A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Poultry Houses at Domgay Hall, Four Crosses, near to Llanymynech in Powys

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Mr. Richard Corbett, of Roger Parry & Partners LLP, on behalf of Mr. M. Evans, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Domgay Hall, Four Crosses, near to Llanymynech in Powys. SY22 6SN.

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

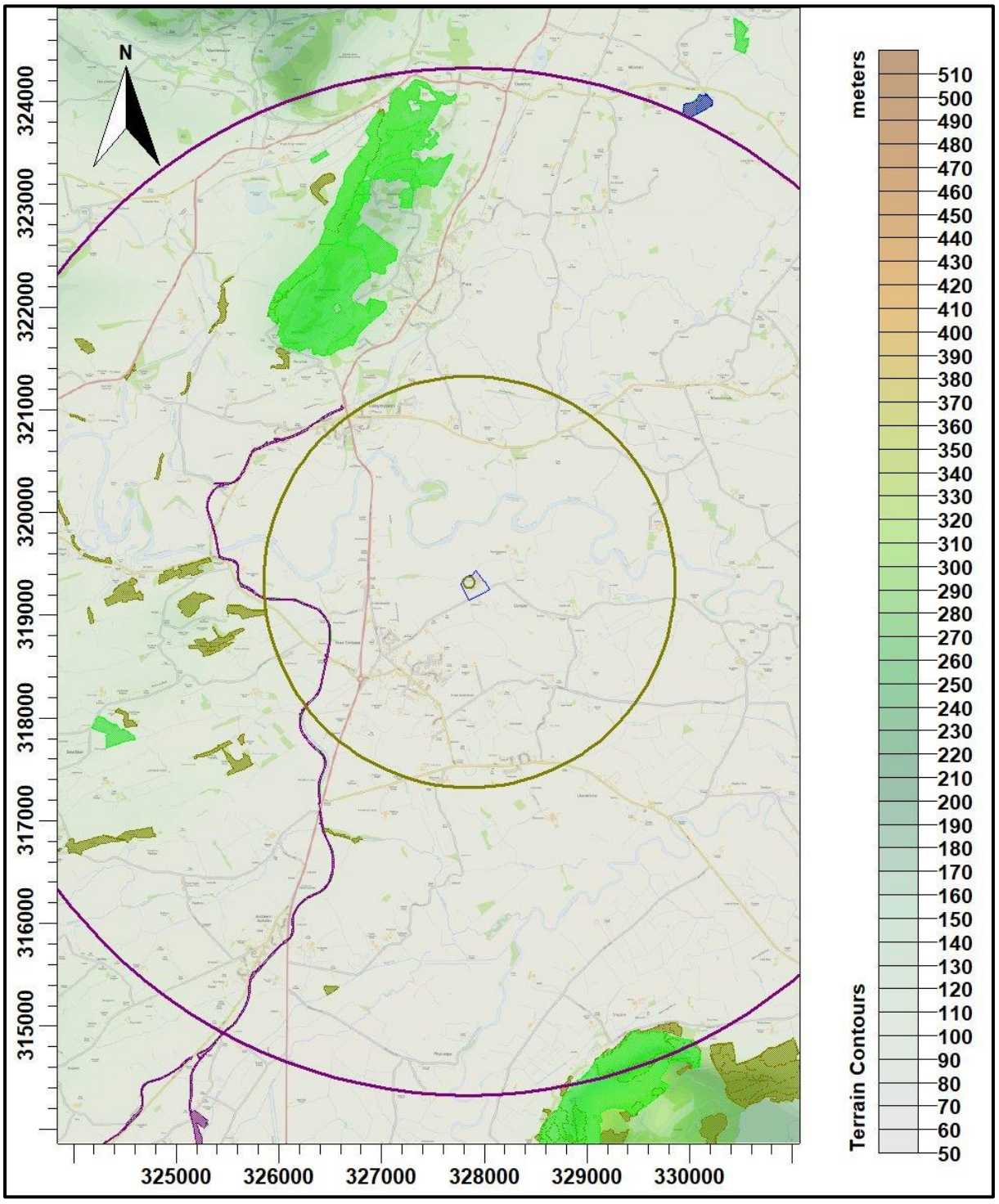
Domgay Hall is in a rural area approximately 750 m to the north-east of the village of Four Crosses, near to Llanymynech in Powys. The surrounding land is used largely for grazing and arable farming and the farm is located on level ground on the banks of the River Vyrnwy at an elevation of around 65 m, with the land rising to the north and west.

There are currently two broiler chicken rearing houses at Domgay Hall. Under the proposal, two new poultry houses would be constructed to the south of the existing houses. The existing and proposed poultry houses would provide accommodation for up to 192,000 broiler chickens. The houses would be ventilated using uncapped high speed ridge fans, with gable end fans providing additional ventilation during hot weather.

There is one area designated as Ancient Woodland (AW) that is within 2 km of Domgay Hall; AS Modelling & Data Ltd. have not identified any other Local Wildlife Sites (LWSs) within 2 km. There are four Sites of Special Scientific Interest (SSSIs) that are within 5 km of the site, namely: the Montgomery Canal SSSI to the west; the Llanymynech and Llynclys Hills SSSI, to the north-north-west; Gweunydd Ty-Brith SSSI to the west-south-west, Breidden Hill SSSI to the south-south-east and Morton Pool and Pasture SSSI to the north-north-east. The Montgomery Canal SSSI is also designated as a Special Area of Conservation (SAC) and Morton Pool and Pasture SSSI is also designated as a Ramsar site.

A map of the surrounding area showing the site of Domgay Hall, AWs, the SSSIs, the SAC and the Ramsar site is provided in Figure 1. In the figure, AWs are shaded in olive, the SSSIs are shaded in green, the SAC is shaded in purple, the Ramsar site is shaded in blue and the site of Domgay Hall is outlined in blue.

Figure 1. The area surrounding Domgay Hall – concentric circles radii 2.0 km (olive) and 5.0 km (purple)



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 ($\mu g\text{-}NH_3/m^3$) 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 Domgay Hall and Montgomery Canal SAC is 2.64 $\mu g\text{-}NH_3/m^3$. The background nitrogen deposition rate to woodland is 35.00 kg-N/ha/y and to short vegetation is 20.58 kg-N/ha/y. The background acid deposition rate to woodland is 2.41 keq/ha/y and to short vegetation is 1.47 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS, April 2020).

