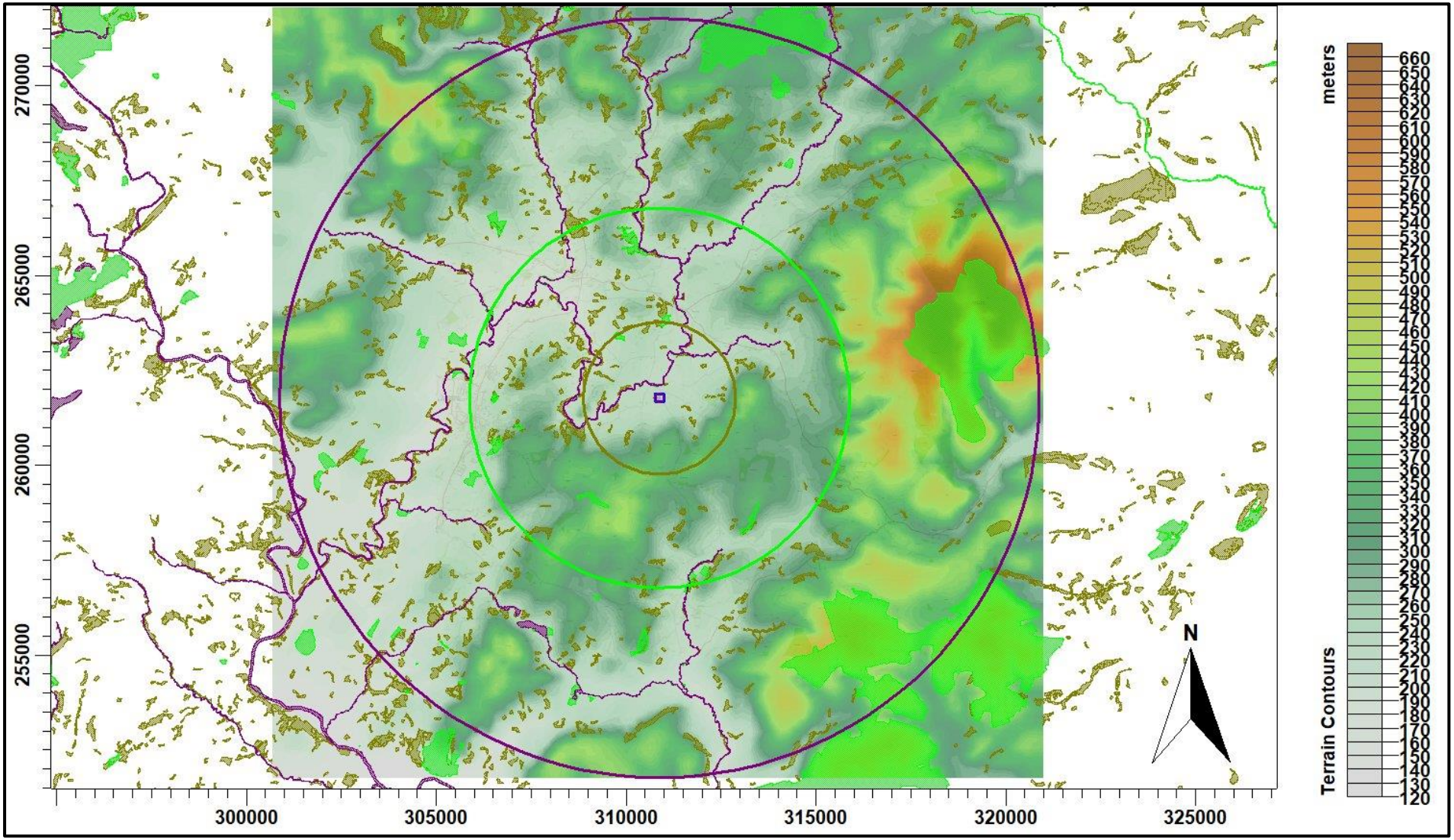
Currently there is a single poultry house at Brynthomas; this house provides accommodation for up to 32,000 egg-laying chickens, which have access to outdoor ranging areas via pop holes on the side of the house. The existing poultry house is naturally ventilated and manure collects within the house, before being cleared out and taken off site at the end of each flock cycle.

Under the proposal, the current poultry house would be replaced by four new poultry houses on the same site. The new poultry houses would provide accommodation for up to 200,000 broiler chickens and would be ventilated via high speed ridge fans with side inlets.

There are a number of areas within 2 km of Brynthomas that are designated as Ancient Woodlands (AWs). Further afield, there are eleven areas designated as Sites of Special Scientific Interest (SSSIs) within 5 km and The River Wye, which is designated as a Special Area of Conservation (SAC), is within 10 km of the site.

A map of the surrounding area showing the position of the site at Brynthomas and the local wildlife sites is provided in Figure 1. In this figure, the SAC is shaded purple, the SSSIs are shaded green, the AWs are shaded olive and the site of the proposed poultry houses is outlined in blue.

Figure 1. The area surrounding Brynthomas – concentric circle radii 10 km purple, 5 km green and 2 km olive



3. Ammonia, Background Levels, Critical Levels & Loads & Emission Rates

3.1 Ammonia concentration and nitrogen and acid deposition

When assessing potential impact on ecological receptors, ammonia concentration is usually expressed in terms of micrograms of ammonia per metre cubed of air (µg-NH_3/m^3) as an annual mean. Ammonia in the air may exert direct effects on the vegetation, or indirectly affect the ecosystem through deposition which causes both hyper-eutrophication (excess nitrogen enrichment) and acidification of soils. Nitrogen deposition, specifically in this case the nitrogen load due to ammonia deposition/absorption is usually expressed in kilograms of nitrogen per hectare per year (kg-N/ha/y). Acid deposition is expressed in terms of kilograms equivalent (of H^+ ions) per hectare per year (keq/ha/y).

3.2 Background ammonia levels and nitrogen and acid deposition

The background ammonia concentration (annual mean) in the area around Brynthomas and the local wildlife sites is 1.15 µg-NH_3/m^3. The background nitrogen deposition rate to woodland is 26.46 kg-N/ha/y and to short vegetation is 16.24 kg-N/ha/y. The background acid deposition rate to woodland is 2.01 keq/ha/y and to short vegetation is 1.26 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS, November 2017).

3.3 Critical Levels & Critical Loads

Critical Levels and Critical Loads are a benchmark for assessing the risk of air pollution impacts to ecosystems. It is important to distinguish between a Critical Level and a Critical Load. The Critical Level is the gaseous concentration of a pollutant in the air, whereas the Critical Load relates to the quantity of pollutant deposited from air to the ground.

Critical Levels are defined as, "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge". (UNECE)

Critical Loads are defined as, "a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge". (UNECE)

For ammonia concentration in air, the Critical Level for higher plants is 3.0 µg-NH_3/m^3 as an annual mean. For sites where there are sensitive lichens and bryophytes present, or where lichens and bryophytes are an integral part of the ecosystem, the Critical Level is 1.0 µg-NH_3/m^3 as an annual mean.

Critical Loads for nutrient nitrogen are set under the Convention on Long-Range Transboundary Air Pollution. They are based on empirical evidence, mainly observations from experiments and gradient studies. Critical Loads are given as ranges (e.g. 10-20 kg-N/ha/y); these ranges reflect variation in ecosystem response across Europe. The Critical Levels and Critical Loads at the wildlife sites assumed in this study are provided in Table 1. The impacts at Howey Brook Stream Section SSSI and Bach y Graig Stream Section SSSI have been disregarded from further investigation as the citations for these sites show that geology is the reason for their designation. N.B. Where the Critical Level of 1.0 µg-NH_3/m^3 is assumed, it is usually unnecessary to consider the Critical Load as the Critical Level provides the stricter test. Normally the Critical Load for nitrogen deposition provides a stricter test than the Critical Load for acid deposition.

Table 1. Critical Levels and Critical Loads at the wildlife sites

Site	Critical Level (µg-NH_3/m^3)	Critical Load - Nitrogen Deposition (kg-N/ha/y)	Critical Load - Acid Deposition (keq/ha/y)
Cae Cwm-Rhocas SSSI	3.0 [1]	10.0 [2]	-
Cae Llwyn SSSI	3.0 [1]	10.0 [2]	-
River Ithon SSSI	1.0 [1]	8.0 [2]	-
Graig Fawr SSSI	1.0 [1]	8.0 [2]	-
Llanfawr Quarries, Llandrindod Wells SSSI	3.0 [1]	8.0 [2]	-
Lake Wood, Llandrindod Wells SSSI	3.0 [1]	10.0 [2]	-
Ithon Valley Woodlands SSSI	3.0 [1]	10.0 [2]	-
Coed Aberdulas SSSI	1.0 [1]	8.0 [2]	-
Caeau Coed Mawr (Coedmawr Fields) SSSI	1.0 [1]	8.0 [2]	-
River Wye SAC (bankside/marginal vegetation)	1.0 [1]	-	-

1. Based on the citation for the site.
2. The lower bound of the range of Critical Loads for the site/species, obtained from APIS.

3.4 Guidance on the significance of ammonia emissions

In March 2017, Natural Resources Wales (Regulation and Permitting Department, EPP) published Operational Guidance Note 41 (OGN 41), "Assessment of ammonia and nitrogen impacts from livestock units when applying for an Environmental Permit or Planning Permission". This guidance was intended to update the way Natural Resources Wales (NRW) assessed emissions, in particular by changing the thresholds of insignificance and the upper threshold process contributions for designated sites. These designated sites include European sites, such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites as well as Sites of Special Scientific Interest (SSSIs).

Table 1 in OGN 41 describes the revised screening distance and thresholds for livestock developments; the threshold of insignificant percentage of the designated site Critical Level or Load is given as 1%; the upper threshold percentage of the designated site Critical Level or Load is given as 8%.

Table 2 in OGN 41 describes the possible outcomes of assessment and for detailed modelling of the application alone, where process contributions, considered in isolation, are up to 1% of the

designated site Critical Level or Load, then it should be determined that there is no significant environmental effect/no likely significant effect/damage to scientific interest.

Where process contributions, considered in isolation, are between 1% and 8% of the designated site Critical Level or Load, an in-combination assessment is required. Should the in-combination process contributions be between 1% and 8% of the designated site Critical Level or Load then it should be determined that the application would cause no significant environmental effect/likely significant effect/damage to scientific interest.

When considering process contributions, in isolation or in-combination, if they exceed 8% of the designated site Critical Level or Load it is necessary to consider background concentrations and whether the designated site Critical Level or Load is breached and whether additional controls may be necessary. The application will then be determined based on whether there will be significant environmental effect/adverse effect/damage to scientific interest.

Please note that as far as AS Modelling & Data Ltd. is aware, currently, there is no publicly available ledger or database of sites with extant planning permission, or other proposed sites in planning, that would provide sufficient information to make an in-combination modelling assessment. Therefore, if Natural Resources Wales, or the Local Authority concerned do not consider the details of the modelling of ammonia emissions from this site provided by this study as sufficient information to fulfil the requirements of their appropriate assessment, then in most cases, it would not be possible for AS Modelling & Data Ltd. to provide this information.

For Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and Ancient Woodlands (AWs), the current assessment procedure usually applied is based on the Environment Agency's horizontal guidance, H1 Environmental Risks Assessment, H1 Annex B - Intensive Farming. The following are taken from this document.

"An emission is insignificant where Process Contribution (PC) is <50% for local and national nature reserves (LNRs & NNRs), ancient woodland and local wildlife sites." And "Where modelling predicts a process contribution >100% at a NNR, LNR, ancient woodland or local wildlife site, your proposal may not be considered acceptable. In such cases, your assessment should include proposals to reduce ammonia emissions."

This document was withdrawn February 1st 2016 and replaced with a web-page titled "Intensive farming risk assessment for your environmental permit", which contains essentially the same criteria. It is assumed that the upper threshold and lower threshold on the web-page refers to the levels that were previously referred to as levels of insignificance and acceptability in Annex B– Intensive Farming.

Within the range between the lower and upper thresholds, whether or not the impact is deemed acceptable is at the discretion of the Environment Agency. N.B. In the case of LWSs and AWs, the Environment Agency do not usually consider other farms that may act in-combination and therefore a PC of up to 100% of Critical Level or Critical Load is usually deemed acceptable for permitting purposes and therefore the upper and lower thresholds are the same (100%).

3.5 IAQM Position Statement on the use of the 1% criterion

A Position Statement issued by the Institute of Air Quality Management (IAQM) in January 2016 further clarifies the use of the 1% criterion for the determination of an '*insignificant*' effect of air quality impacts on sensitive habitats. The Position Statement states: "*the use of a criterion of 1% of an environmental standard or assessment level in the context of habitats should be used only to screen out impacts that will have an insignificant effect. It should not be used as a threshold above which damage is implied.*" Furthermore, if the impacts are plainly above 1% then this should be regarded as potentially significant; where impacts are just slightly greater than 1% then a degree of professional judgement should be applied with regards to the theoretical risk.

3.6 Quantification of Ammonia Emissions

Ammonia emission rates from poultry houses depend on many factors and are likely to be highly variable. However, the benchmarks for assessing impacts of ammonia and nitrogen deposition are framed in terms of an annual mean ammonia concentration and annual nitrogen deposition rates. To obtain relatively robust figures for these statistics, it is not necessary to model short term temporal variations and a steady continuous emission rate can be assumed. In fact, modelling short term temporal variations might introduce rather more uncertainty than modelling continuous emissions.

3.5.1 Existing and proposed chicken housing ammonia emissions

The Environment Agency provides an Intensive Farming guidance note which lists standard ammonia emission factors for a variety of livestock, including poultry. For free-range egg laying chickens caged with deep pit manure stores underneath, the Environment Agency figure is 0.29 kg-NH_3/bird place/year and for broiler chickens it is 0.034 kg-NH_3/bird place/year; these figures are used as the basis of the calculation of the emissions from the existing and proposed poultry units.

3.5.2 Proposed ranging area ammonia emissions

As the birds in the existing egg-laying chicken houses would have access to outdoor ranging areas, some of the birds' droppings, which is the source of the ammonia, would be deposited on these ranging areas. For modelling purposes, it is assumed that 12% of the droppings are deposited on the ranging areas; this assumption is based upon figures from "Ammonia emission factors for UK agriculture" (Misselbrook *et al*)[1]. To estimate the ammonia emissions from the ranges, it has been assumed that laying hens produce 0.8 kg-N/y (Misselbrook) in their droppings and that 35% of ammoniacal nitrogen is emitted as ammonia (Misselbrook and Defra). This equates to an emission factor of 0.34 kg-NH_3/bird/year. Details of the poultry numbers and types and emission factors used and calculated baseline ammonia emission rates are provided in Table 2.

1. A figure of 20% is sometimes assumed. However, it should be noted that this figure is probably based primarily upon the widely accepted figure of 80% of dropping occurring at night when birds are housed and a single report; however, because, even under optimal conditions, not all of the birds go outside (50% is considered high percentage), this does not imply that 20% of droppings occur outside the house.

Table 2. Details of poultry numbers and baseline ammonia emission rates

Source	Animal numbers/ Tonnes	Type or weight	Emission factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Existing Housing	32,000 (x 0.88)	Caged with deep pit manure storage underneath	0.29	0.258778
Existing Ranges	32,000 (x 0.12)	Range (AS Modelling & Data figure)	0.34	0.041372
Proposed Housing	200,000	Broiler Chickens	0.034	0.215479

4. The Atmospheric Dispersion Modelling System (ADMS) and model parameters

The Atmospheric Dispersion Modelling System (ADMS) ADMS 5 is a new generation Gaussian plume air dispersion model, which means that the atmospheric boundary layer properties are characterised by two parameters; the boundary layer depth and the Monin-Obukhov length rather than in terms of the single parameter Pasquill-Gifford class.

Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian expression).

ADMS has a number of model options including: dry and wet deposition; NO_x chemistry; impacts of hills; variable roughness; buildings and coastlines; puffs; fluctuations; odours; radioactivity decay (and γ-ray dose); condensed plume visibility; time varying sources and inclusion of background concentrations.

ADMS has an in-built meteorological pre-processor that allows flexible input of meteorological data both standard and more specialist. Hourly sequential and statistical data can be processed and all input and output meteorological variables are written to a file after processing.

The user defines the pollutant, the averaging time (which may be an annual average or a shorter period), which percentiles and exceedance values to calculate, whether a rolling average is required or not and the output units. The output options are designed to be flexible to cater for the variety of air quality limits which can vary from country to country and are subject to revision.

4.1 Meteorological data

Computer modelling of dispersion requires hourly sequential meteorological data and to provide robust statistics the record should be of a suitable length; preferably four years or longer.

