A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Poultry Houses at Wetmore Farm, near Onibury in Herefordshire

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Vicky Price of Berrys, on behalf of the applicant, Tom Calvert, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Wetmore Farm, near Onibury in Herefordshire. SY7 9BH.

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

The site of the broiler rearing houses at Wetmore Farm is in a rural area, approximately 2.0 km to the south-south-west of the village of Onibury in Herefordshire. The surrounding land is used largely for arable farming, although there are some meadows and semi-natural wooded areas. The site is at an altitude of between 120 m and 130m, with the land falling towards the River Teme Valley to the east and rising towards Shelderton Hill to the west.

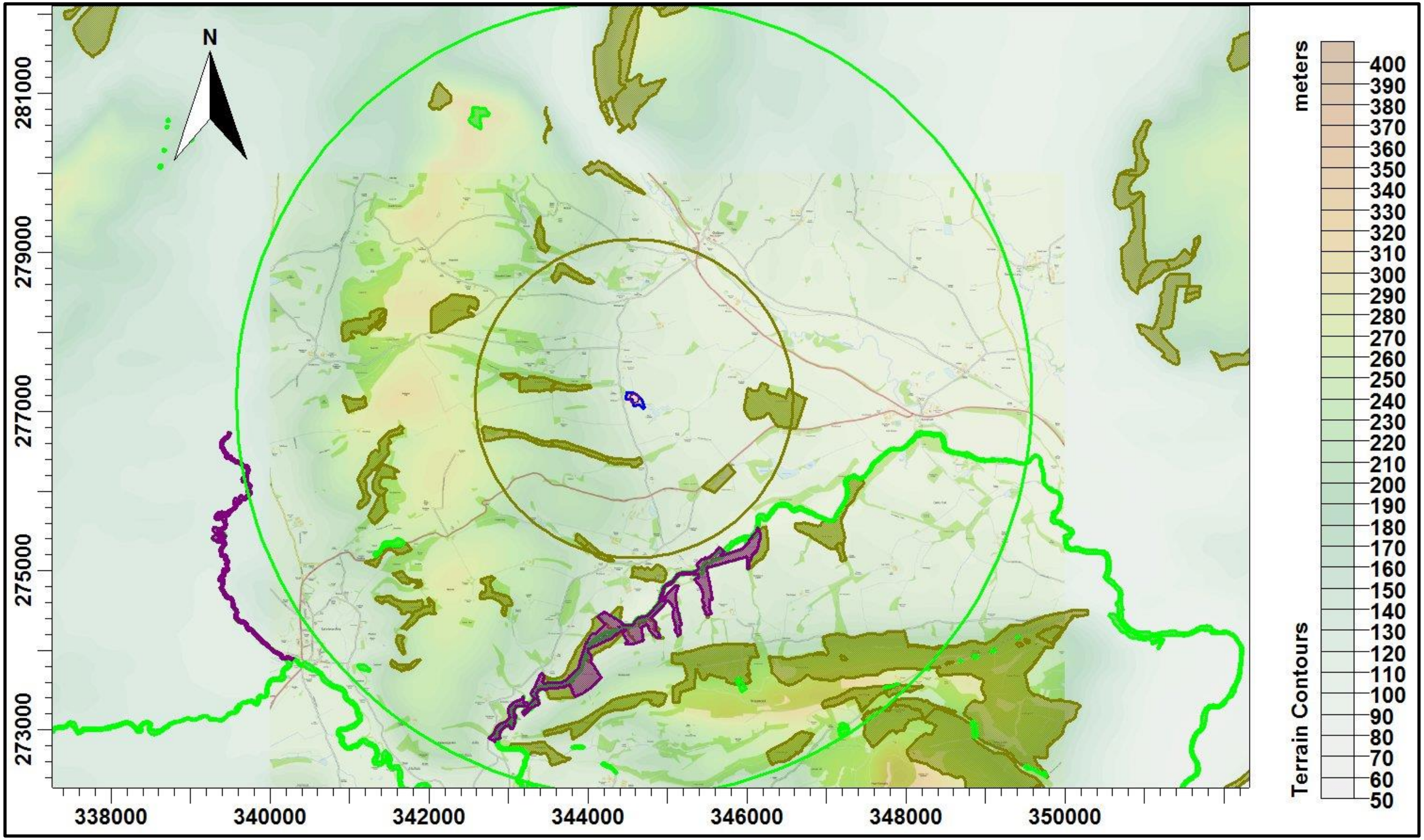
There are currently seven poultry rearing houses at the site; five of these houses are of and older design and nearing the end of their life-span. The existing poultry houses are used to accommodate up to 192,000 broiler chickens and are ventilated using side/gable end mounted fans and/or capped ridge fans.

It is proposed that five of the existing poultry houses be demolished and replaced by four new broiler rearing houses. The remaining two existing houses and the four new houses together would provide accommodation for up to 235,000 broiler chickens. The two existing houses are ventilated using side mounted fans, whilst the new houses would be ventilated by uncapped high speed ridge/roof mounted fans, each with a short chimney. The chickens would be reared from day old chicks to up to around 39 days old and there would be approximately eight flocks per annum.

There are five areas of Ancient Woodlands (AWs) which are also designated as Local Wildlife Sites (LWSs) and one additional LWS within 2 km of the poultry houses at Wetmore Farm. There are nine Sites of Special Scientific Interest (SSSIs) within 2 km and one of the SSSIs, namely Downton Gorge, is also designated as a Special Area of Conservation (SAC). There is one other SAC within 10 km of the farm, but no Special Protection Areas (SPAs), or Ramsar sites.

A map of the surrounding area showing the positions of the poultry unit, the AWs, the LWSs, the SSSIs and the SACs is provided in Figure 1. In this figure, the AWs and LWSs are shaded in olive, the SSSIs are shaded in green, the SACs are shaded in purple and the site of the poultry houses is outlined in blue.

Figure 1. The area surrounding Wetmore Farm – concentric circles radii 2 km (olive) and 5 km (green)



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 Wetmore Farm and the wildlife sites is 1.75 $\mu g\text{-}NH_3/m^3$. The background nitrogen deposition rate to woodland is 30.52 kg-N/ha/y and to short vegetation is 18.34 kg-N/ha/y. The background acid deposition rate to woodland is 2.26 keq/ha/y and to short vegetation is 1.40 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS).

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.

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)
AWs and LWSs	1.0 [1]	-	-
SSSIs	1.0 [1]	-	-
SACs	1.0 [1]	-	-

1. A precautionary figure, used where details of the site are unavailable, or citations indicate that sensitive lichens and bryophytes may be present.

3.4 Guidance on the Significance of Ammonia Emissions

The following are obtained from the Environment Agency's horizontal guidance, H1 Environmental Risks Assessment, H1 Annex B - Intensive Farming.

"An emission is insignificant where Process Contribution (PC) is <4% of Critical Levels for SACs, SPAs and Ramsars, <20% for SSSIs, and <50% for local and national nature reserves (LNRs & NNRs), ancient woodland and local wildlife sites."

"Where modelling predicts a process contribution >20% of the Critical Level/Load at a SAC, SPA or Ramsar, >50% at a SSSI or >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."

Within the range between what is considered insignificant and what may not be considered acceptable; 4% to 20% for SACs, SPAs and Ramsars; 20% to 50% for SSSIs and 50% to 100% for other non-statutory wildlife sites, whether or not the impact is deemed acceptable is at the discretion of the Environment Agency. In making their decision, the Environment Agency will consider whether other farming installations might act in combination with the application site and the sensitivities of the wildlife sites. N.B. In the case of LWSs and AWs, the Environment Agency do not consider other farms that may act in combination, therefore a PC of up to 100% of Critical Level or Critical Load is usually deemed acceptable.