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 $\mu g\text{-}NH_3/m^3$ 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 $\mu g\text{-}NH_3/m^3$ 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. 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. Assuming typical deposition velocities, the strictest test is highlighted with bold text.

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)
AW	**1.0** [1]	-	-
Llanymynech and Llynclys Hills SSSI	**1.0** [1 & 2]	10.0 [2 & 3]	-
Gweunydd Ty-Brith SSSI	3.0 [1 & 2]	**10.0** [2 & 3]	-
Breidden Hill SSSI	1.0 [1 & 2]	**5.0** [2, 3 & 4]	-
Montgomery Canal SAC (bankside/marginal vegetation)	**3.0** [1]	n/a	n/a
Morton Pool & Pasture SSSI/Ramsar	3.0 [1 & 2]	**10.0** [2 & 3]	-

1. A precautionary figure used where no details of the ecology of the site are available, or the citation for the site contains reference to sensitive lichens and/or bryophytes.
2. Based upon the citation for the site and information from APIS.
3. The lower bound of the range of Critical Loads for the site/species, obtained from APIS.
4. Assuming a deposition velocity for ammonia of 0.02 m/s the Critical Load for nitrogen deposition of 5.0 kg-N/ha/y provides a slightly stricter test than does the Critical level of 1.0 µg-NH_3/m^3.

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). The Natural Resources Wales (Regulation and Permitting Department, EPP) published Operational Guidance Note 20 (OGN 20) co0ntains essentially the same thresholds.

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 1% 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.

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 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.

The Environment Agency provided an Intensive farming guidance note which lists standard ammonia emission factors for a variety of livestock, including broiler chickens. The emission factor for broiler chickens is 0.034 kg-NH_3/bird place/y; this figure is used to calculate the emissions from the proposed poultry house.

Details of the poultry numbers and types and emission factors used and calculated ammonia emission rates are provided in Table 2.

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

Source	Animal numbers	Type or weight	Emission factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Existing & Proposed Housing	192,000	Broiler Chickens	0.034	0.206860

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 that include: 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). There are no nearby traditional observational meteorological datasets that could be considered representative of the area around Domgay Hall, or that could be considered as suitable for use as driving data for modelling terrain flow; however, data from the observational meteorological stations at Lake Vyrnwy and RAF Shawbury have been considered, primarily to demonstrate that the use of GFS data provides similar results to traditional observational meteorological data.

The GFS is a spectral model: the physics/dynamics model has an equivalent resolution of approximately 13 km (latterly 9km); terrain is understood to be resolved at a resolution of approximately 2 km, with sub-13 km terrain effects parameterised. Site specific data may be extrapolated from nearby archive grid points or a most representative grid point chosen. 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). The use of NWP data has advantages over traditional observational 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

A wind rose showing the distribution of wind speeds and directions in the GFS derived data 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, wind speeds and directions will be modified. The terrain and roughness length modified wind rose for Domgay Hall is shown in Figure 2b. Note that elsewhere in the modelling domain the modified wind roses may differ more markedly and that the resolution of

the wind field in terrain runs is approximately 180 m. Please also note that FLOWSTAR is used to obtain a local flow field, not to explicitly model dispersion in complex terrain as defined in the ADMS User Guide; therefore, the ADMS default value for minimum turbulence length has been amended.

Data from the meteorological recording stations at Lake Vyrnwy and Shawbury have also been considered. However, neither Lake Vyrnwy nor Shawbury, has an aspect that in any way could be considered similar to Domgay Hall; therefore, it should be noted that the frequency of winds from a particular direction in the Lake Vyrnwy and Shawbury data may be either high or low in comparison to what might occur at Domgay Hall, which means mean concentrations downwind may be either over or under predicted. Additionally, periods of light winds and calms cannot be properly modelled. Therefore, the results obtained using the GFS data, particularly when modified by using FLOWSTAR, should be given more weight when interpreting the results of the modelling. The wind roses for Lake Vyrnwy and Shawbury are shown in Figures 2c and 2d.

