A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Proposed Free Range Egg Laying Chicken House at Cefn Gribin, near Llanfyllin, Montgomeryshire in Powys

Prepared by Sally Howse

AS Modelling & Data Ltd.

Email: sally@asmodata.co.uk

Telephone: 01952 462500

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Rosina Bloor of Roger Parry & Partners LLP, on behalf of the applicant, to use computer modelling to assess the impact of ammonia emissions from the proposed free range egg laying chicken house at Cefn Gribin, near Llanfyllin in Powys. SY22 5EN.

Ammonia emission rates from the proposed poultry house 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

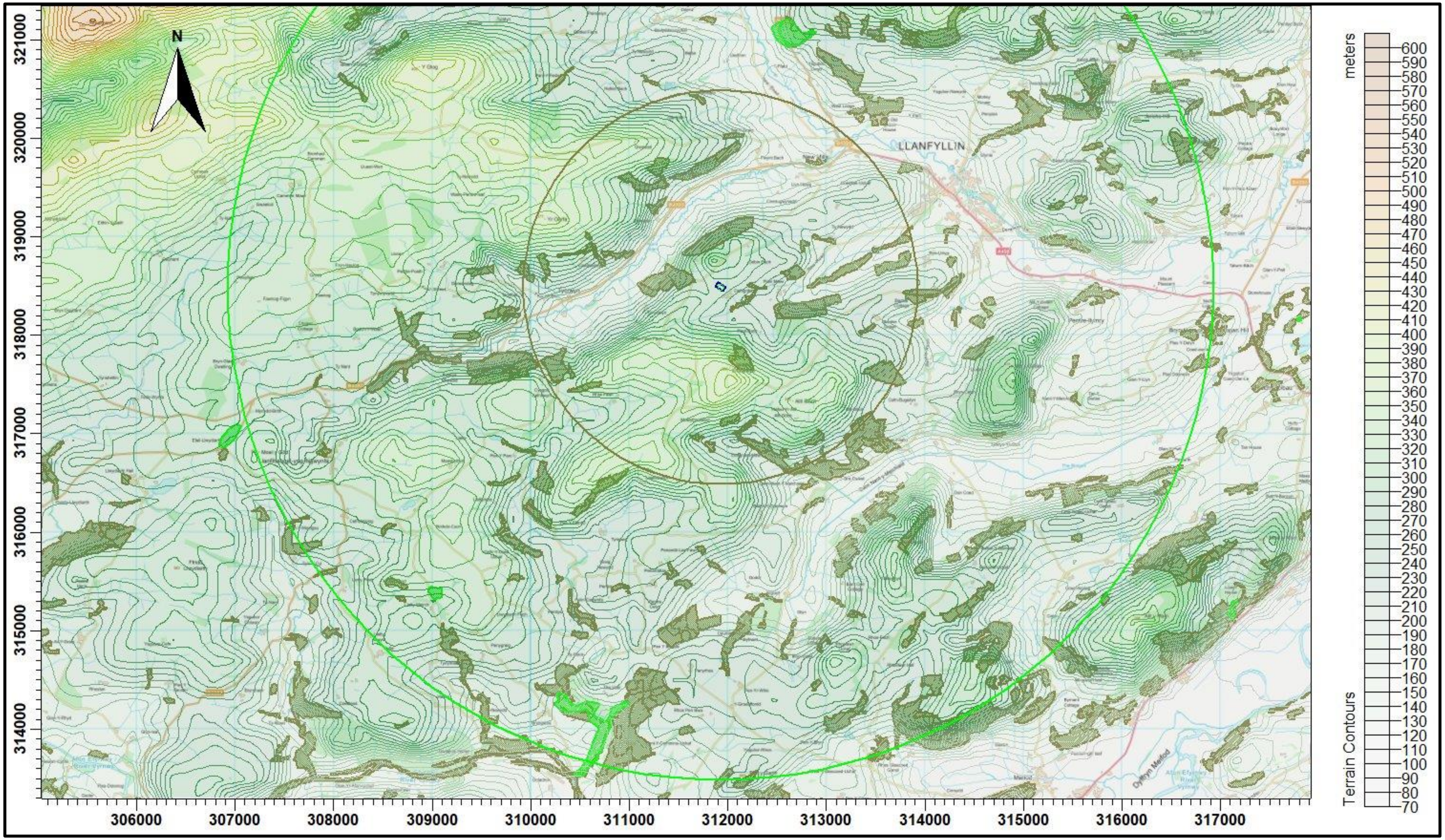
The site of the proposed free range chicken house at Cefn Gribin is in a rural area, approximately 2 km to the south-west of the small market town of Llanfyllin in Powys. The surrounding land is used predominantly for livestock farming, but there are some wooded areas and areas of semi-natural grassland nearby. The site is at an altitude of around 260 m, surrounded by undulating hills, mountain tops and valleys with land rising to higher ground to the south-west and falling gently towards the River Able to the east and the Nant Alan valley to the north-west.

Under the proposal, a new poultry house would be constructed at Cefn Gribin. The poultry house would provide accommodation for up to 32,000 free range egg laying chickens. The poultry house would have pop holes to provide the birds with daytime access to outside ranging areas and would be ventilated by uncapped high speed ridge/roof mounted fans, each with a short chimney. Every four days, the birds' droppings would be removed by a belt collection system and stored temporarily on the farm, prior to being removed from site or spreading on land.

There are several areas of Ancient Woodlands (AWs) within 2 km of the site of Cefn Gribin. There are also three Sites of Special Scientific Interest (SSSI) found within 5 km, namely: Coed Yr Allt SSSI; Pen Dugwm Woods SSSI and Cors Farchwel SSSI. There are no internationally designated wildlife sites within 5 km of the farm.

A map of the surrounding area showing the positions of the proposed poultry house and the nearby wildlife sites is provided in Figure 1. In this figure, the AWs are outlined in olive, the SSSIs are shaded green and the site of the proposed poultry house is outlined in blue.

Figure 1. The area surrounding the site – concentric circles radii at 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 the site of the proposed poultry unit and the wildlife sites is 1.29 $\mu g\text{-}NH_3/m^3$. The background nitrogen deposition rate to woodland is 28.84 kg-N/ha/y and to short vegetation is 18.76 kg-N/ha/y. The background acid deposition rate to woodland is 2.21 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, December 2018).

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. However, it may be necessary to consider nitrogen deposition should a Critical Load of 5.0 kg-N/ha/y be appropriate. 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 (kg-N/ha/y)	Critical Load Acid (keq/ha/y)
AWs	1.0 [1]	-	-
Coed Yr Allt SSSI and Pen-Dugwm Woods SSSI	1.0 [1 & 2]	5.0 [2 & 3]	-
Cors Farchwel SSSI	1.0 [1]	8.0 [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 in the citation for the site and information obtained from the APIS website (October 2018).
3. The lower bound of the range of Critical Loads for habitats present at the site.

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 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 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, ranging areas and manure spreading 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.

3.6.1 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, in an aviary system, where manure is removed frequently using a belt system, the Environment Agency figure is 0.08 kg-NH_3/bird place/year.

3.6.2 Proposed ranging area ammonia emissions

As the birds 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%[1] 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*). 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/y.

Details of the poultry numbers and types, the emission factors used and the calculated 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 a high percentage), this does not imply that 20% of droppings occur outside the house.

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)
Proposed Housing	32,000 (x 0.88)	Egg laying chickens, aviary system	0.08 (EA/BREF figure)	0.071387
Proposed Range	32,000 (x 0.12)	Ranging areas	0.34 (AS Modelling & Data figure)	0.041372

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: the physics/dynamics model has an equivalent resolution of approximately 13 km; terrain is understood to be resolved at a resolution of approximately 2 km (with sub-13 km terrain effects parameterised) and data are archived at a resolution of 0.25 degrees (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 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 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 at the proposed poultry house at Cefn Gribin is shown in Figure 2b. It should be noted that the local wind flow is strongly affected by the River Clwyd valley and nearby hills/mountains and that elsewhere in the modelling domain, the modified wind roses may differ markedly, reflecting the local flow in that part of the domain. The resolution of the wind field in terrain runs is approximately 150 m in the preliminary and low resolution detailed modelling and 100 m in the high resolution detailed modelling. 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.

