

# A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing Turkey Rearing Houses and the Proposed Broiler Chicken Rearing Houses at Hergest Camp Farm, Lower Hergest, Kington in Herefordshire

# AS Modelling & Data Ltd.

01952 462500

[www.asmodata.co.uk](http://www.asmodata.co.uk)

Prepared by Phil Edgington

[philedgington@asmodata.co.uk](mailto:philedgington@asmodata.co.uk)

07483 340262

25th June 2021

Reviewed by Steve Smith

[stevesmith@asmodata.co.uk](mailto:stevesmith@asmodata.co.uk)

01952 462500

25th June 2021

# Introduction

AS Modelling & Data Ltd. has been instructed by T. L. Whittall Ltd., the operator, to use computer modelling to assess the impact of ammonia emissions from the existing turkey rearing houses and the proposed broiler chicken rearing houses at Hergest Camp Farm, Lower Hergest, Kington in Herefordshire. HR5 3ER.

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 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.

# Background Details

The poultry houses at Hergest Camp Farm are located in a semi-rural area approximately 550 m to the south of the small village of Lower Hergest in Herefordshire. The surrounding land is used for arable cultivation, fodder production and there are some areas of woodland. The poultry houses lie in a narrow valley on the banks of the River Arrow, at an elevation of around 190 m with hills in all directions, notably with the Hergest Ridge, at an altitude of 423 m, close by to the north-west.

Currently, the poultry houses provide accommodation for up to 34,000 stag turkeys and are ventilated by high speed ridge fans, each with a short chimney, with gable end fans providing additional ventilation during periods of hot weather. Under the proposals, the use of the poultry houses would change and instead of stag turkeys, 215,000 broiler chickens would be accommodated at the farm; the ventilation systems used would not change. Manure is, or would be, taken off site at the end of the crop.

There are a number of areas of Ancient Woodlands (AWs) and Local Wildlife Sites (LWSs) within 2 km of Hergest Camp Farm, one of which, namely the River Arrow LWS, is within 100 m of the poultry houses. Beyond these, there are two areas in Wales that have been identified by Natural Resources Wales (NRWs) as Ammonia Sensitive Ancient Woodlands (AWs) and thirteen areas that have been identified as Sites of Special Scientific Interest (SSSIs), that are within 5 km of the poultry houses. There are two further areas designated as SSSIs within 10 km of the poultry houses; namely the River Wye SSSI and the Rhos Goch SSSI, both of which are also designated as Special Areas of Conservation (SACs).

Maps of the surrounding area showing the positions of the poultry houses and the nearby wildlife sites are provided in Figure 1a and Figure 1b. In these figures, the LWSs are shaded in yellow, the AWs are shaded in olive, the ammonia sensitive AWs are shaded in blue, the SSSIs are shaded in green, the SACs are shaded in purple and the site of the poultry houses is outlined in blue.

*Figure 1a. The area surrounding the site of the proposed poultry unit – a broad scale view*

Map

Description automatically generated

© Crown copyright and database rights. 2021.

*Figure 1b. The area surrounding the site of the proposed poultry unit – a closer view*

Map

Description automatically generated

© Crown copyright and database rights. 2021.

# 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-NH3/m3) 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 Hergest Camp Farm is 2.03 µg-NH3/m3. The background nitrogen deposition rate to woodland is 32.48 kg-N/ha/y and to short vegetation is 19.74 kg-N/ha/y. The background acid deposition rate to woodland is 2.41 keq/ha/y and to short vegetation is 1.47 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS, June 2021).

## 3.3 Critical Levels & Critical Loads

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

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

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

For ammonia concentration in air, the Critical Level for higher plants is 3.0 µg-NH3/m3 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-NH3/m3 as an annual mean.