Figure 2a. The wind rose. Raw GFS derived data, for 52.766 N, 3.067 W, 2015-2018

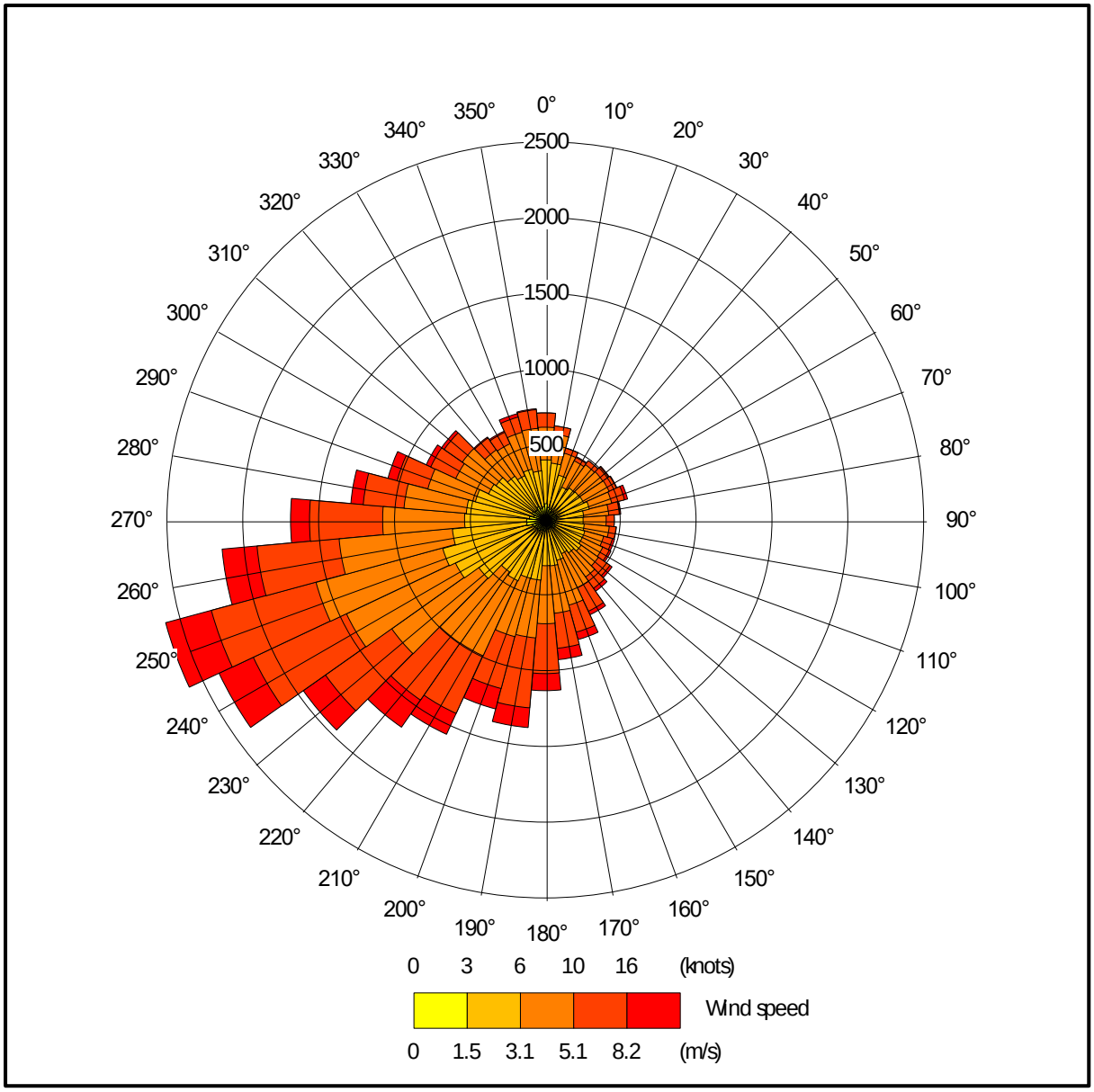


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 327050, 319750, 2015-2018

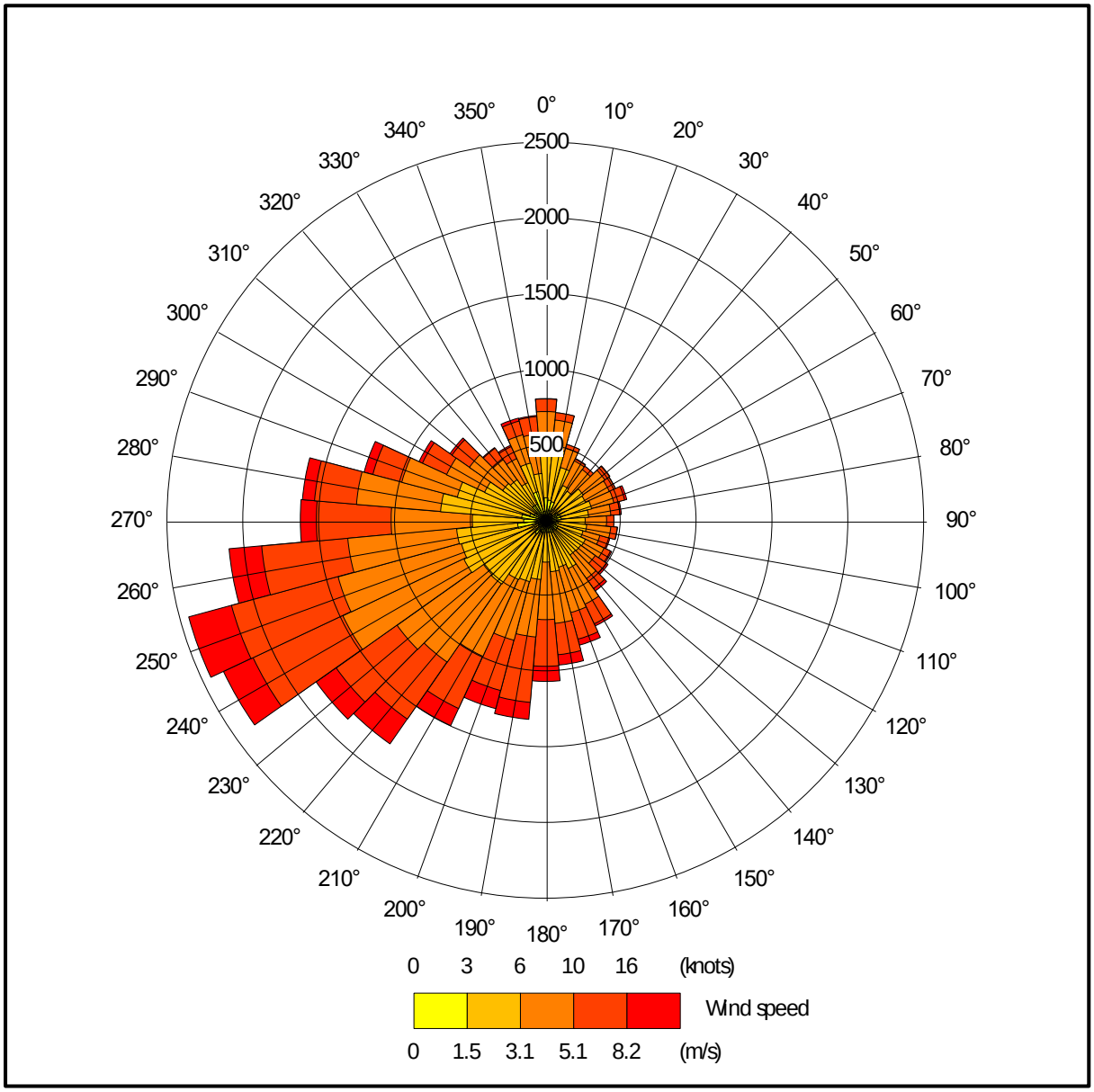


Figure 2c. The wind rose. Recorded meteorological data at Lake Vyrnwy , 2015-2018