The meteorological data used in this study is obtained from assimilation and short term forecast fields of the Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS). Observational meteorological data from Shobdon Airfield, Trawsgoed and Sennybridge is also considered.

The GFS is a spectral model and data are archived at a horizontal resolution of 0.25 degrees, which is approximately 25 km over the UK (formerly 0.5 degrees, or approximately 50 km). The GFS resolution adequately captures major topographical features and the broad-scale characteristics of the weather over the UK. Smaller scale topological features may be included in the dispersion modelling by using the flow field module of ADMS (FLOWSTAR)[1]. The use of NWP data has advantages over traditional meteorological records because:

- Calm periods in traditional observational records may be over represented, this is because the instrumentation used may not record wind speeds below approximately 0.5 m/s and start up wind speeds may be greater than 1.0 m/s. In NWP data, the wind speed is continuous down to 0.0 m/s, allowing the calms module of ADMS to function correctly.

- Traditional records may include very local deviations from the broad-scale wind flow that would not necessarily be representative of the site being modelled; these deviations are difficult to identify and remove from a meteorological record. Conversely, local effects at the site being modelled are relatively easy to impose on the broad-scale flow and provided horizontal resolution is not too great, the meteorological records from NWP data may be expected to represent well the broad-scale flow.

- Information on the state of the atmosphere above ground level which would otherwise be estimated by the meteorological pre-processor may be included explicitly.

The wind rose for the raw GFS data for the Brynthomas site is shown in Figure 2a.

Wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and where terrain data is included in the modelling, the raw GFS wind speeds and directions will be modified. The terrain and roughness length modified wind rose for the location of the existing and proposed poultry houses at Brynthomas is shown in Figure 2b. Note that elsewhere in the modelling domain the modified wind roses may differ more, or less, markedly and that the resolution of the wind field is approximately 350 m.

Data from the meteorological recording stations at Shobdon Airfield, Trawsgoed and Sennybridge have also been considered as the closest to the site. Shobdon Airfield is approximately 28.5 km to the east, Trawsgoed is 45 km approximately to the west and Sennybridge is approximately 29 km to the south-west of Brynthomas. However, neither Shobdon Airfield, Trawsgoed nor Sennybridge is considered to have an aspect that in any way could be considered similar to that at Brynthomas; therefore, it should be noted that the frequency of winds from a particular direction in the Shobdon Airfield, Trawsgoed or Sennybridge data may be either high or low in comparison to what might occur at Brynthomas, which means mean concentrations downwind may be either over or under predicted. Additionally, periods of light winds and calms cannot be properly modelled. Therefore, it is the opinion of AS Modelling & Data Ltd. that the results obtained using the GFS data, particularly when modified by using FLOWSTAR[2], are less likely to have gross errors than the results obtained using the observational data and should be given more weight when interpreting the results of the modelling. The wind rose for Shobdon Airfield is shown in Figure 2c, the wind rose for Trawsgoed is shown in Figure 2d and the wind rose for Sennybridge is shown in Figure 2e.

1. Note that FLOWSAR requirements are for meteorological data representative of the upwind flow over the modelling domain and that single site meteorological data that is representative of the application site is not generally suitable.
2. When modelling complex terrain with ADMS, by default, the minimum turbulence length has 0.1 m added to the flat terrain value (calculated from the Monin–Obukhov length). Whist this might be appropriate over hill/mountain tops in terrain with slopes > 1:10 in lesser terrain it introduces model behaviour that is not desirable where FLOWSTAR is simply being used to modify the upwind flow. Specifically, the parameter sigma z of the Gaussian plume model is overly constrained, which for point sources emissions, may cause over prediction of ground level concentrations in stable weather conditions and light winds (Steven R. Hanna & Biswanath Chowdhury, 2013). Note that this becomes particularly important if calm and light wind conditions are not being ignored as they often are when using traditional observational meteorological datasets. To reduce this behaviour, where terrain is modelled, AS Modelling & Data Ltd. have set a minimum turbulence length of 0.025 m in ADMS. This approximates the normal behaviour of ADMS with flat terrain.

Figure 2a. The wind rose. Raw GFS derived data, for 52.247 N, 3.307 W, 2013-2016

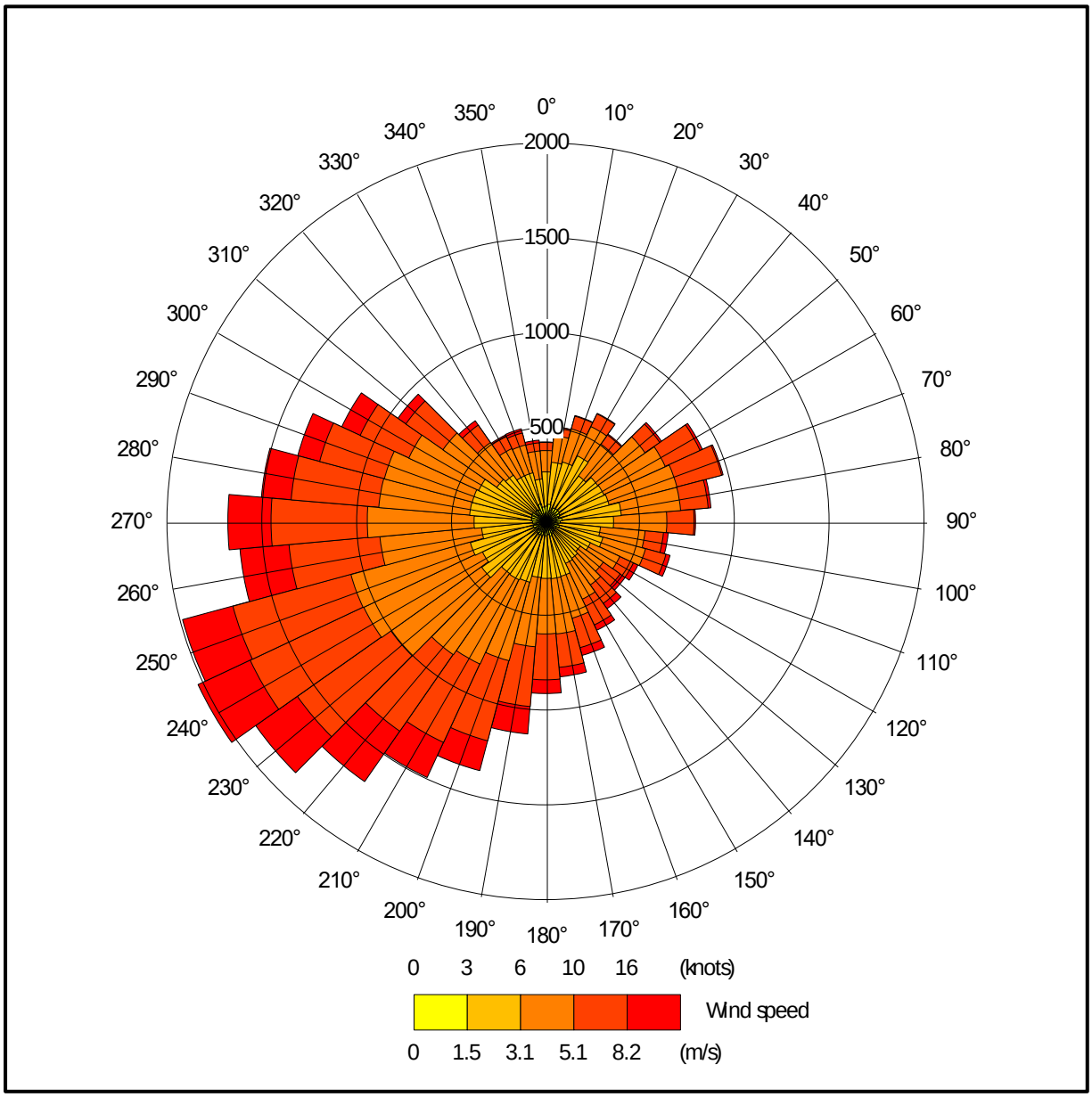


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 310875, 261765, 2013-2016

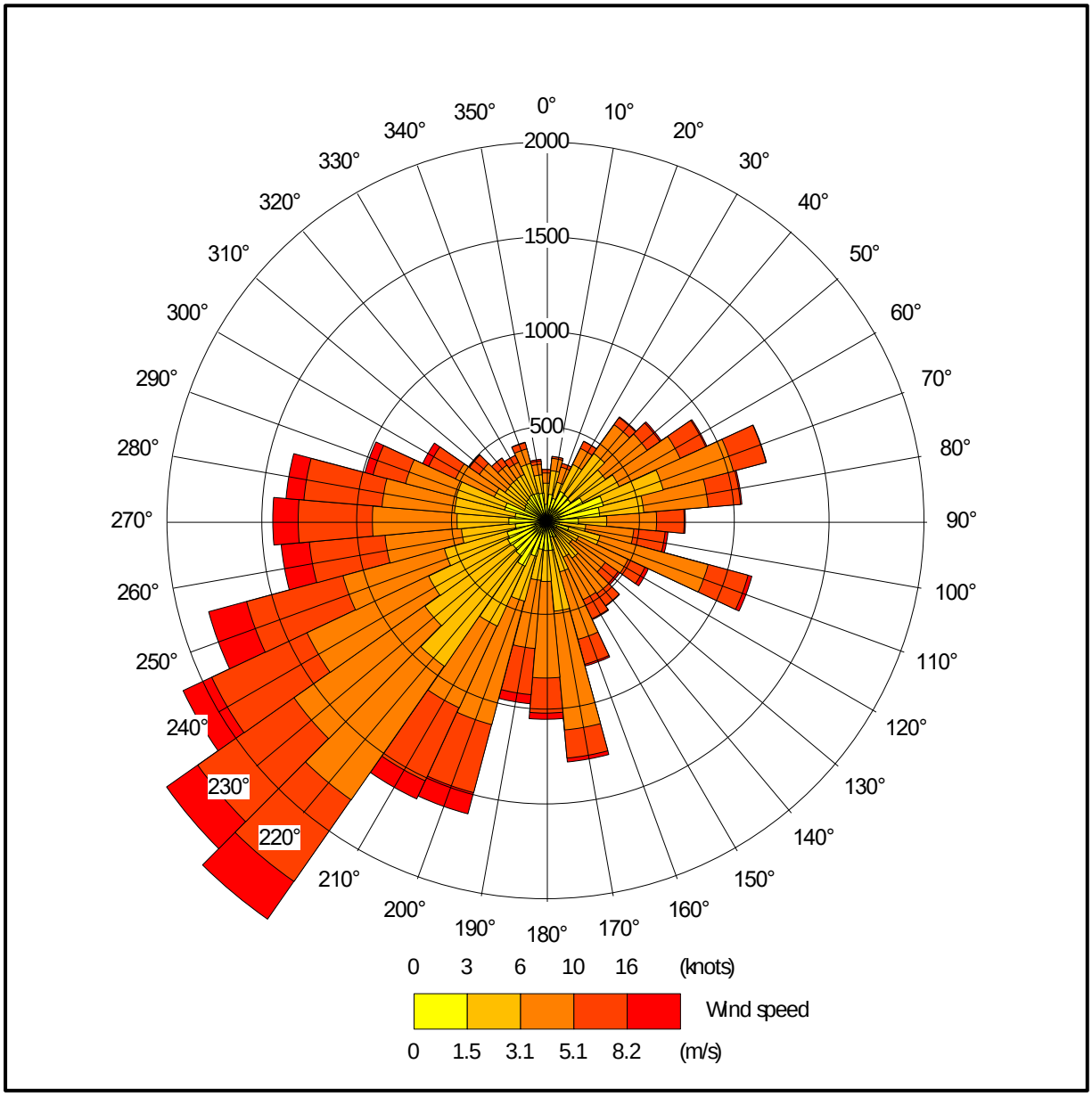


Figure 2c. The wind rose. Recorded meteorological data at Shobdon Airfield, 2013-2016

