A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing Manure Spreading and Proposed Free Range Egg-Laying Chicken House at Glanmyddyfi, Pentrefelin near Llandeilo in Carmarthenshire

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Gail Jenkins of Roger Parry & Partners LLP, on behalf of Mr. Terry Davies, to use computer modelling to assess the impact of ammonia emissions from the proposed free range egg-laying chicken house at Glanmyddyfi, Pentrefelin, Llandeilo, Carmarthenshire. SA19 7AA.

Ammonia emission rates from the proposed poultry house have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. Emissions of ammonia from the proposed ranging area have been assessed and quantified based upon figures obtained from a variety of sources. Emissions of ammonia from the existing field spreading of manure have been estimated by AS Modelling & Data Ltd., based upon estimated tonnage of manure spread, published figures for nitrogen content of poultry manure and percentage of nitrogen emitted as ammonia from field spreading of poultry manure. 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

Glanmyddiyfi is in an isolated rural area, approximately 2.5 km to the west-north-west of the town of Llandeilo in Carmarthenshire. The surrounding land is used primarily for livestock farming, although there are isolated arable fields and areas of semi-natural woodlands and grassland. The site is at an altitude of around 50 m with the land rising towards hills to the north and falling towards the Afon Myddyfi Valley to the south.

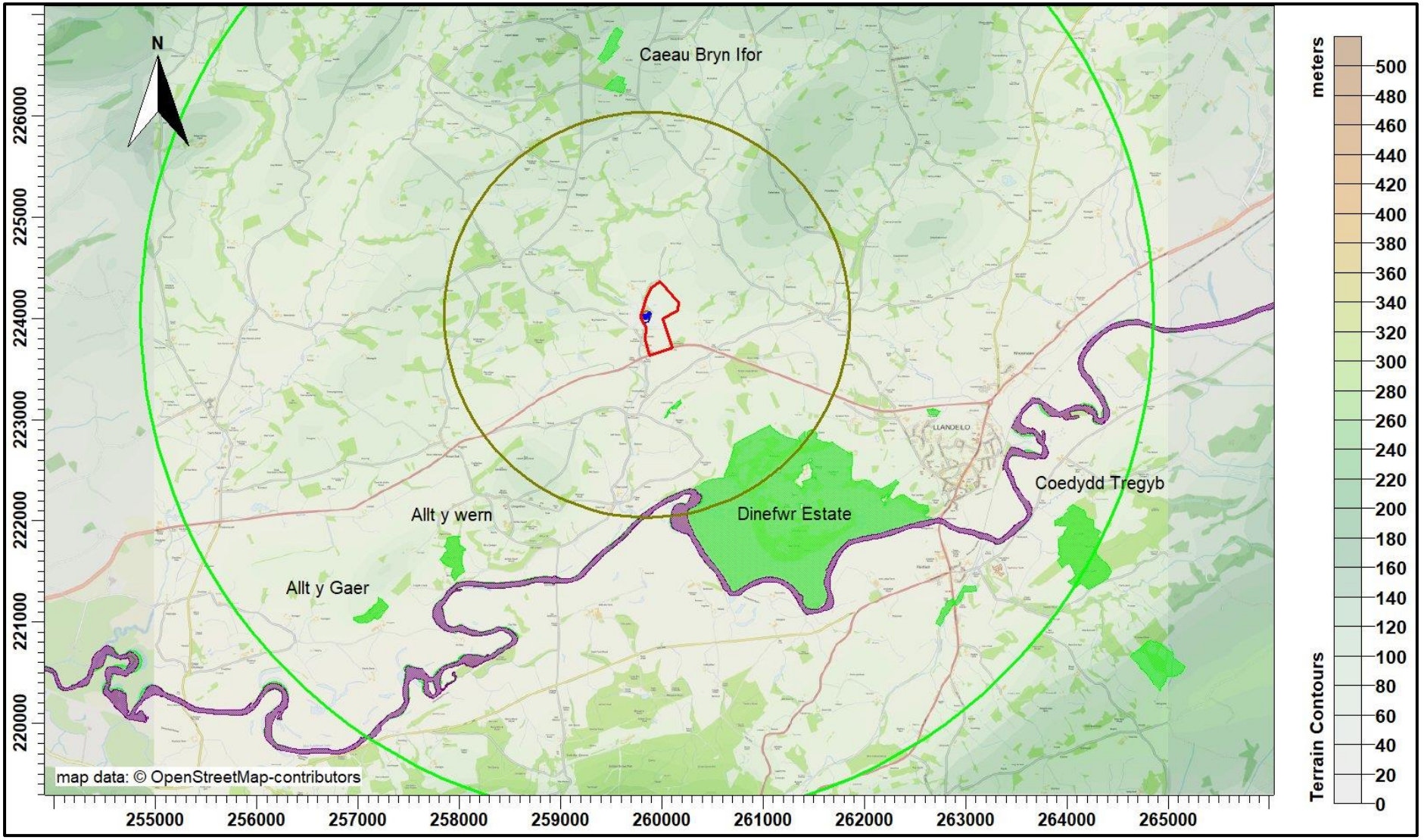
It is proposed that a new egg laying chicken house, with a capacity of 16,000 birds, be constructed at Glanmyddiyfi. The new poultry house would be ventilated by uncapped high speed roof mounted fans, each with a short chimney. Pop holes on the side of the house would provide access to an outside ranging area. The house would be fitted with a manure belt system to collect droppings, usually twice weekly, and then removed from the site. Manure from the free range egg laying unit would not be stored at the site, nor spread on any of the land at Glanmyddyfi.

To improve fertility, the current improved grassland pasture at Glanmyddyfi is spread with approximately 126 tonnes of poultry manure per annum. Under the proposal, manure spreading at Glanmyddyfi would cease. The reduction in ammonia emissions from the manure spreading is expected to some extent compensate for the ammonia emissions from the proposed poultry housing and ranging area. Additionally, the grassland outside of the proposed ranging area is expected to gradually return to an unimproved state.

There are seven Sites of Special Scientific Interest (SSSIs) within 5 km of Glanmyddyfi and parts of the Afon Tywi Special Area of Conservation (SAC) is also within 5 km. Of these eight sites, only four are designated for their flora (which may be susceptible to damage from excess ammonia and nitrogen and acid deposition), they are: the Dinefwr Estate SSSI; the Caeau Bryn Ifor SSSI, Coedydd Tregyb SSSI and the Allt y wern SSSI.

A map of the surrounding area showing the extent of the land at Glanmyddyfi, the position of the proposed poultry house, the SSSIs and SACs is provided in Figures 1. In the figures, the SSSIs are shaded in green, the SACs are shaded in purple, the extent of the land at Glanmyddyfi is outlined in red and the site of the proposed poultry house is outlined in blue.

Figure 1. The area around the site of the proposed poultry unit– 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 (µg-NH_3/m^3) as an annual mean. Ammonia in the air may exert direct effects on the vegetation, or indirectly affect the ecosystem through deposition which causes both hyper-eutrophication (excess nitrogen enrichment) and acidification of soils. Nitrogen deposition, specifically in this case the nitrogen load due to ammonia deposition/absorption, is usually expressed in kilograms of nitrogen per hectare per year (kg-N/ha/y). Acid deposition is expressed in terms of kilograms equivalent (of H^+ ions) per hectare per year (keq/ha/y).

3.2 Background ammonia levels and nitrogen and acid deposition

The background ammonia concentration (annual mean) in the area around the site of the proposed poultry unit and the wildlife sites is 1.66 µg-NH_3/m^3. The background nitrogen deposition rate to woodland is 28.70 kg-N/ha/y and to short vegetation is 18.62 kg-N/ha/y. The background acid deposition rate to woodland is 1.71 keq/ha/y and to short vegetation is 1.21 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS, June 2020).