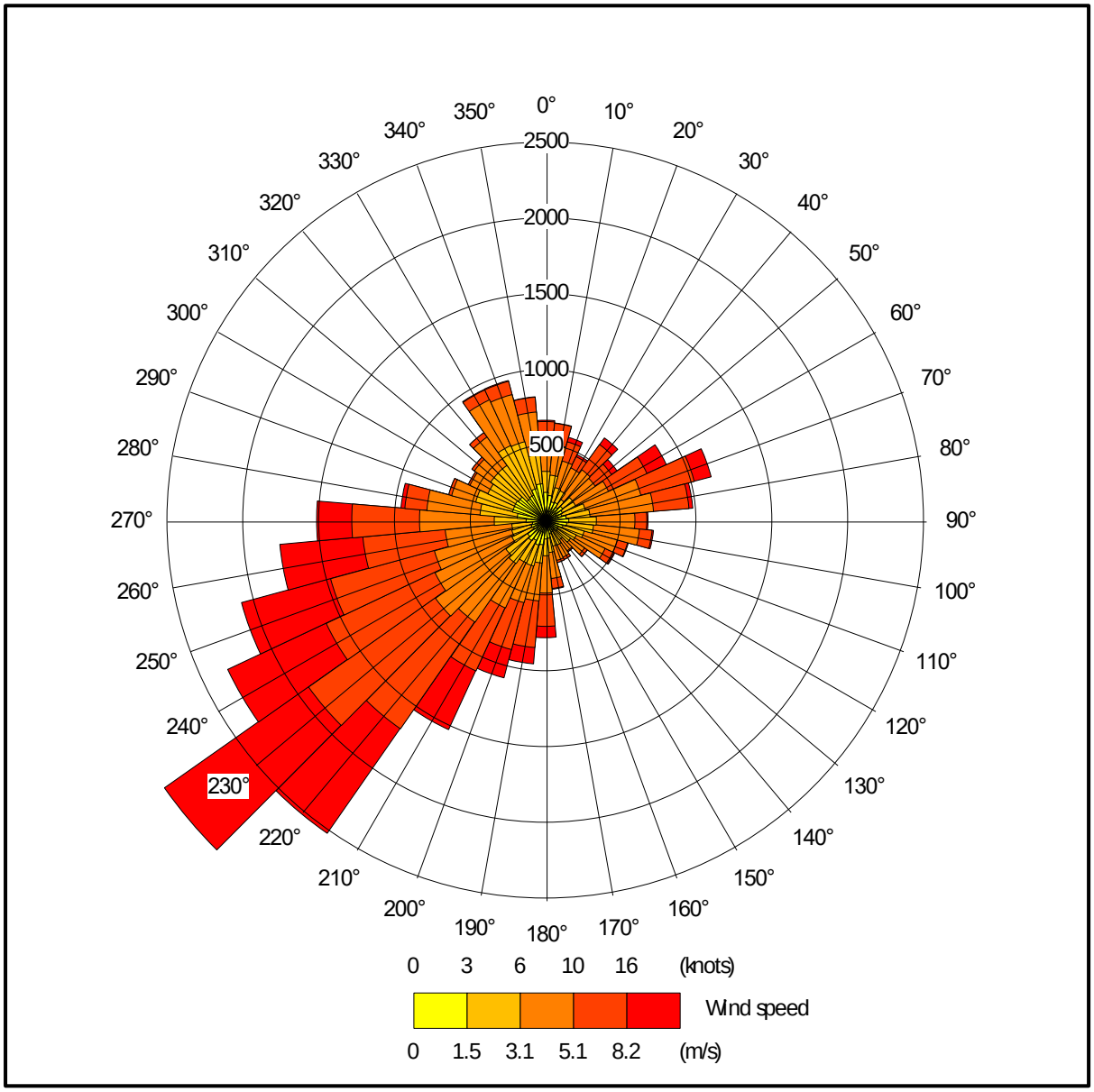
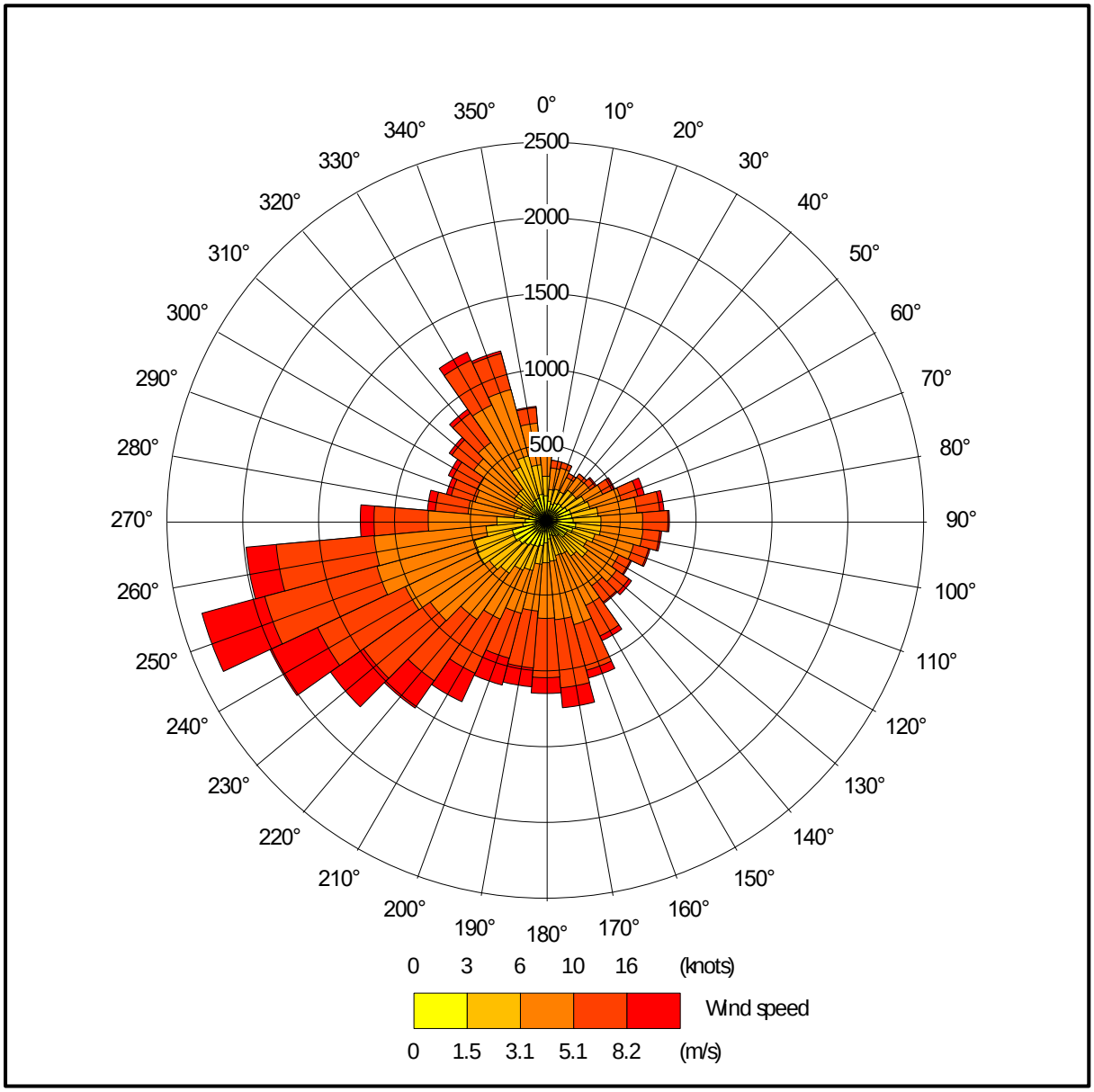


Figure 2d. The wind rose. Recorded meteorological data at Shawbury, 2015-2018



4.2 Emission sources

Emissions from the chimneys of uncapped high speed ridge fans on the existing and proposed poultry houses are represented by three point sources per house within ADMS (EX1 and EX2; 1, 2 & 3 and PR1 and PR2; 1, 2 & 3). Details of the point source parameters are shown in Table 3a and the positions of the point sources may be seen in Figure 3.