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 unit.

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 ammonia emission rates

Source	Animal numbers	Type or weight	Emission factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Existing Housing	192,000	Broiler Chickens	0.034	0.206860
Proposed Housing	235,000	Broiler Chickens	0.034	0.253188

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).

The GFS is a spectral model and data are archived at a horizontal resolution of 0.5 degrees, or approximately 50 km over the UK (latterly 0.25 degrees, or approximately 25km). 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 meteorological records because:

- Calm periods in traditional records may be over represented, this is because the instrumentation used may not record wind speed 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 at the site of the proposed poultry unit at Wetmore Farm 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 site of the poultry unit at Wetmore Farm is shown in Figure 2b. Note that elsewhere in the modelling domain, modified wind roses may differ markedly and that the resolution of the wind field in terrain runs is 300 m.

Figure 2a. The wind rose. Raw GFS derived data, for 52.389 N, 2.814 W, 2011 – 2014

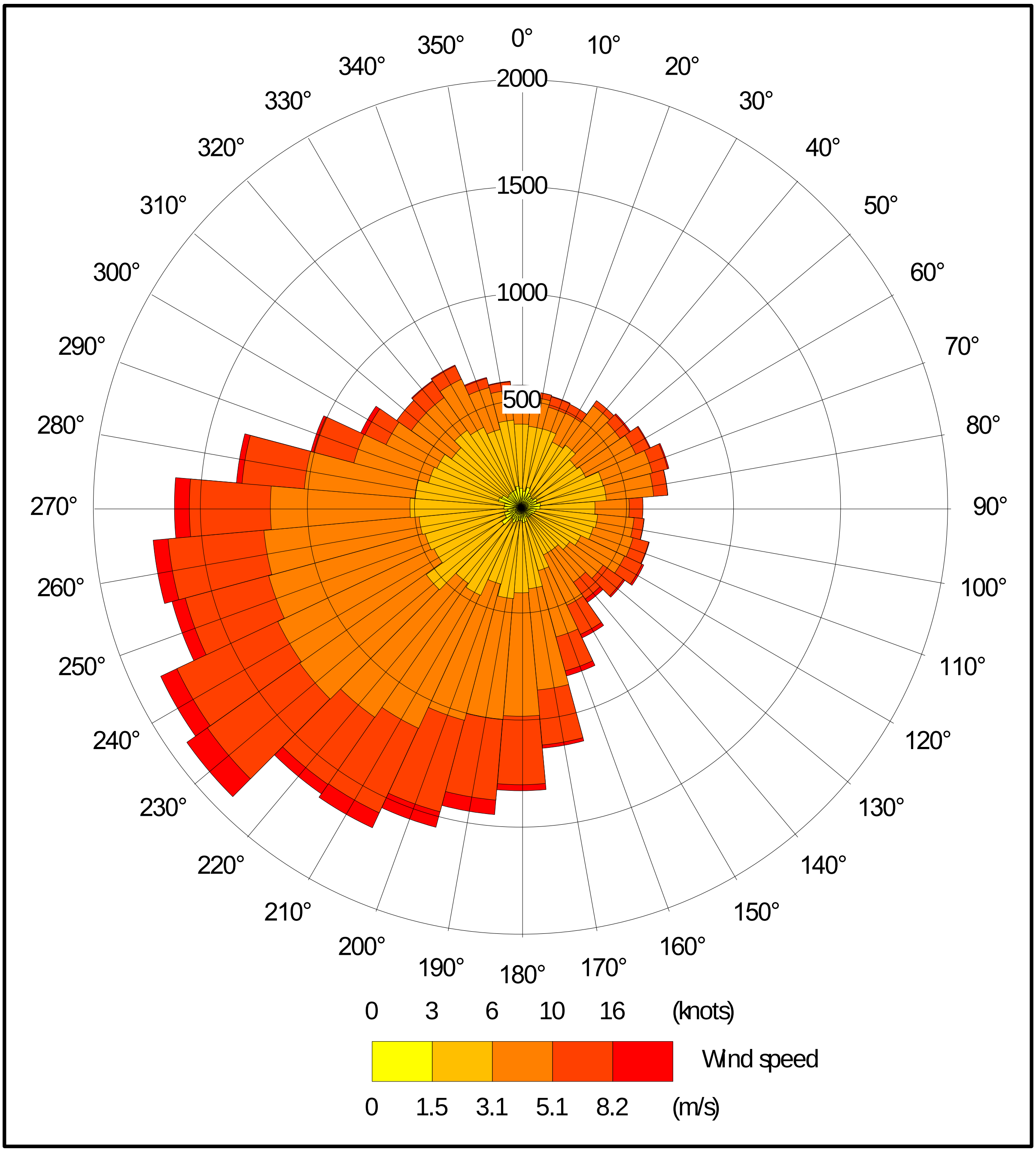
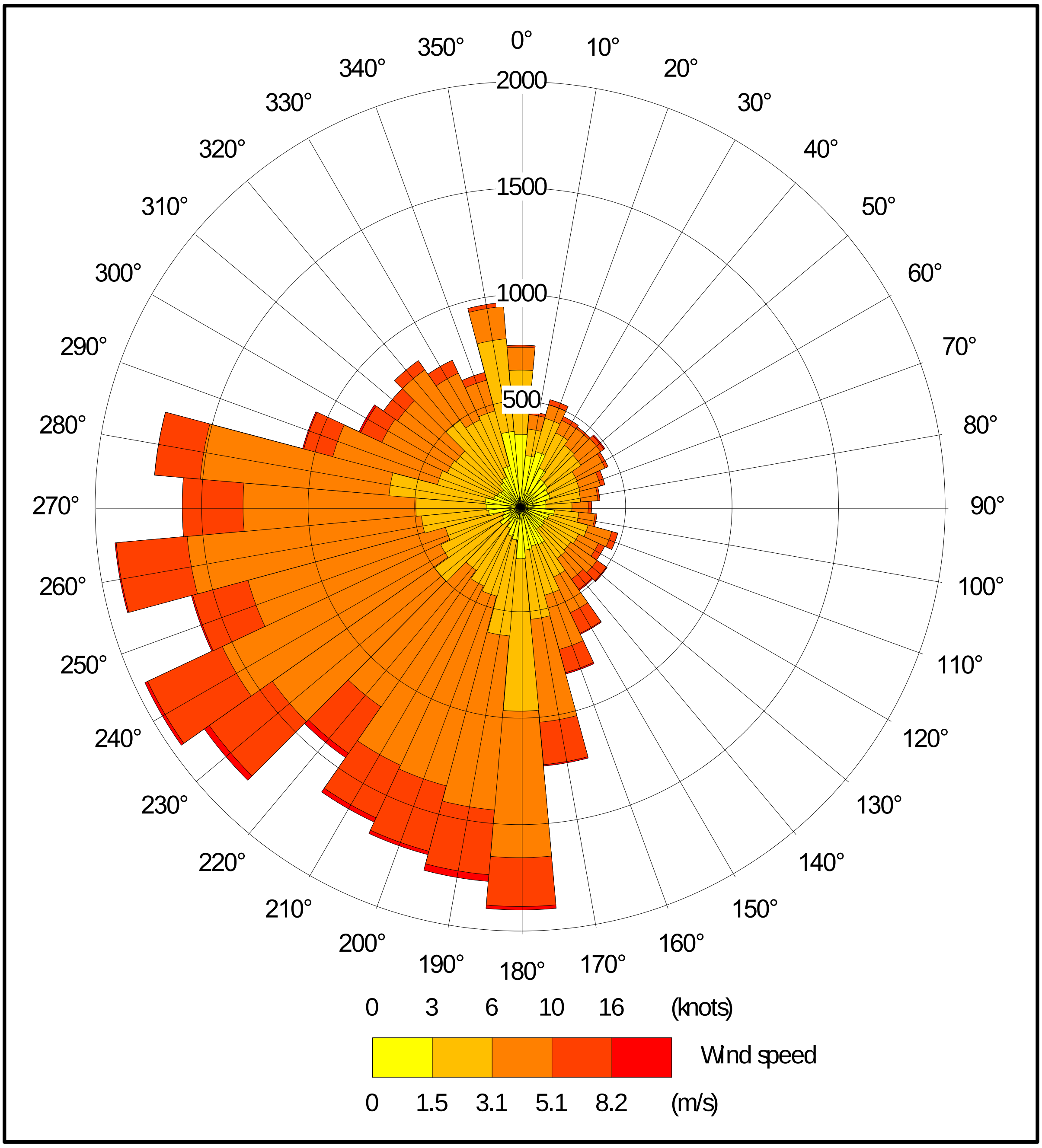