Figure 2a. The wind rose. Raw GFS derived data, for 52.756 N, 3.301 W, 2014-2017

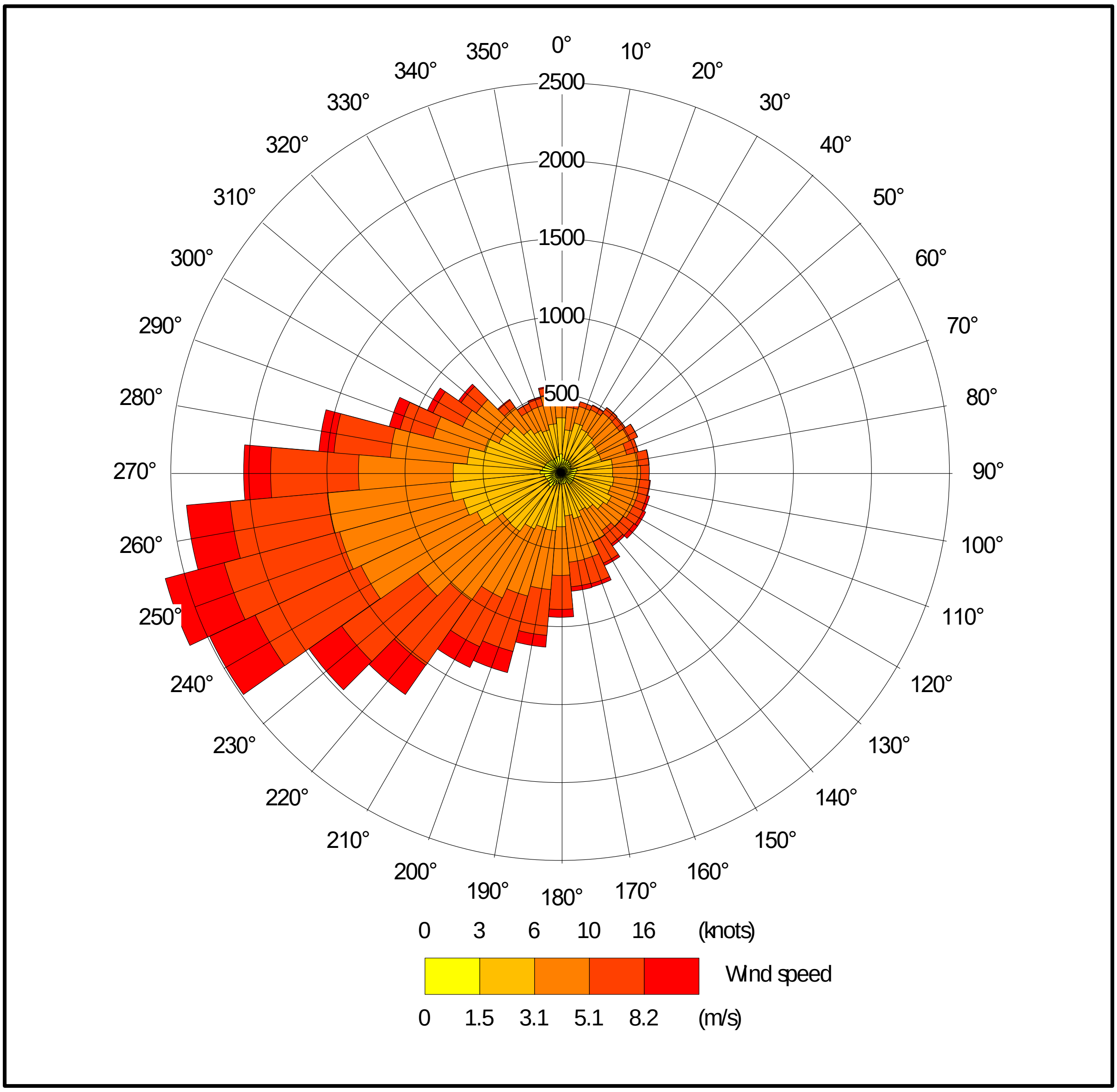
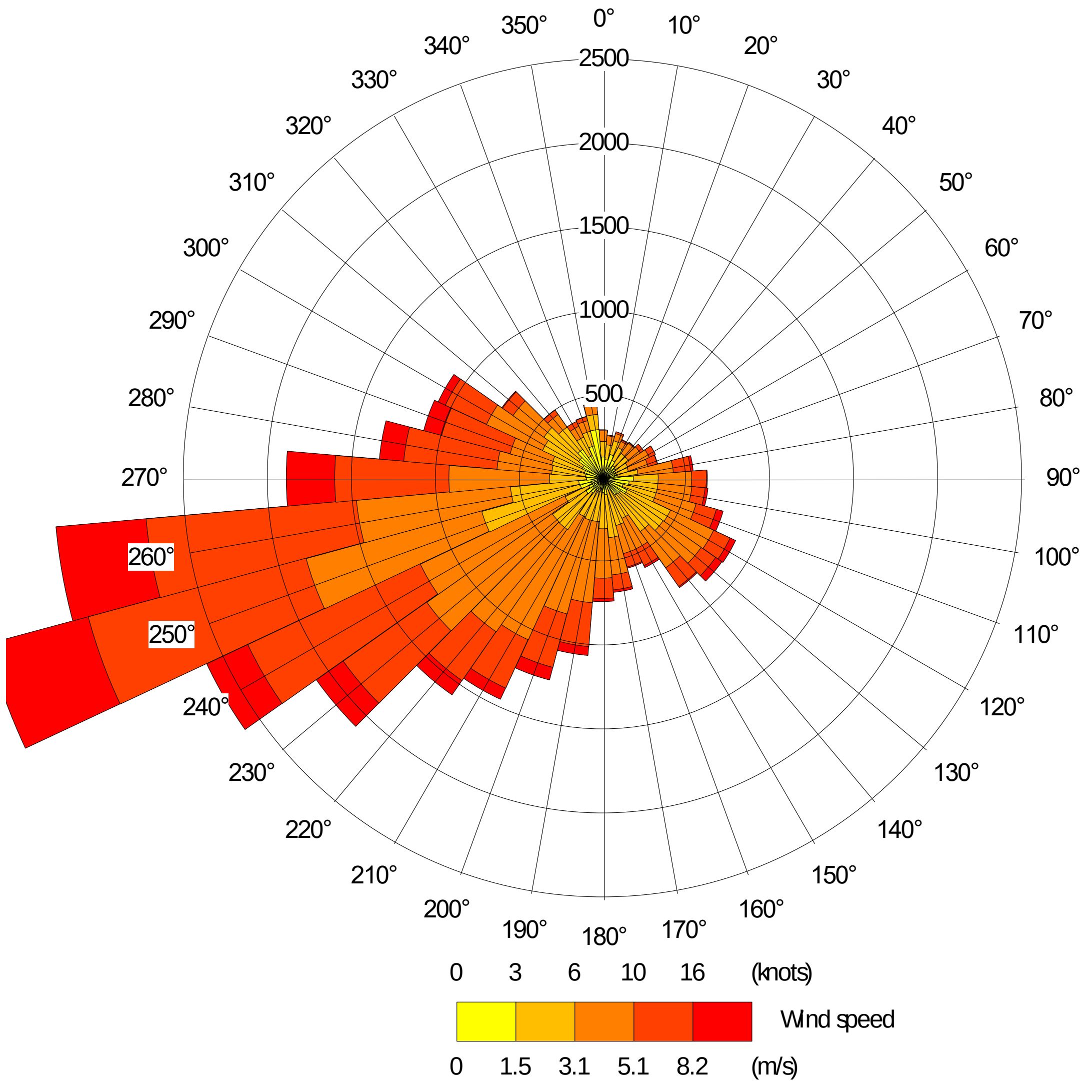


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 312200, 318450



4.2 Emission sources

Emissions from the high speed ridge/roof fans that would be used to ventilate the poultry house are represented by three point sources within ADMS (PR a, b & c). Details of the point source parameters are shown in Table 3a. The positions of the point sources may be seen in Figure 3, where they are indicated by red star symbols.