Table 3a. 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)
EX1 and EX2; 1, 2 & 3	6.0	0.8	11.0	22.0 [2]	0.017238 [1]
PR1 and PR2; 1, 2 & 3	6.0	0.8	11.0	22.0 [2]	0. 017238 [1]

1. Reduced by 50% when the ambient temperature equals or exceeds 21 Celsius.
2. Or ambient temperature, if >22 Celsius.

The existing and proposed houses are/would be fitted with gable end fans which would be used to provide supplementary ventilation in hot weather conditions. The emissions from the gable end fans are represented by a two volume sources within ADMS (EX12_GAB and PR34_GAB). These volume sources are assumed to emit 50% of the total emission only when the ambient temperature equals or exceeds 20 Celsius; when the volume sources are emitting, emissions from the associated point sources are reduced by 50%. Details of the volume source parameters are shown in Table 3b and their positions may be seen in Figure 3.

Table 3b. 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)
EX12_GAB	5.0	56.5	3.0	0.0	Ambient	0.051715 [3]
PR34_GAB	5.0	56.5	3.0	0.0	Ambient	0.051715 [3]

3. 50% of the total emission is emitted when the ambient temperature equals or exceeds 21 Celsius.

4.3 Modelled buildings

The structure of the existing and proposed poultry houses and other nearby farm buildings may affect the plumes from the point sources. Therefore, the buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3, where they are marked by grey rectangles.

4.4 Discrete receptors

Nineteen discrete receptors have been defined: one at the AW, (1); 10 at the SSSIs (2 to 11); seven at the SAC (12 to 18) and one at the Ramsar site (19). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figure 4, where they are marked by enumerated pink rectangles.

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 4, where it is marked by grey lines.

4.6 Terrain data

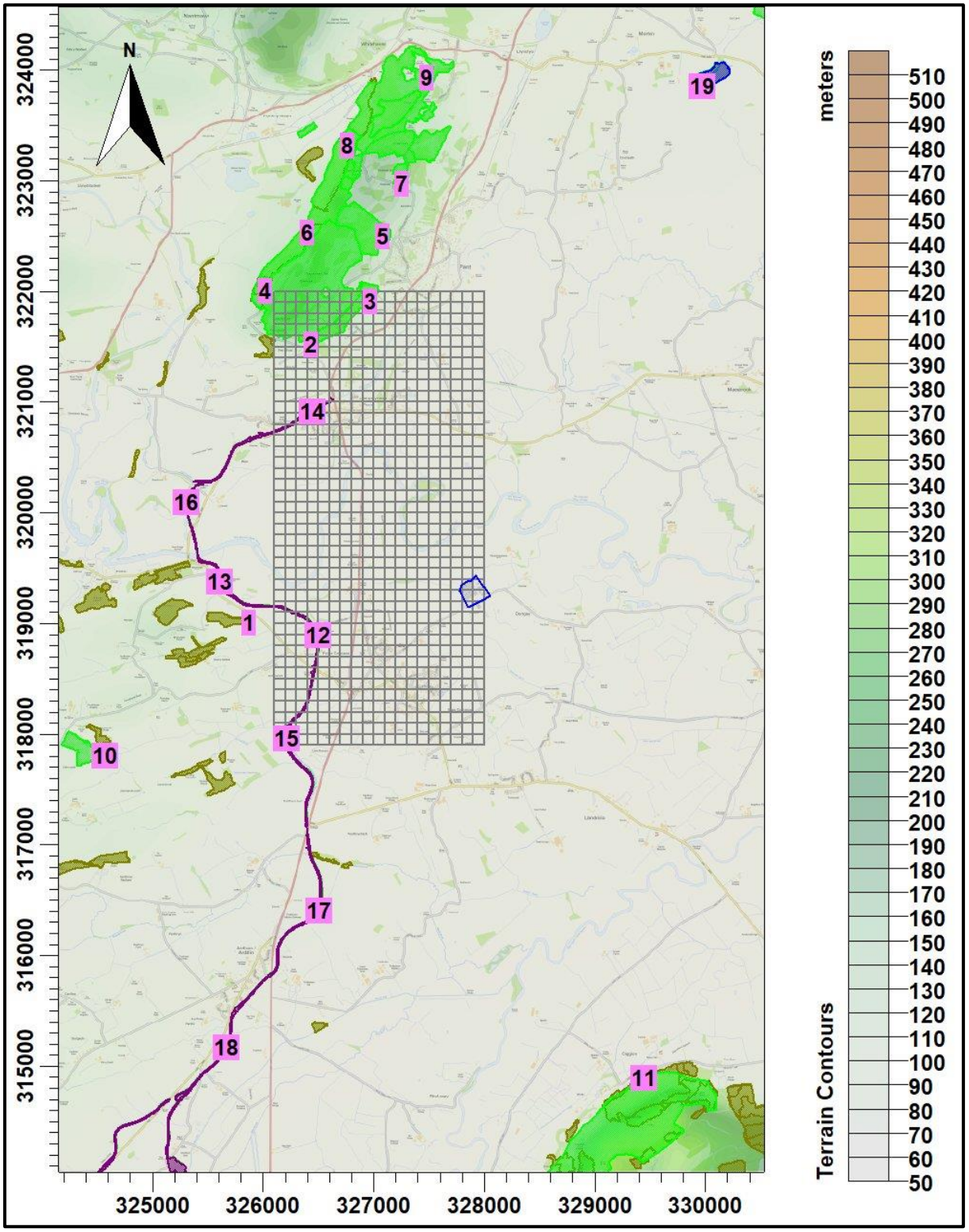
Terrain has been considered in the modelling. The terrain data are based upon the Ordnance Survey 50 m Digital Elevation Model. A 12.0 km x 12.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for use in the preliminary modelling and detailed. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field is approximately 180 m.