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data, for 52.389 N, 2.814 W, 2011 – 2014



4.2 Emission sources

Emissions from the existing houses that are ventilated using side mounted fans are represented by a single volume source per house within ADMS (EX3_vol, EX6_vol and EX_7_vol). Details of the volume source parameters are shown in Table 2b. The positions of the volume sources may be seen in Figure 4a (existing scenario) and 4b (proposed scenario).

Emissions from the existing houses that are ventilated primarily by capped ridge mounted fans are represented by three point sources per house within ADMS (EX1 a, b & c; EX2 a, b & c; EX4 a, b & c and EX5 a, b & c). Details of the point source parameters are shown in Table 2a. The positions of the point sources may be seen in Figure 4a. These house are also be fitted with gable end fans which are used to provide supplementary ventilation in hot weather conditions. The emissions from the gable end fans are represented by a single volume source per house within ADMS (EX1_gab; EX2_gab; EX5_gab and EX5_gab). Details of these volume source parameters are shown in Table 2b. The positions of the volume sources may be seen in Figure 4a.

Emissions from the chimneys of uncapped high speed ridge/roof fans that would be used to ventilate the proposed poultry houses (PR1 a, b & c to PR3 a, b & c), are represented by three point sources per house within ADMS. Details of the point source parameters are shown in Table 2a. The positions of the point sources may be seen in Figure 4b.

Table 3a. Point source parameters

Source ID (scenario)	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (˚C)	Emission rate per source ($g\text{-}NH_3/s$)
EX1 a, b & c (existing)	4	2	0.1	22.0	0.004937 [1]
EX2 a, b & c (existing)	4	2	0.1	22.0	0.004443 [1]
EX4 a, b & c (existing)	4.5	2	0.1	22.0	0.009874 [1]
EX5 a, b & c (existing)	4.5	2	0.1	22.0	0.011849 [1]
PR1 a, b & c (proposed)	6.5	0.8	11	22.0	0.020528
PR2 a, b & c (proposed)	6.5	0.8	11	22.0	0.020528
PR3 a, b & c (proposed)	6.5	0.8	11	22.0	0.020528

1. Reduced by 50% when the ambient temperature equals or exceeds 21 Celsius.

Table 3b. Volume source parameters

Source ID (scenario)	Length Y (m)	Width X (m)	Depth (m)	Base height (m)	Emission temperature (°C)	Emission rate ($g\text{-}NH_3/s$)
EX1_gab (existing)	5	15	3.0	0.0	Ambient	0.007405 [2]
EX2_gab (existing)	-5	14	3.0	0.0	Ambient	0.006665 [2]
EX3_vol (existing)	61	21	3.0	0.0	Ambient	0.034559
EX4_gab (existing)	5	18	3.0	0.0	Ambient	0.014811 [2]
EX5_gab (existing)	18	5	3.0	0.0	Ambient	0.017773 [2]
EX6_vol (existing)	24	61	3.0	0.0	Ambient	0.039496
EX7_vol (existing)	24	61	3.0	0.0	Ambient	0.039496
EX6_vol (proposed)	24	61	3.0	0.0	Ambient	0.034307
EX7_vol (proposed)	24	61	3.0	0.0	Ambient	0.034307

2. 50% of the total emission is emitted when the ambient temperature equals or exceeds 21 Celsius.

4.3 Modelled buildings

The structure of the poultry houses 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 Figures 3a (existing) and 3b (proposed), where they are marked by grey rectangles.

4.4 Discrete receptors

Thirty-nine discrete receptors have been defined: thirteen at the AWs/LWSs (1 to 13); fifteen at the SSSIs (14 to 28) and eleven at the SAC (29 to 39). 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 grid

To produce the contour plots presented in Section 5 of this report and to define the spatially varying deposition velocity field, 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 10.0 km x 10.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for use in the modelling. N.B. The resolution of FLOWSTAR is 32 x 32 grid points; therefore, the effective resolution of the wind field is approximately 300 m.

4.7 Roughness Length

A fixed surface roughness length of 0.3 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 0.2 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 3a. The positions of modelled buildings & sources – existing scenario