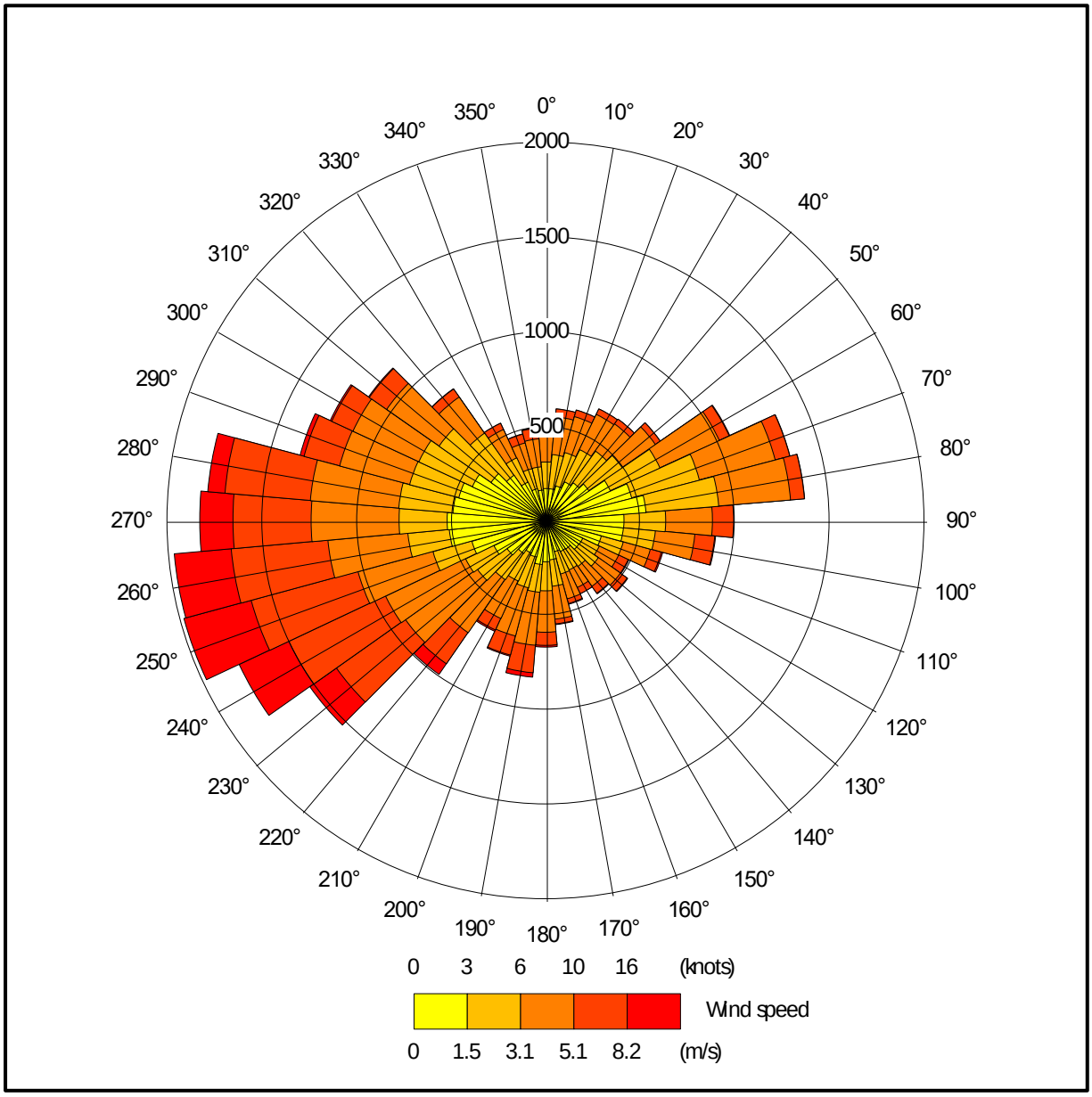


Figure 2d. The wind rose. Recorded meteorological data at Trawgoed, 2013-2016

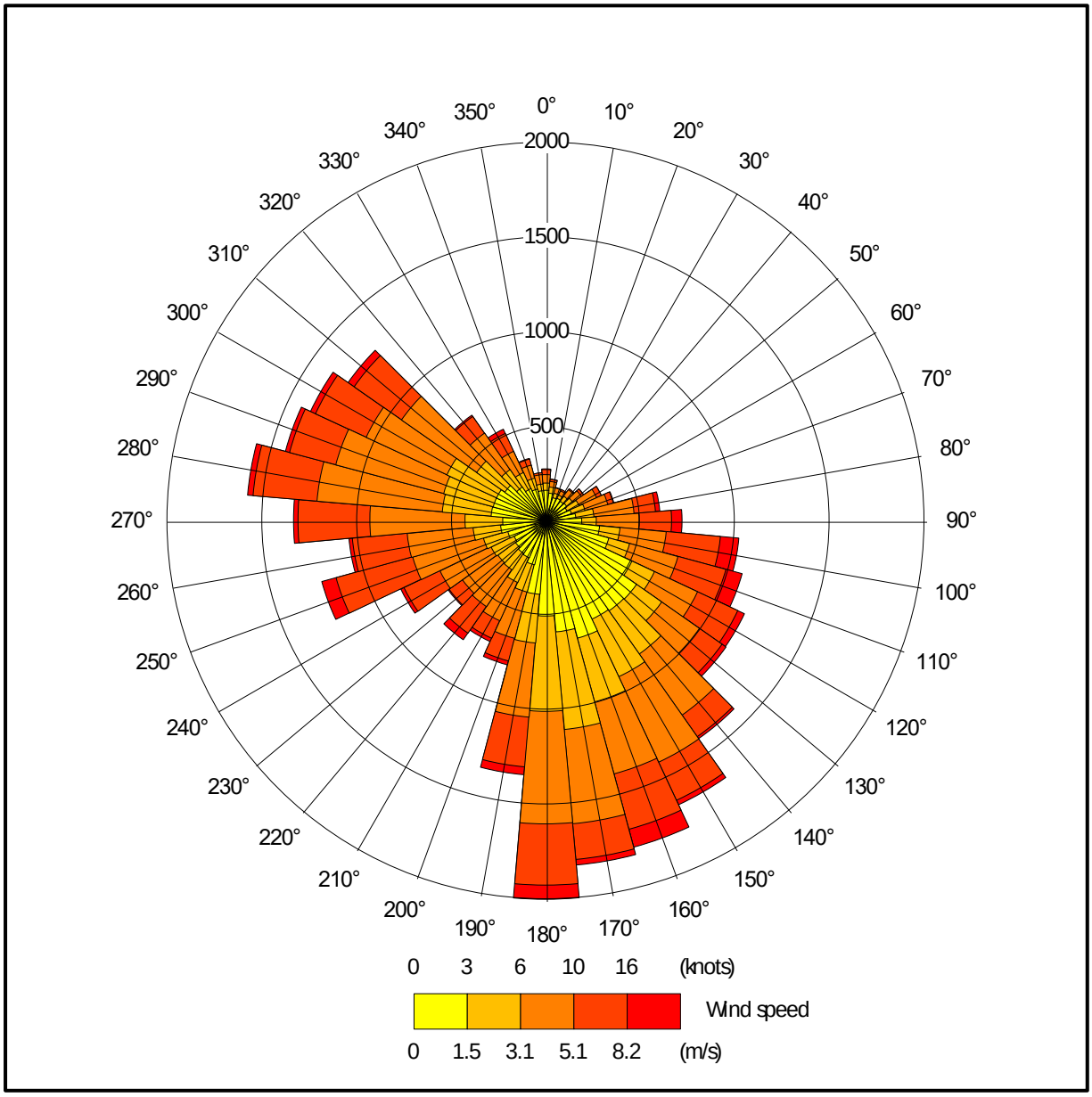
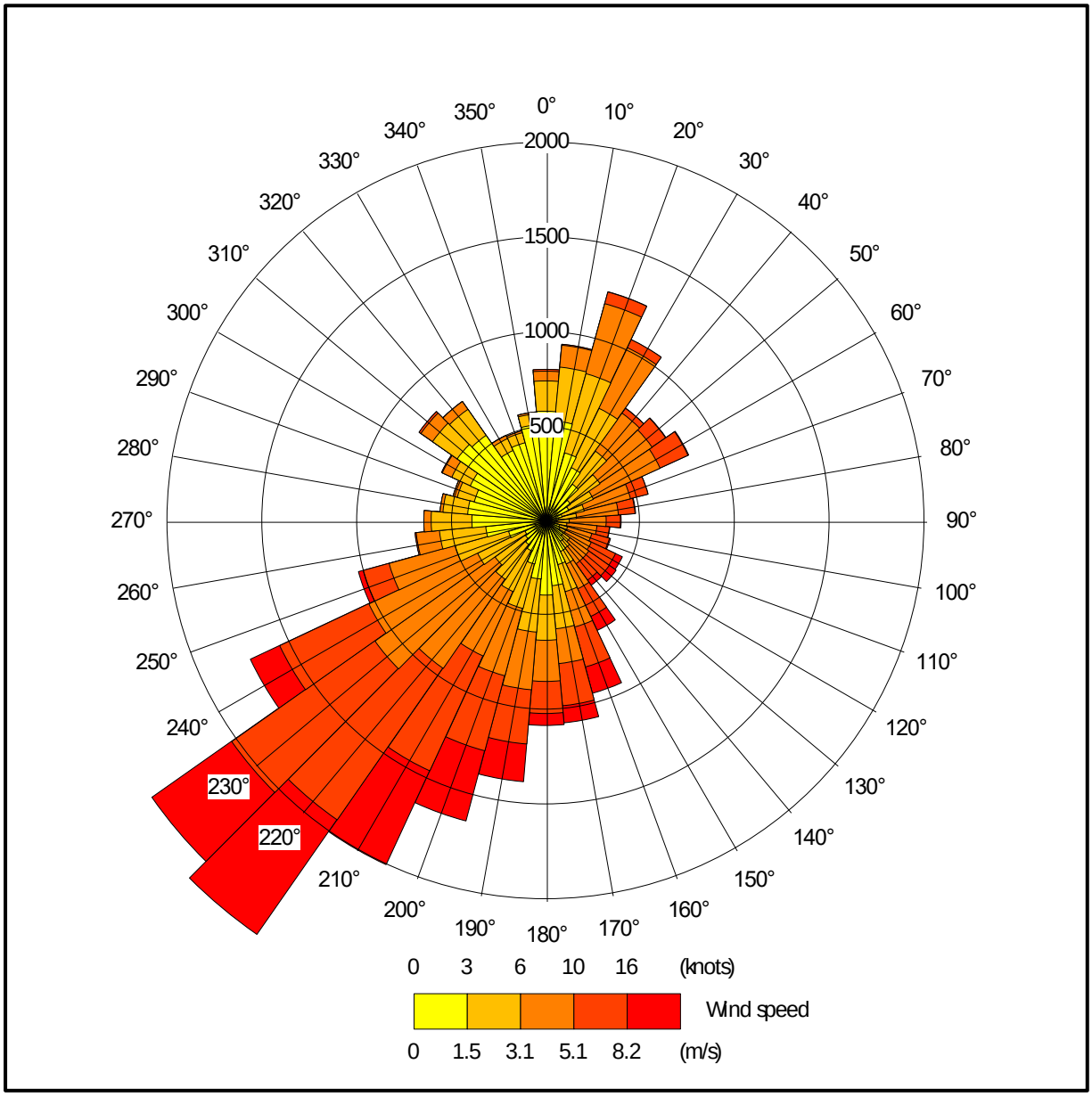


Figure 2e. The wind rose. Recorded meteorological data at Sennybridge, 2013-2016



4.2 Emission sources

Emissions from the naturally ventilated existing layer house are represented by a single volume source within ADMS (EX1v). Details of the volume source parameters are shown in Table 3a and the position of the volume source may be seen in Figure 3a, where it is indicated by a red rectangle.

Table 3a. Volume source parameters

Source ID	Length Y (m)	Width X (m)	Depth (m)	Base height (m)	Emission temperature (°C)	Emission rate (g-NH_3/s)
EX1v	110.0	18.5	3.0	0.0	Ambient	0.258778

The egg-laying chickens in the existing poultry house have access to external ranging areas. Emissions from these ranging areas are represented by area sources within ADMS (EX1_rana and EX1_ranb). Details of the area source parameters are shown in Table 3b and the position of the area sources may be seen in Figure 3a, where they are indicated by red polygons.

Table 3b. Area source parameters

Source ID	Area (m^2)	Base height (m)	Emission temperature (°C)	Emission rate (g-NH_3/s)
EX1_rana	1,779	0.0	Ambient	0.020686
EX1_ranb	2,136	0.0	Ambient	0.020686

Emissions from the chimneys of uncapped high speed ridge fans on the proposed poultry houses are represented by three point sources per house within ADMS (PR1 to PR4; a, b & c). Details of the point source parameters are shown in Table 3c and the positions of the point sources may be seen in Figure 3b, where they are indicated by red stars.

Table 3c. Point source parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (°C)	Baseline emission rate per source (g-NH_3/s)
PR1 to PR4; a, b & c	6.0	0.8	11.0	21.0	0.017957

4.3 Modelled buildings

The structure of the proposed poultry houses may affect the plumes from the point sources on the proposed new poultry houses. Therefore, these buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3b, where they are marked by grey rectangles.

4.4 Discrete receptors

One hundred and forty-eight discrete receptors have been defined: forty-three at the AWs (1 to 43), twenty-one at the SSSIs (44 to 64) and eighty-four at The River Wye SAC (65 to 148). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figure 4a, a broad scale view and Figure 4b, a closer view, where they are marked by enumerated pink rectangles.

Figure 3a. The positions of modelled sources - existing

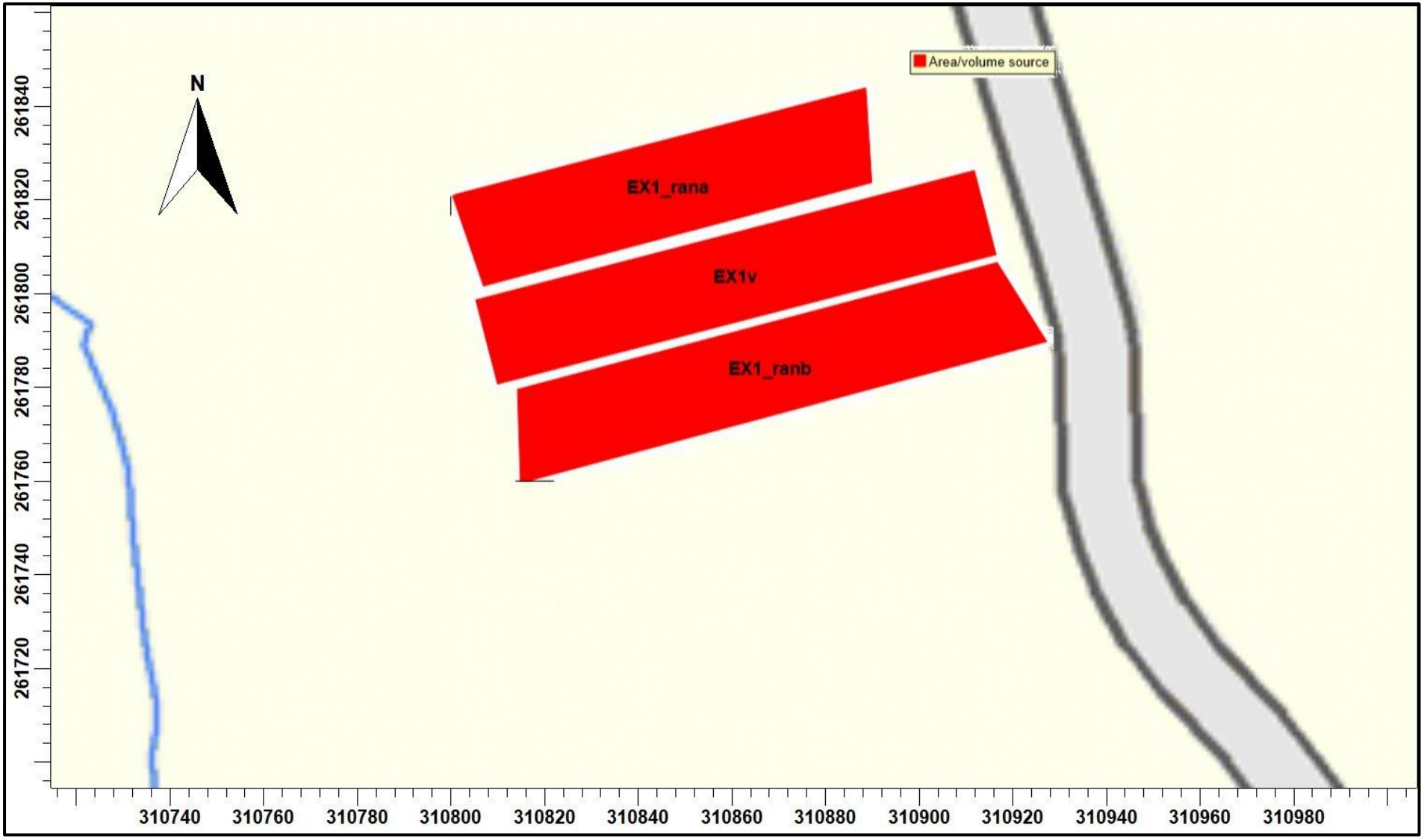
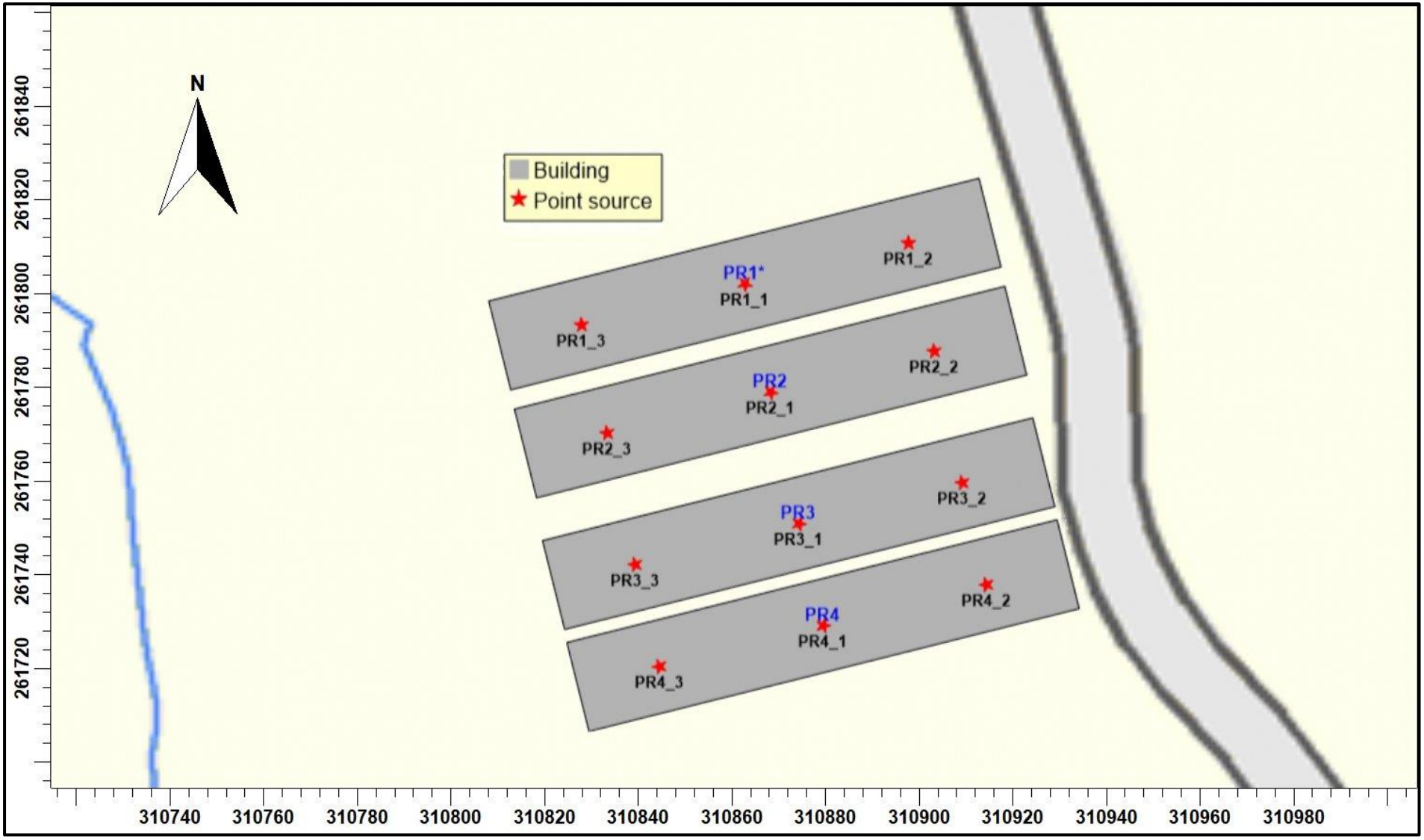


Figure 3b. The positions of modelled buildings & sources - proposed



4.5 Cartesian grids

To produce the contour plots presented in Section 5 of this report and to define the spatially varying deposition fields used in the detailed modelling, a regular Cartesian grid has been defined within ADMS. The individual grid receptors are defined at ground level within ADMS. The position of the Cartesian grid may be seen in Figure 4b, where it is marked by grey lines bounded by a purple rectangle.