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.

Figure 3. The positions of modelled buildings & sources

Figure 4. The discrete receptors and Cartesian grid receptors



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.

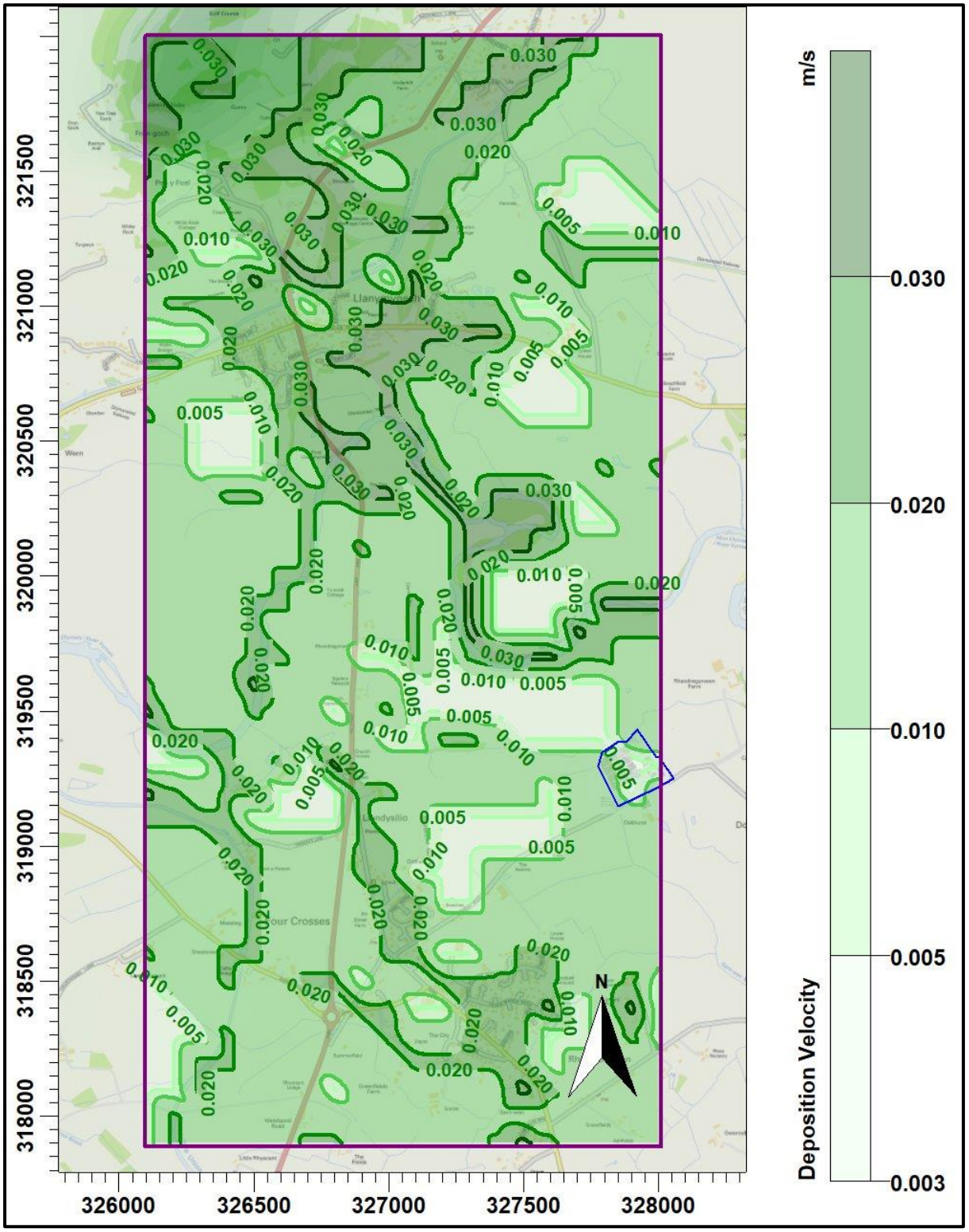
Table 4. Deposition velocities

NH_3 concentration (PC + background) ($\mu g/m^3$)	< 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 and model sensitivity tests

ADMS was run a total of twenty-eight times, once for each year in the meteorological record in the following seven modes:

- In basic mode without calms, or terrain – GFS data.
- With calms and without terrain – GFS data.
- Without calms and with terrain – GFS data.
- Without calms and with terrain – GFS data with a fixed deposition at 0.003 m/s.
- In basic mode without calms, or terrain – Lake Vyrnwy data.
- In basic mode without calms, or terrain – Shawbury data.

For each mode, statistics for the maximum annual mean ammonia concentration at each receptor were compiled.

Details of the predicted annual mean ammonia concentrations at each receptor are provided in Table 5. In the Table, predicted ammonia concentrations, including those that would lead to a nitrogen deposition rate, that are in excess of the Natural Resources Wales upper threshold (8% of Critical Level or Load for a SSSI/SAC/Ramsar site and 100% of a Critical Level or Load for an AW) are coloured red. Concentrations in the range between the Natural Resources Wales upper threshold and lower threshold (1% to 8% for a SSSI/SAC/Ramsar site and 100% to 100% for an AW) are coloured blue. For convenience, cells referring to the AW are shaded olive, cells referring to the SSSIs are shaded green cells referring to the SAC are shaded green and cells referring to the Ramsar site are shaded blue.