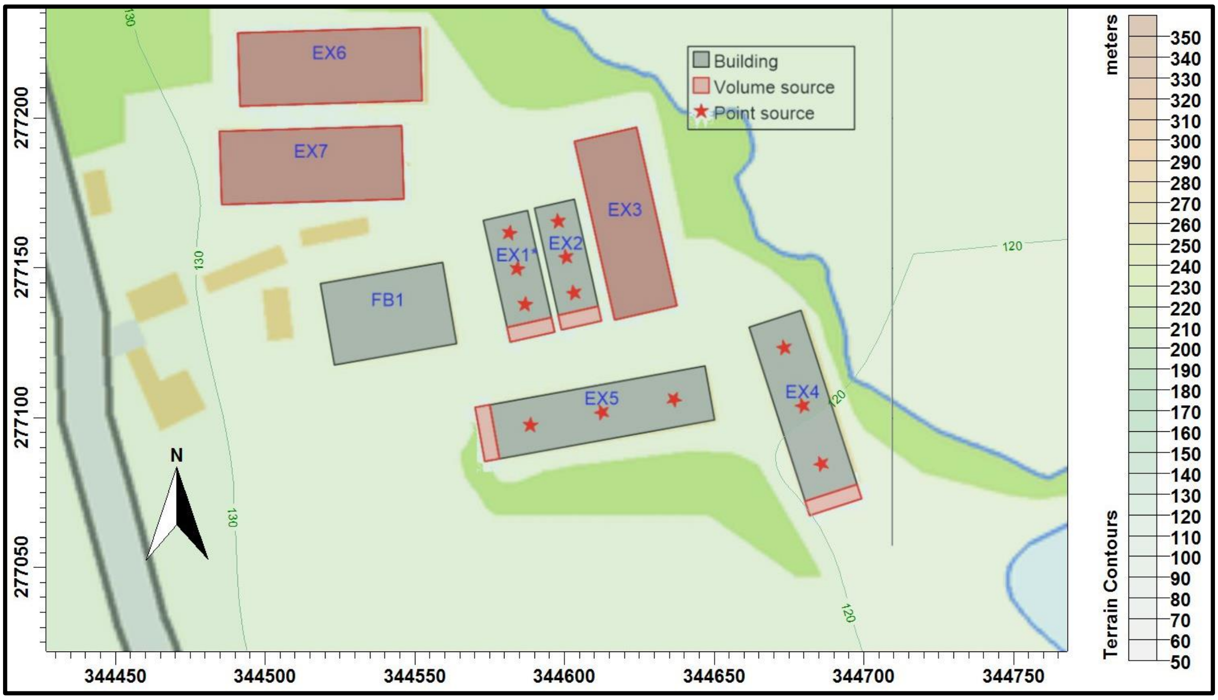


Figure 3b. The positions of modelled buildings & sources – proposed scenario

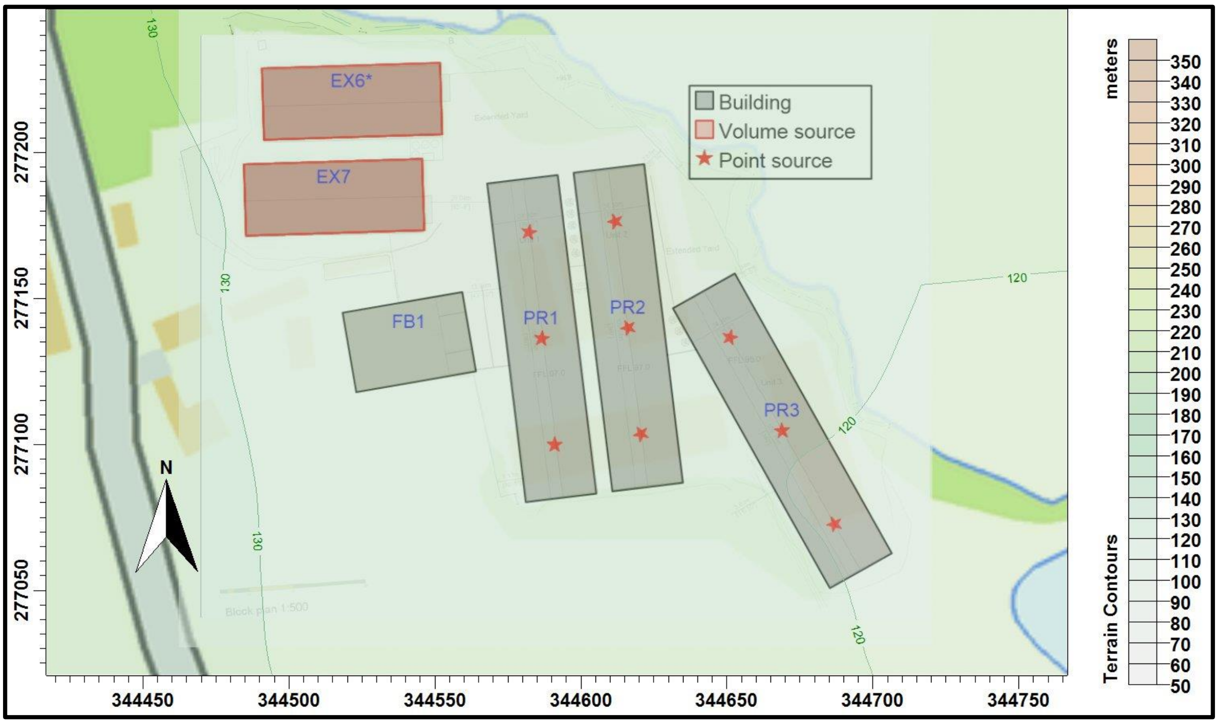
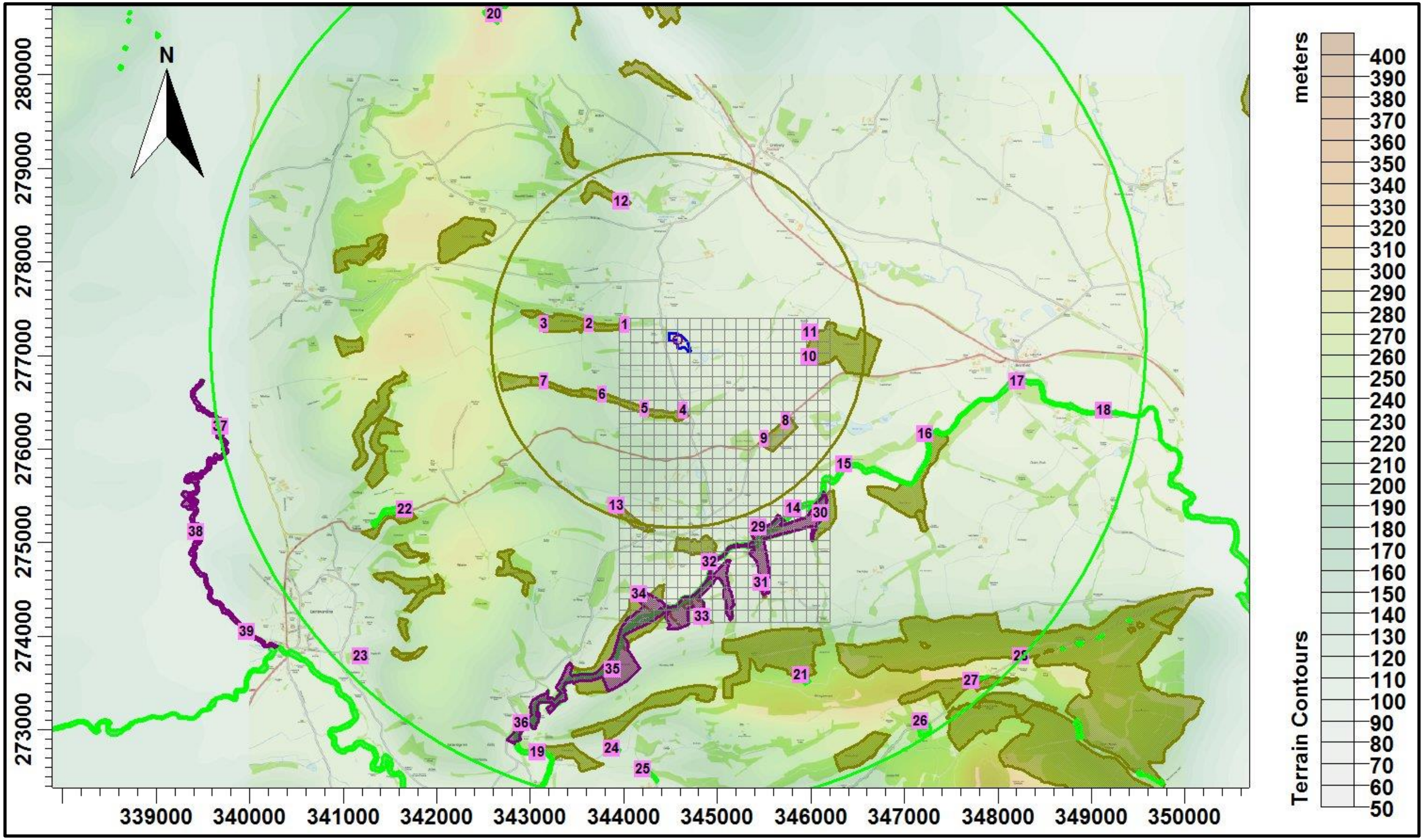


Figure 4. The discrete receptors – concentric circles radii 2 km (olive) and, 5 km (green)



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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 to compensate for possible saturation effects due to fertilizer/manure application and to allow for periods when fields are clear of crops (Sutton *et al*). The deposition velocity is also set to 0.002 m/s where grid points are over the poultry houses, or other vegetation free areas.