3.3 Critical Levels and Critical Loads

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

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

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

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

Critical Loads for nutrient nitrogen are set under the Convention on Long-Range Transboundary Air Pollution. They are based on empirical evidence, mainly observations from experiments and gradient studies. Critical Loads are given as ranges (e.g. 10-20 kg-N/ha/y); these ranges reflect variation in ecosystem response across Europe.

The Critical Levels and Critical Loads at the wildlife sites assumed in this study are provided in Table 1. 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 does 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)
Dinefwr Estate SSSI, Caeau Bryn Ifor SSSI & Coedydd Tregyb SSSI	1.0 [1 & 2]	-	-
Allt y wern SSSI	3.0 [1]	10.0 [1]	-

1. Carmarthenshire County Council consultation response - Lisa Jones, Natural Resources Wales, 30th September 2014.
2. A precautionary figure used where no details of the ecology of the site are available, or the citation for the sites indicates that sensitive lichens and/or bryophytes are present.

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 still applies, namely 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%).

The Natural Resources Wales Operational Guidance Note 20 (OGN 20), provides essentially the same thresholds.

3.5 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.

3.5.1 Housing Emissions

The Environment Agency provides an Intensive farming guidance note which lists standard ammonia emission factors for a variety of livestock, including egg laying chickens. The emission factor for egg laying chickens in an aviary system with manure belts is 0.08 kg-NH_3/bird place/y; this figure is used to calculate emissions from the proposed poultry house.

3.5.3 Ranging area 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.

Three scenarios are considered for ranging area emissions:

- Scenario 1 – The Realistic Scenario – in which ranging emissions are based upon a figure of 7.34% range usage obtained from recent peer reviewed scientific investigations of very similar housing/ranging systems (Pettersson et al).

- Scenario 2 – The Pessimistic Scenario - in which ranging emissions based upon a figure of 12% range usage which is at the higher end of the range of percentages obtained from available peer reviewed scientific investigations (Chielo *et al*. Dawkins *et al*. Hegelund *et al*. Misselbrook *et al*. Pettersson *et al*. Sossidou *et al*. Whay *et al*.).

- Scenario 3 – The Unsound Scenario - in which ranging emissions based upon a figure of 20% range usage which is a figure that has been suggested by Natural Resources Wales, but is not based upon any peer reviewed literature and has not been included in the UK Ammonia Emission Inventory since 2015 (prior to which the figure was mentioned, but only as personal correspondence, with no reference to any peer reviewed work).

To estimate the ammonia emissions from the ranges for each scenario, 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.

3.5.3 Ammonia emissions from the existing manure spreading

It has been estimated that poultry manure application at Glanmyddyfi is currently approximately 126 tonnes per annum. To calculate ammonia emission from the manure it is assumed that the nitrogen content of the manure is 1.9% (from the Welsh Government Fertiliser Manual RB209 8th edition, as requested by Natural Resources Wales) and that 45% of the nitrogen is emitted to air as ammonia (Misselbrook).

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

Table 2. Details of poultry numbers and ammonia emission rates (housing and ranges based upon Pessimistic Scenario)

Ammonia source	Animal numbers	Source of emission data	Emission factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Proposed Housing	16,000 (x0.88)	EA figure for laying chickens in aviary system (belt removal)	0.08	0.035693
Proposed Ranging	16,000 (x0.12)	AS Modelling & Data Ltd. figure (after Misselbrook *et al*)	0.34	0.020686
Existing Manure spreading	-	AS Modelling & Data Ltd. figure (after Misselbrook *et al*)	-	0.041543

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).

The GFS is a spectral model: the physics/dynamics model has an equivalent resolution of approximately 13 km (latterly 9 km); terrain is understood to be resolved at a resolution of approximately 2 km, with sub-13/9 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 meteorological records because:

- Calm periods in traditional records may be over represented 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.

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 because 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 proposed poultry house is shown in Figure 2b; it should be noted that elsewhere in the modelling domain the modified wind roses may differ, reflecting the local flow in that part of the domain. 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.

Figure 2a. The wind rose. Raw GFS derived data, for 51.896 N, 4.037 W, 2016 – 2019