Table 3a. Point source parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (˚C)	Emission rate per source (g-NH_3/s)
PR a, b & c	6.5	0.8	11.0	21.0	0.023796

The poultry house would have ranging areas, which are represented by an area source within ADMS (PR_RAN). Note that the area source covers the parts of the ranges most likely to be used frequently and not the whole ranging area.

Details of the area source parameters are provided in Table 3b. The position of the area source is shown in Figure 3.

Table 3b. Area source parameters

Source ID	Area (m^2)	Base height (m)	Emission temperature (°C)	Emission rate (g-NH_3/s)
PR_RAN	3,297.87	0.0	Ambient	0.041372

4.3 Modelled buildings

The structure of the poultry house may affect the plumes from the point sources. Therefore, the proposed poultry house is modelled within ADMS. The position of the modelled building may be seen in Figure 3, where it is marked by a grey rectangle.

4.4 Discrete receptors

Fifty discrete receptors have been defined: forty-six at the AWs (1 to 46) and four at the SSSIs (47 to 50). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figures 4a and 4b, 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 fields used in the detailed modelling, two regular Cartesian grids have been defined within ADMS at high and low resolution. The grid receptors are defined at ground level within ADMS. The positions of the Cartesian grids may be seen in Figures 4a and 4b, where they are 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 the preliminary and low resolution detailed modelling. A 6.4 km x 6.4 km domain has been resampled at 50 m horizontal resolution for use within ADMS for the high resolution detailed modelling. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field is approximately 185 m in the preliminary and low resolution detailed modelling and 100 m in the high resolution detailed modelling.

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 0.275 m. The effect of the difference in roughness length is precautionary as it increases the frequency of low wind speeds and stability and therefore increases predicted ground level concentrations.

Figure 3. The positions of the modelled building and sources

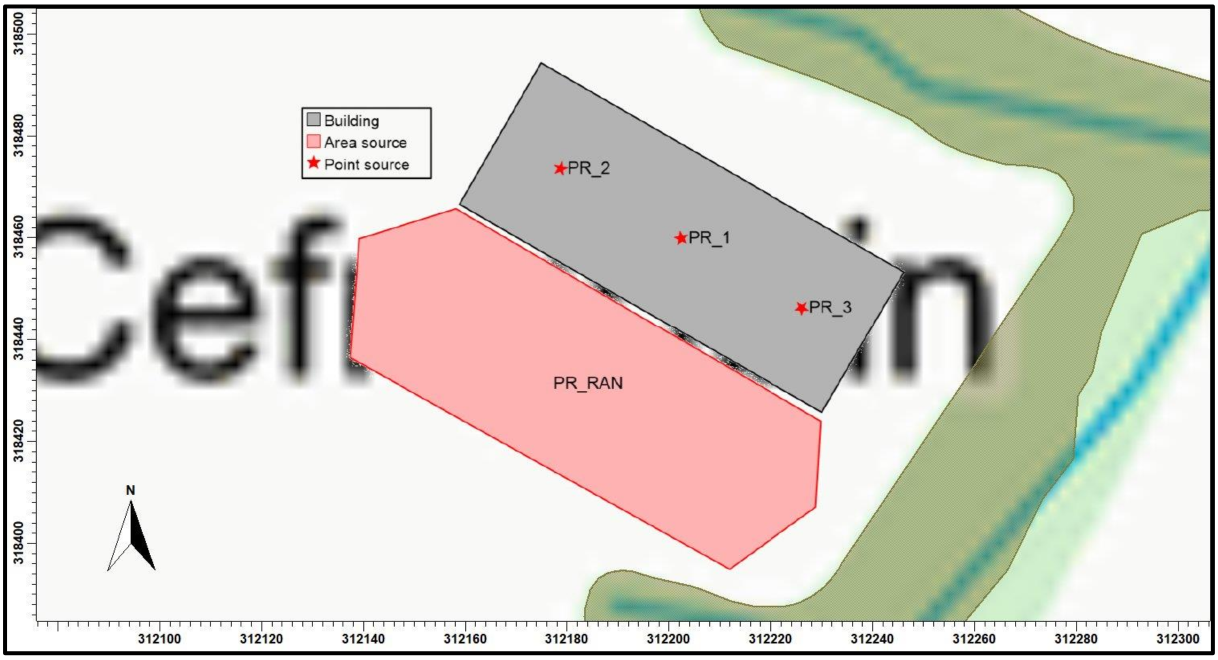


Figure 4a. The discrete receptors and regular Cartesian grids – a broad scale view