Table 5. Predicted maximum annual mean ammonia concentration rate at the discrete receptors

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration - (µg/m³)					
				Existing & Proposed					
				GFS No Calms No Terrain	GFS Calms No Terrain	GFS No Calms Terrain Fixed depo 0.003 m/s	GFS No Calms Terrain	Shawbury No Calms No Terrain	Lake Vyrnwy Calms No Terrain
1	325866	319021	AW	0.026	0.026	0.034	0.022	0.049	0.039
2	326425	321533	Llanymynech and Llynclys Hills SSSI	**0.021**	**0.021**	**0.011**	0.008	**0.023**	**0.011**
3	326962	321918	Llanymynech and Llynclys Hills SSSI	**0.026**	**0.026**	**0.012**	0.008	**0.025**	**0.011**
4	326013	322017	Llanymynech and Llynclys Hills SSSI	**0.017**	**0.017**	0.008	0.006	**0.018**	0.009
5	327079	322509	Llanymynech and Llynclys Hills SSSI	**0.022**	**0.022**	0.010	0.007	**0.021**	**0.012**
6	326398	322545	Llanymynech and Llynclys Hills SSSI	**0.017**	**0.017**	0.006	0.004	**0.017**	0.008
7	327249	322983	Llanymynech and Llynclys Hills SSSI	**0.019**	**0.019**	0.009	0.006	**0.019**	**0.012**
8	326756	323333	Llanymynech and Llynclys Hills SSSI	**0.016**	**0.016**	0.007	0.005	**0.015**	0.009
9	327472	323941	Llanymynech and Llynclys Hills SSSI	**0.014**	**0.014**	0.009	0.006	**0.015**	**0.011**
10	324563	317818	Gweunydd Ty-Brith SSSI	0.017	0.017	**0.028**	0.014	**0.021**	0.018
11	329433	314908	Breidden Hill SSSI	**0.019**	**0.019**	**0.010**	0.006	**0.021**	**0.029**
12	326487	318900	Montgomery Canal SSSI/SAC	**0.045**	**0.045**	**0.053**	**0.038**	**0.065**	**0.064**
13	325596	319389	Montgomery Canal SSSI/SAC	0.022	0.022	0.025	0.017	**0.041**	0.029
14	326441	320927	Montgomery Canal SSSI/SAC	0.029	0.028	0.027	0.017	0.029	0.014
15	326202	317969	Montgomery Canal SSSI/SAC	**0.031**	**0.031**	**0.047**	0.029	**0.030**	0.027
16	325300	320106	Montgomery Canal SSSI/SAC	0.019	0.019	0.021	0.014	0.028	0.019
17	326495	316413	Montgomery Canal SSSI/SAC	0.020	0.019	0.030	0.016	0.015	0.015
18	325657	315181	Montgomery Canal SSSI/SAC	0.013	0.013	0.015	0.008	0.011	0.010
19	329967	323867	Morton Pool & Pasture SSSI/Ramsar	0.015	0.015	0.017	0.012	0.017	0.014

5.2 Detailed deposition modelling

The detailed modelling, which includes ammonia deposition and the consequent plume depletion, was carried out over a restricted domain covering the poultry houses at Domgay Hall, closer stretches of Montgomery Canal SAC and southern parts of the Llanymynech and Llynclys Hills SSSI, the areas where preliminary modelling (GFS fixed deposition run) indicated that annual mean ammonia concentrations or nitrogen deposition rates would potentially exceed 1% of the Critical Level, which is the Natural Resources Wales lower threshold percentage for a SSSI/SAC.

At the AW, other SSSIs, and the Ramsar site, the preliminary modelling indicated that ammonia levels (and nitrogen deposition rates) would be below Natural Resources Wales relevant lower threshold percentage of the Critical Level/Load for the designation of the site.

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 at the discrete receptors within the detailed modelling domain are shown in Table 6. In the Table, predicted ammonia concentrations or nitrogen deposition rates that are in excess of the Natural Resources Wales upper threshold (8% of Critical Level or Load for a SSSI) are coloured red. Concentrations that are in the range between the Natural Resources Wales lower and upper threshold (1% to 8% for a SSSI) are coloured blue.

Contour plots of the predicted ground level maximum annual mean ammonia concentration and maximum nitrogen deposition rate are shown in Figures 6a and 6b, respectively.

Table 6. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors – for bankside vegetation

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	Process Contribution (µg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
2	326425	321533	Llanymynech and Llynclys Hills SSSI	0.030	1.0	10.0	0.0060	0.596	0.05	0.5
3	326962	321918	Llanymynech and Llynclys Hills SSSI	0.030	1.0	10.0	0.0055	0.546	0.04	0.4
12	326487	318900	Montgomery Canal SSSI/SAC	0.030	3.0	-	0.0299	0.996	0.23	-
14	326441	320927	Montgomery Canal SSSI/SAC	0.030	3.0	-	0.0130	0.434	0.10	-
15	326202	317969	Montgomery Canal SSSI/SAC	0.030	3.0	-	0.0221	0.737	0.17	-