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

The Critical Levels and Critical Loads at the wildlife sites assumed in this study are provided in Table 1. The SSSI citations for Bradnor Hill Quarry SSSI and Dolyhir Quarry SSSI indicate that the reason for designation is due to the site geology; therefore, these sites have not been considered further. N.B. Where the Critical Level of 1.0 µg-NH3/m3 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-NH3/m3) | Critical Load - Nitrogen Deposition  (kg-N/ha/y) | Critical Load - Acid Deposition  (keq/ha/y) |
| Unnamed AWs/LWSs | 1.0 1 | 10.0 | - |
| River Arrow LWS, Gladestry Brook LWS, Land near Lower Way Farm LWS, Unnamed AW at 327345,254774 | 3.0 2 | 10.0 2 | - |
| Ammonia sensitive AWs | 1.0 1 | 10.0 | - |
| Glascwm And Gladestry Hills SSSI | 1.0 3 | 5.0 4 | - |
| Bushy Hazels & Cwmma Moors SSSI, Stanner Rocks SSSI, Burfa Boglands SSSI, Rhos Goch SSSI/SAC | 1.0 3 | 10.0 4 | - |
| River Wye SSSI/SAC | 1.0 3 | - | - |
| Flintsham & Titley Pools SSSI | 3.0 3 | 10.0 4 | - |
| Birches SSSI, Upper Welson Marsh SSSI, The Sturts SSSI | 3.0 3 | 15.0 4 | - |
| Quebb Meadow SSSI, Questmoor Meadow SSSI, Dolyhir Meadows SSSI | 3.0 3 | 20.0 4 | - |

1. A precautionary figure, used where details of the site are unavailable, or citations indicate that sensitive lichens and bryophytes may be present.
2. From Pre-application Report EPR/BP3003MP/A001 (to Steve Raash, on behalf of T. H. Whittal Ltd.), June 2021.
3. Based upon the citation for the site and/or information from APIS.
4. The lower bound of the range of Critical Loads obtained from APIS.

## 3.4 Guidance on the significance of ammonia emissions

### 3.4.1 Environment Agency Criteria

The Environment Agency web-page titled “Intensive farming risk assessment for your environmental permit”, contains a set of criteria, with thresholds defined by percentages of the Critical Level or Critical Load, for: internationally designated wildlife sites (Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites); Sites of Special Scientific Interest (SSSIs) and other non-statutory wildlife sites. The lower and upper thresholds are: 4% and 20% for SACs, SPAs and Ramsar sites; 20% and 50% for SSSIs and 100% and 100% for non-statutory wildlife sites.

If the predicted process contributions to Critical Level or Critical Load are below the lower threshold percentage, the impact is usually deemed acceptable.

If the predicted process contributions to Critical Level or Critical Load are in the range between the lower and upper thresholds; 4% to 20% for SACs, SPAs and Ramsar sites; 20% to 50% for SSSIs and 100% 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 farm and the sensitivities of the wildlife sites. 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%).

### 3.4.2 Natural England advisory criterion

Natural England are a statutory consultee at planning and usually advise that, if predicted process contributions exceed 1% of Critical Level or Critical Load at a SSSI, SAC, SPA or Ramsar site, then the local authority should consider whether other farming installations1 might act in-combination or cumulatively with the farm and the sensitivities of the wildlife sites. This advice is based primarily upon the Habitats Directive, EIA Directive and the Countryside and Rights of Way Act.

Recent advice from Natural England2 states that “At the screening assessment stage for agricultural proposals acting alone the threshold is 4% for both SSSI and N2K sites” and “At the detailed assessment stage where there is an in-combination assessment, the threshold for agricultural proposals is 20% for N2K sites and 50% for SSSIs”.

1. The process contribution from most farming installations is already included in the background ammonia concentrations and nitrogen and acid deposition rates. Therefore, it is normally only necessary to consider new installations and installations with extant planning permission and proposed developments when understanding the additional impact of a proposal upon nearby ecologies. However, established farms in close proximity may need to be considered given the background concentrations and deposition rates are derived as an average for a 5 km by 5 km grid.
2. Hack, Richard M. “NE guideline screening thresholds for air pollution”. Message to Nicola Stone, cc Ian Pick. 2nd October 2020. E-mail.

### 3.4.3 Natural Resources Wales guidance

In May 2021, Natural Resources Wales published guidance for ammonia assessments. Which contains the following:

* We are using Critical Level as a standard to ensure the sensitive site is protected and to enable sustainable development. The following statements should help you decide on the next course of action.
* If the process contribution and background levels do not exceed the Critical Level and there are no other sources to consider then normally the application can proceed.
* There will be occasions where the Critical Level is close to being reached. It is important to note that the Critical Level is not a target but a level that we want to avoid. Where the background is close to the critical level we may advise against the development even if the Critical Level is not exceeded.
* If the process contribution plus the background level reaches or exceeds the Critical Level then abatement must be used to reduce the process contribution to below 1% of the critical level in order for the application to proceed.
* If your process contribution is below 1% of the Critical Level and there are no other sources of ammonia to consider, the application can proceed regardless of the background level.