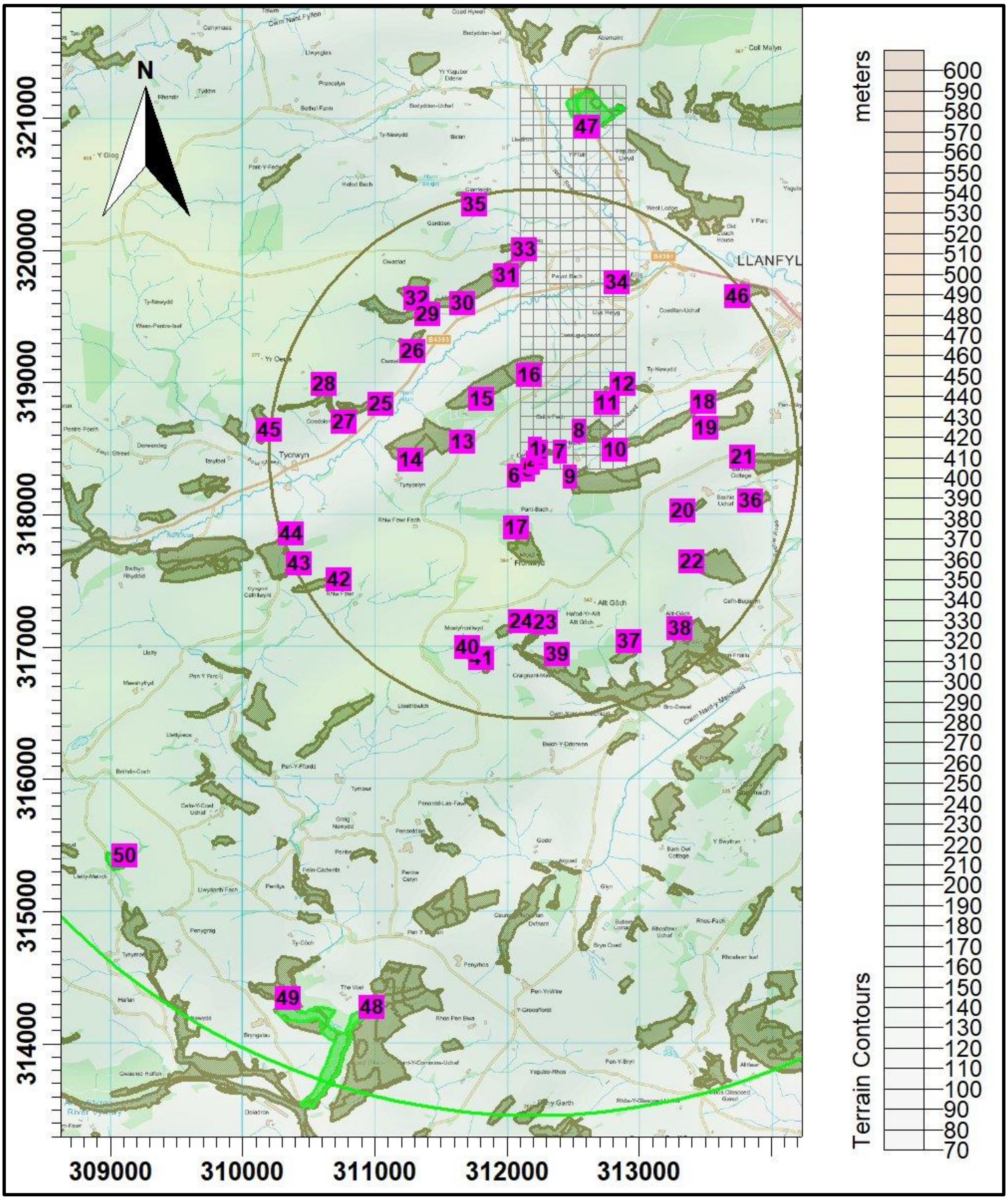
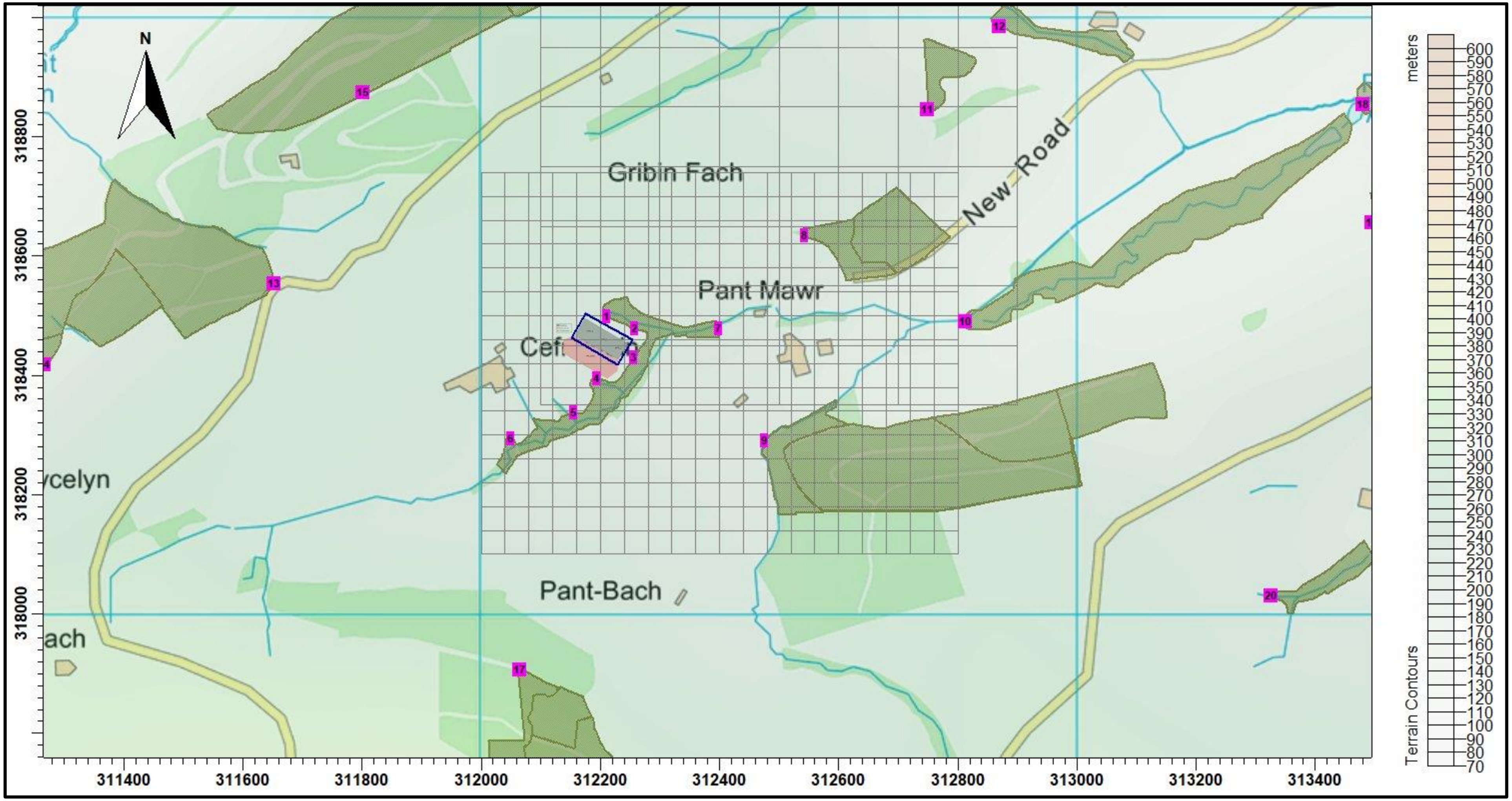


Figure 4b. The discrete receptors and regular Cartesian grids – a closer view



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 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 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.

Contour plots of the high and low resolution spatially varying deposition fields are provided in Figures 5a and 5b.