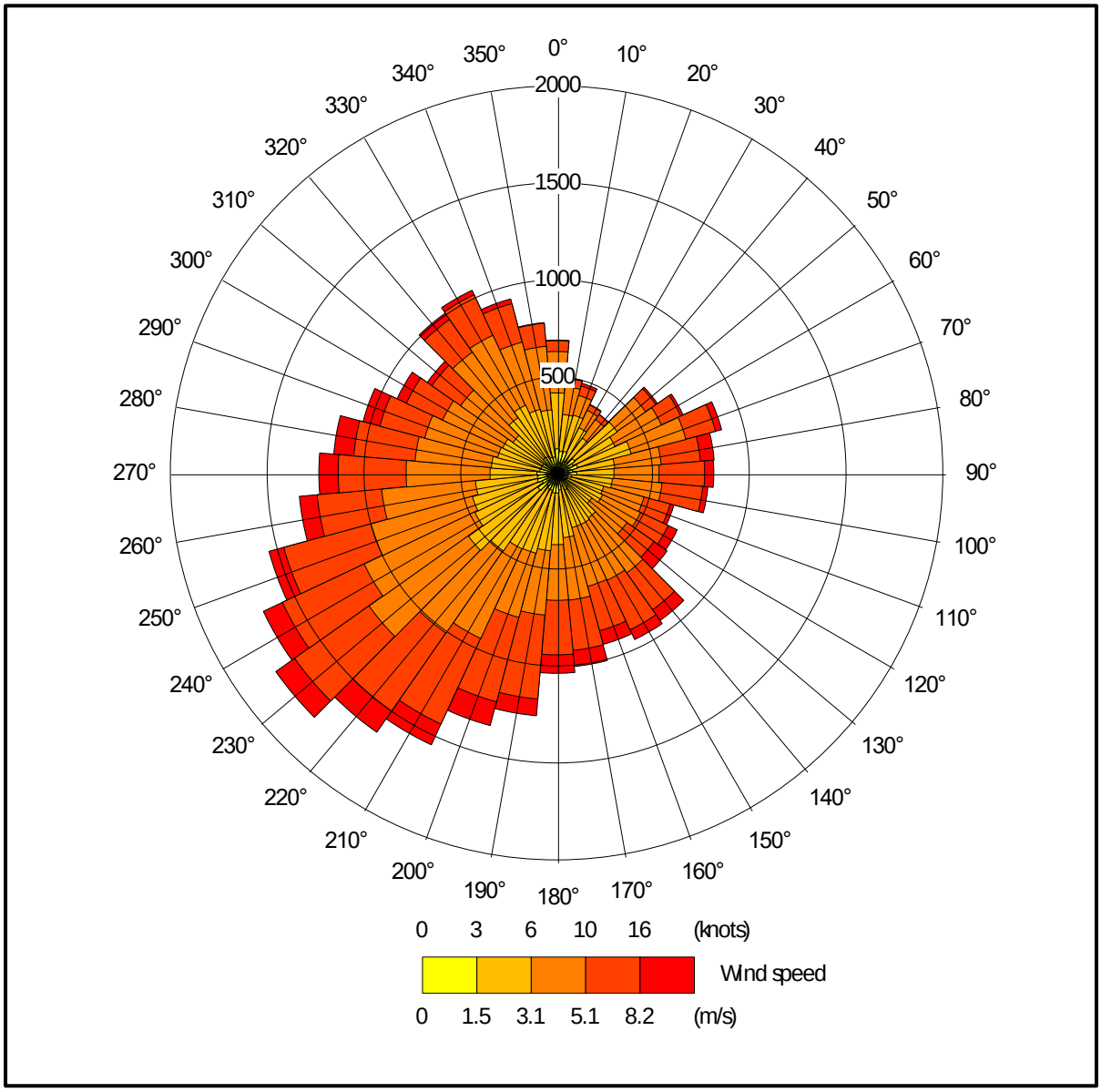
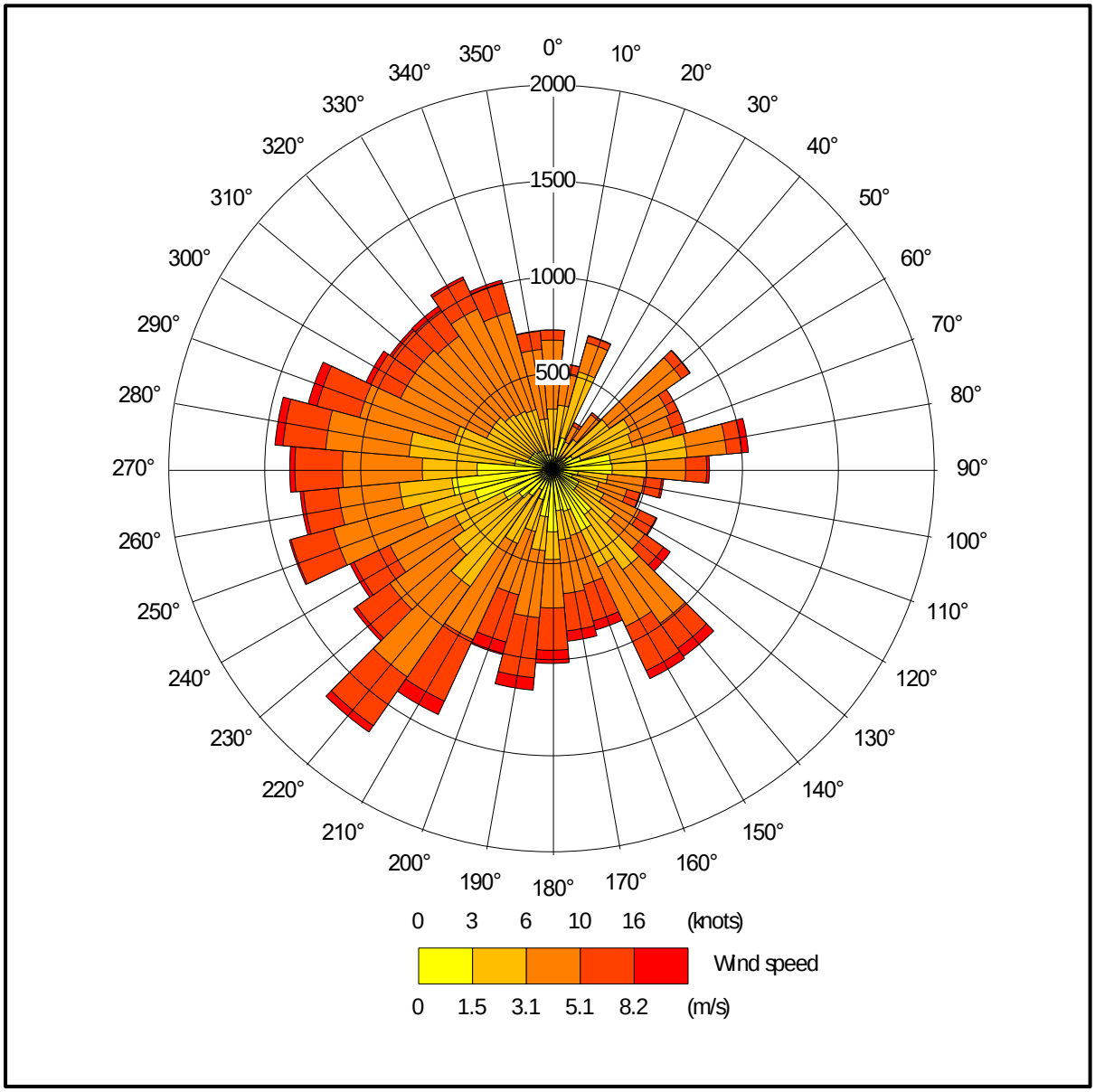


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 259850, 224000, 2016-2019



4.2 Emission sources

Emissions from the chimneys of the uncapped high speed ridge/roof fans that would be used to ventilate the proposed poultry houses are represented by three point sources within ADMS. Details of the point source parameters are shown in Table 3a. The positions of the point sources may be seen in Figure 3a.

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)
PR1 1	7.0	0.8	11.0	22.0	0.011898
PR1 2 & 3	6.0	0.8	11.0	22.0	0.011898

Emissions from the ranging area are represented by a single area source within ADMS (PR_RAN). Emissions from the field manure spreading are represented by two area sources within ADMS (FIELDS_N and FIELDS_S). Details of the area source parameters are shown in Table 3b. The positions of the area sources may be seen in Figures 3a and 3b (for the existing manure spreading).

Table 3b. Area source parameters

Source ID	Height (m)	Area (m^2)	Emission temperature (°C)	Emission rate per source (g-NH_3/s)
PR_RAN	0.0	3,554.0	Ambient	0.020686
FIELDS_N	0.0	100,014.0	Ambient	0.025781
FIELDS_S	0.0	60,797.7	Ambient	0.015672

The housing and ranging emission figures given in Tables 3a and 3b are based upon Scenario 2, which assumes that 12% of droppings occur on the ranging areas and 88% of droppings occur within in the housing.

4.3 Modelled buildings

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

4.4 Discrete receptors

Eighteen discrete receptors have been defined at the SSSIs (1 to 18). 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 fields used in the detailed modelling, a regular Cartesian grid has been 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. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field for the terrain runs is approximately 180 m.

4.7 Roughness Length

A fixed surface roughness length of 0.30 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 the stability and therefore increases predicted ground level concentrations.

Figure 3a. Modelled buildings and sources - proposed free-range egg laying chicken unit