For new developments at existing farms, it is assumed that the process contribution means the change in process contribution, rather than the entire process contribution and that the existing process contribution is included in background figures. However, AS Modelling & Data Ltd. would note that although the process contribution from most farming installations is already included in the background ammonia concentrations and nitrogen and acid deposition rates, for established farms that are in close proximity to a wildlife site then, because the background concentrations and deposition rates are derived as an average for a 5 km by 5 km grid, there may be large underestimation of the existing process contributions to the local background level.

The Natural Resources Wales guidance appears to apply to statutory sites and some Ancient Woodlands. For Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and other Ancient Woodlands (AWs), it is assumed that the Environment Agency’s horizontal guidance, H1 Environmental Risks Assessment, H1 Annex B - Intensive Farming is still applicable as there is no other official guidance that AS Modelling & Data Ltd. are aware of.

## 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 turkeys and broiler chickens. The emission factor for stag turkeys is 0.45 kg-NH3/bird place/y and for broiler chickens is 0.034 kg-NH3/bird place/y; this figure is used to calculate the emissions from the existing and proposed poultry houses.

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 animal numbers and ammonia emission rates*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | Animal numbers | Type or weight | Emission factor  (kg-NH3/place/y) | Emission rate  (g-NH3/s) |
| Existing housing | 34,000 | Stag turkeys | 0.45 | 0.484828 |
| Proposed Housing | 215,000 | Broiler chickens | 0.034 | 0.231640 |

# 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; NOx 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 9 km (latterly 6 km); terrain is understood to be resolved at a resolution of approximately 2 km, with sub-9/6 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 (FLOWSTAR1). 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 raw GFS wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and where terrain data is included in the modelling, wind speeds and directions will be further modified. The raw GFS wind rose is shown in Figure 2a and the terrain and roughness length modified wind rose for the location of the poultry houses at Hergest Camp Farm is shown in Figure 2b. Note that elsewhere in the modelling domain, the modified wind roses may differ more markedly and that the resolution of the wind field in terrain runs is approximately 300 m for the preliminary modelling runs and the detailed modelling at 500 m horizontal resolution and is approximately 150 m for the detailed modelling at 50 m horizontal resolution. 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 amended2.

1. Note that FLOWSAR requirements are for meteorological data representative of the upwind flow over the modelling domain and that single site meteorological data (observational or from high resolution modelled data) that is representative of the application site is not generally suitable (personal correspondence: CERC 2019 and UK Met O 2015).
2. When modelling complex terrain with ADMS, by default, the minimum turbulence length has 0.1 m added to the flat terrain value (calculated from the Monin–Obukhov length). Whilst this might be appropriate over hill/mountain tops in terrain with slopes > 1:10 (and quite possibly only in certain wind directions) in lesser terrain it introduces model behaviour that is not desirable where FLOWSTAR is simply being used to modify the upwind flow. Specifically, the parameter sigma z of the Gaussian plume model is overly constrained, which for point sources emissions, may cause over prediction of ground level concentrations in stable weather conditions and light winds (Steven R. Hanna & Biswanath Chowdhury, 2013). Note that this becomes particularly important overnight and if calm and light wind conditions are not being ignored as they often are when using traditional observational meteorological datasets. To reduce this behaviour, where terrain is modelled, AS Modelling & Data Ltd. have set a minimum turbulence length of 0.025 m in ADMS. This approximates the normal behaviour of ADMS with flat terrain.

*Figure 2a. The wind rose. Raw GFS derived data for 52.186 N, 3.06 W, 2017-2020*

**

*Figure 2b. The wind rose. FLOWSTAR data for NGR 327600, 254675, 2017-2020*

**

## 4.2 Emission sources

Emissions from the chimneys of the uncapped high speed ridge fans used for the primary ventilation of the poultry houses are represented by three point sources per house within ADMS (H1 1, 2 & 3 to H6 1, 2 & 3). The poultry houses are also fitted with gable end fans, which are used to provide additional ventilation during periods of hot weather; these gable end fans are represented by two volume sources per house within ADMS, located in the north and south gable ends (H1\_gabN to H6\_gabN and H1\_gabS to H6\_gabS).