Figure 5a. The high resolution spatially varying deposition field

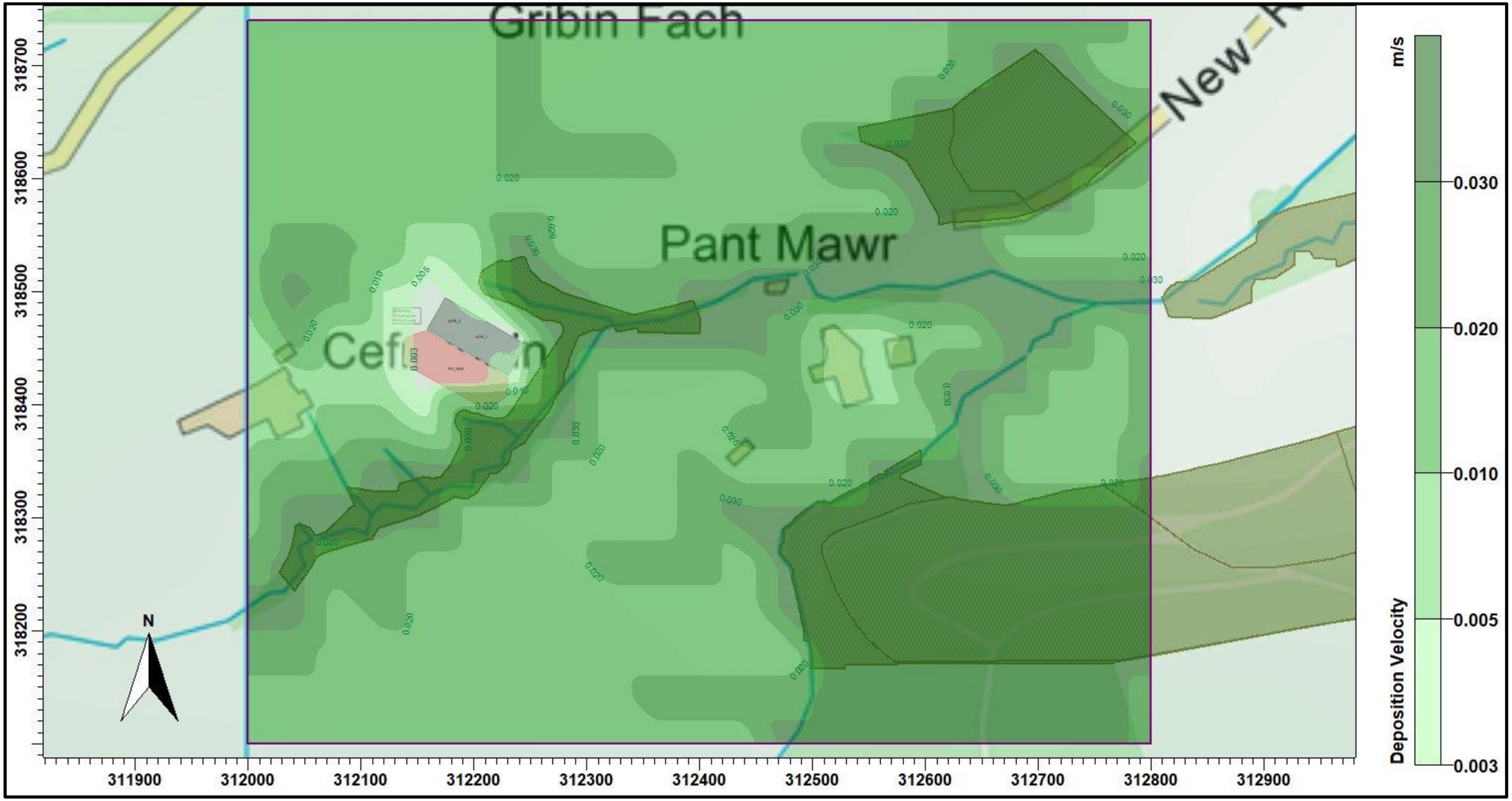
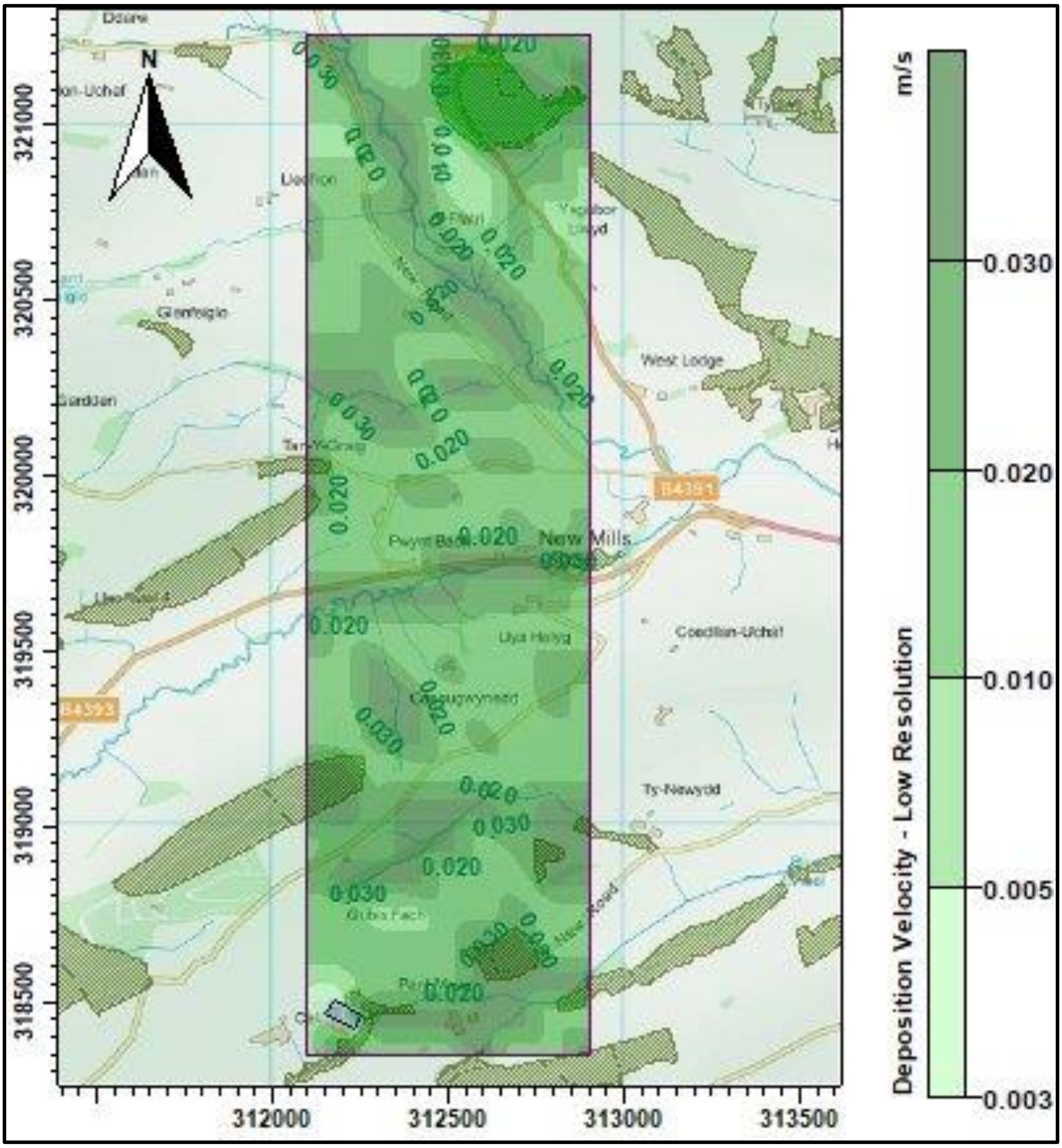


Figure 5b. The low resolution spatially varying deposition field



5. Details of the Model Runs and Results

5.1 Preliminary modelling

ADMS was run a total of sixteen times; once for each year of the meteorological record and in the following four 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, with terrain and a fixed deposition at 0.003 m/s – 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, 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 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 and 50%[1] to 100% for an AW) are coloured blue. For convenience, cells referring to the SSSIs are shaded green and cells referring to the AWs are shaded olive.

1. The Pre-February 2016 figure is retained.

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

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration - ($\mu g/m^3$)			
				GFS No Calms No Terrain	GFS Calms No Terrain	GFS No Calms Terrain	GFS No Calms Terrain Fixed Dep 0.003 m/s
1	312211	318498	Unnamed AW	**12.448**	**12.528**	**13.469**	**10.226**
2	312257	318478	Unnamed AW	**14.521**	**14.255**	**16.027**	**12.626**
3	312256	318429	Unnamed AW	**27.037**	**26.540**	**34.715**	**27.294**
4	312193	318394	Unnamed AW	**36.793**	**36.863**	**41.564**	**32.846**
5	312155	318337	Unnamed AW	**4.947**	**4.996**	**6.772**	**4.363**
6	312050	318293	Unnamed AW	**1.727**	**1.709**	**2.068**	**1.252**
7	312399	318478	Unnamed AW	**3.901**	**3.819**	**4.129**	**3.041**
8	312543	318633	Unnamed AW	**1.140**	**1.117**	**1.322**	**0.995**
9	312475	318290	Pant Wood AW	**1.011**	**1.016**	**1.080**	**0.689**
10	312813	318490	Godor AW	**0.661**	**0.649**	**0.630**	0.416
11	312749	318845	Unnamed AW	0.402	0.395	0.469	0.343
12	312870	318985	Unnamed AW	0.252	0.248	0.287	0.206
13	311653	318554	Coed Caeau-gwynedd AW	0.388	0.386	**0.520**	0.308
14	311267	318418	Coed Caeau-gwynedd AW	0.166	0.163	0.290	0.159
15	311800	318873	Cefn Llwyni AW	0.254	0.253	0.420	0.276
16	312163	319057	Cefn Llwyni AW	0.253	0.258	0.287	0.215
17	312065	317906	The Larches AW	0.266	0.271	0.280	0.117
18	313480	318853	Unnamed AW	0.178	0.174	0.254	0.178
19	313496	318655	Coed Ioan-Adams AW	0.198	0.194	0.240	0.153
20	313325	318031	Bechie Uchaf AW	0.138	0.138	0.084	0.043
21	313775	318438	Coed Garth AW	0.142	0.140	0.121	0.067
22	313391	317647	Coed y Glyn AW	0.067	0.068	0.043	0.023
23	312281	317185	Unnamed AW	0.073	0.074	0.067	0.029
24	312099	317193	Unnamed AW	0.079	0.080	0.065	0.028
25	311036	318834	Coed Siencyn AW	0.103	0.103	0.193	0.074
26	311280	319233	Unnamed AW	0.086	0.086	0.149	0.058
27	310757	318698	Unnamed AW	0.080	0.079	0.116	0.043
28	310609	318985	Unnamed AW	0.063	0.063	0.053	0.018
29	311389	319513	Ceunant y Garys AW	0.060	0.060	0.069	0.029
30	311653	319598	Coed Pwynt AW	0.070	0.070	0.078	0.036
31	311990	319811	Coed Pwynt AW	0.065	0.064	0.055	0.027
32	311308	319633	Unnamed AW	0.051	0.051	0.040	0.018
33	312122	320009	Unnamed AW	0.053	0.054	0.042	0.023
34	312824	319753	Unnamed AW	0.077	0.078	0.105	0.077
35	311746	320347	Unnamed AW	0.040	0.039	0.039	0.017
36	313833	318108	Unnamed AW	0.104	0.102	0.075	0.039
37	312914	317041	Unnamed AW	0.042	0.042	0.033	0.015
38	313302	317138	Unnamed AW	0.044	0.044	0.036	0.016
39	312374	316948	Big Wood AW	0.052	0.052	0.055	0.024
40	311692	316995	Craignant-Mawr AW	0.052	0.052	0.059	0.026
41	311800	316913	Unnamed AW	0.047	0.047	0.052	0.023
42	310718	317507	Unnamed AW	0.043	0.043	0.038	0.018
43	310419	317631	Unnamed AW	0.036	0.036	0.039	0.021
44	310357	317856	Graig Coppice AW	0.035	0.035	0.052	0.025
45	310194	318640	Graig Coppice AW	0.050	0.049	0.062	0.023
46	313734	319654	Unnamed AW	0.067	0.066	0.083	0.055
47	312596	320936	Coed Yr Allt SSSI	**0.026**	**0.027**	**0.031**	**0.018**
48	310969	314277	Pen-Dugwm Woods SSSI	**0.011**	**0.010**	**0.010**	0.004
49	310335	314347	Pen-Dugwm Woods SSSI	**0.013**	**0.013**	**0.011**	0.004
50	309100	315420	Cors Farchwel SSSI	**0.011**	**0.011**	0.009	0.004