4.6 Terrain data

Terrain has been considered in the modelling. The terrain data are based upon the Ordnance Survey 50 m Digital Elevation Model. A 22.0 km x 22.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS. N.B. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field is approximately 350 m.

Figure 4a. The discrete receptors and Cartesian grid receptors – concentric circles radius 10 km (purple), 5 km (green) and 2 km (olive)

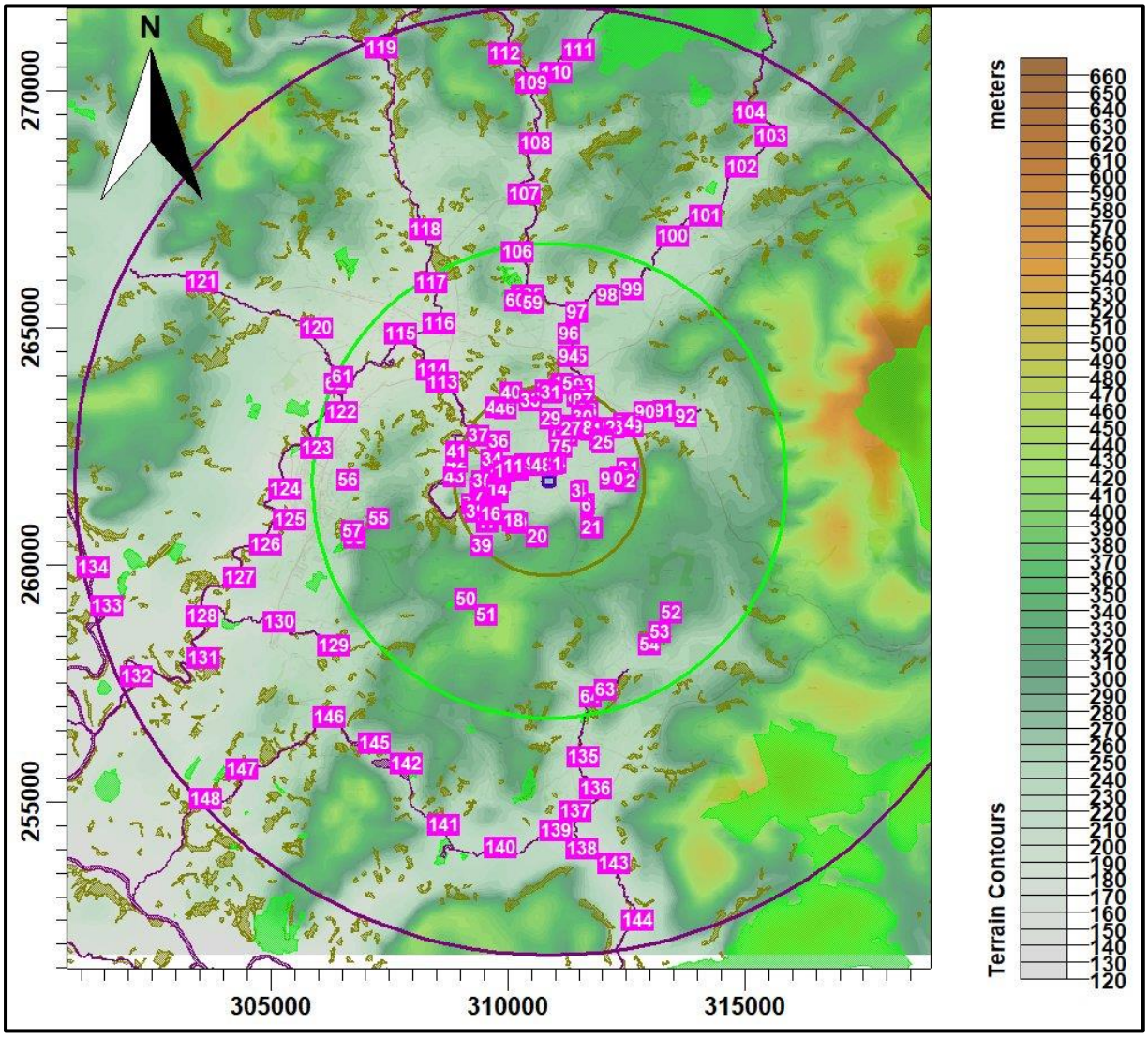
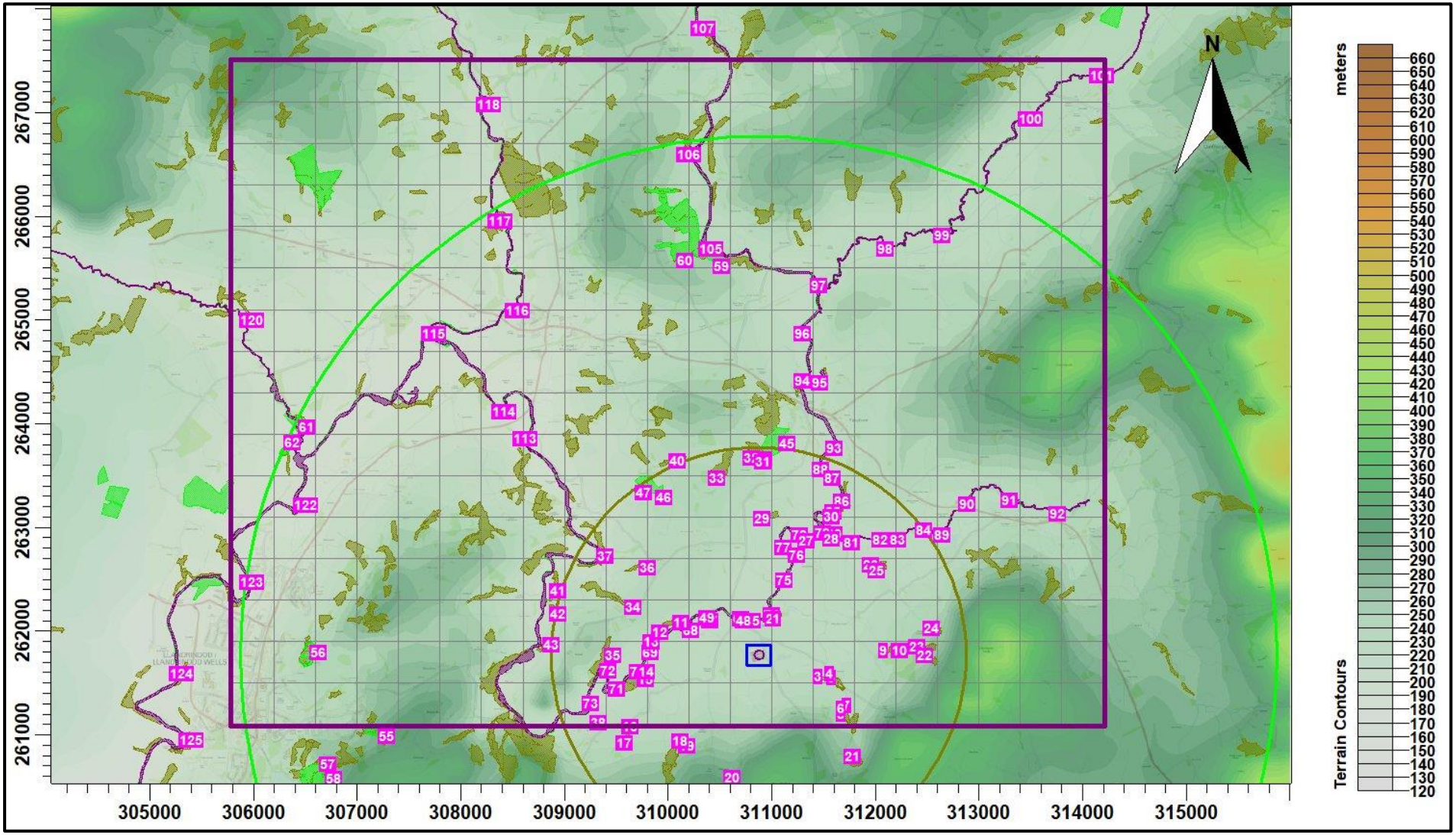


Figure 4b. The discrete receptors and Cartesian grid receptors – concentric circles radii 5 km (green) and 2 km (olive)



4.7 Roughness Length

A fixed surface roughness length of 0.25 m has been applied over the entire modelling domain. As a precautionary measure, the GFS meteorological data is assumed to have a roughness length of 0.225 m. The effect of the difference in roughness length is precautionary as it increases the frequency of low wind speeds and the stability and therefore increases predicted ground level concentrations.

4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based on a document titled "Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming" from the Environment Agency's Air Quality Modelling and Assessment Unit, 22 November 2010. N.B. AS Modelling & Data Ltd. has restricted deposition over arable farmland and heavily grazed and fertilised pasture; this is to compensate for possible saturation effects due to fertilizer application and to allow for periods when fields are clear of crops (Sutton), the deposition is also restricted over areas with little or no vegetation and the deposition velocity is set to 0.002 m/s where grid points are over the poultry housing and 0.015 m/s over heavily grazed grassland. Where deposition over water surfaces is calculated, a deposition velocity of 0.005 m/s is used.

In summary, the method is as follows:

- A preliminary run of the model without deposition is used to provide an ammonia concentration field.
- The preliminary ammonia concentration field, along with land usage, has been used to define two deposition velocity fields. The deposition velocities used are provided in Table 4.

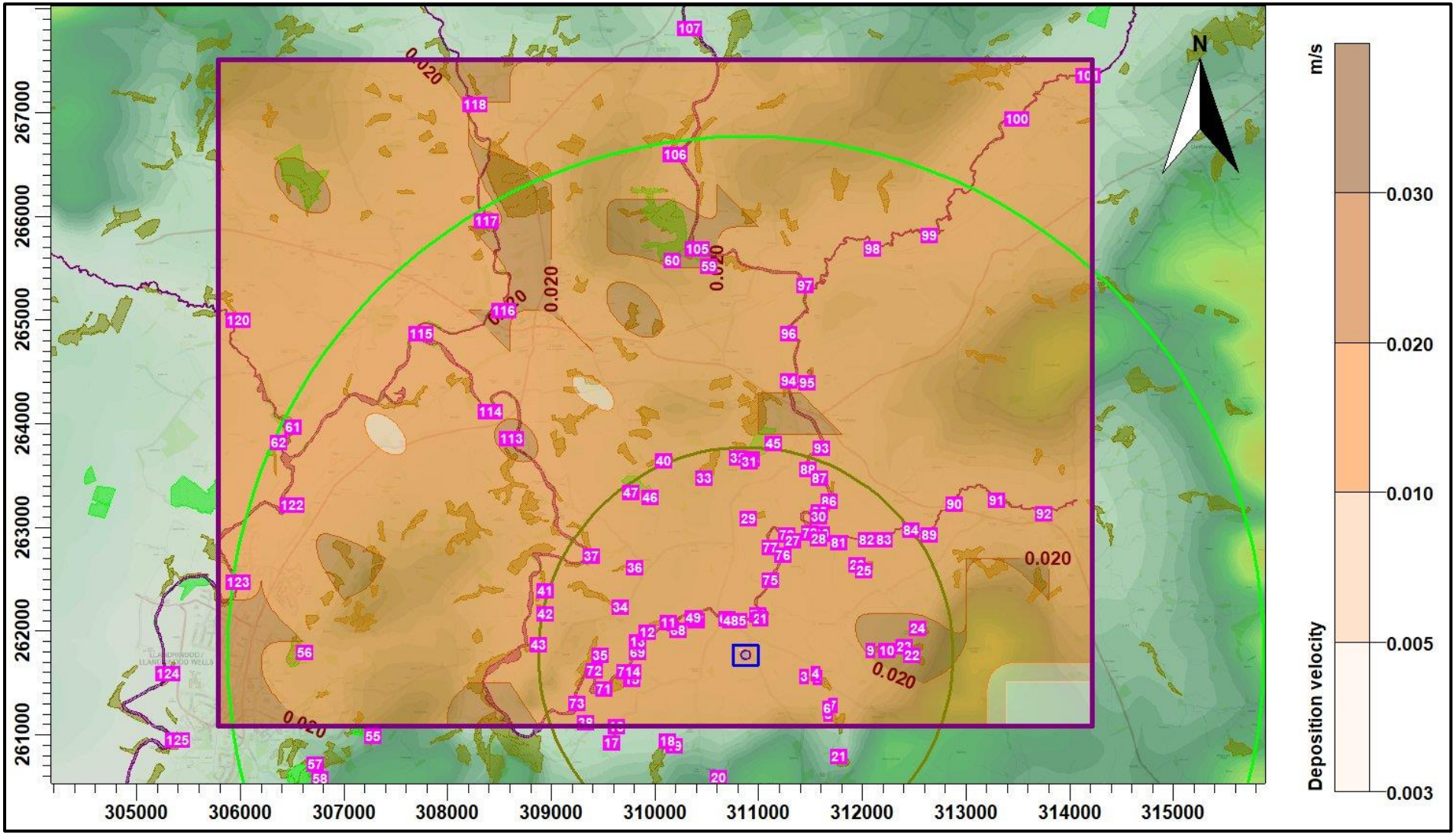
Table 4. Deposition velocities

NH3 concentration (PC + background) (µg/m^3)	< 10	10 - 20	20 - 30	30 – 80	> 80
Deposition velocity – woodland (m/s)	0.03	0.015	0.01	0.005	0.003
Deposition velocity – short vegetation (m/s)	0.02 (0.015 over heavily grazed grassland)	0.015	0.01	0.005	0.003
Deposition velocity – arable farmland/rye grass (m/s)	0.005	0.005	0.005	0.005	0.003

- The model is then rerun with the spatially varying deposition module.

A contour plot of the spatially varying deposition field is provided in Figure 5.

Figure 5. The spatially varying deposition field



5. Details of the Model Runs and Results

5.1 Preliminary modelling

ADMS was effectively run a total of forty-eight times, once for each year of the meteorological record for the existing and proposed scenarios in six modes:

- In basic mode without calms, or terrain – GFS data.
- With calms and without terrain – GFS data.
- Without calms and with terrain – GFS data.
- In basic mode without calms, or terrain – Sennybridge data.
- In basic mode without calms, or terrain – Shobdon Airfield data.
- In basic mode without calms, or terrain – Trawsgoed data.

For each mode, statistics for the maximum annual mean ammonia concentration at each receptor were compiled. Equivalent ammonia concentrations are shown in Tables 5a and 5b below.

Details of the predicted annual mean ammonia concentrations at each receptor are provided in Table 6a, for the existing poultry unit and Table 6b, for the proposed poultry unit. In these Tables, predicted ammonia concentrations that are in excess of Natural Resources Wales' upper threshold (8% of Critical Level or Load for a SSSI or SAC, 100% of Critical Level or Load for a non-statutory wildlife site) are coloured red. Concentrations in the range between Natural Resources Wales' upper threshold and lower threshold (1% to 8% for a SSSI/SAC, 100% to 100% for a non-statutory wildlife site) are coloured blue.