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 is used to define a deposition velocity field. The deposition velocities used are provided in Table 4.

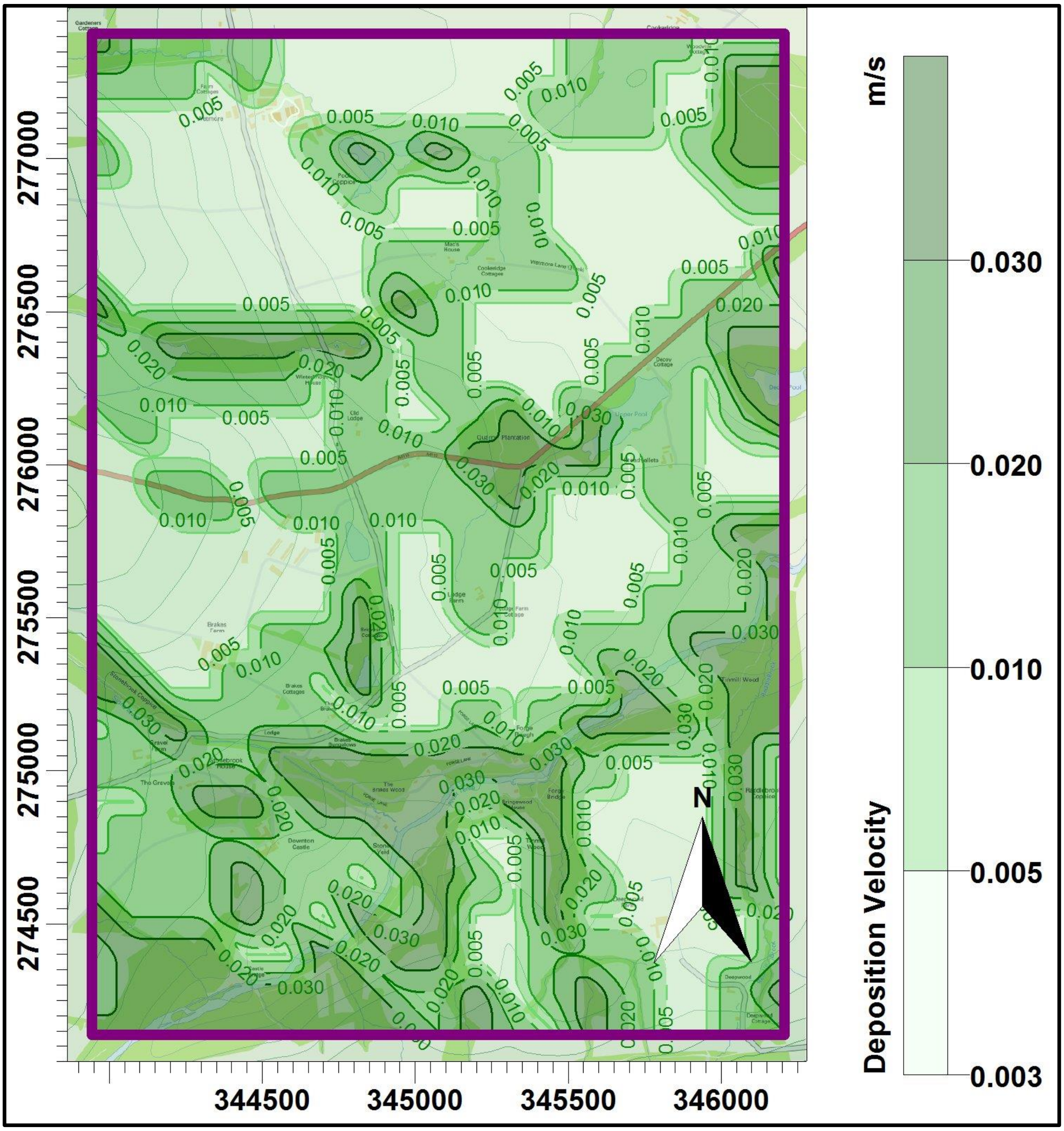
Table 4. Deposition velocities

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	0.01	0.005	0.003
Deposition velocity – arable farmland (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 run a total of twenty-four times, once for each year of the meteorological record in four modes and for both the existing and proposed scenarios:

- In basic mode without calms, or terrain – GFS data.
- With calms and without terrain – GFS data.
- Without calms and with terrain – GFS 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 that are in excess of that which may be considered acceptable (20% of Critical Level for a SAC, 50% of Critical Level for a SSSI and 100% of Critical Level for a non-statutory wildlife site) are coloured red. Concentrations in the range between what is considered insignificant and what may not be considered acceptable (4% to 20% for a SAC, 20% to 50% for a SSSI and 50% to 100% for a non-statutory wildlife site) are coloured blue.

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

Receptor number	X(m)	Y(m)	Maximum annual mean ammonia concentration (µg/m³)					
			Existing			Proposed		
			GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain
1	344017	277321	**0.769**	**0.895**	**1.014**	**0.556**	**0.649**	**0.716**
2	343633	277332	0.360	0.411	0.462	0.253	0.289	0.325
3	343153	277332	0.197	0.223	0.232	0.140	0.157	0.166
4	344638	276406	0.464	**0.530**	**0.507**	0.319	0.348	0.313
5	344226	276428	0.493	**0.551**	**0.535**	0.332	0.372	0.374
6	343775	276581	0.274	0.320	0.312	0.195	0.230	0.200
7	343155	276722	0.168	0.194	0.158	0.134	0.144	0.112
8	345738	276299	0.232	0.256	0.221	0.158	0.173	0.146
9	345510	276104	0.205	0.233	0.199	0.145	0.162	0.152
10	345992	276976	0.221	0.248	0.207	0.184	0.199	0.162
11	346001	277239	0.210	0.239	0.203	0.189	0.205	0.170
12	343985	278645	0.118	0.142	0.118	0.093	0.109	0.086
13	343926	275392	0.139	0.154	0.133	0.100	0.110	0.092
14	345823	275358	0.103	0.117	0.138	0.079	0.087	0.111
15	346368	275832	0.115	0.127	0.136	0.084	0.092	0.092
16	347234	276152	0.084	0.093	0.098	0.066	0.071	0.069
17	348217	276721	0.046	0.052	0.052	0.043	0.046	0.042
18	349142	276403	0.032	0.036	0.040	0.031	0.033	0.031
19	343081	272753	0.033	0.037	0.025	0.029	0.031	0.023
20	342624	280642	0.023	0.029	0.010	0.021	0.024	0.009
21	345906	273577	0.041	0.047	0.043	0.035	0.039	0.036
22	341663	275350	0.036	0.044	0.018	0.033	0.037	0.016
23	341193	273786	0.023	0.027	0.014	0.021	0.023	0.014
24	343880	272798	0.033	0.038	0.026	0.030	0.032	0.022
25	344215	272577	0.028	0.033	0.022	0.026	0.028	0.019
26	347180	273086	0.029	0.033	0.021	0.027	0.029	0.015
27	347727	273518	0.028	0.032	0.023	0.025	0.027	0.016
28	348255	273786	0.028	0.032	0.028	0.025	0.027	0.018
29	345448	275164	**0.106**	**0.119**	**0.149**	**0.080**	**0.088**	**0.134**
30	346111	275308	**0.086**	**0.098**	**0.112**	**0.066**	**0.074**	**0.088**
31	345481	274567	**0.069**	**0.078**	**0.113**	**0.055**	**0.060**	**0.099**
32	344928	274788	**0.074**	**0.085**	**0.097**	**0.061**	**0.065**	**0.086**
33	344850	274202	**0.052**	**0.060**	**0.079**	**0.043**	**0.046**	**0.059**
34	344176	274445	**0.071**	**0.080**	**0.078**	**0.056**	**0.061**	**0.057**
35	343888	273638	**0.048**	**0.054**	**0.043**	**0.041**	**0.044**	0.035
36	342915	273063	0.034	0.039	0.026	0.030	0.032	0.024
37	339699	276237	0.025	0.030	0.013	0.024	0.026	0.013
38	339434	275109	0.019	0.022	0.012	0.019	0.020	0.011
39	339981	274047	0.016	0.020	0.012	0.016	0.018	0.010