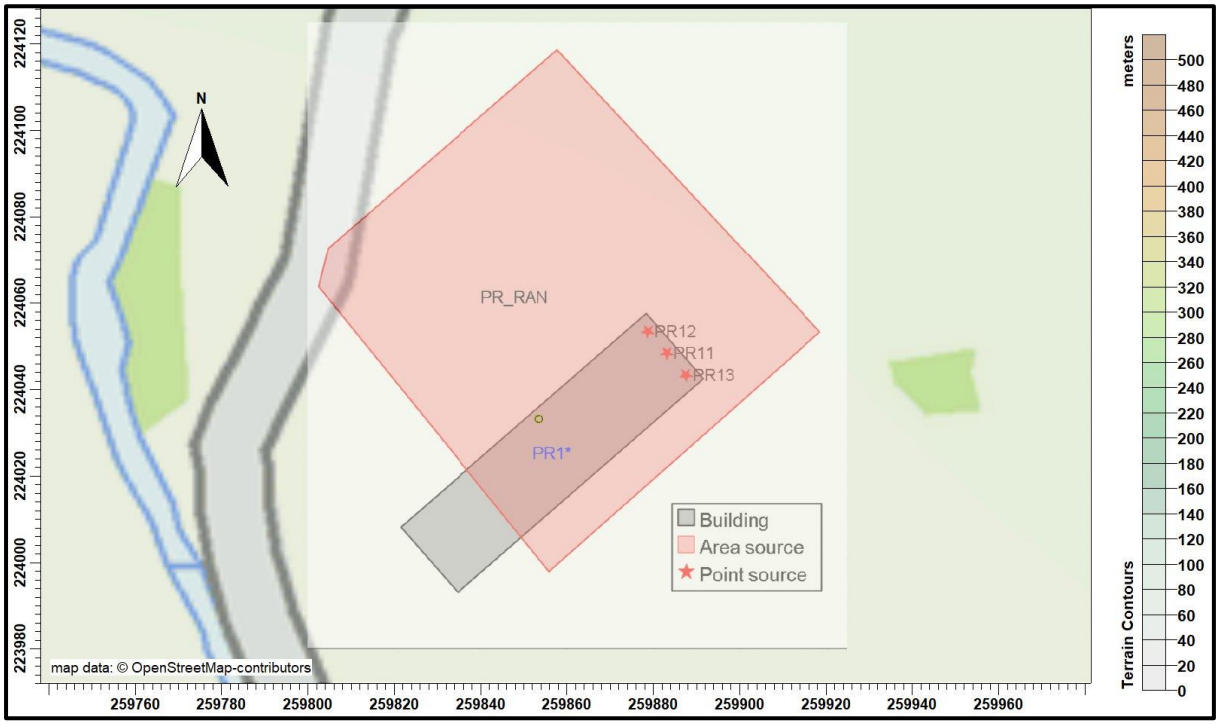


Figure 3b. Modelled area sources (outlined in green) – existing manure spreading

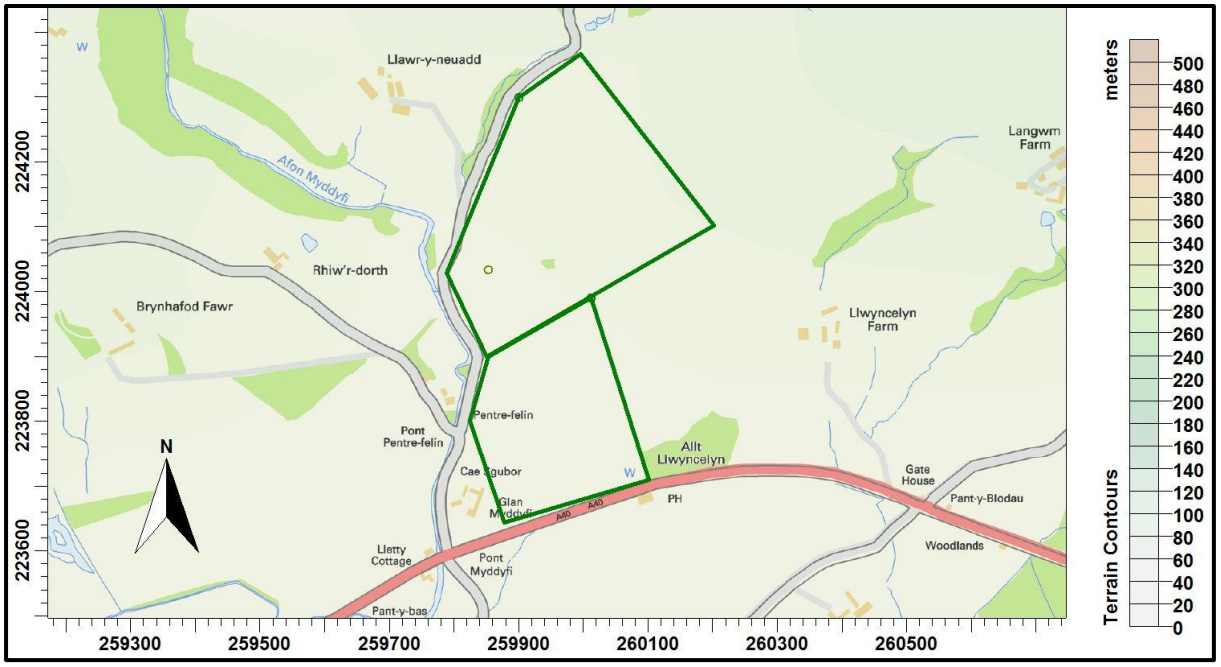
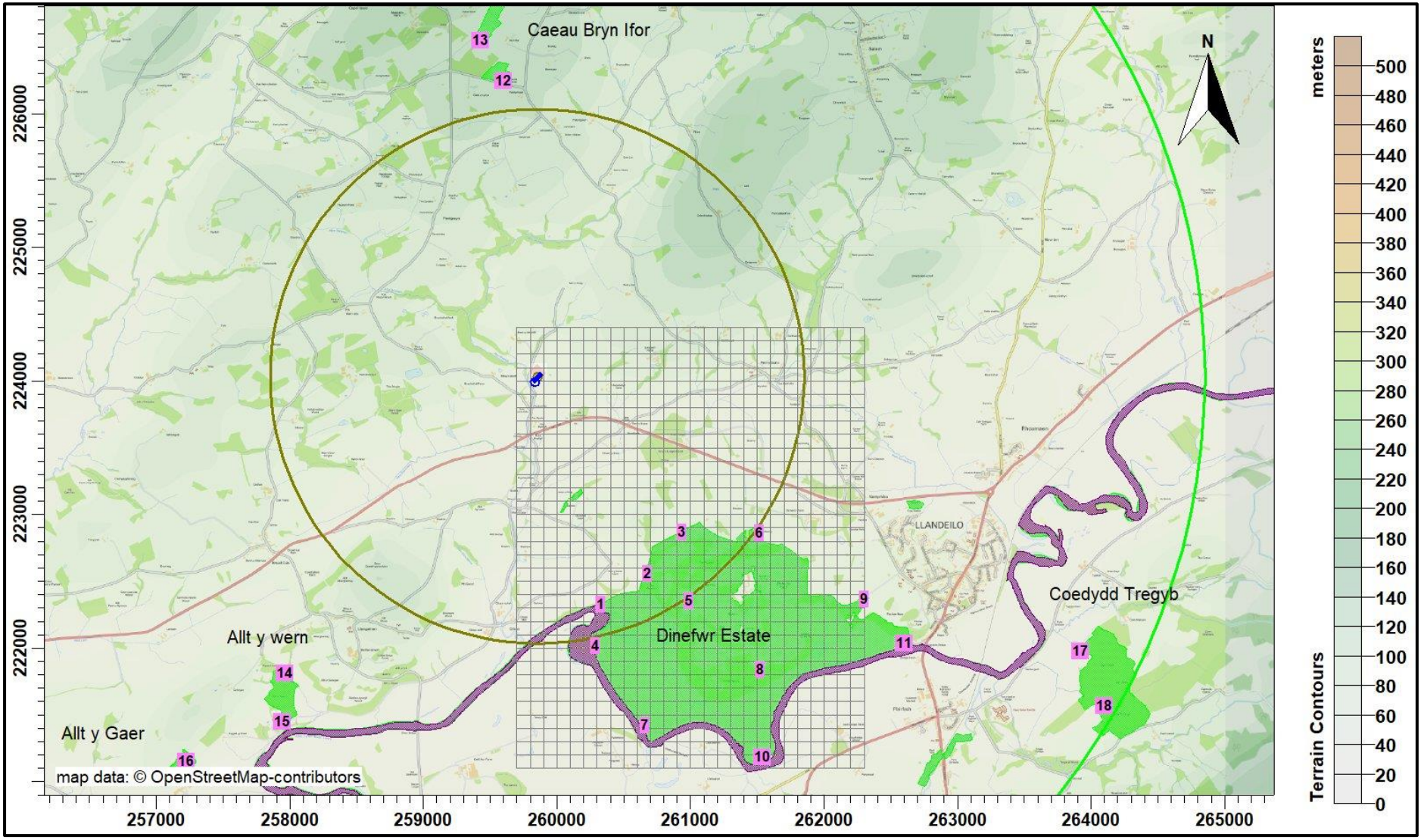


Figure 4. The discrete receptors and regular Cartesian grid



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

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 (0.010 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 plot of the spatially varying deposition fields are provided in Figures 5a and 5b.

In this case, the model has also been run with a fixed deposition at 0.003 m/s and similarly to not modelling deposition at all, the predicted ammonia concentrations (and nitrogen and acid deposition rates) are always higher than if deposition were modelled explicitly as Environment Agency guidance, particularly where there is some distance between the source and a receptor.