Table 5a. Equivalent ammonia concentrations (bankside vegetation)

Deposition Velocity (m/s)	Concentration equivalent to X % of Critical Load of 10 kg/ha (µg/m^3)					
	100%	50%	20%	8%	4%	1%
0.03	1.284	0.642	0.257	0.103	**0.051**	0.013
0.02	1.925	0.963	0.385	0.154	0.077	0.019

Table 5b. Equivalent ammonia concentrations (aquatic vegetation)

Deposition Velocity (m/s)	Concentration equivalent to X % of Critical Load of 3 kg/ha (µg/m^3)					
	100%	50%	20%	8%	4%	1%
0.005	2.310	1.155	0.462	0.185	0.092	0.023

Table 6a. Predicted maximum annual mean ammonia concentration rate at the discrete receptors – existing poultry unit

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m^3)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
1	311051	262101	Unnamed AW	**3.859**	**4.246**	**3.337**	**7.030**	**4.926**	**4.672**
2	310983	262101	Unnamed AW	**4.258**	**4.714**	**3.789**	**9.747**	**5.741**	**7.324**
3	311442	261548	Unnamed AW	**1.612**	**1.688**	**1.798**	**2.217**	**4.455**	**2.655**
4	311557	261572	Unnamed AW	**1.236**	**1.313**	**1.460**	**1.633**	**3.588**	**2.037**
5	311574	261540	Unnamed AW	**1.167**	**1.221**	**1.333**	**1.535**	**3.343**	**1.932**
6	311668	261243	Unnamed AW	0.668	0.709	0.781	**1.287**	**1.910**	**1.082**
7	311724	261269	Unnamed AW	0.658	0.693	0.773	**1.151**	**1.880**	**1.085**
8	311671	261184	Unnamed AW	0.601	0.643	0.701	**1.258**	**1.714**	0.972
9	312080	261795	Unnamed AW	0.534	0.575	0.690	0.731	**1.556**	0.631
10	312239	261798	Unnamed AW	0.430	0.464	0.563	0.592	**1.262**	0.508
11	310127	262069	Unnamed AW	0.828	0.851	0.673	0.439	**1.694**	**1.694**
12	309927	261972	Unnamed AW	0.643	0.699	0.875	0.294	**1.491**	0.952
13	309836	261887	Unnamed AW	0.622	0.669	0.955	0.271	**1.440**	0.720
14	309792	261593	Unnamed AW	0.647	0.693	**1.068**	0.321	**1.752**	0.458
15	309780	261519	Unnamed AW	0.618	0.663	**1.074**	0.330	**1.682**	0.425
16	309633	261069	Unnamed AW	0.351	0.380	0.571	0.344	0.776	0.199
17	309580	260904	Unnamed AW	0.291	0.316	0.423	0.332	0.604	0.162
18	310121	260925	Unnamed AW	0.486	0.525	0.346	0.824	0.764	0.263
19	310186	260878	Unnamed AW	0.504	0.542	0.331	0.906	0.724	0.266
20	310616	260575	Unnamed AW	0.351	0.396	0.358	**1.188**	0.466	0.263
21	311780	260778	Unnamed AW	0.278	0.313	0.325	0.789	0.791	0.464
22	312480	261754	Unnamed AW	0.328	0.354	0.414	0.453	0.956	0.393
23	312406	261840	Unnamed AW	0.346	0.374	0.441	0.488	**1.036**	0.408
24	312539	262016	Unnamed AW	0.274	0.300	0.306	0.393	0.856	0.331
25	312015	262566	Unnamed AW	0.389	0.405	0.448	0.462	0.628	0.386
26	311956	262628	Unnamed AW	0.395	0.411	0.472	0.489	0.597	0.396
27	311333	262854	Unnamed AW	0.433	0.484	0.430	0.992	0.611	0.690

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m^3)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
28	311580	262881	Unnamed AW	0.366	0.407	0.418	0.690	0.499	0.447
29	310907	263072	Unnamed AW	0.302	0.342	0.399	**1.227**	0.516	**1.270**
30	311580	263089	Unnamed AW	0.286	0.319	0.348	0.593	0.397	0.387
31	310915	263622	Unnamed AW	0.159	0.181	0.209	0.666	0.278	0.695
32	310805	263657	Unnamed AW	0.152	0.174	0.182	0.651	0.259	0.726
33	310474	263463	Unnamed AW	0.208	0.226	0.193	0.634	0.248	0.901
34	309667	262219	Unnamed AW	0.358	0.368	0.309	0.185	0.757	0.717
35	309469	261756	Unnamed AW	0.399	0.428	0.663	0.176	0.993	0.347
36	309804	262598	Unnamed AW	0.281	0.322	0.176	0.297	0.390	0.955
37	309389	262713	Unnamed AW	0.176	0.202	0.116	0.159	0.280	0.568
38	309332	261103	Unnamed AW	0.282	0.305	0.511	0.216	0.715	0.181
39	309451	260402	Unnamed AW	0.184	0.200	0.185	0.288	0.336	0.101
40	310086	263631	Unnamed AW	0.167	0.182	0.149	0.347	0.158	0.657
41	308939	262378	Unnamed AW	0.162	0.167	0.148	0.081	0.369	0.304
42	308939	262153	Unnamed AW	0.182	0.199	0.214	0.084	0.434	0.275
43	308878	261853	Unnamed AW	0.208	0.224	0.308	0.091	0.502	0.211
44	310930	263645	Cae Cwm-Rhocas SSSI	**0.155**	**0.177**	**0.207**	**0.650**	**0.273**	**0.672**
45	311145	263800	Cae Cwm-Rhocas SSSI	**0.137**	**0.156**	**0.231**	**0.521**	**0.240**	**0.470**
46	309957	263276	Cae Llwyn SSSI	**0.181**	**0.201**	**0.177**	**0.312**	**0.187**	**0.788**
47	309767	263318	Cae Llwyn SSSI	**0.142**	**0.161**	**0.121**	**0.224**	**0.169**	**0.674**
48	310732	262083	River Ithon SSSI	**4.050**	**4.433**	**2.380**	**8.121**	**4.059**	**16.297**
49	310375	262111	River Ithon SSSI	**1.218**	**1.387**	**1.009**	**1.093**	**1.829**	**3.811**
50	309111	259263	Howey Brook Stream Section SSSI	**0.093**	**0.101**	**0.053**	**0.175**	**0.133**	**0.050**
51	309550	258929	Howey Brook Stream Section SSSI	**0.093**	**0.101**	**0.046**	**0.213**	**0.114**	**0.050**
52	313456	258981	Graig Fawr SSSI	**0.050**	**0.056**	**0.034**	**0.143**	**0.144**	**0.083**
53	313216	258574	Graig Fawr SSSI	**0.044**	**0.047**	**0.030**	**0.127**	**0.109**	**0.067**
54	312996	258313	Graig Fawr SSSI	**0.045**	**0.048**	**0.031**	**0.118**	**0.092**	**0.058**
55	307283	260976	Bach y Graig Stream Section SSSI	**0.081**	**0.087**	**0.087**	**0.042**	**0.228**	**0.057**
56	306625	261781	Llannfawr Quarries, Llandrindod Wells SSSI	**0.059**	**0.064**	**0.059**	**0.026**	**0.148**	**0.055**

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m^3)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
57	306719	260705	Lake Wood, Llandrindod Wells SSSI	0.062	0.067	0.063	0.034	0.176	0.044
58	306771	260569	Lake Wood, Llandrindod Wells SSSI	0.062	0.067	0.061	0.035	0.175	0.043
59	310521	265509	Ithon Valley Woodlands SSSI	0.048	0.054	0.066	0.200	0.075	0.238
60	310166	265561	Ithon Valley Woodlands SSSI	0.051	0.056	0.055	0.176	0.068	0.233
61	306510	263953	Coed Aberdulas SSSI	0.033	0.035	0.040	0.023	0.063	0.090
62	306375	263807	Coed Aberdulas SSSI	0.034	0.035	0.041	0.021	0.067	0.083
63	312056	257342	Caeau Coed Mawr (Coedmawr Fields) SSSI	0.042	0.044	0.040	0.100	0.052	0.036
64	311754	257216	Caeau Coed Mawr (Coedmawr Fields) SSSI	0.040	0.042	0.039	0.104	0.048	0.035
65	310811	262086	River Wye SAC	4.499	4.914	3.562	14.323	5.764	19.312
66	310701	262101	River Wye SAC	3.283	3.621	2.147	5.945	3.277	13.264
67	310403	262091	River Wye SAC	1.359	1.547	1.155	1.209	2.060	4.226
68	310223	261993	River Wye SAC	1.106	1.158	0.985	0.557	2.421	2.061
69	309831	261784	River Wye SAC	0.670	0.718	0.994	0.294	1.634	0.605
70	309711	261591	River Wye SAC	0.571	0.612	0.944	0.279	1.544	0.407
71	309505	261424	River Wye SAC	0.413	0.444	0.695	0.225	1.130	0.283
72	309418	261602	River Wye SAC	0.387	0.415	0.654	0.180	1.035	0.284
73	309253	261286	River Wye SAC	0.298	0.321	0.532	0.173	0.812	0.202
74	310997	262139	River Wye SAC	3.426	3.797	2.965	7.901	4.647	5.907
75	311118	262474	River Wye SAC	0.986	1.100	0.830	2.387	1.389	1.772
76	311241	262721	River Wye SAC	0.560	0.625	0.533	1.328	0.794	0.953
77	311114	262791	River Wye SAC	0.497	0.557	0.594	1.496	0.771	1.240
78	311270	262916	River Wye SAC	0.401	0.449	0.440	1.021	0.587	0.764
79	311497	262935	River Wye SAC	0.358	0.400	0.423	0.738	0.495	0.481
80	311607	262920	River Wye SAC	0.343	0.382	0.389	0.647	0.469	0.420
81	311774	262840	River Wye SAC	0.352	0.381	0.379	0.555	0.461	0.391
82	312049	262869	River Wye SAC	0.293	0.309	0.350	0.401	0.417	0.310
83	312216	262872	River Wye SAC	0.262	0.274	0.294	0.333	0.393	0.268
84	312468	262965	River Wye SAC	0.207	0.216	0.230	0.254	0.324	0.209
85	311594	263140	River Wye SAC	0.268	0.300	0.330	0.564	0.374	0.369

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
86	311681	263236	River Wye SAC	0.234	0.262	0.263	0.483	0.327	0.314
87	311588	263462	River Wye SAC	0.193	0.217	0.274	0.459	0.281	0.322
88	311476	263542	River Wye SAC	0.182	0.205	0.299	0.485	0.275	0.367
89	312646	262911	River Wye SAC	0.186	0.195	0.193	0.221	0.317	0.189
90	312886	263214	River Wye SAC	0.142	0.148	0.158	0.172	0.228	0.143
91	313297	263245	River Wye SAC	0.110	0.116	0.115	0.131	0.196	0.115
92	313755	263121	River Wye SAC	0.087	0.093	0.078	0.109	0.197	0.098
93	311605	263752	River Wye SAC	0.148	0.167	0.261	0.382	0.222	0.281
94	311294	264396	River Wye SAC	0.087	0.100	0.195	0.325	0.154	0.288
95	311466	264385	River Wye SAC	0.090	0.102	0.194	0.300	0.151	0.252
96	311294	264857	River Wye SAC	0.065	0.075	0.145	0.255	0.118	0.230
97	311455	265319	River Wye SAC	0.052	0.059	0.106	0.195	0.092	0.172
98	312099	265673	River Wye SAC	0.045	0.052	0.069	0.134	0.073	0.104
99	312646	265801	River Wye SAC	0.042	0.048	0.054	0.103	0.063	0.071
100	313494	266928	River Wye SAC	0.027	0.031	0.033	0.062	0.040	0.041
101	314181	267347	River Wye SAC	0.023	0.026	0.026	0.048	0.033	0.031
102	314943	268377	River Wye SAC	0.017	0.019	0.018	0.035	0.025	0.023
103	315555	269032	River Wye SAC	0.014	0.016	0.015	0.029	0.021	0.019
104	315104	269536	River Wye SAC	0.014	0.015	0.016	0.030	0.020	0.020
105	310414	265673	River Wye SAC	0.046	0.051	0.056	0.183	0.069	0.223
106	310199	266585	River Wye SAC	0.033	0.036	0.036	0.126	0.048	0.158
107	310339	267798	River Wye SAC	0.022	0.024	0.025	0.091	0.035	0.108
108	310586	268871	River Wye SAC	0.016	0.018	0.022	0.071	0.028	0.081
109	310521	270137	River Wye SAC	0.013	0.014	0.013	0.055	0.021	0.062
110	311026	270373	River Wye SAC	0.011	0.013	0.014	0.052	0.021	0.055
111	311487	270845	River Wye SAC	0.011	0.012	0.013	0.047	0.020	0.046
112	309932	270770	River Wye SAC	0.012	0.013	0.012	0.047	0.018	0.057
113	308622	263841	River Wye SAC	0.063	0.074	0.050	0.082	0.088	0.263
114	308416	264103	River Wye SAC	0.052	0.061	0.046	0.070	0.073	0.225

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m^3)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
115	307741	264852	River Wye SAC	0.033	0.039	0.034	0.046	0.047	0.149
116	308547	265077	River Wye SAC	0.040	0.045	0.032	0.063	0.046	0.189
117	308378	265939	River Wye SAC	0.032	0.036	0.025	0.057	0.034	0.143
118	308266	267062	River Wye SAC	0.026	0.029	0.025	0.051	0.025	0.107
119	307348	270882	River Wye SAC	0.013	0.014	0.012	0.027	0.012	0.049
120	305981	264984	River Wye SAC	0.022	0.026	0.026	0.022	0.035	0.077
121	303565	265957	River Wye SAC	0.013	0.014	0.012	0.011	0.023	0.040
122	306505	263204	River Wye SAC	0.040	0.041	0.041	0.021	0.091	0.078
123	305981	262455	River Wye SAC	0.040	0.044	0.046	0.018	0.098	0.055
124	305307	261575	River Wye SAC	0.038	0.041	0.052	0.017	0.100	0.033
125	305401	260939	River Wye SAC	0.041	0.044	0.049	0.020	0.114	0.030
126	304895	260414	River Wye SAC	0.035	0.038	0.046	0.018	0.099	0.025
127	304352	259721	River Wye SAC	0.029	0.031	0.037	0.017	0.081	0.020
128	303547	258916	River Wye SAC	0.022	0.024	0.029	0.015	0.060	0.015
129	306337	258279	River Wye SAC	0.031	0.035	0.028	0.040	0.066	0.018
130	305176	258785	River Wye SAC	0.028	0.031	0.027	0.025	0.070	0.018
131	303584	258017	River Wye SAC	0.019	0.021	0.024	0.017	0.048	0.012
132	302161	257643	River Wye SAC	0.015	0.017	0.022	0.012	0.039	0.010
133	301543	259122	River Wye SAC	0.016	0.018	0.024	0.009	0.047	0.011
134	301262	259946	River Wye SAC	0.016	0.018	0.024	0.008	0.046	0.012
135	311599	255939	River Wye SAC	0.026	0.028	0.029	0.077	0.032	0.024
136	311861	255264	River Wye SAC	0.022	0.024	0.028	0.063	0.027	0.020
137	311431	254796	River Wye SAC	0.019	0.021	0.023	0.062	0.024	0.018
138	311562	254010	River Wye SAC	0.016	0.018	0.022	0.051	0.020	0.015
139	311019	254384	River Wye SAC	0.017	0.019	0.020	0.059	0.021	0.017
140	309858	254028	River Wye SAC	0.015	0.017	0.017	0.057	0.020	0.014
141	308659	254515	River Wye SAC	0.019	0.021	0.015	0.058	0.025	0.012
142	307854	255807	River Wye SAC	0.027	0.029	0.017	0.060	0.034	0.014
143	312236	253691	River Wye SAC	0.016	0.017	0.021	0.043	0.019	0.014

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m^3)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
144	312741	252493	River Wye SAC	**0.013**	**0.014**	**0.014**	**0.033**	**0.015**	**0.011**
145	307198	256219	River Wye SAC	**0.026**	**0.029**	**0.018**	**0.051**	**0.037**	**0.014**
146	306243	256781	River Wye SAC	**0.023**	**0.026**	**0.021**	**0.040**	**0.042**	**0.013**
147	304389	255676	River Wye SAC	**0.015**	**0.017**	**0.015**	**0.023**	**0.029**	0.008
148	303640	255058	River Wye SAC	**0.013**	**0.014**	**0.014**	**0.019**	**0.025**	0.007

Table 6b. Predicted maximum annual mean ammonia concentration rate at the discrete receptors – proposed poultry unit

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
1	311051	262101	Unnamed AW	0.740	0.726	0.991	0.890	0.434	0.516
2	310983	262101	Unnamed AW	0.800	0.785	0.895	0.816	0.471	0.714
3	311442	261548	Unnamed AW	0.288	0.284	0.326	0.126	0.351	0.366
4	311557	261572	Unnamed AW	0.257	0.253	0.254	0.107	0.301	0.290
5	311574	261540	Unnamed AW	0.234	0.230	0.256	0.099	0.281	0.276
6	311668	261243	Unnamed AW	0.136	0.135	0.265	0.078	0.201	0.177
7	311724	261269	Unnamed AW	0.129	0.128	0.254	0.072	0.194	0.176
8	311671	261184	Unnamed AW	0.129	0.128	0.253	0.077	0.191	0.159
9	312080	261795	Unnamed AW	0.131	0.129	0.126	0.080	0.165	0.111
10	312239	261798	Unnamed AW	0.110	0.108	0.117	0.070	0.144	0.093
11	310127	262069	Unnamed AW	0.118	0.117	0.145	0.068	0.103	0.168
12	309927	261972	Unnamed AW	0.101	0.100	0.100	0.056	0.098	0.125
13	309836	261887	Unnamed AW	0.098	0.097	0.081	0.052	0.107	0.106
14	309792	261593	Unnamed AW	0.115	0.114	0.110	0.063	0.166	0.069
15	309780	261519	Unnamed AW	0.117	0.116	0.126	0.064	0.172	0.063
16	309633	261069	Unnamed AW	0.068	0.068	0.123	0.064	0.117	0.031
17	309580	260904	Unnamed AW	0.056	0.056	0.134	0.061	0.093	0.023
18	310121	260925	Unnamed AW	0.073	0.073	0.195	0.103	0.094	0.019
19	310186	260878	Unnamed AW	0.077	0.077	0.180	0.112	0.090	0.018
20	310616	260575	Unnamed AW	0.074	0.073	0.052	0.113	0.070	0.019
21	311780	260778	Unnamed AW	0.079	0.079	0.130	0.061	0.112	0.077
22	312480	261754	Unnamed AW	0.088	0.087	0.095	0.058	0.122	0.077
23	312406	261840	Unnamed AW	0.092	0.091	0.100	0.061	0.125	0.078
24	312539	262016	Unnamed AW	0.078	0.077	0.092	0.053	0.107	0.065
25	312015	262566	Unnamed AW	0.112	0.111	0.168	0.123	0.099	0.068
26	311956	262628	Unnamed AW	0.111	0.110	0.180	0.131	0.093	0.064
27	311333	262854	Unnamed AW	0.119	0.117	0.134	0.147	0.083	0.100