5.2 Detailed deposition modelling

The detailed modelling was carried out over two restricted domains where the preliminary modelling indicated that annual mean ammonia concentrations could potentially exceed the relevant lower or upper threshold percentages of the Critical Level of 1.0 µg-NH_3/m^3. A high resolution domain covers the proposed poultry house and ranges at Cefn Gribin, the nearby unnamed AWs to the east and south and Pant Wood AW to the south-east, whilst a low resolution domain extends over Coed Yr Allt SSSI. At all other receptors considered, the preliminary modelling (fixed deposition results) indicated that ammonia levels (and nitrogen and acid deposition rates) would be below the Natural Resources Wales lower threshold percentage of Critical Level/Load for the designation of the site.

The predicted maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors over high and low resolution domains are shown in Tables 6a and 6b. In the tables, 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 and 100% of Critical Level or Load for an AW) are coloured red. Concentrations that are in the range between the Natural Resources Wales lower and upper thresholds (1% to 8% for a SSSI and 50%[1] to 100% for an AW) are coloured blue.

Contour plots of the predicted ground level maximum annual mean ammonia concentration at high and low resolution are shown in Figures 6a and 6b. Contour plots of the predicted ground level maximum nitrogen deposition rates at high and low resolution are shown in Figures 7a and 7b.

1. The Pre-February 2016 figure is retained

Table 6a. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors – high resolution

Receptor number	X(m)	Y(m)	Designation	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
1	312211	318498	Unnamed AW	0.030	1.0	10.0	8.932	**893.2**	69.59	**695.9**
2	312257	318478	Unnamed AW	0.030	1.0	10.0	10.674	**1067.4**	83.16	**831.6**
3	312256	318429	Unnamed AW	0.030	1.0	10.0	21.865	**2186.5**	170.35	**1703.5**
4	312193	318394	Unnamed AW	0.030	1.0	10.0	27.591	**2759.1**	214.96	**2149.6**
5	312155	318337	Unnamed AW	0.030	1.0	10.0	2.249	**224.9**	17.52	**175.2**
6	312050	318293	Unnamed AW	0.030	1.0	10.0	0.647	**64.7**	5.04	**50.4**
7	312399	318478	Unnamed AW	0.030	1.0	10.0	2.133	**213.3**	16.62	**166.2**
8	312543	318633	Unnamed AW	0.030	1.0	10.0	0.619	**61.9**	4.82	**48.2**
9	312475	318290	Pant Wood AW	0.030	1.0	10.0	0.306	**30.6**	2.38	**23.8**

Table 6b. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors – low resolution

Receptor number	X(m)	Y(m)	Designation	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
10	312813	318490	Godor AW	0.030	1.0	10.0	0.242	24.2	1.88	18.8
11	312749	318845	Unnamed AW	0.030	1.0	10.0	0.242	24.2	1.88	18.8
12	312870	318985	Unnamed AW	0.030	1.0	10.0	0.136	13.6	1.06	10.6
16	312163	319057	Cefn Llwyni AW	0.030	1.0	10.0	0.159	15.9	1.24	12.4
33	312122	320009	Unnamed AW	0.030	1.0	10.0	0.015	1.5	0.12	1.2
34	312824	319753	Unnamed AW	0.030	1.0	10.0	0.053	5.3	0.41	4.1
47	312596	320936	Coed Yr Allt SSSI	0.030	1.0	5.0	0.011	**1.1**	0.08	**1.6**