Figure 5a. The spatially varying deposition field – existing manure spreading

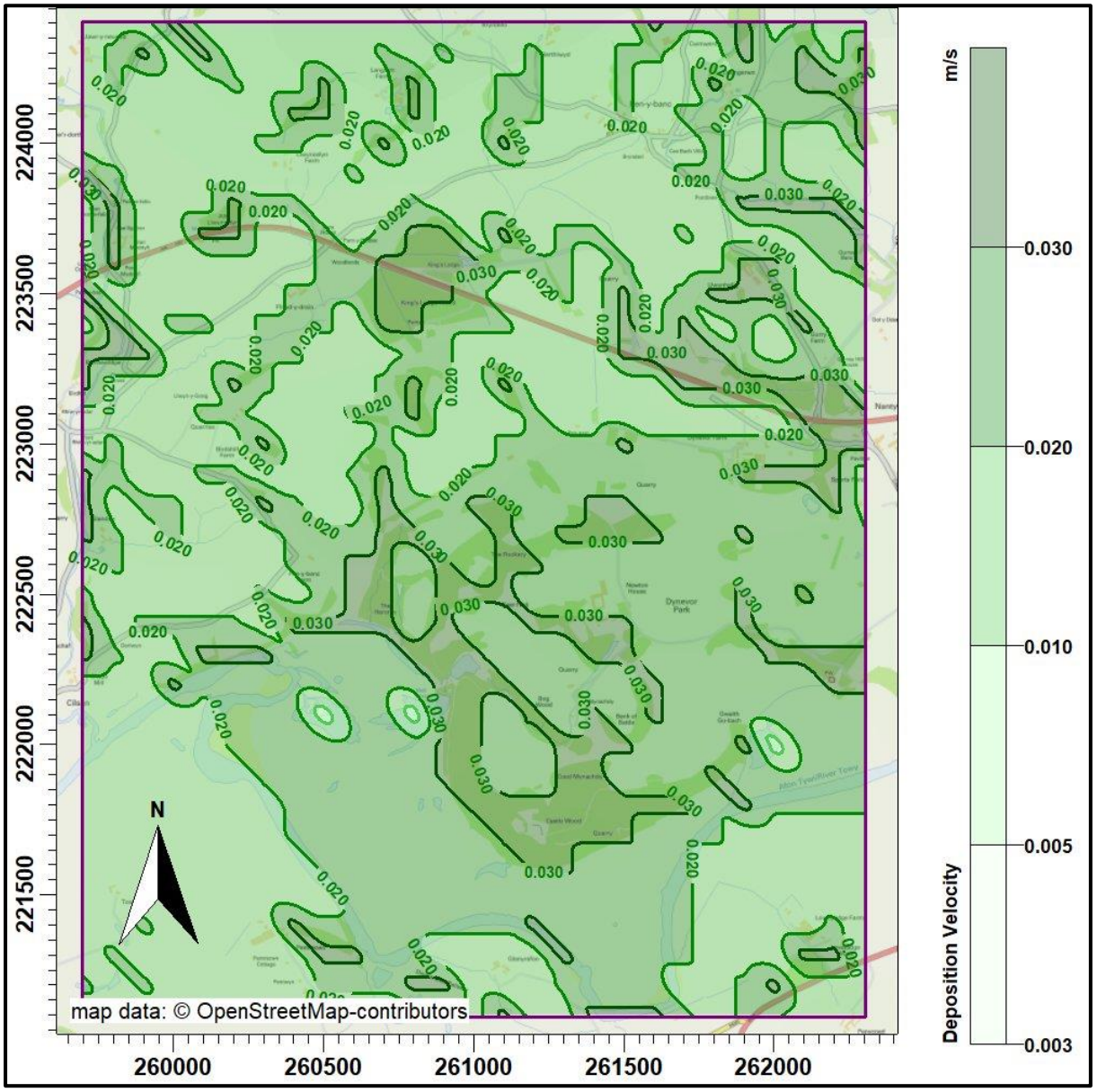
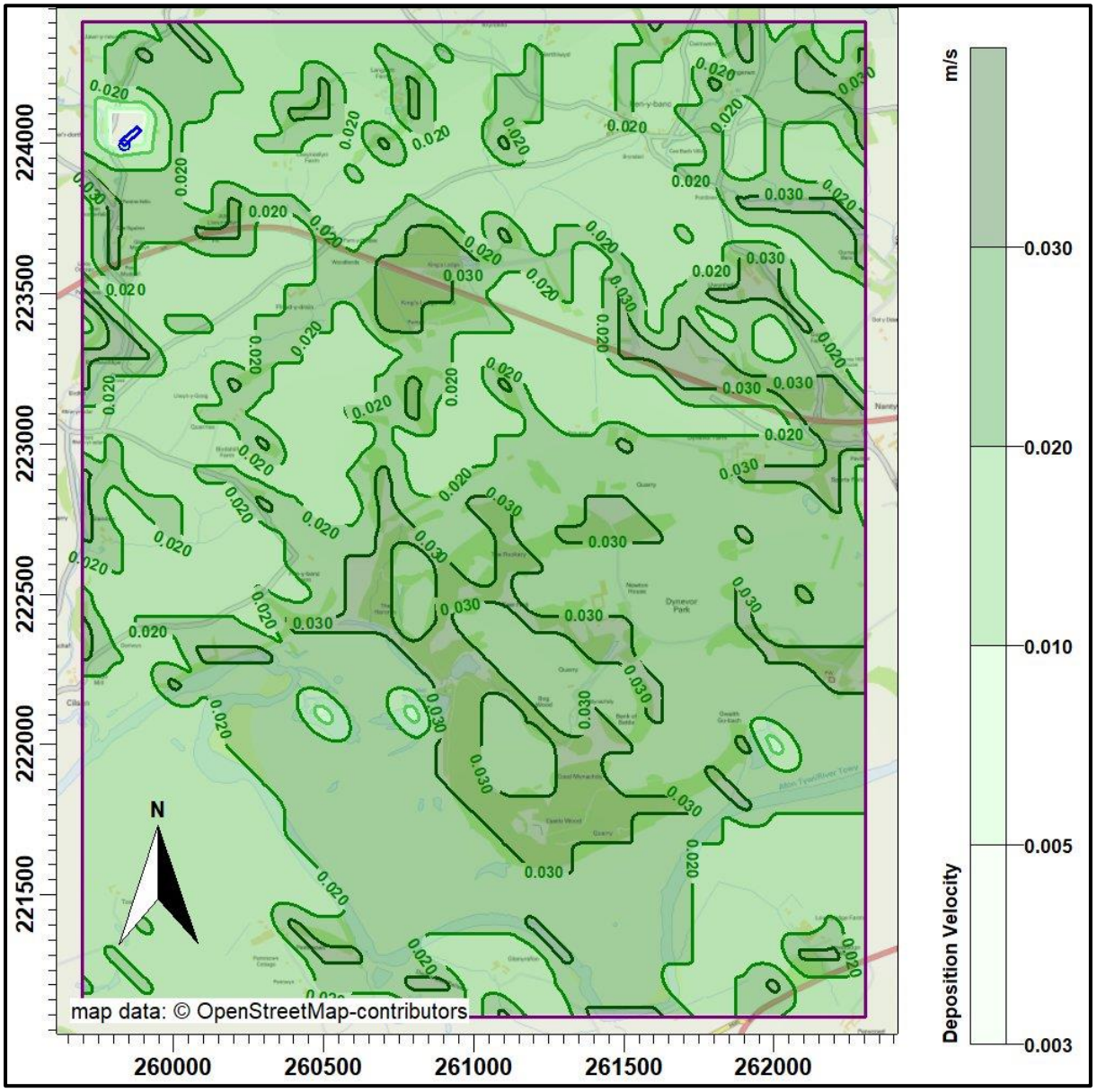


Figure 5b. The spatially varying deposition field – proposed with no manure spreading



5. Details of the Model Runs and Results

5.1 Preliminary modelling and model sensitivity tests

The results of the preliminary modelling are based upon Scenario 2, which assumes that 12% of droppings occur on the ranging areas and 88% of droppings occur within the housing.