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
28	311580	262881	Unnamed AW	0.099	0.098	0.155	0.134	0.070	0.071
29	310907	263072	Unnamed AW	0.082	0.081	0.099	0.129	0.069	0.178
30	311580	263089	Unnamed AW	0.082	0.081	0.109	0.108	0.059	0.064
31	310915	263622	Unnamed AW	0.048	0.048	0.061	0.092	0.045	0.119
32	310805	263657	Unnamed AW	0.044	0.044	0.065	0.090	0.042	0.124
33	310474	263463	Unnamed AW	0.045	0.045	0.090	0.080	0.036	0.141
34	309667	262219	Unnamed AW	0.063	0.063	0.084	0.033	0.058	0.089
35	309469	261756	Unnamed AW	0.073	0.072	0.062	0.037	0.094	0.060
36	309804	262598	Unnamed AW	0.058	0.058	0.069	0.027	0.050	0.096
37	309389	262713	Unnamed AW	0.042	0.042	0.051	0.019	0.039	0.069
38	309332	261103	Unnamed AW	0.063	0.063	0.097	0.045	0.108	0.030
39	309451	260402	Unnamed AW	0.038	0.038	0.101	0.048	0.058	0.012
40	310086	263631	Unnamed AW	0.038	0.037	0.061	0.048	0.028	0.108
41	308939	262378	Unnamed AW	0.037	0.037	0.059	0.018	0.037	0.051
42	308939	262153	Unnamed AW	0.043	0.042	0.053	0.021	0.045	0.049
43	308878	261853	Unnamed AW	0.047	0.046	0.046	0.022	0.058	0.041
44	310930	263645	Cae Cwm-Rhocas SSSI	**0.048**	**0.047**	**0.060**	**0.091**	**0.045**	**0.116**
45	311145	263800	Cae Cwm-Rhocas SSSI	**0.046**	**0.045**	**0.053**	**0.082**	**0.043**	**0.088**
46	309957	263276	Cae Llwyn SSSI	**0.036**	**0.036**	**0.054**	**0.037**	**0.031**	**0.114**
47	309767	263318	Cae Llwyn SSSI	**0.030**	**0.030**	**0.037**	**0.027**	**0.028**	**0.100**
48	310732	262083	River Ithon SSSI	**0.420**	**0.416**	**0.391**	**0.398**	**0.330**	**1.001**
49	310375	262111	River Ithon SSSI	**0.177**	**0.176**	**0.170**	**0.098**	**0.152**	**0.261**
50	309111	259263	Howey Brook Stream Section SSSI	**0.026**	**0.026**	**0.034**	**0.040**	**0.032**	0.007
51	309550	258929	Howey Brook Stream Section SSSI	**0.028**	**0.028**	**0.020**	**0.049**	**0.027**	0.007
52	313456	258981	Graig Fawr SSSI	**0.020**	**0.020**	**0.017**	**0.028**	**0.040**	**0.024**
53	313216	258574	Graig Fawr SSSI	**0.018**	**0.018**	0.014	**0.026**	**0.031**	**0.019**
54	312996	258313	Graig Fawr SSSI	**0.017**	**0.017**	0.014	**0.023**	**0.025**	**0.016**
55	307283	260976	Bach y Graig Stream Section SSSI	**0.027**	**0.027**	**0.021**	0.014	**0.050**	**0.016**
56	306625	261781	Llanfawr Quarries, Llandrindod Wells SSSI	**0.020**	**0.020**	**0.018**	0.009	**0.031**	**0.016**

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
57	306719	260705	Lake Wood, Llandrindod Wells SSSI	0.023	0.023	0.017	0.012	0.044	0.013
58	306771	260569	Lake Wood, Llandrindod Wells SSSI	0.023	0.023	0.017	0.012	0.045	0.013
59	310521	265509	Ithon Valley Woodlands SSSI	0.017	0.016	0.029	0.047	0.019	0.063
60	310166	265561	Ithon Valley Woodlands SSSI	0.017	0.017	0.026	0.042	0.017	0.063
61	306510	263953	Coed Aberdulas SSSI	0.012	0.012	0.019	0.006	0.015	0.024
62	306375	263807	Coed Aberdulas SSSI	0.011	0.012	0.018	0.006	0.015	0.023
63	312056	257342	Caeau Coed Mawr (Coedmawr Fields) SSSI	0.015	0.015	0.016	0.019	0.014	0.009
64	311754	257216	Caeau Coed Mawr (Coedmawr Fields) SSSI	0.014	0.014	0.014	0.020	0.014	0.009
65	310811	262086	River Wye SAC	0.580	0.572	0.630	0.613	0.419	1.195
66	310701	262101	River Wye SAC	0.354	0.351	0.310	0.320	0.288	0.866
67	310403	262091	River Wye SAC	0.192	0.191	0.184	0.109	0.165	0.283
68	310223	261993	River Wye SAC	0.149	0.148	0.184	0.089	0.128	0.208
69	309831	261784	River Wye SAC	0.103	0.102	0.081	0.055	0.129	0.095
70	309711	261591	River Wye SAC	0.103	0.102	0.100	0.056	0.150	0.063
71	309505	261424	River Wye SAC	0.087	0.086	0.102	0.048	0.133	0.046
72	309418	261602	River Wye SAC	0.074	0.073	0.073	0.040	0.110	0.048
73	309253	261286	River Wye SAC	0.069	0.068	0.085	0.039	0.109	0.035
74	310997	262139	River Wye SAC	0.675	0.663	0.753	0.698	0.401	0.601
75	311118	262474	River Wye SAC	0.243	0.239	0.267	0.271	0.155	0.216
76	311241	262721	River Wye SAC	0.148	0.146	0.163	0.177	0.100	0.129
77	311114	262791	River Wye SAC	0.136	0.134	0.141	0.166	0.099	0.162
78	311270	262916	River Wye SAC	0.112	0.111	0.120	0.141	0.081	0.107
79	311497	262935	River Wye SAC	0.099	0.098	0.130	0.127	0.069	0.076
80	311607	262920	River Wye SAC	0.094	0.093	0.148	0.128	0.067	0.067
81	311774	262840	River Wye SAC	0.093	0.092	0.184	0.134	0.074	0.059
82	312049	262869	River Wye SAC	0.084	0.083	0.160	0.109	0.071	0.050
83	312216	262872	River Wye SAC	0.079	0.078	0.142	0.094	0.068	0.046
84	312468	262965	River Wye SAC	0.066	0.065	0.127	0.075	0.058	0.041
85	311594	263140	River Wye SAC	0.078	0.077	0.101	0.103	0.057	0.062

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
86	311681	263236	River Wye SAC	**0.069**	**0.068**	**0.092**	**0.093**	**0.052**	**0.055**
87	311588	263462	River Wye SAC	**0.060**	**0.059**	**0.072**	**0.083**	**0.049**	**0.055**
88	311476	263542	River Wye SAC	**0.058**	**0.057**	**0.069**	**0.084**	**0.049**	**0.062**
89	312646	262911	River Wye SAC	**0.061**	**0.061**	**0.113**	**0.065**	**0.058**	**0.041**
90	312886	263214	River Wye SAC	**0.049**	**0.048**	**0.111**	**0.054**	**0.046**	**0.032**
91	313297	263245	River Wye SAC	**0.040**	**0.040**	**0.088**	**0.042**	**0.042**	**0.029**
92	313755	263121	River Wye SAC	**0.033**	**0.033**	**0.065**	**0.033**	**0.043**	**0.027**
93	311605	263752	River Wye SAC	**0.049**	**0.048**	**0.064**	**0.072**	**0.042**	**0.050**
94	311294	264396	River Wye SAC	**0.032**	**0.031**	**0.045**	**0.063**	**0.033**	**0.063**
95	311466	264385	River Wye SAC	**0.033**	**0.032**	**0.052**	**0.060**	**0.033**	**0.055**
96	311294	264857	River Wye SAC	**0.025**	**0.025**	**0.044**	**0.056**	**0.027**	**0.056**
97	311455	265319	River Wye SAC	**0.021**	**0.021**	**0.040**	**0.047**	**0.024**	**0.046**
98	312099	265673	River Wye SAC	**0.019**	**0.019**	**0.031**	**0.037**	**0.021**	**0.029**
99	312646	265801	River Wye SAC	**0.017**	**0.018**	**0.028**	**0.031**	**0.019**	**0.020**
100	313494	266928	River Wye SAC	**0.012**	**0.012**	**0.023**	**0.022**	**0.014**	**0.014**
101	314181	267347	River Wye SAC	**0.010**	**0.011**	**0.018**	**0.018**	**0.012**	**0.011**
102	314943	268377	River Wye SAC	0.008	0.008	**0.014**	**0.015**	0.010	0.009
103	315555	269032	River Wye SAC	0.007	0.007	**0.012**	**0.013**	0.009	0.008
104	315104	269536	River Wye SAC	0.007	0.007	**0.011**	**0.013**	0.008	0.008
105	310414	265673	River Wye SAC	**0.016**	**0.016**	**0.027**	**0.044**	**0.018**	**0.061**
106	310199	266585	River Wye SAC	**0.012**	**0.012**	**0.022**	**0.036**	**0.014**	**0.049**
107	310339	267798	River Wye SAC	0.009	0.009	**0.016**	**0.030**	**0.012**	**0.038**
108	310586	268871	River Wye SAC	0.007	0.007	**0.015**	**0.026**	**0.010**	**0.031**
109	310521	270137	River Wye SAC	0.006	0.006	0.008	**0.021**	0.008	**0.025**
110	311026	270373	River Wye SAC	0.006	0.006	0.007	**0.021**	0.009	**0.023**
111	311487	270845	River Wye SAC	0.005	0.006	0.007	**0.019**	0.008	**0.020**
112	309932	270770	River Wye SAC	0.006	0.006	0.008	**0.019**	0.007	**0.024**
113	308622	263841	River Wye SAC	**0.019**	**0.019**	**0.025**	**0.011**	**0.019**	**0.050**
114	308416	264103	River Wye SAC	**0.016**	**0.017**	**0.023**	**0.010**	**0.017**	**0.047**

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
115	307741	264852	River Wye SAC	**0.012**	**0.012**	**0.018**	0.008	**0.013**	**0.038**
116	308547	265077	River Wye SAC	**0.012**	**0.012**	**0.012**	**0.013**	**0.012**	**0.049**
117	308378	265939	River Wye SAC	**0.011**	**0.011**	**0.011**	**0.015**	**0.010**	**0.042**
118	308266	267062	River Wye SAC	**0.010**	**0.010**	**0.010**	**0.015**	0.009	**0.036**
119	307348	270882	River Wye SAC	0.006	0.006	0.006	**0.011**	0.005	**0.021**
120	305981	264984	River Wye SAC	0.009	0.010	**0.010**	0.006	**0.011**	**0.022**
121	303565	265957	River Wye SAC	0.006	0.006	0.004	0.004	0.008	**0.015**
122	306505	263204	River Wye SAC	**0.013**	**0.014**	**0.018**	0.006	**0.019**	**0.022**
123	305981	262455	River Wye SAC	**0.015**	**0.015**	**0.020**	0.007	**0.022**	**0.017**
124	305307	261575	River Wye SAC	**0.015**	**0.015**	**0.016**	0.007	**0.026**	**0.011**
125	305401	260939	River Wye SAC	**0.016**	**0.016**	**0.014**	0.008	**0.032**	**0.011**
126	304895	260414	River Wye SAC	**0.015**	**0.015**	**0.014**	0.008	**0.031**	0.009
127	304352	259721	River Wye SAC	**0.013**	**0.013**	**0.014**	0.007	**0.028**	0.008
128	303547	258916	River Wye SAC	**0.010**	**0.011**	**0.014**	0.006	**0.023**	0.006
129	306337	258279	River Wye SAC	**0.012**	**0.012**	**0.014**	**0.014**	**0.023**	0.005
130	305176	258785	River Wye SAC	**0.012**	**0.012**	**0.013**	**0.010**	**0.025**	0.006
131	303584	258017	River Wye SAC	0.009	0.009	**0.014**	0.007	**0.019**	0.005
132	302161	257643	River Wye SAC	0.007	0.008	**0.013**	0.006	**0.017**	0.004
133	301543	259122	River Wye SAC	0.008	0.009	**0.010**	0.004	**0.019**	0.005
134	301262	259946	River Wye SAC	0.008	0.008	0.007	0.004	**0.019**	0.005
135	311599	255939	River Wye SAC	**0.011**	**0.011**	**0.010**	**0.018**	**0.011**	0.007
136	311861	255264	River Wye SAC	0.009	0.010	0.010	**0.016**	0.010	0.006
137	311431	254796	River Wye SAC	0.009	0.009	0.007	**0.017**	0.009	0.006
138	311562	254010	River Wye SAC	0.008	0.008	0.007	**0.015**	0.008	0.005
139	311019	254384	River Wye SAC	0.008	0.008	0.006	**0.018**	0.008	0.005
140	309858	254028	River Wye SAC	0.008	0.008	0.005	**0.019**	0.008	0.004
141	308659	254515	River Wye SAC	0.009	0.009	0.005	**0.021**	**0.010**	0.004
142	307854	255807	River Wye SAC	**0.012**	**0.012**	0.009	**0.022**	**0.012**	0.004
143	312236	253691	River Wye SAC	0.007	0.007	0.006	**0.013**	0.008	0.005

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m^3)					
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	Shobdon Airfield No Calms No terrain	Trawsgoed No Calms No terrain
144	312741	252493	River Wye SAC	0.006	0.006	0.004	**0.011**	0.007	0.004
145	307198	256219	River Wye SAC	**0.011**	**0.011**	**0.011**	**0.018**	**0.014**	0.004
146	306243	256781	River Wye SAC	0.010	0.010	**0.013**	**0.015**	**0.016**	0.004
147	304389	255676	River Wye SAC	0.007	0.007	0.009	0.010	**0.013**	0.003
148	303640	255058	River Wye SAC	0.006	0.006	0.009	0.008	**0.011**	0.003

5.2 Preliminary deposition modelling

A preliminary deposition modelling run, using a fixed deposition velocity of 0.003 m/s, was performed for discrete receptors where the preliminary modelling indicated that annual mean ammonia concentrations and nitrogen deposition rates could potentially exceed lower threshold percentage of the Critical Level or Critical Load for the site.

Terrain effects may be significant; therefore, the preliminary deposition run was made with terrain. The results of the preliminary runs demonstrate that the effect of calms upon the modelling is not significant in this case, therefore calms are not modelled.

The predicted maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors are shown in Table 7. In this Table, predicted ammonia concentrations that are in excess of Natural Resources Wales' upper threshold for the site (8% for a SAC or SSSI and 100% of Critical Level or Load for a non-statutory wildlife site) are coloured red. Concentrations in the range between Natural Resources Wales' upper threshold and lower threshold for the site (1% to 8% for a SAC or SSSI and 100% to 100% of Critical Level or Load for a non-statutory wildlife site) are coloured blue.