5.2 Detailed deposition modelling

The detailed deposition modelling was carried out over a domain covering the poultry unit, closer AWs and closer parts of the Downton Gorge SAC, where the preliminary modelling indicated that annual mean ammonia concentrations would potentially exceed 4% (for SACs) or 50% (for AWs/LWSs) of the Critical Level of 1.0 $\mu g/m^3$. At all other receptors, annual mean ammonia concentrations were predicted to be at levels that would be deemed insignificant for permitting purposes (or acceptable in the case of non-statutory sites) in the preliminary modelling.

Spatially varying deposition and terrain cannot be modelled in conjunction with the calms module of ADMS. In this case, the preliminary modelling suggests that the effect of calms is significant for the existing and proposed scenario. However, it should be noted that ADMS uses a continuous equation that produces finite results at all distances from the source and that it is unlikely that calms increase the exposure as the model suggests at Downton Gorge SAC because any katabatic winds would probably blow down the gorge and downhill from the farm. At some of the closer AWs/LWS, downhill from the farm, the increase predicted using the calms module is probably representative of the reality and therefore, this should be considered when interpreting the results (the calms results in the preliminary modelling are around 13% higher than the basic run results at receptors 9, 10, 11 and 12). Also note that if using a traditional observational meteorological dataset, then the effects of calms would be ignored entirely in most cases and that it is the use of NWP data that allows this consideration to be properly made. The model was run four times, once for each year of the meteorological record.

The results of the detailed deposition modelling are shown in Table 6. In this Table, predicted ammonia concentrations and nitrogen deposition rates that are in excess of that which may be considered acceptable (20% of Critical Level for a SAC, 50% of Critical Level for a SSSI and 100% of Critical Level for a non-statutory wildlife site) are coloured red. Concentrations in the range between what is considered insignificant and what may not be considered acceptable (4% to 20% for a SAC, 20% to 50% for a SSSI and 50% to 100% for a non-statutory wildlife site) are coloured blue. The abbreviations PC, Cle and Clo, used in the table, mean Process Contribution, Critical Level and Critical Load, respectively.

Contour plots of the predicted maximum annual ammonia concentrations and nitrogen deposition rates are shown in Figures 6a and 6b (existing scenario) and Figures 7a and 7b (proposed scenario).

Table 6. Annual ammonia concentration and nitrogen deposition rate at the discrete receptors

Receptor number	X(m)	Y(m)	Site Parameters			Existing				Proposed			
						Maximum annual mean ammonia concentration at ground level		Maximum annual deposition rate		Maximum annual mean ammonia concentration at ground level		Maximum annual deposition rate	
			Critical Level (µg/m³)	Critical Load (kg/ha)	Deposition Velocity (m/s)	PC (µg/m³)	%age of Cle	PC(kg/ha)	%age of Clo	PC (µg/m³)	%age of Cle	PC(kg/ha)	%age of Clo
1	344017	277321	1.0	10.0	0.03	0.305	30.5	2.376	23.8	0.234	23.4	1.820	18.2
4	344638	276406	1.0	10.0	0.03	0.230	23.0	1.794	17.9	0.159	15.9	1.237	12.4
5	344226	276428	1.0	10.0	0.03	0.199	19.9	1.553	15.5	0.140	14.0	1.091	10.9
8	345738	276299	1.0	10.0	0.03	0.074	7.4	0.577	5.8	0.065	6.5	0.510	5.1
9	345510	276104	1.0	10.0	0.03	0.076	7.6	0.590	5.9	0.071	7.1	0.551	5.5
10	345992	276976	1.0	10.0	0.03	0.103	10.3	0.799	8.0	0.093	9.3	0.726	7.3
11	346001	277239	1.0	10.0	0.03	0.117	11.7	0.911	9.1	0.115	11.5	0.893	8.9
13	343926	275392	1.0	10.0	0.03	0.036	3.6	0.277	2.8	0.026	2.6	0.202	2.0
14	345823	275358	1.0	10.0	0.03	0.028	2.8	0.215	2.2	0.028	2.8	0.216	2.2
29	345448	275164	1.0	10.0	0.03	0.030	3.0	0.233	2.3	0.033	3.3	0.261	2.6
30	346111	275308	1.0	10.0	0.03	0.022	2.2	0.168	1.7	0.023	2.3	0.179	1.8
31	345481	274567	1.0	10.0	0.03	0.018	1.8	0.138	1.4	0.021	2.1	0.161	1.6
32	344928	274788	1.0	10.0	0.03	0.025	2.5	0.198	2.0	0.031	3.1	0.245	2.4
33	344850	274202	1.0	10.0	0.03	0.017	1.7	0.134	1.3	0.021	2.1	0.165	1.7
34	344176	274445	1.0	10.0	0.03	0.018	1.8	0.144	1.4	0.019	1.9	0.146	1.5
35	343888	273638	1.0	10.0	0.03	0.010	1.0	0.082	0.8	0.012	1.2	0.095	0.9