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 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 for emissions from the existing manure spreading and from the proposed poultry unit. Note that these are preliminary results for screening and sensitivity testing. Please also note that, because deposition of ammonia and the consequent plume depletion are not accounted for or not fully accounted for, the results are precautionary. Therefore, predicted ammonia concentrations (and nitrogen and acid deposition rates) are always higher than if deposition were modelled explicitly, particularly where there is some distance between the source and a receptor. In this case, a preliminary fixed deposition velocity run has been conducted, it should be noted that this is also precautionary, compared to full spatially varying deposition modelling.

Details of the predicted annual mean ammonia concentrations at each receptor are provided in Table 5. In the Table, predicted ammonia concentrations (or concentrations equivalent to deposition rates) that are in excess of the Natural Resources Wales upper threshold (8% of a Critical Level or Critical Load for a SSSI) are coloured red. Concentrations (or concentrations equivalent to deposition rates) in the range between the Natural Resources Wales lower and upper threshold (1% and 8% of Critical Level or Critical Load for a SSSI) are coloured blue.

Table 5. Predicted annual mean ammonia concentration - preliminary modelling

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration - (µg/m^3)							
				Proposed Housing & Ranging				Existing Manure Spreading			
				GFS No Calms No Terrain	GFS Calms No Terrain	GFS No Calms Terrain	GFS Calms Correction Terrain Fixed depo 0.003 m/s	GFS No Calms No Terrain	GFS Calms No Terrain	GFS No Calms Terrain	GFS No Calms Terrain Fixed depo 0.003 m/s
1	260327	222323	Dinefwr Estate SSSI	**0.026**	**0.025**	**0.027**	**0.013**	**0.042**	**0.017**	**0.048**	**0.018**
2	260677	222560	Dinefwr Estate SSSI	**0.024**	**0.024**	**0.024**	**0.013**	**0.036**	**0.015**	**0.038**	**0.015**
3	260932	222867	Dinefwr Estate SSSI	**0.027**	**0.026**	**0.024**	**0.012**	**0.040**	**0.017**	**0.041**	**0.015**
4	260285	222013	Dinefwr Estate SSSI	**0.022**	**0.021**	**0.023**	**0.010**	**0.034**	**0.014**	**0.040**	**0.014**
5	260986	222353	Dinefwr Estate SSSI	**0.018**	**0.018**	**0.017**	0.010	**0.023**	**0.011**	**0.025**	**0.010**
6	261516	222859	Dinefwr Estate SSSI	**0.018**	**0.018**	**0.017**	0.008	**0.027**	**0.011**	**0.027**	0.009
7	260655	221423	Dinefwr Estate SSSI	**0.013**	**0.013**	**0.014**	0.006	**0.019**	0.008	**0.024**	0.008
8	261519	221835	Dinefwr Estate SSSI	**0.011**	**0.011**	**0.010**	0.005	**0.014**	0.007	**0.014**	0.005
9	262303	222365	Dinefwr Estate SSSI	**0.010**	**0.010**	**0.010**	0.005	**0.014**	0.006	**0.014**	0.005
10	261536	221181	Dinefwr Estate SSSI	0.008	0.008	**0.011**	0.005	**0.010**	0.005	**0.016**	0.005
11	262598	222033	Dinefwr Estate SSSI	0.008	0.008	0.009	0.004	**0.011**	0.005	**0.012**	0.004
12	259601	226247	Dinefwr Estate SSSI	**0.019**	**0.019**	**0.019**	0.007	**0.023**	**0.012**	**0.027**	0.008
13	259425	226546	Dinefwr Estate SSSI	**0.015**	**0.015**	**0.014**	0.006	**0.018**	0.009	**0.019**	0.006
14	257960	221814	Allt y wern SSSI	0.010	0.010	0.008	0.004	**0.012**	0.006	**0.011**	0.004
15	257941	221450	Allt y wern SSSI	0.009	0.008	0.007	0.003	**0.010**	0.005	0.009	0.004
16	257223	221150	Allt y wern SSSI	0.006	0.006	0.005	0.002	0.007	0.004	0.007	0.003
17	263917	221975	Coedydd Tregyb SSSI	0.006	0.006	0.008	0.003	0.007	0.003	**0.011**	0.003
18	264100	221566	Coedydd Tregyb SSSI	0.005	0.005	0.007	0.003	0.006	0.003	**0.010**	0.003

5.2 Detailed modelling

The detailed modelling, which includes ammonia deposition and the consequent plume depletion, was carried out over a restricted domain covering the site of the proposed poultry houses and range at Glanmyddyfi and Dinefwr Estate SSSI, the area where the preliminary modelling (GFS fixed deposition run) indicated that annual mean ammonia concentrations or nitrogen deposition rates would potentially exceed 1% of the Critical Level and/or Critical Load. At the other wildlife sites, the preliminary modelling indicated that ammonia levels (and nitrogen deposition rates) would be below the Natural Resources Wales lower threshold percentage of Critical Level/Load for the designation of the site.

Terrain effects may be significant at some receptors; therefore, the detailed deposition run was made with terrain. Calms cannot be used with terrain or spatially varying deposition; therefore, calms have not been included in the detailed modelling. However, the results of the preliminary modelling indicate that the effects of calms are likely to be insignificant.

The predicted maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors within the detailed modelling domain due to the process contribution from the proposed housing and ranging are shown in Tables 6a (Realistic Scenario), 6b (Pessimistic Scenario) and 6c (Unsound Scenario). The process contribution from the existing manure spreading are shown in Table 7. The predicted change in process contributions (existing manure spreading minus proposed free range chicken housing and ranging) are shown in Tables 8a (Realistic Scenario), 8b (Pessimistic Scenario) and 8c (Unsound Scenario).

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 100% to 100% for an AW) are coloured blue.

Contour plots of the predicted ground level maximum annual mean ammonia concentration and the maximum nitrogen deposition rate for the Pessimistic Scenario due to the process contribution from the proposed poultry house and range are shown in Figures 6a and 6b. Please note that upon request, contour plots can be provided for any Scenario and, or all, of the partial process contributions above.

Table 6a. Predicted maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors - detailed modelling – proposed housing & ranging - Realistic Scenario

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.030	1.0	10.0	0.005	0.5	0.04	0.4
2	260677	222560	Dinefwr Estate SSSI	0.030	1.0	10.0	0.006	0.6	0.05	0.5
3	260932	222867	Dinefwr Estate SSSI	0.030	1.0	10.0	0.006	0.6	0.04	0.4
4	260285	222013	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
5	260986	222353	Dinefwr Estate SSSI	0.030	1.0	10.0	0.005	0.5	0.04	0.4
6	261516	222859	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
7	260655	221423	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
8	261519	221835	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
9	262303	222365	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
10	261536	221181	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
11	262598	222033	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
12	259601	226247	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
13	259425	226546	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
14	257960	221814	Allt y wern SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
15	257941	221450	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
16	257223	221150	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
17	263917	221975	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1

Table 6b. Predicted maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors - detailed modelling – proposed housing & ranging - Pessimistic Scenario

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.030	1.0	10.0	0.006	0.6	0.05	0.5
2	260677	222560	Dinefwr Estate SSSI	0.030	1.0	10.0	0.007	0.7	0.06	0.6
3	260932	222867	Dinefwr Estate SSSI	0.030	1.0	10.0	0.006	0.6	0.05	0.5
4	260285	222013	Dinefwr Estate SSSI	0.030	1.0	10.0	0.005	0.5	0.04	0.4
5	260986	222353	Dinefwr Estate SSSI	0.030	1.0	10.0	0.005	0.5	0.04	0.4
6	261516	222859	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
7	260655	221423	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
8	261519	221835	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
9	262303	222365	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
10	261536	221181	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
11	262598	222033	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
12	259601	226247	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
13	259425	226546	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
14	257960	221814	Allt y wern SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
15	257941	221450	Allt y wern SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
16	257223	221150	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
17	263917	221975	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1