Table 7. Predicted maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors – existing and proposed poultry units, fixed deposition modelling runs

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					Maximum annual mean nitrogen deposition (kg/ha)					
				Critical Level	Existing	%age of CLe	Proposed	%age of CLe	Critical Load	Deposition Velocity (m/s)	Existing	%age of CLo	Proposed	%age of CLo
1	311051	262101	Unnamed AW	1.0	2.516	251.6	0.944	94.4	10.0	0.03	19.605	196.0	7.357	73.6
2	310983	262101	Unnamed AW	1.0	4.258	425.8	0.855	85.5	10.0	0.03	33.174	331.7	6.665	66.6
3	311442	261548	Unnamed AW	1.0	1.612	161.2	0.265	26.5	10.0	0.03	12.560	125.6	2.063	20.6
4	311557	261572	Unnamed AW	1.0	1.236	123.6	0.215	21.5	10.0	0.03	9.629	96.3	1.677	16.8
5	311574	261540	Unnamed AW	1.0	1.167	116.7	0.204	20.4	10.0	0.03	9.089	90.9	1.591	15.9
14	309792	261593	Unnamed AW	1.0	0.668	66.8	0.090	9.0	10.0	0.03	5.201	52.0	0.700	7.0
15	309780	261519	Unnamed AW	1.0	0.658	65.8	0.102	10.2	10.0	0.03	5.128	51.3	0.798	8.0
44	310930	263645	Cae Cwm-Rhocas SSSI	3.0	0.601	20.0	0.049	1.6	10.0	0.03	4.679	46.8	0.381	3.8
45	311145	263800	Cae Cwm-Rhocas SSSI	3.0	0.534	17.8	0.043	1.4	10.0	0.03	4.158	41.6	0.338	3.4
46	309957	263276	Cae Llwyn SSSI	3.0	0.430	14.3	0.035	1.2	10.0	0.03	3.349	33.5	0.275	2.7
47	309767	263318	Cae Llwyn SSSI	3.0	0.828	27.6	0.026	0.9	10.0	0.03	6.449	64.5	0.200	2.0
48	310732	262083	River Ithon SSSI	1.0	0.643	64.3	0.378	37.8	8.0	0.02	3.338	41.7	1.963	24.5
49	310375	262111	River Ithon SSSI	1.0	0.622	62.2	0.157	15.7	8.0	0.02	3.229	40.4	0.815	10.2
52	313456	258981	Graig Fawr SSSI	1.0	0.351	35.1	0.009	0.9	8.0	0.02	1.826	22.8	0.044	0.6
53	313216	258574	Graig Fawr SSSI	1.0	0.291	29.1	0.007	0.7	8.0	0.02	1.512	18.9	0.036	0.4
54	312996	258313	Graig Fawr SSSI	1.0	0.486	48.6	0.007	0.7	8.0	0.02	2.526	31.6	0.039	0.5
56	306625	261781	Llannfawr Quarries, Llandrindod Wells SSSI	3.0	0.351	11.7	0.010	0.3	8.0	0.02	1.825	22.8	0.053	0.7
57	306719	260705	Lake Wood, Llandrindod Wells SSSI	3.0	0.278	9.3	0.010	0.3	10.0	0.03	2.169	21.7	0.080	0.8
58	306771	260569	Lake Wood, Llandrindod Wells SSSI	3.0	0.328	10.9	0.010	0.3	10.0	0.03	2.559	25.6	0.080	0.8
59	310521	265509	Ithon Valley Woodlands SSSI	3.0	0.346	11.5	0.019	0.6	10.0	0.03	2.693	26.9	0.152	1.5
60	310166	265561	Ithon Valley Woodlands SSSI	3.0	0.274	9.1	0.017	0.6	10.0	0.03	2.136	21.4	0.129	1.3
61	306510	263953	Coed Aberdulas SSSI	1.0	0.389	38.9	0.011	1.1	8.0	0.02	2.022	25.3	0.055	0.7
62	306375	263807	Coed Aberdulas SSSI	1.0	0.395	39.5	0.010	1.0	8.0	0.02	2.050	25.6	0.053	0.7
63	312056	257342	Caeau Coed Mawr (Coedmawr Fields) SSSI	1.0	0.433	43.3	0.007	0.7	8.0	0.02	2.251	28.1	0.037	0.5

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					Maximum annual mean nitrogen deposition (kg/ha)					
				Critical Level	Existing	%age of CLe	Proposed	%age of CLe	Critical Load	Deposition Velocity (m/s)	Existing	%age of CLo	Proposed	%age of CLo
64	311754	257216	Caeau Coed Mawr (Coedmawr Fields) SSSI	1.0	0.366	36.6	0.006	0.6	8.0	0.02	1.903	23.8	0.033	0.4
65	310811	262086	River Wye SAC	1.0	0.302	30.2	0.608	60.8	-	-	-	-	-	-
66	310701	262101	River Wye SAC	1.0	0.286	28.6	0.299	29.9	-	-	-	-	-	-
67	310403	262091	River Wye SAC	1.0	0.159	15.9	0.171	17.1	-	-	-	-	-	-
68	310223	261993	River Wye SAC	1.0	0.152	15.2	0.173	17.3	-	-	-	-	-	-
69	309831	261784	River Wye SAC	1.0	0.208	20.8	0.073	7.3	-	-	-	-	-	-
70	309711	261591	River Wye SAC	1.0	0.358	35.8	0.081	8.1	-	-	-	-	-	-
71	309505	261424	River Wye SAC	1.0	0.399	39.9	0.079	7.9	-	-	-	-	-	-
72	309418	261602	River Wye SAC	1.0	0.281	28.1	0.055	5.5	-	-	-	-	-	-
73	309253	261286	River Wye SAC	1.0	0.176	17.6	0.062	6.2	-	-	-	-	-	-
74	310997	262139	River Wye SAC	1.0	0.282	28.2	0.717	71.7	-	-	-	-	-	-
75	311118	262474	River Wye SAC	1.0	0.184	18.4	0.247	24.7	-	-	-	-	-	-
76	311241	262721	River Wye SAC	1.0	0.167	16.7	0.147	14.7	-	-	-	-	-	-
77	311114	262791	River Wye SAC	1.0	0.162	16.2	0.127	12.7	-	-	-	-	-	-
78	311270	262916	River Wye SAC	1.0	0.182	18.2	0.106	10.6	-	-	-	-	-	-
79	311497	262935	River Wye SAC	1.0	0.208	20.8	0.111	11.1	-	-	-	-	-	-
80	311607	262920	River Wye SAC	1.0	0.155	15.5	0.126	12.6	-	-	-	-	-	-
81	311774	262840	River Wye SAC	1.0	0.137	13.7	0.156	15.6	-	-	-	-	-	-
82	312049	262869	River Wye SAC	1.0	0.181	18.1	0.133	13.3	-	-	-	-	-	-
83	312216	262872	River Wye SAC	1.0	0.142	14.2	0.115	11.5	-	-	-	-	-	-
84	312468	262965	River Wye SAC	1.0	4.050	405.0	0.097	9.7	-	-	-	-	-	-
85	311594	263140	River Wye SAC	1.0	1.218	121.8	0.086	8.6	-	-	-	-	-	-
86	311681	263236	River Wye SAC	1.0	0.093	9.3	0.079	7.9	-	-	-	-	-	-
87	311588	263462	River Wye SAC	1.0	0.093	9.3	0.059	5.9	-	-	-	-	-	-
88	311476	263542	River Wye SAC	1.0	0.050	5.0	0.056	5.6	-	-	-	-	-	-
89	312646	262911	River Wye SAC	1.0	0.044	4.4	0.082	8.2	-	-	-	-	-	-
90	312886	263214	River Wye SAC	1.0	0.045	4.5	0.079	7.9	-	-	-	-	-	-
91	313297	263245	River Wye SAC	1.0	0.081	8.1	0.060	6.0	-	-	-	-	-	-
92	313755	263121	River Wye SAC	1.0	0.059	5.9	0.043	4.3	-	-	-	-	-	-

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					Maximum annual mean nitrogen deposition (kg/ha)					
				Critical Level	Existing	%age of CLe	Proposed	%age of CLe	Critical Load	Deposition Velocity (m/s)	Existing	%age of CLo	Proposed	%age of CLo
93	311605	263752	River Wye SAC	1.0	0.062	**6.2**	0.049	**4.9**	-	-	-	-	-	-
94	311294	264396	River Wye SAC	1.0	0.062	**6.2**	0.033	**3.3**	-	-	-	-	-	-
95	311466	264385	River Wye SAC	1.0	0.048	**4.8**	0.037	**3.7**	-	-	-	-	-	-
96	311294	264857	River Wye SAC	1.0	0.051	**5.1**	0.030	**3.0**	-	-	-	-	-	-
97	311455	265319	River Wye SAC	1.0	0.033	**3.3**	0.026	**2.6**	-	-	-	-	-	-
98	312099	265673	River Wye SAC	1.0	0.034	**3.4**	0.020	**2.0**	-	-	-	-	-	-
99	312646	265801	River Wye SAC	1.0	0.042	**4.2**	0.018	**1.8**	-	-	-	-	-	-
100	313494	266928	River Wye SAC	1.0	0.040	**4.0**	0.013	**1.3**	-	-	-	-	-	-
101	314181	267347	River Wye SAC	1.0	4.499	**449.9**	0.011	**1.1**	-	-	-	-	-	-
102	314943	268377	River Wye SAC	1.0	3.283	**328.3**	0.008	0.8	-	-	-	-	-	-
103	315555	269032	River Wye SAC	1.0	1.359	**135.9**	0.007	0.7	-	-	-	-	-	-
104	315104	269536	River Wye SAC	1.0	1.106	**110.6**	0.006	0.6	-	-	-	-	-	-
105	310414	265673	River Wye SAC	1.0	0.670	**67.0**	0.018	**1.8**	-	-	-	-	-	-
106	310199	266585	River Wye SAC	1.0	0.571	**57.1**	0.012	**1.2**	-	-	-	-	-	-
107	310339	267798	River Wye SAC	1.0	0.413	**41.3**	0.009	0.9	-	-	-	-	-	-
108	310586	268871	River Wye SAC	1.0	0.387	**38.7**	0.008	0.8	-	-	-	-	-	-
109	310521	270137	River Wye SAC	1.0	0.298	**29.8**	0.004	0.4	-	-	-	-	-	-
110	311026	270373	River Wye SAC	1.0	3.426	**342.6**	0.004	0.4	-	-	-	-	-	-
111	311487	270845	River Wye SAC	1.0	0.986	**98.6**	0.004	0.4	-	-	-	-	-	-
112	309932	270770	River Wye SAC	1.0	0.560	**56.0**	0.004	0.4	-	-	-	-	-	-
113	308622	263841	River Wye SAC	1.0	0.497	**49.7**	0.018	**1.8**	-	-	-	-	-	-
114	308416	264103	River Wye SAC	1.0	0.401	**40.1**	0.016	**1.6**	-	-	-	-	-	-
115	307741	264852	River Wye SAC	1.0	0.358	**35.8**	0.012	**1.2**	-	-	-	-	-	-
116	308547	265077	River Wye SAC	1.0	0.343	**34.3**	0.009	0.9	-	-	-	-	-	-
117	308378	265939	River Wye SAC	1.0	0.352	**35.2**	0.006	0.6	-	-	-	-	-	-
118	308266	267062	River Wye SAC	1.0	0.293	**29.3**	0.006	0.6	-	-	-	-	-	-
119	307348	270882	River Wye SAC	1.0	0.262	**26.2**	0.003	0.3	-	-	-	-	-	-
120	305981	264984	River Wye SAC	1.0	0.207	**20.7**	0.006	0.6	-	-	-	-	-	-
121	303565	265957	River Wye SAC	1.0	0.268	**26.8**	0.003	0.3	-	-	-	-	-	-

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)					Maximum annual mean nitrogen deposition (kg/ha)					
				Critical Level	Existing	%age of CLe	Proposed	%age of CLe	Critical Load	Deposition Velocity (m/s)	Existing	%age of CLo	Proposed	%age of CLo
122	306505	263204	River Wye SAC	1.0	0.234	23.4	0.011	1.1	-	-	-	-	-	-
123	305981	262455	River Wye SAC	1.0	0.193	19.3	0.010	1.0	-	-	-	-	-	-
124	305307	261575	River Wye SAC	1.0	0.182	18.2	0.008	0.8	-	-	-	-	-	-
125	305401	260939	River Wye SAC	1.0	0.186	18.6	0.008	0.8	-	-	-	-	-	-
126	304895	260414	River Wye SAC	1.0	0.142	14.2	0.008	0.8	-	-	-	-	-	-
127	304352	259721	River Wye SAC	1.0	0.110	11.0	0.007	0.7	-	-	-	-	-	-
128	303547	258916	River Wye SAC	1.0	0.087	8.7	0.007	0.7	-	-	-	-	-	-
129	306337	258279	River Wye SAC	1.0	0.148	14.8	0.007	0.7	-	-	-	-	-	-
130	305176	258785	River Wye SAC	1.0	0.087	8.7	0.007	0.7	-	-	-	-	-	-
131	303584	258017	River Wye SAC	1.0	0.090	9.0	0.007	0.7	-	-	-	-	-	-
132	302161	257643	River Wye SAC	1.0	0.065	6.5	0.006	0.6	-	-	-	-	-	-
133	301543	259122	River Wye SAC	1.0	0.052	5.2	0.005	0.5	-	-	-	-	-	-
134	301262	259946	River Wye SAC	1.0	0.045	4.5	0.003	0.3	-	-	-	-	-	-
135	311599	255939	River Wye SAC	1.0	0.042	4.2	0.004	0.4	-	-	-	-	-	-
136	311861	255264	River Wye SAC	1.0	0.027	2.7	0.004	0.4	-	-	-	-	-	-
137	311431	254796	River Wye SAC	1.0	0.023	2.3	0.003	0.3	-	-	-	-	-	-
138	311562	254010	River Wye SAC	1.0	0.017	1.7	0.003	0.3	-	-	-	-	-	-
139	311019	254384	River Wye SAC	1.0	0.014	1.4	0.003	0.3	-	-	-	-	-	-
140	309858	254028	River Wye SAC	1.0	0.014	1.4	0.003	0.3	-	-	-	-	-	-
141	308659	254515	River Wye SAC	1.0	0.046	4.6	0.003	0.3	-	-	-	-	-	-
142	307854	255807	River Wye SAC	1.0	0.033	3.3	0.004	0.4	-	-	-	-	-	-
143	312236	253691	River Wye SAC	1.0	0.022	2.2	0.003	0.3	-	-	-	-	-	-
144	312741	252493	River Wye SAC	1.0	0.016	1.6	0.002	0.2	-	-	-	-	-	-
145	307198	256219	River Wye SAC	1.0	0.013	1.3	0.005	0.5	-	-	-	-	-	-
146	306243	256781	River Wye SAC	1.0	0.011	1.1	0.006	0.6	-	-	-	-	-	-
147	304389	255676	River Wye SAC	1.0	0.011	1.1	0.004	0.4	-	-	-	-	-	-
148	303640	255058	River Wye SAC	1.0	0.012	1.2	0.004	0.4	-	-	-	-	-	-

5.3 Detailed deposition modelling

The detailed modelling was carried out for the proposed poultry unit over a smaller domain that covers the proposed poultry houses at Brynthomas, the closer SSSIs and the nearby stretches of The River Wye SAC, the area where the preliminary modelling indicated that annual mean ammonia concentrations and nitrogen deposition rates could potentially exceed Natural Resources Wales' lower threshold percentage of the Critical Level or Critical Load for the site. At the other discrete receptors at the excluded AWs, SSSIs and more distant reaches of The River Wye SAC, the preliminary modelling indicated that ammonia levels (and nitrogen deposition rates) would be below the Natural Resources Wales' or the Environment Agency's lower threshold percentage of Critical Level/Load for a SSSI/SAC.

The detailed deposition modelling run was made with terrain included. Calms cannot be used with terrain or spatially varying deposition; however, the results of the preliminary runs demonstrate that the effect of calms upon the modelling is not significant.

The predicted maximum annual mean ground level ammonia concentrations and nitrogen deposition rates are shown in Table 8 for the discrete receptors included in the detailed modelling domain. In this Table, predicted ammonia concentrations that are in excess of Natural Resources Wales' upper threshold for the site (8% for a SSSI/SAC) are coloured red. Concentrations in the range between the Natural Resources Wales' upper threshold and lower threshold for the site (1% to 8% for a SSSI/SAC) are coloured blue.

A contour plot of the predicted ground level maximum annual mean ammonia is shown in Figure 6 and a contour plot of the predicted nitrogen deposition rates is shown in Figure 7.