Details of the point and volume source parameters are shown in Table 3a and Table 3b. The positions of the point and volume sources used are shown in Figure 3, where the point sources are marked by red stars and the volume sources are marked by red rectangles. Note, the modelling has been performed using emissions calculated for the existing poultry houses, which are used to accommodate 34,000 stag turkeys using an emission factor of 0.45 kg‑NH3/bird place/y, and the impacts adjusted by a factor of 0.478 to correct for the proposed poultry houses, which would be used to accommodate 215,000 broiler chickens with an emission factor of 0.034 kg‑NH3/bird place/y.

*Table 3a. Point source parameters*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source ID | Height (m) | Diameter (m) | Efflux velocity (m/s) | Emission temperature (˚C) | Emission rate per source  (g-NH3/s) |
| H1 to H4; 1, 2 & 3 | 5.5 | 0.7 | 7.0 | Variable 1 | 0.025251 2 |
| H5 and H5; 1, 2 & 3 | 5.5 | 0.7 | 7.0 | Variable 1 | 0.030302 2 |

1. 25 C or, where the ambient temperature exceeds this, ambient temperature.

2. 100% of the house emissions, adjusted by a factor of 0.7 when the ambient temperature equals or exceeds 25 C.

*Table 3b. Volume source parameters*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Source ID | Length (m) | Width (m) | Depth (m) | Base height (m) | Emission temperature (°C) | Emission rate  (g-NH3/s) |
|
| H1\_gabN to H4\_gabN, H1\_gabS to H4\_gabS | 15.0 | 5.0 | 3.0 | 0.5 | Ambient | 0.005682 1 |
| H5\_gabN to H6\_gabN, H5\_gabS to H6\_gabS | 18.0 | 5.0 | 3.0 | 0.5 | Ambient | 0.006818 1 |

1. 15% of the house emissions, only emitted when the ambient temperature equals or exceeds 25 C.

## 4.3 Modelled buildings

The structure of the poultry houses and other nearby buildings may affect the plumes from the point sources. Therefore, the buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3.

## 4.4 Discrete receptors

Ninety-five discrete receptors have been defined at the nearby wildlife sites: sixty-seven at the AWs/LWSs (1 to 67), four at the ammonia sensitive AWs (68 to 71), nineteen at the SSSIs (72 to 90) and five at the SACs (91 to 95). These receptors have been defined at ground level within ADMS. The position of the discrete receptors may be seen in Figure 4a and Figure 4b, where they are marked by enumerated pink rectangles.

*Figure 3. The positions of modelled buildings and sources*

*Diagram, map

Description automatically generated*

© Crown copyright and database rights. 2021.

## 4.5 Cartesian grid

To produce the contour plots presented in Section 5 of this report and to define the spatially varying deposition fields, two regular Cartesian grids have been defined within ADMS. The individual grid receptors are defined at ground level within ADMS.

## 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 20.0 km by 20.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for the preliminary modelling and the detailed modelling at 500 m resolution and a 10.0 km by 10.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for the detailed modelling at 50 m resolution; therefore, the effective resolution of the wind field is approximately 300 m for the preliminary modelling and lower (500 m) resolution detailed modelling and is approximately 150 m for the higher (50 m) 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 4a. The discrete receptor and regular Cartesian grids – a broad view*

*Map

Description automatically generated*

© Crown copyright and database rights. 2021.

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

*A picture containing chart

Description automatically generated*

© Crown copyright and database rights. 2021.

## 4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based primarily upon Frederik Schrader and Christian Brümmer. Land Use Specific Ammonia Deposition Velocities: a Review of Recent Studies (2004–2013). 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 0.010 m/s to 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 is used to define a deposition velocity field. The deposition velocities used are provided in Table 4.