Figure 6a. Predicted maximum annual mean ammonia concentrations

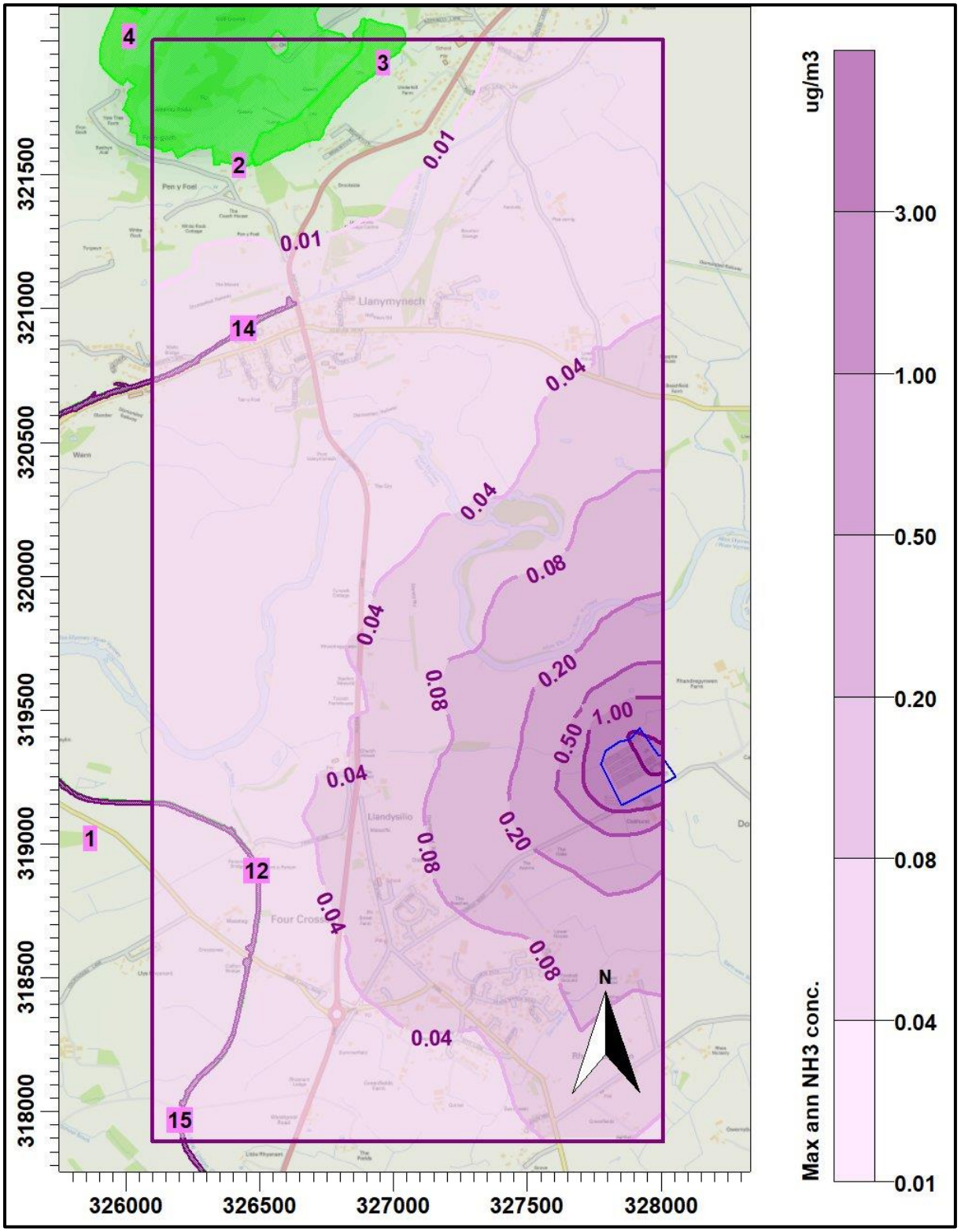
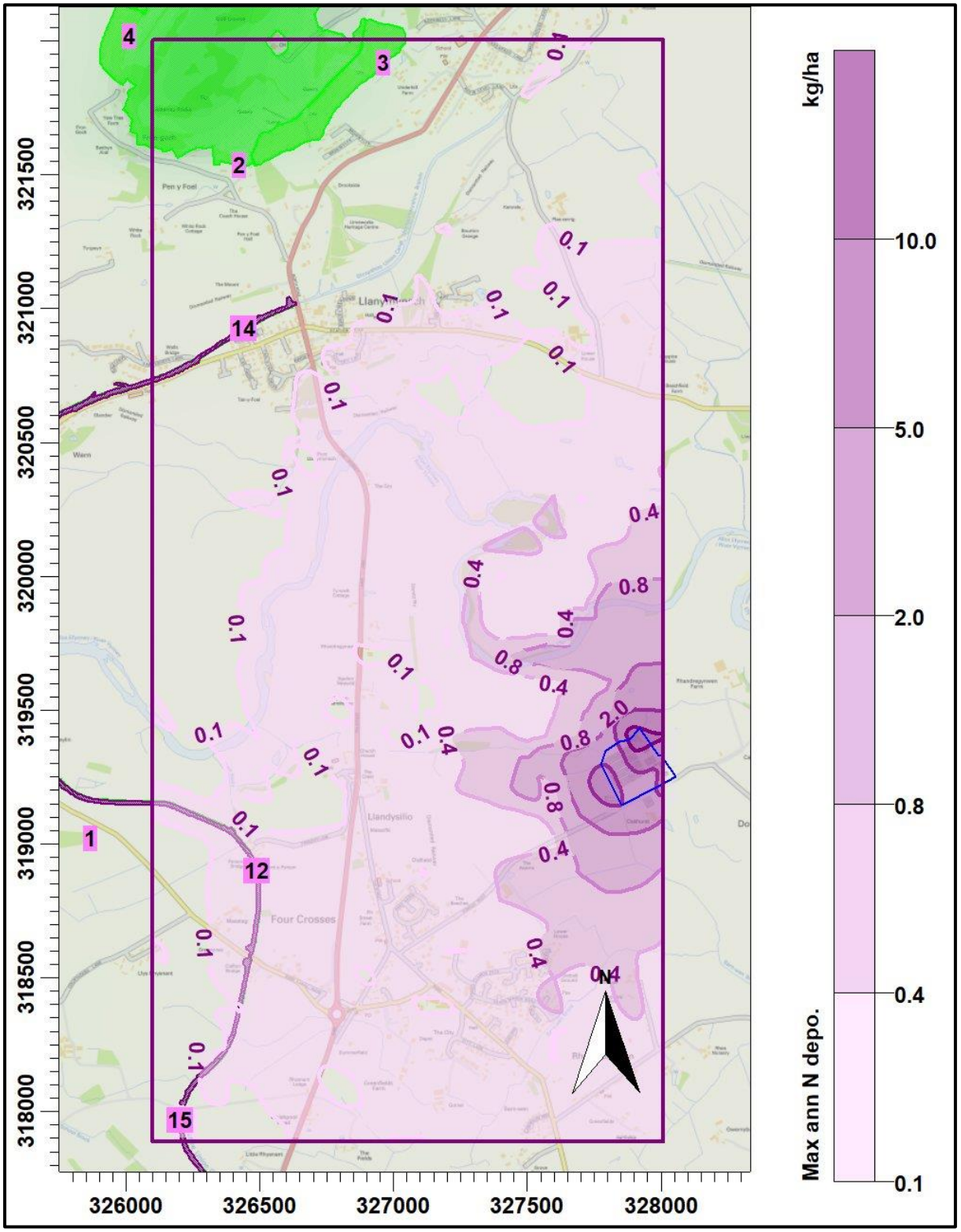


Figure 6b. Predicted maximum annual nitrogen deposition rates



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Mr. Richard Corbett, of Roger Parry & Partners LLP, on behalf of Mr. M. Evans, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Domgay Hall, Four Crosses, near to Llanymynech in Powys. SY22 6SN.

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.

The modelling predicts that:

- The process contribution from the existing and proposed poultry houses to the annual ammonia concentration and the nitrogen deposition rate would be below the Natural Resources Wales lower threshold percentage of the Critical Level and/or Load (1% for a SSSI/SAC) at the Montgomery Canal SAC, Llanymynech and Llynclys Hills SSSI, Gweunydd Ty-Brith SSSI and Breidden Hill SSSI.

- The process contribution from the existing and proposed poultry houses to the annual ammonia concentration and the nitrogen deposition rate would be below the Natural Resources Wales lower threshold percentage of the Critical Level and/or Load (100 % for a AW) at all AWs considered.

7. References

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