Table 8. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors (Proposed Scenario)

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)			Maximum annual mean nitrogen deposition (kg/ha)			
				Critical Level	Proposed	%age of CLe	Critical Load	Deposition Velocity (m/s)	Proposed	%age of CLo
44	310930	263645	Cae Cwm-Rhocas SSSI	3.0	0.039	**1.3**	10.0	0.03	0.306	**3.1**
45	311145	263800	Cae Cwm-Rhocas SSSI	3.0	0.034	**1.1**	10.0	0.03	0.262	**2.6**
46	309957	263276	Cae Llwyn SSSI	3.0	0.027	0.9	10.0	0.03	0.209	**2.1**
47	309767	263318	Cae Llwyn SSSI	3.0	0.020	0.7	10.0	0.03	0.156	**1.6**
48	310732	262083	River Ithon SSSI	1.0	0.339	**33.9**	8.0	0.02	1.761	**22.0**
49	310375	262111	River Ithon SSSI	1.0	0.134	**13.4**	8.0	0.02	0.697	**8.7**
59	310521	265509	Ithon Valley Woodlands SSSI	3.0	0.013	0.4	10.0	0.03	0.102	**1.0**
60	310166	265561	Ithon Valley Woodlands SSSI	3.0	0.011	0.4	10.0	0.03	0.086	0.9
61	306510	263953	Coed Aberdulas SSSI	1.0	0.007	0.7	8.0	0.02	0.036	0.5
62	306375	263807	Coed Aberdulas SSSI	1.0	0.007	0.7	8.0	0.02	0.035	0.4
65	310811	262086	River Wye SAC	1.0	0.544	**54.4**	-	-	-	-
66	310701	262101	River Wye SAC	1.0	0.268	**26.8**	-	-	-	-
67	310403	262091	River Wye SAC	1.0	0.147	**14.7**	-	-	-	-
68	310223	261993	River Wye SAC	1.0	0.146	**14.6**	-	-	-	-
69	309831	261784	River Wye SAC	1.0	0.061	**6.1**	-	-	-	-
70	309711	261591	River Wye SAC	1.0	0.065	**6.5**	-	-	-	-
71	309505	261424	River Wye SAC	1.0	0.060	**6.0**	-	-	-	-
72	309418	261602	River Wye SAC	1.0	0.044	**4.4**	-	-	-	-
73	309253	261286	River Wye SAC	1.0	0.045	**4.5**	-	-	-	-
74	310997	262139	River Wye SAC	1.0	0.633	**63.3**	-	-	-	-
75	311118	262474	River Wye SAC	1.0	0.211	**21.1**	-	-	-	-
76	311241	262721	River Wye SAC	1.0	0.123	**12.3**	-	-	-	-
77	311114	262791	River Wye SAC	1.0	0.108	**10.8**	-	-	-	-
78	311270	262916	River Wye SAC	1.0	0.088	**8.8**	-	-	-	-
79	311497	262935	River Wye SAC	1.0	0.090	**9.0**	-	-	-	-
80	311607	262920	River Wye SAC	1.0	0.100	**10.0**	-	-	-	-
81	311774	262840	River Wye SAC	1.0	0.119	**11.9**	-	-	-	-

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration (µg/m³)			Maximum annual mean nitrogen deposition (kg/ha)			
				Critical Level	Proposed	%age of CLe	Critical Load	Deposition Velocity (m/s)	Proposed	%age of CLo
82	312049	262869	River Wye SAC	1.0	0.100	**10.0**	-	-	-	-
83	312216	262872	River Wye SAC	1.0	0.086	**8.6**	-	-	-	-
84	312468	262965	River Wye SAC	1.0	0.072	**7.2**	-	-	-	-
85	311594	263140	River Wye SAC	1.0	0.069	**6.9**	-	-	-	-
86	311681	263236	River Wye SAC	1.0	0.062	**6.2**	-	-	-	-
87	311588	263462	River Wye SAC	1.0	0.047	**4.7**	-	-	-	-
88	311476	263542	River Wye SAC	1.0	0.045	**4.5**	-	-	-	-
89	312646	262911	River Wye SAC	1.0	0.062	**6.2**	-	-	-	-
90	312886	263214	River Wye SAC	1.0	0.058	**5.8**	-	-	-	-
91	313297	263245	River Wye SAC	1.0	0.043	**4.3**	-	-	-	-
92	313755	263121	River Wye SAC	1.0	0.030	**3.0**	-	-	-	-
93	311605	263752	River Wye SAC	1.0	0.038	**3.8**	-	-	-	-
94	311294	264396	River Wye SAC	1.0	0.025	**2.5**	-	-	-	-
95	311466	264385	River Wye SAC	1.0	0.028	**2.8**	-	-	-	-
96	311294	264857	River Wye SAC	1.0	0.023	**2.3**	-	-	-	-
97	311455	265319	River Wye SAC	1.0	0.019	**1.9**	-	-	-	-
98	312099	265673	River Wye SAC	1.0	0.015	**1.5**	-	-	-	-
99	312646	265801	River Wye SAC	1.0	0.013	**1.3**	-	-	-	-
100	313494	266928	River Wye SAC	1.0	0.009	0.9	-	-	-	-
101	314181	267347	River Wye SAC	1.0	0.008	0.8	-	-	-	-
105	310414	265673	River Wye SAC	1.0	0.012	**1.2**	-	-	-	-
106	310199	266585	River Wye SAC	1.0	0.008	0.8	-	-	-	-
113	308622	263841	River Wye SAC	1.0	0.013	**1.3**	-	-	-	-
114	308416	264103	River Wye SAC	1.0	0.012	**1.2**	-	-	-	-
115	307741	264852	River Wye SAC	1.0	0.008	0.8	-	-	-	-
122	306505	263204	River Wye SAC	1.0	0.007	0.7	-	-	-	-
123	305981	262455	River Wye SAC	1.0	0.006	0.6	-	-	-	-

Figure 6. Predicted maximum annual mean ammonia concentrations (Proposed Scenario)

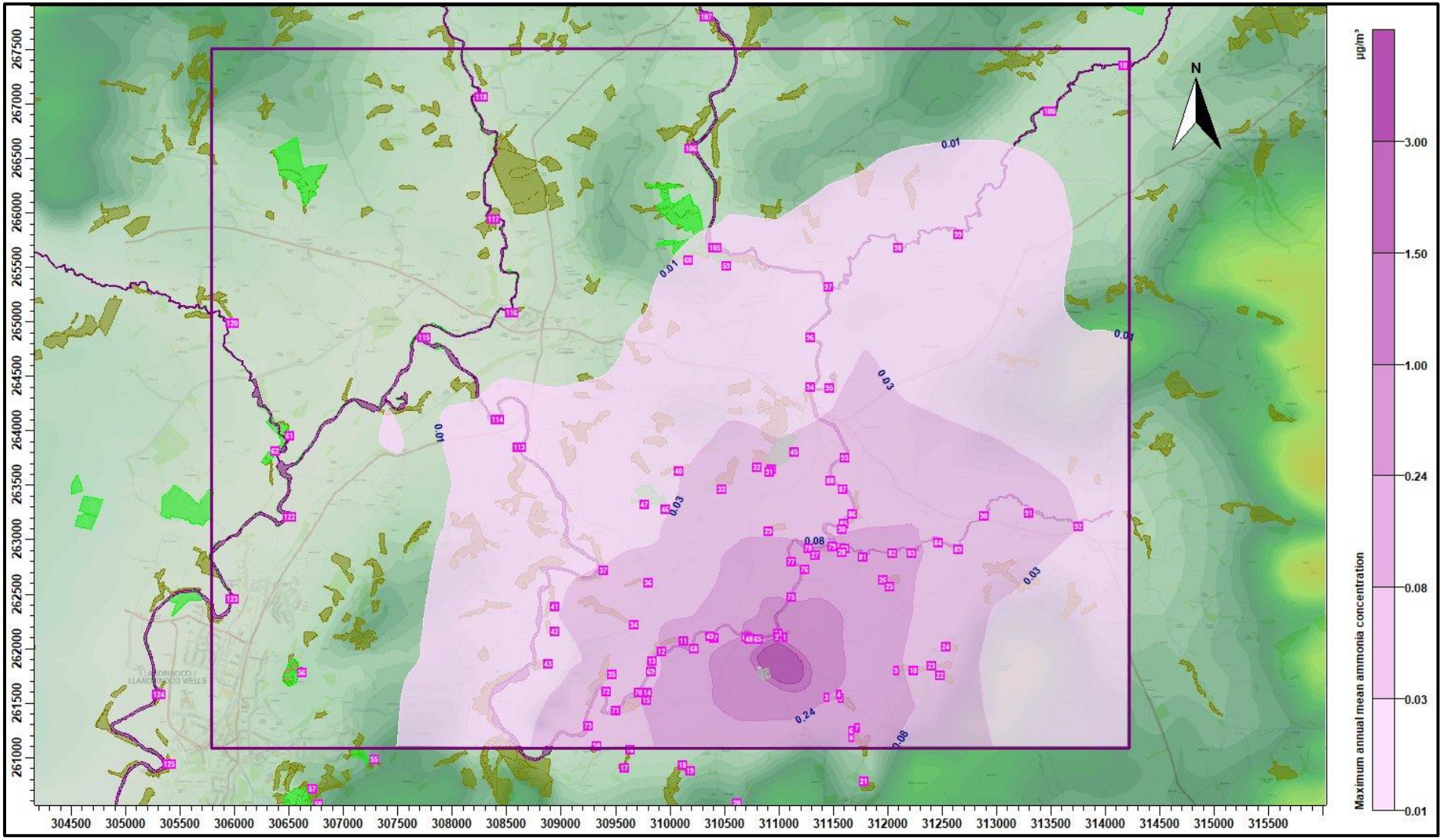
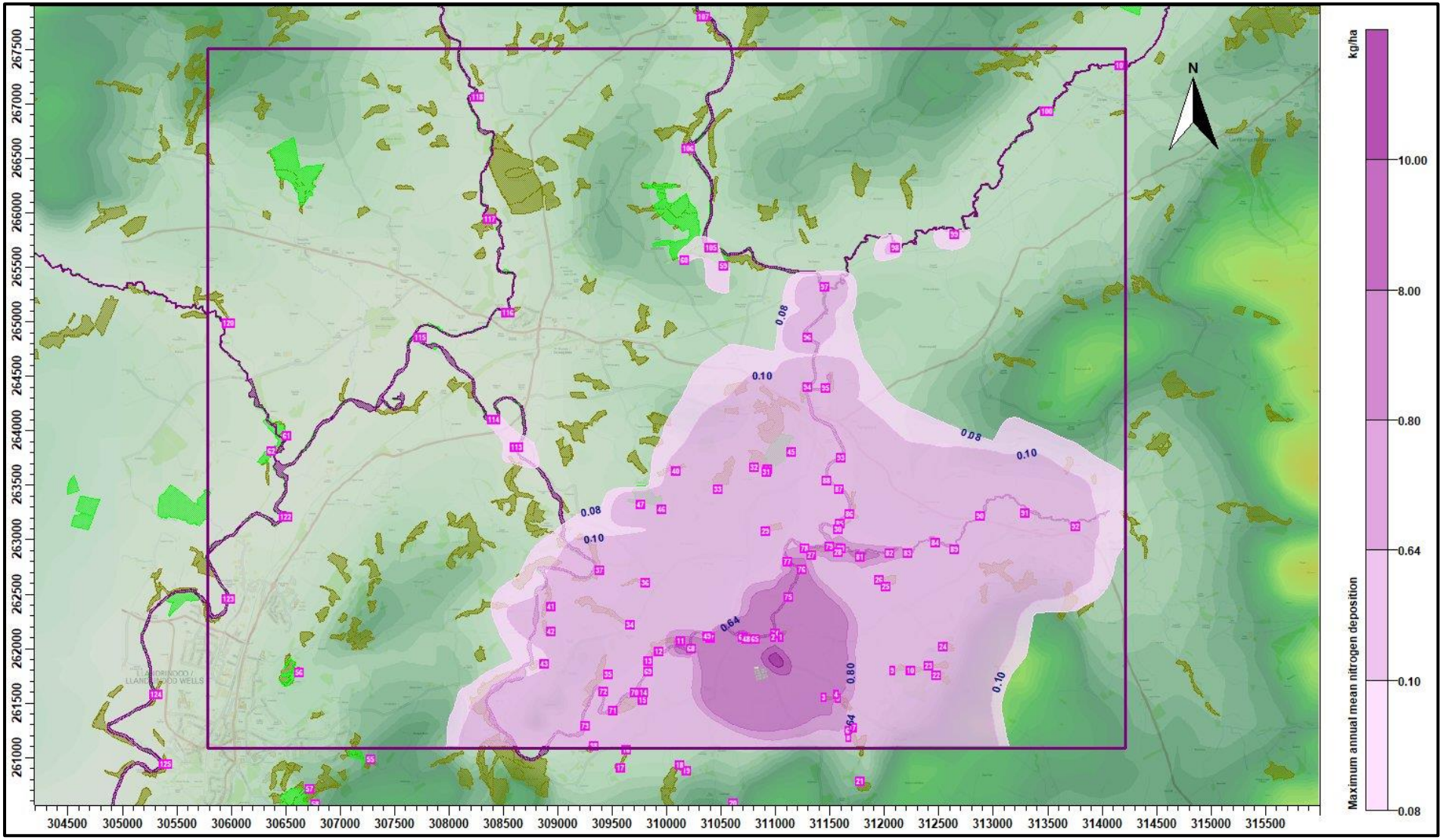


Figure 7. Predicted maximum annual nitrogen deposition rates (Proposed Scenario)



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Steve Raasch, on behalf of Ben Owens, the applicant, to use computer modelling to assess the impact of ammonia emissions from the existing free range egg-laying poultry house and the proposed broiler chicken rearing houses at Brynthomas, Penybont, near to Llandrindod Wells in Powys. LD1 5SP.

Ammonia emission rates from the existing and proposed poultry houses have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. The ammonia emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

6.1. Existing poultry unit

The preliminary and fixed deposition modelling runs predict that there are many exceedances of Natural Resources Wales' or the Environment Agency's upper threshold and lower threshold percentage of the Critical Level or Critical Load at the discrete receptors located at many of the Ancient Woodlands (AWs), Sites of Special Scientific Interest (SSSIs) and at The River Wye Special Area of Conservation (SAC).

6.2. Proposed poultry unit

The preliminary modelling predicts that there would be no exceedances of the Environment Agency's lower threshold percentage of the precautionary Critical Level of 1.0 µg/m³ at the discrete receptors located at the AWs.

The preliminary and fixed deposition modelling runs predict that there would be exceedances of Natural Resources Wales' upper threshold percentage and lower threshold percentage of the Critical Levels and Critical Loads at a number of the SSSIs and The River Wye SAC.

The detailed modelling predicts that the process contribution of the proposed poultry unit to ammonia concentrations and nitrogen deposition rates would exceed Natural Resources Wales' upper threshold at The River Ithon SSSI, which is also designated as part of The River Wye SAC. In addition, the detailed modelling predicts that process contributions from the proposed poultry unit would exceed Natural Resources Wales' lower threshold percentage of the Critical Level at Cae Cwm-Rhocas SSSI and further stretches of The River Wye SAC and process contributions to nitrogen deposition rates would exceed Natural Resources Wales' lower threshold percentage of the Critical Loads at Cae Cwm-Rhocas SSSI, Cae Llwyn SSSI and Ithon Valley Woodlands SSSI.

The exceedances of the upper threshold percentage of the Critical Level are predicted to impact upon approximately 4.0 km stretches of The River Ithon SSSI / The River Wye SAC. The exceedances of the upper threshold percentage of the Critical Load are predicted to impact upon approximately 3.1 km stretches of The River Ithon SSSI.

The exceedances of the lower threshold percentage of the Critical Levels are predicted to impact upon approximately 4.8 ha of Cae Cwm-Rhocas SSSI and approximately 21.2 km stretches of The River Wye SAC. The exceedances of the lower threshold percentage of the Critical Loads are predicted to impact upon approximately 5.0 ha of Cae Cwm-Rhocas SSSI, approximately 2.8 ha of Cae Llwyn SSSI and a very small part, less than 0.1 ha, of Ithon Valley Woodlands SSSI.

6.3. Comparison of the existing and proposed poultry units

When considering the proposed poultry unit in comparison to the existing poultry house, the proposals represent a reduction in the amount of ammonia produced by poultry rearing at Brynthomas and also improved dispersion of the pollutant. The preliminary and fixed deposition runs demonstrate that, largely, the proposals represent a reduction in process contributions to ammonia concentrations and nitrogen deposition rates. There is a small stretch of The River Wye SAC where the fixed deposition modelling run demonstrates that the proposals may represent an increase in impact at The River Wye SAC for four discrete receptors (65 to 68). However, the modelling predicts that in the majority of locations at the wildlife sites the result of the proposals will be to significantly reduce the impact of process contributions to ammonia concentrations and nitrogen deposition rates.

7. References

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