Figure 6a. Maximum annual ammonia concentration – high resolution

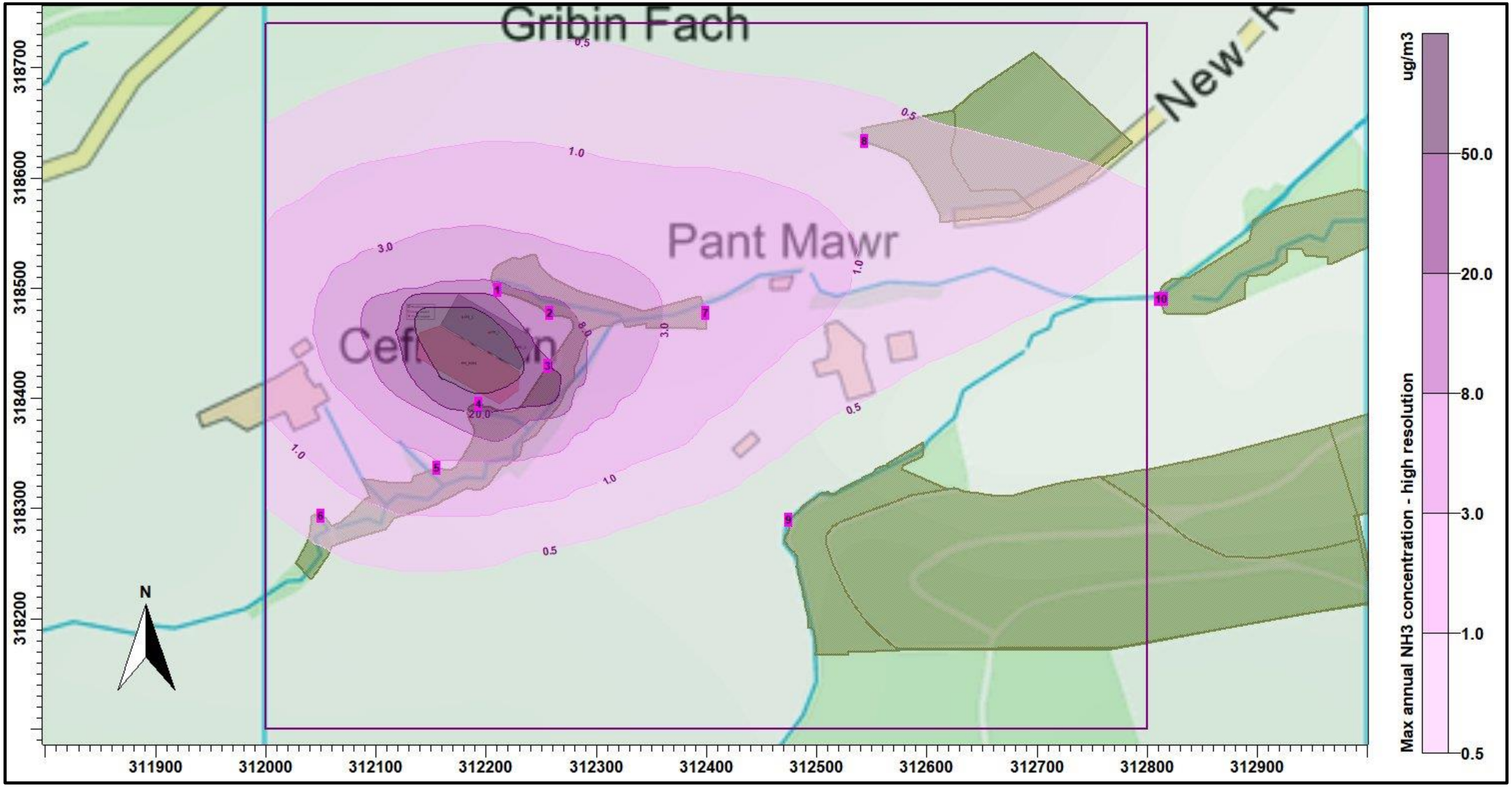


Figure 6b. Maximum annual ammonia concentration – low resolution

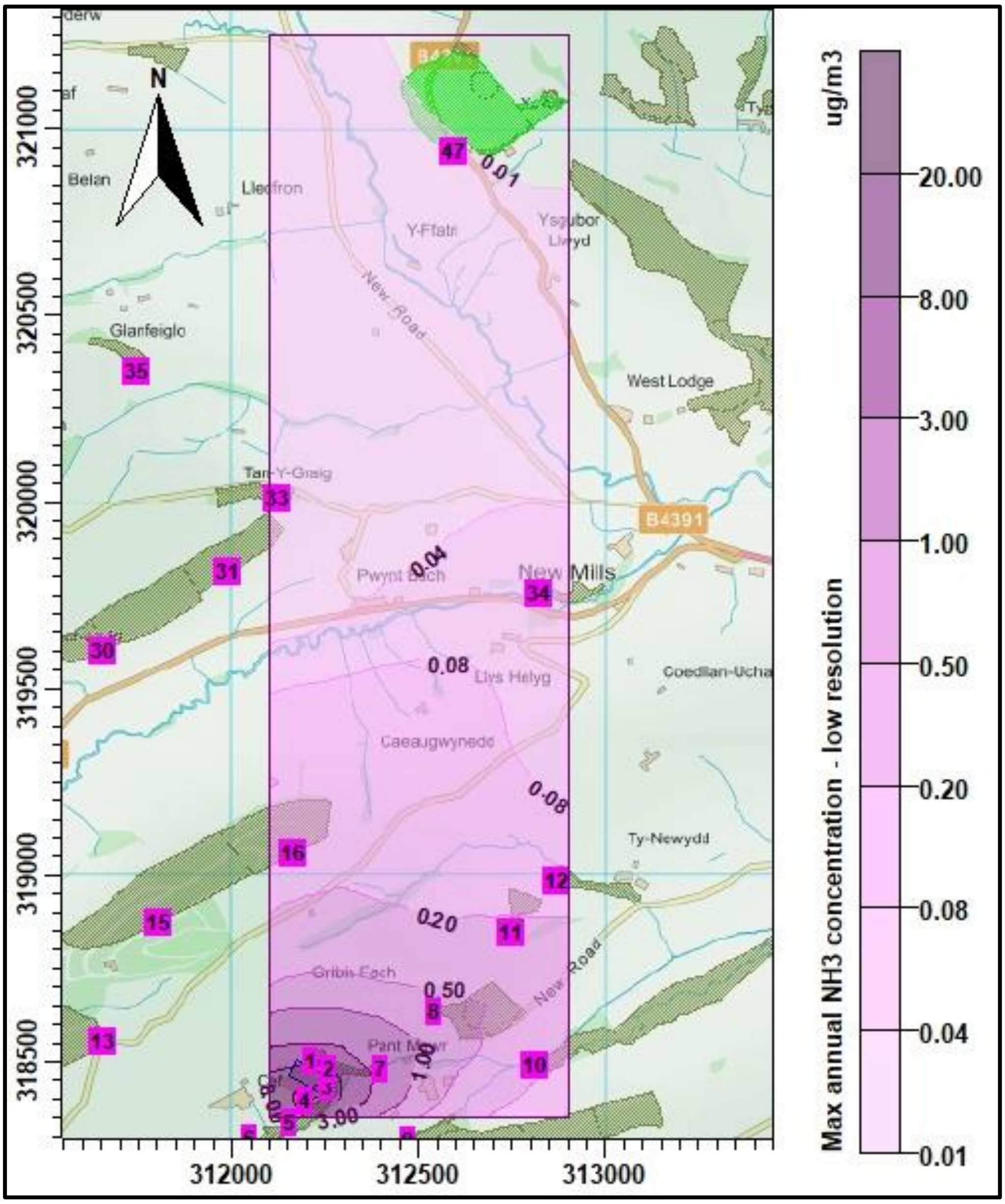


Figure 7a. Maximum annual nitrogen deposition rate – high resolution

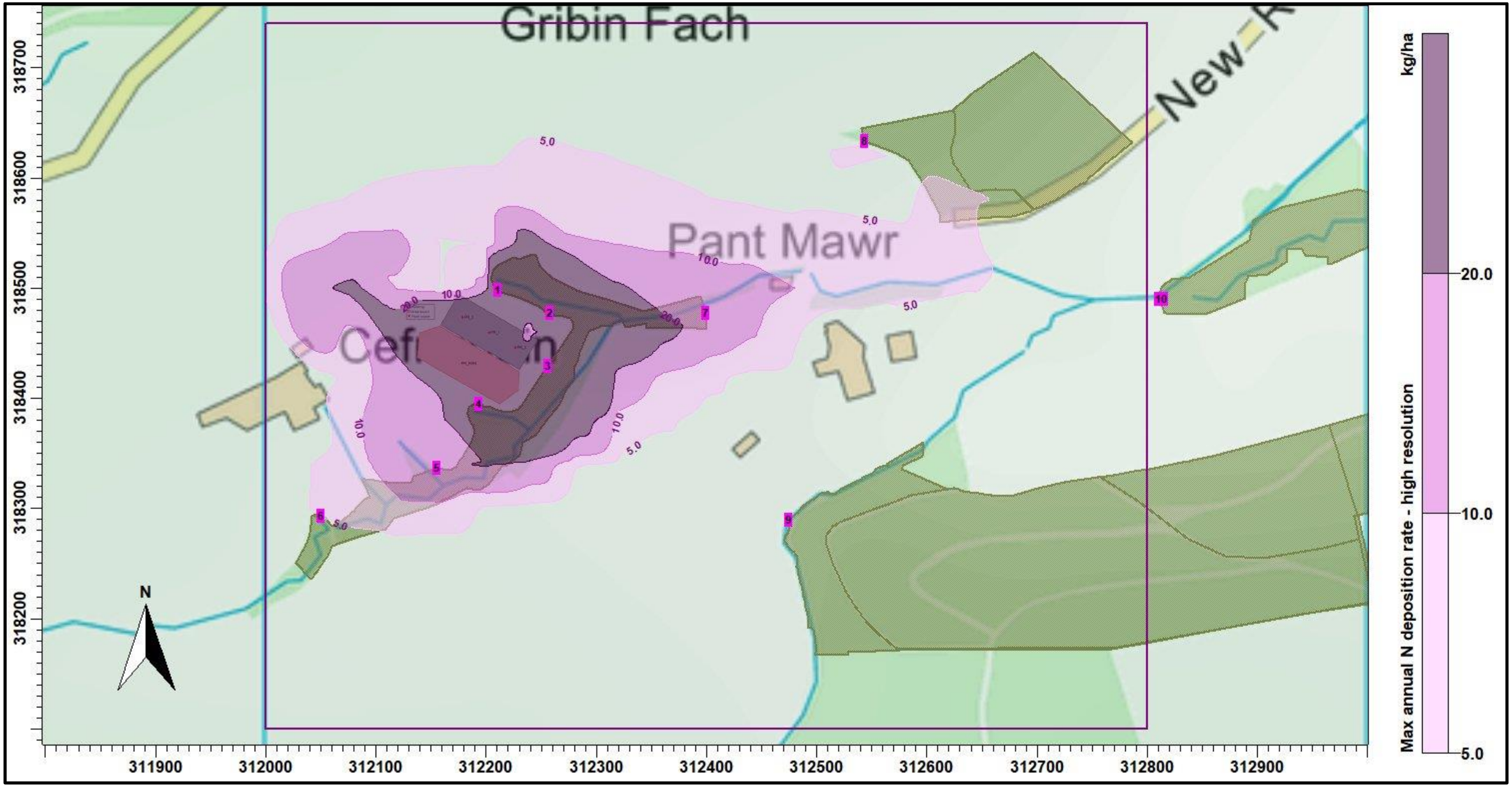
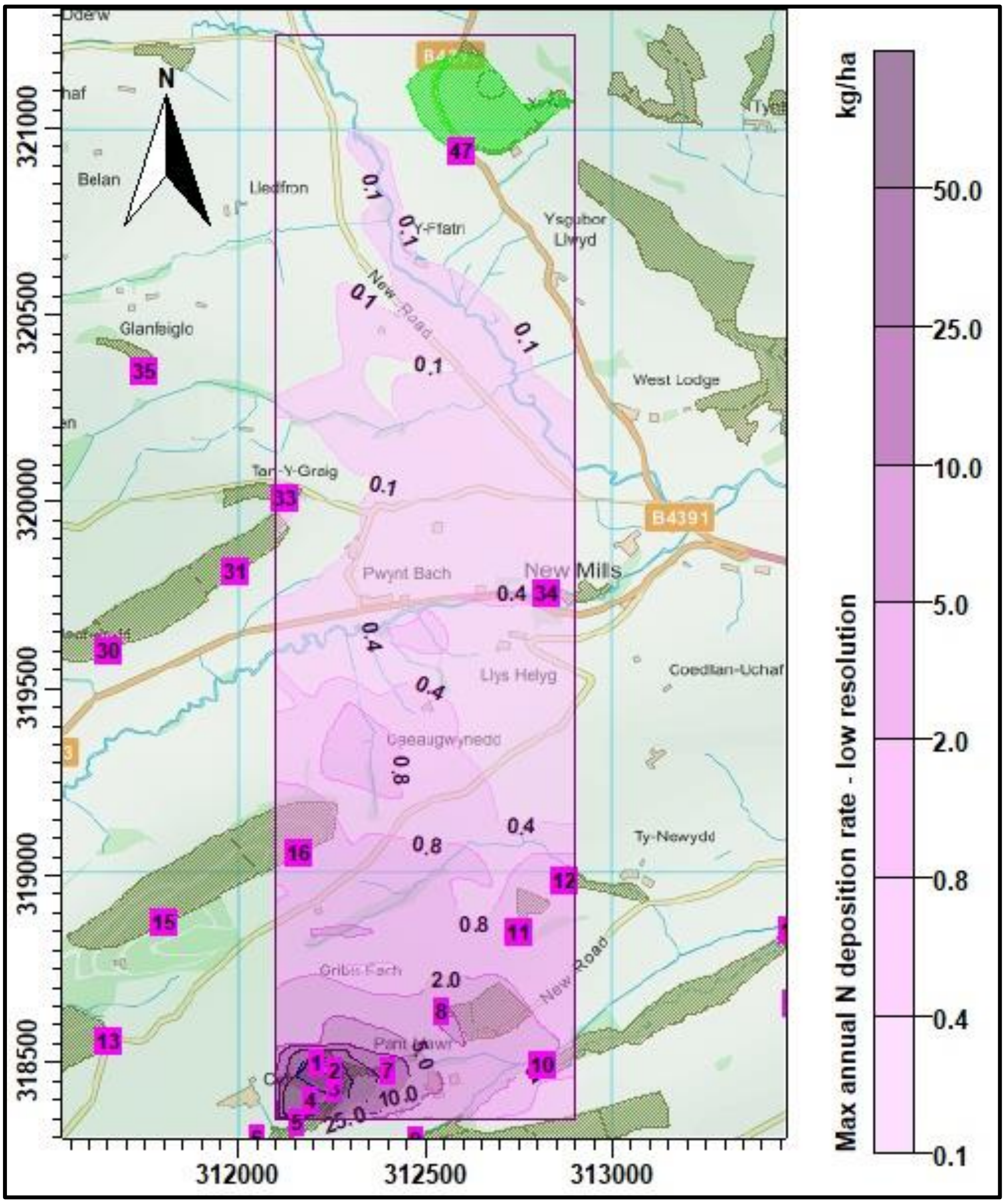


Figure 7b. Maximum annual nitrogen deposition rate – low resolution



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Rosina Bloor of Roger Parry & Partners LLP, on behalf of the applicant, to use computer modelling to assess the impact of ammonia emissions from the proposed free range egg laying chicken house at Cefn Gribin, near Llanfyllin in Powys. SY22 5EN.

Ammonia emission rates from the proposed poultry house 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.

Preliminary modelling

The preliminary modelling predicts that:

- The process contribution to annual mean ammonia concentrations at the closest unnamed AW that extends from the east to the south of the proposed poultry unit would potentially exceed Natural Resources Wales upper threshold (100% for an AW) of the precautionary Critical Level of 1.0 µg-NH_3/m^3.

- At the unnamed AW to the north-east and Pant Wood AW to the south-east, the process contribution to annual mean ammonia concentrations would potentially be between Natural Resources Wales lower and upper thresholds (50% and 100% for an AW) of the precautionary Critical Level of 1.0 µg-NH_3/m^3.

- The process contribution to annual mean ammonia concentrations at Coed Yr Allt SSSI would potentially exceed the Natural Resources Wales lower threshold (1% for a SSSI) of the Critical Level of 1.0 µg-NH_3/m^3 by a small margin.

- At all other sites considered, the process contribution to the annual ammonia concentration and the nitrogen deposition rate would be below Natural Resources Wales lower threshold percentage of the Critical Level for the site (1% for a SSSI and 100% for non-statutory sites).

Detailed deposition modelling

The detailed modelling predicts that when deposition and consequent plume depletion are fully considered:

- The process contribution to annual mean ammonia concentrations in the high resolution scenario at the closest AW are predicted to exceed the Natural Resources Wales upper threshold percentage (100%) of the Critical Level of 1.0 µg-NH_3/m^3 over most of the wood.

- The process contribution to annual mean ammonia concentrations in the high resolution scenario at the unnamed AW to the north-east and Pant Wood AW are predicted to be below the Natural Resources Wales lower threshold percentage (50%) of the Critical Level of 1.0 µg-NH_3/m^3.

- Over small parts of Coed Yr Allt SSSI, the process contribution to annual mean ammonia concentration in the low resolution scenario is predicted to exceed the Natural Resources Wales lower threshold percentage (1%) of the Critical Level of 1.0 µg-NH_3/m^3 by a small margin. The process contribution to annual mean nitrogen deposition rate is also predicted to exceed the lower threshold percentage of the Critical Load of 5.0 kg/ha.

Mitigation

Where exceedances of the upper threshold are predicted at an AW, some form of mitigation is usually required. AS Modelling & Data Ltd. would recommend that, if available, to compensate for possible detrimental effects on the nearby AWs, that land of at least a similar area to the exceedance of 100% of the Critical Level is set aside for nature conservation and be planted or seeded with native species (approximately 0.9 ha). Alternatively, or additionally, buffer zones and corridors could be set up around and between the AW to the south-east of the proposed poultry unit; such buffer zones and corridors can greatly enhance bio-diversity over time.

Where there is a predicted exceedance of the Natural Resources Wales lower threshold percentage of Critical Level or Critical Load at a SSSI, but the upper threshold in not exceeded, the proposal may or may not be deemed acceptable, depending on the presence, or not, of other installations that may have in-combination effects, background ammonia concentrations and the sensitivity of the wildlife sites involved.

7. References

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