Figure 6a. Maximum annual mean ammonia concentration – existing scenario

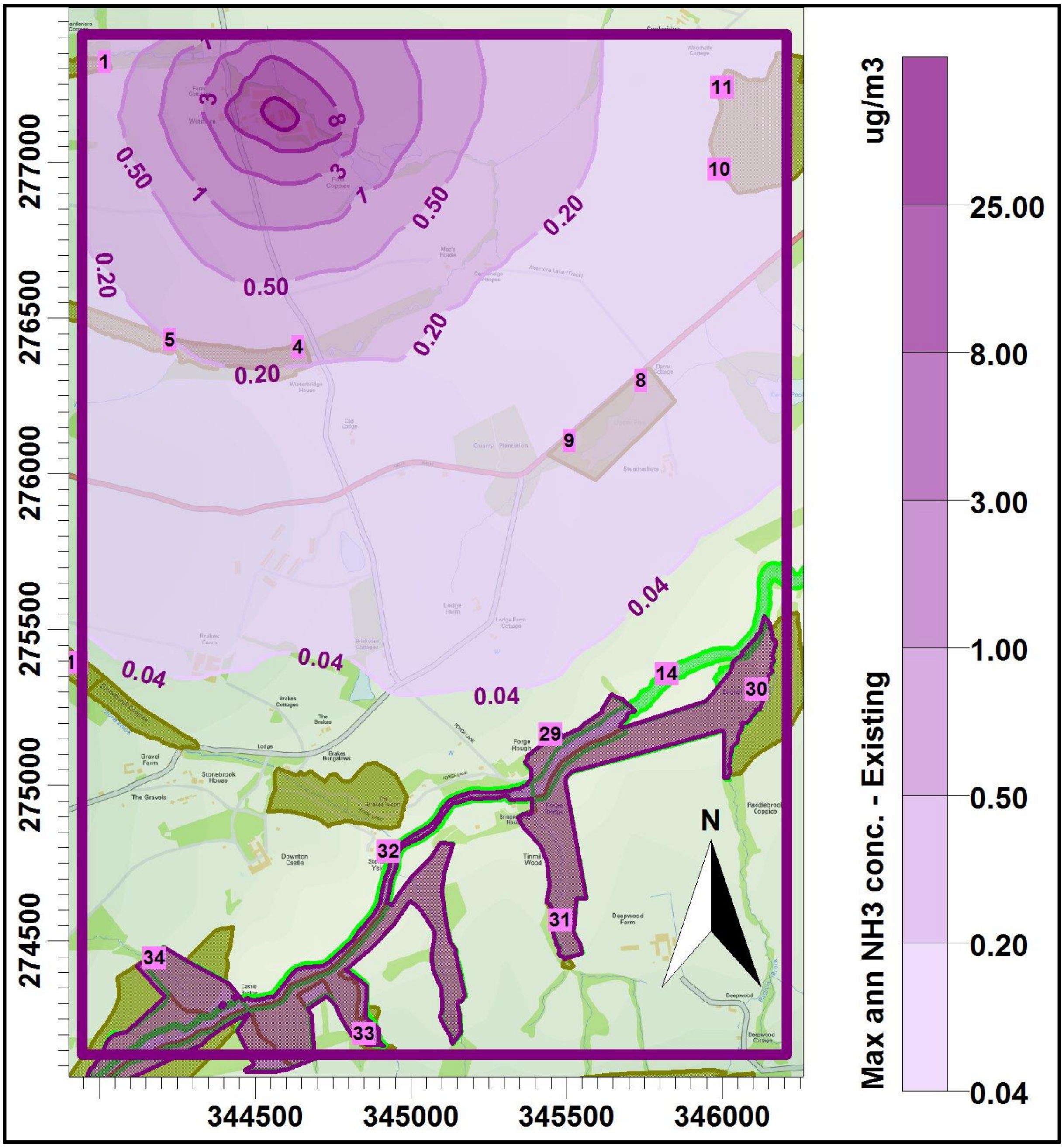


Figure 6b. Maximum annual nitrogen deposition rate – existing scenario

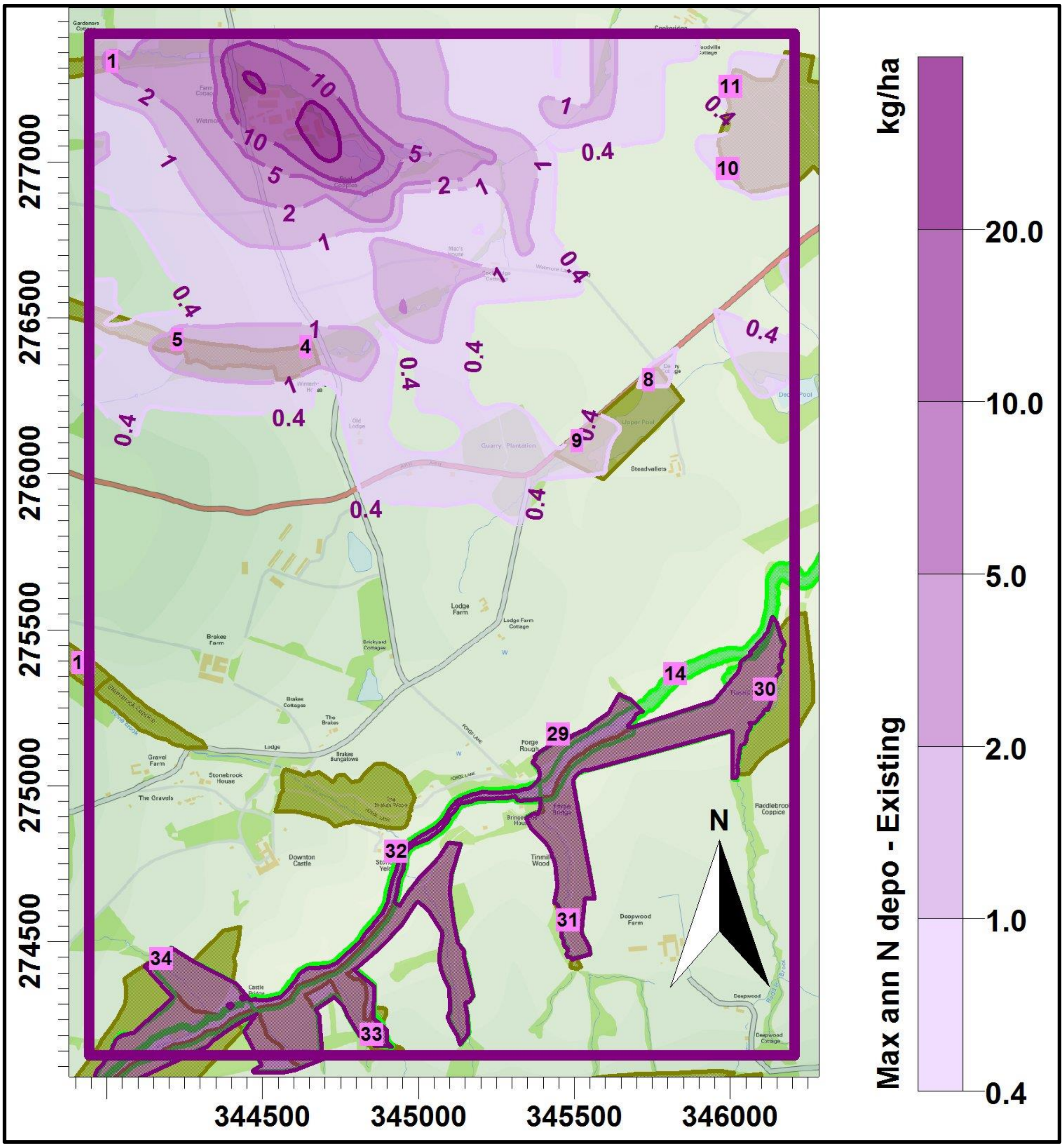


Figure 7a. Maximum annual mean ammonia concentration – proposed scenario

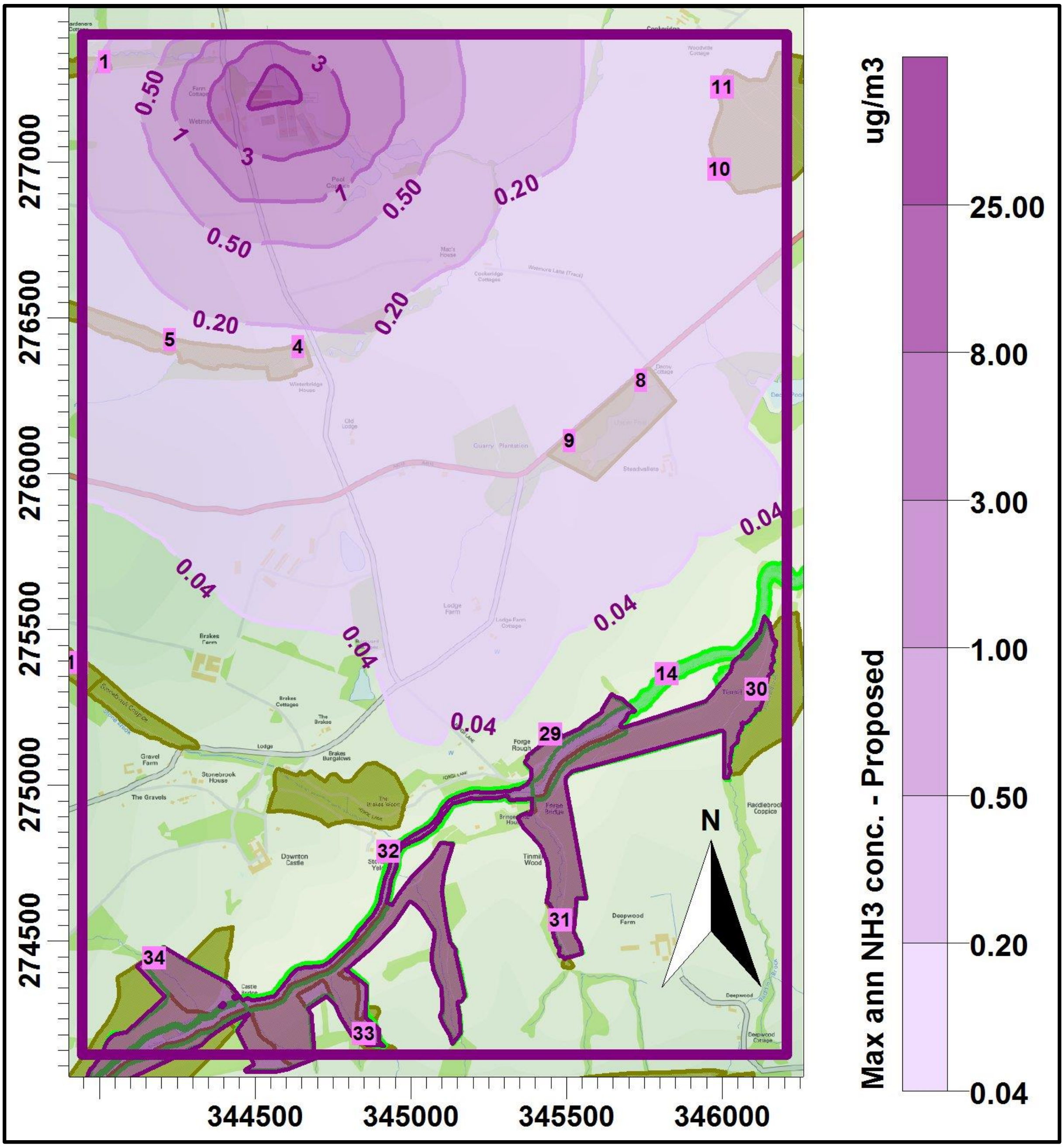
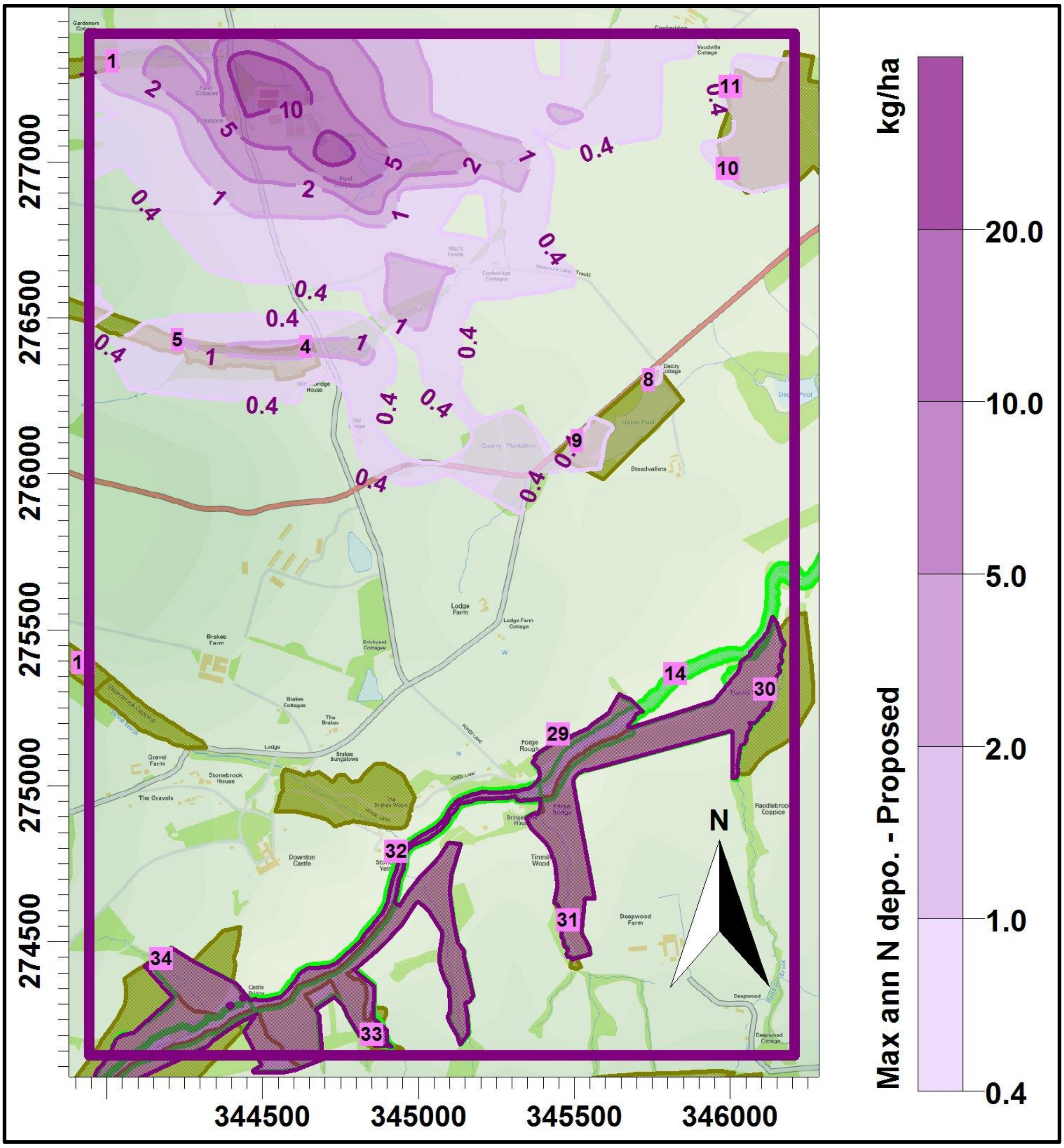


Figure 7b. Maximum annual nitrogen deposition rate – proposed scenario



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Vicky Price of Berrys, on behalf of the applicant, Tom Calvert, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Wetmore Farm, near Onibury in Herefordshire. SY7 9BH.

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 contributions to the maximum annual mean ammonia concentration (and nitrogen and acid deposition rates) are currently at levels usually deemed insignificant for permitting purposes at all receptors considered and would remain at levels usually deemed insignificant for permitting purposes under the proposed scenario.

7. References

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