Table 6c. Predicted maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors - detailed modelling – proposed housing & ranging - Unsound Scenario

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.030	1.0	10.0	0.008	0.8	0.06	0.6
2	260677	222560	Dinefwr Estate SSSI	0.030	1.0	10.0	0.009	0.9	0.07	0.7
3	260932	222867	Dinefwr Estate SSSI	0.030	1.0	10.0	0.008	0.8	0.06	0.6
4	260285	222013	Dinefwr Estate SSSI	0.030	1.0	10.0	0.006	0.6	0.05	0.5
5	260986	222353	Dinefwr Estate SSSI	0.030	1.0	10.0	0.006	0.6	0.05	0.5
6	261516	222859	Dinefwr Estate SSSI	0.030	1.0	10.0	0.005	0.5	0.04	0.4
7	260655	221423	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.03	0.3
8	261519	221835	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.03	0.3
9	262303	222365	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.02	0.2
10	261536	221181	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.03	0.3
11	262598	222033	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
12	259601	226247	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
13	259425	226546	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.03	0.3
14	257960	221814	Allt y wern SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
15	257941	221450	Allt y wern SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
16	257223	221150	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
17	263917	221975	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1

Table 7. Predicted maximum annual mean ammonia concentrations as a percentage of the Critical level of 1.0 µg-NH_3/m^3 - detailed modelling – Existing Manure Spreading

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
2	260677	222560	Dinefwr Estate SSSI	0.030	1.0	10.0	0.005	0.5	0.04	0.4
3	260932	222867	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
4	260285	222013	Dinefwr Estate SSSI	0.030	1.0	10.0	0.004	0.4	0.03	0.3
5	260986	222353	Dinefwr Estate SSSI	0.030	1.0	10.0	0.003	0.3	0.03	0.3
6	261516	222859	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.02	0.2
7	260655	221423	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
8	261519	221835	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
9	262303	222365	Dinefwr Estate SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
10	261536	221181	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
11	262598	222033	Dinefwr Estate SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
12	259601	226247	Dinefwr Estate SSSI	0.030	1.0	10.0	0.002	0.2	0.01	0.1
13	259425	226546	Dinefwr Estate SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
14	257960	221814	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
15	257941	221450	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
16	257223	221150	Allt y wern SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
17	263917	221975	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.030	1.0	10.0	0.001	0.1	0.01	0.1

Table 8a. Predicted maximum annual mean ammonia concentrations as a percentage of the Critical level of 1.0 µg-NH_3/m^3 - detailed modelling – Predicted Change - Realistic Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
2	260677	222560	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
3	260932	222867	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
4	260285	222013	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
5	260986	222353	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
6	261516	222859	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
7	260655	221423	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
8	261519	221835	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
9	262303	222365	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
10	261536	221181	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
11	262598	222033	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
12	259601	226247	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
13	259425	226546	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
14	257960	221814	Allt y wern SSSI	0.03	1.0	10.0	0.000	0.0	0.00	0.0
15	257941	221450	Allt y wern SSSI	0.03	1.0	10.0	0.000	0.0	0.00	0.0
16	257223	221150	Allt y wern SSSI	0.03	1.0	10.0	0.000	0.0	0.00	0.0
17	263917	221975	Coedydd Tregyb SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.03	1.0	10.0	0.000	0.0	0.00	0.0

Table 8b. Predicted maximum annual mean ammonia concentrations as a percentage of the Critical level of 1.0 µg-NH_3/m^3 - detailed modelling – Predicted Change - Pessimistic Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
2	260677	222560	Dinefwr Estate SSSI	0.03	1.0	10.0	0.003	0.3	0.02	0.2
3	260932	222867	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.02	0.2
4	260285	222013	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
5	260986	222353	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.02	0.2
6	261516	222859	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.02	0.2
7	260655	221423	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
8	261519	221835	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
9	262303	222365	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
10	261536	221181	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
11	262598	222033	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
12	259601	226247	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
13	259425	226546	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
14	257960	221814	Allt y wern SSSI	0.03	1.0	10.0	0.001	0.1	0.00	0.0
15	257941	221450	Allt y wern SSSI	0.03	1.0	10.0	0.001	0.1	0.00	0.0
16	257223	221150	Allt y wern SSSI	0.03	1.0	10.0	0.000	0.0	0.00	0.0
17	263917	221975	Coedydd Tregyb SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.03	1.0	10.0	0.001	0.1	0.00	0.0

Table 8c. Predicted maximum annual mean ammonia concentrations as a percentage of the Critical level of 1.0 µg-NH_3/m^3 - detailed modelling – Predicted Change - Unsound Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m^3)	Critical Load (kg/ha)	Process Contribution (µg/m^3)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	260327	222323	Dinefwr Estate SSSI	0.03	1.0	10.0	0.003	0.3	0.02	0.2
2	260677	222560	Dinefwr Estate SSSI	0.03	1.0	10.0	0.004	0.4	0.03	0.3
3	260932	222867	Dinefwr Estate SSSI	0.03	1.0	10.0	0.004	0.4	0.03	0.3
4	260285	222013	Dinefwr Estate SSSI	0.03	1.0	10.0	0.003	0.3	0.02	0.2
5	260986	222353	Dinefwr Estate SSSI	0.03	1.0	10.0	0.003	0.3	0.02	0.2
6	261516	222859	Dinefwr Estate SSSI	0.03	1.0	10.0	0.003	0.3	0.02	0.2
7	260655	221423	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
8	261519	221835	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
9	262303	222365	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
10	261536	221181	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
11	262598	222033	Dinefwr Estate SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
12	259601	226247	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.02	0.2
13	259425	226546	Dinefwr Estate SSSI	0.03	1.0	10.0	0.002	0.2	0.01	0.1
14	257960	221814	Allt y wern SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
15	257941	221450	Allt y wern SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
16	257223	221150	Allt y wern SSSI	0.03	1.0	10.0	0.001	0.1	0.00	0.0
17	263917	221975	Coedydd Tregyb SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1
18	264100	221566	Coedydd Tregyb SSSI	0.03	1.0	10.0	0.001	0.1	0.01	0.1

Figure 6a. Maximum annual ammonia concentration – Pessimistic Scenario – proposed housing and ranging

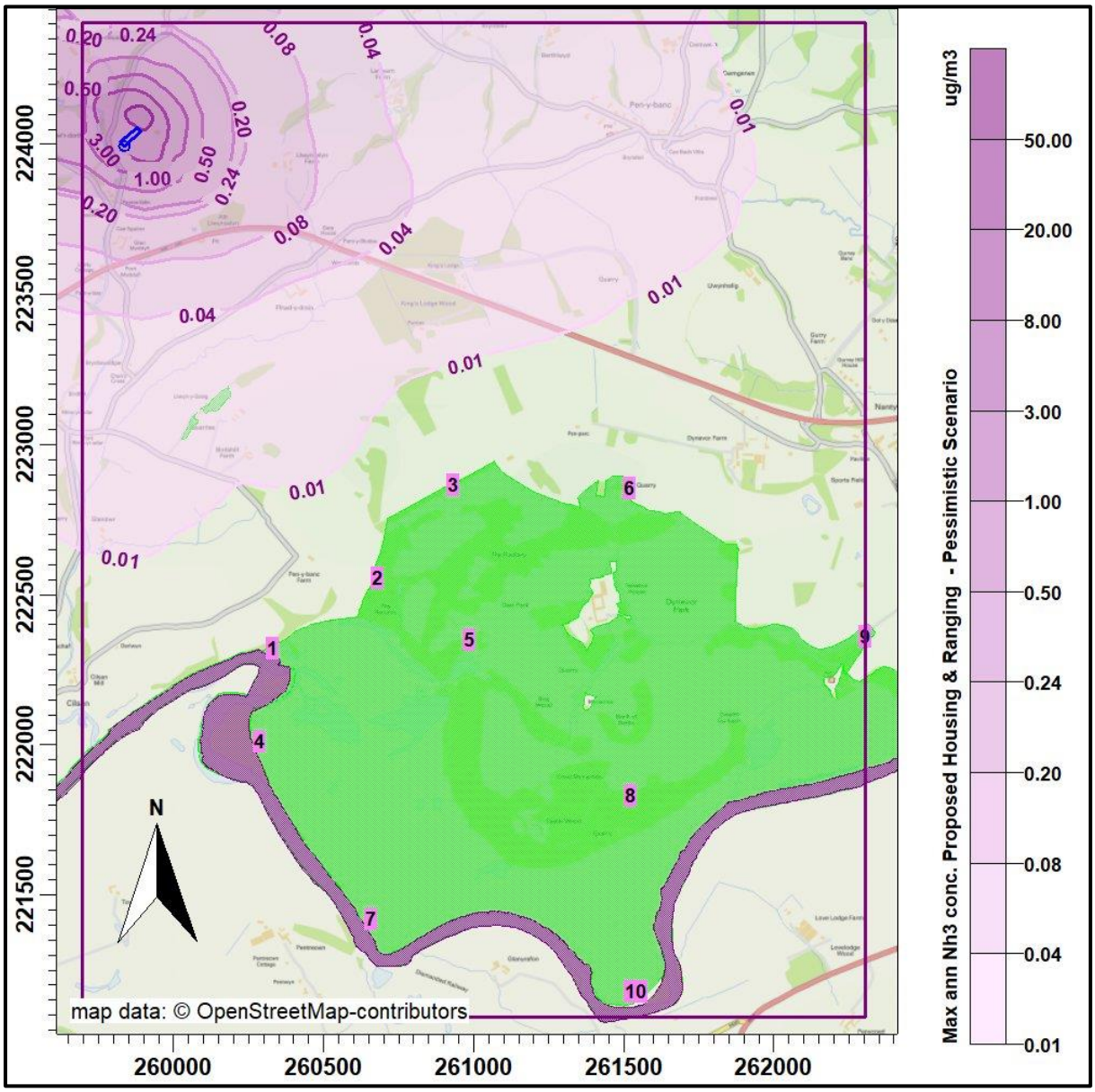
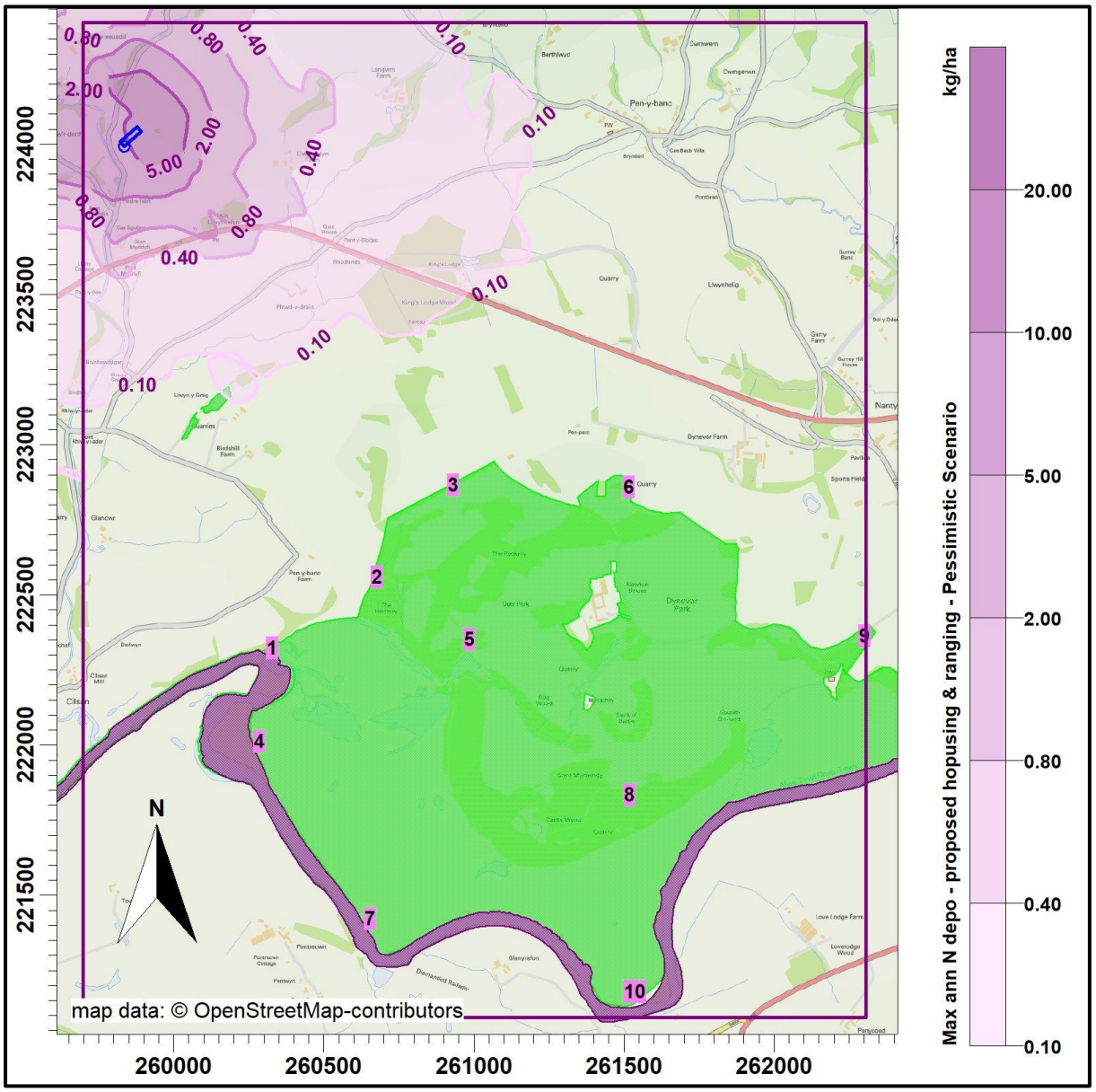


Figure 6b. Maximum annual nitrogen deposition rates – Pessimistic Scenario – proposed housing and ranging



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Gail Jenkins of Roger Parry & Partners LLP, on behalf of Mr. Terry Davies, to use computer modelling to assess the impact of ammonia emissions from the proposed free range egg-laying chicken house at Glanmyddyfi, Pentrefelin, Llandeilo, Carmarthenshire. SA19 7AA.

Ammonia emission rates from the proposed poultry house have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. Emissions of ammonia from the proposed ranging area have been assessed and quantified based upon figures obtained from a variety of sources. Emissions of ammonia from the existing field spreading of manure have been estimated by AS Modelling & Data Ltd., based upon estimated tonnage of manure spread, published figures for nitrogen content of poultry manure and percentage of nitrogen emitted as ammonia from field spreading of poultry manure. 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.

Modelling Results

The modelling predicts that:

- The process contribution from the proposed poultry housing and ranging to the annual ammonia concentration and the nitrogen deposition rate would below 1% of the Critical Level and/or Critical Load at all the SSSIs considered under all scenarios considered.

- If process contribution from the existing manure spreading are subtracted from process contribution from the proposed poultry housing and ranging the predicted increase less than 0.5 % of the Critical Level at Dinefwr Estate SSSI, even under the Unsound Scenario.

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