*Table 4. Deposition velocities*

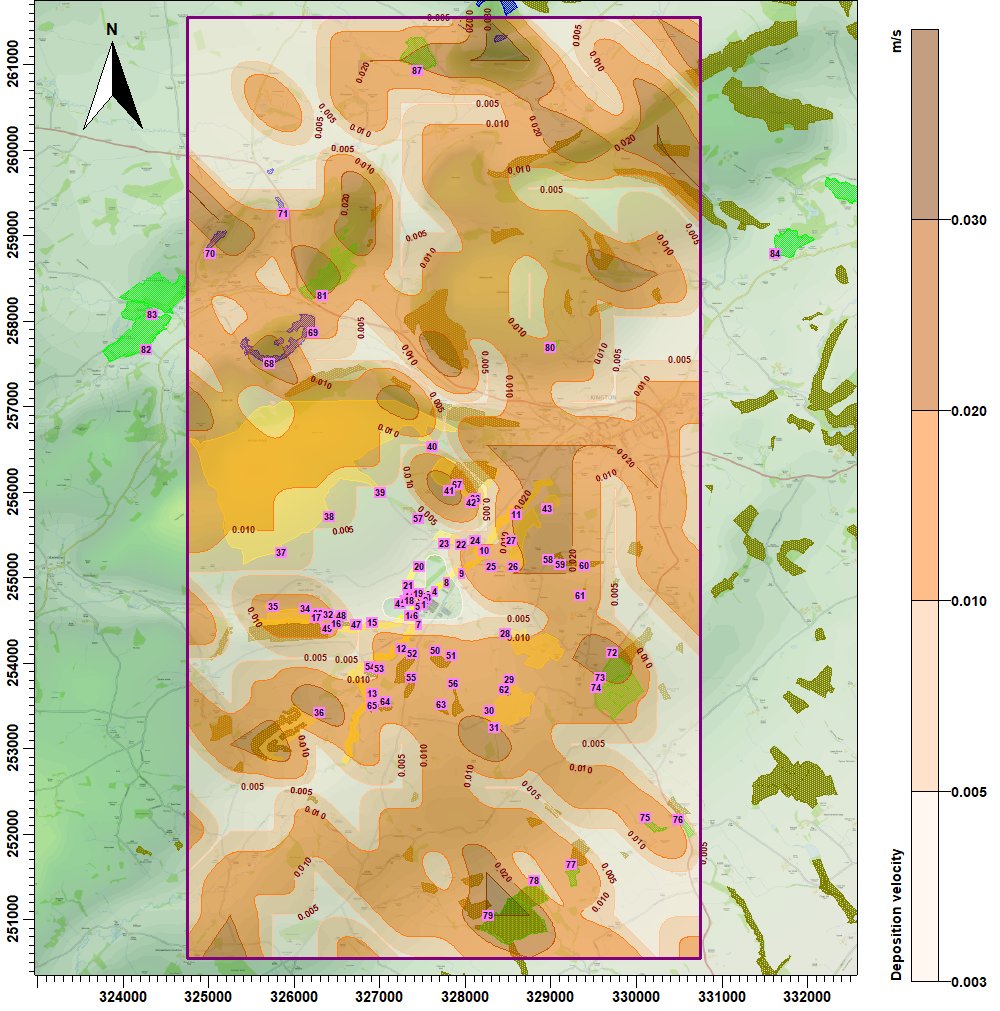
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NH3 concentration  (PC + background) (µg/m3) | < 10 | 10 - 20 | 20 - 30 | 30 – 80 | > 80 |
| Deposition velocity – woodland  (m/s) | 0.03 | 0.015 | 0.01 | 0.005 | 0.003 |
| Deposition velocity – short vegetation  (m/s) | 0.02 (0.010 to 0.015 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 spatially varying deposition fields are provided in Figure 5a and Figure 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 spatially varying deposition were modelled explicitly, particularly where there is some distance between the source and a receptor.

*Figure 5a. The spatially varying deposition field – 500 m resolution domain*



© Crown copyright and database rights. 2021.

*Figure 5b. The spatially varying deposition field – 50 m resolution domain*

Map

Description automatically generated

© Crown copyright and database rights. 2021.

# Details of the Model Runs and Results

## 5.1 Preliminary modelling and model sensitivity tests

ADMS was run a totalof twenty times, once for each year of the meteorological record and in the following five modes:

* In basic mode without calms, or terrain – GFS data.
* With calms and without terrain – GFS data.
* Without calms, with terrain and using the ADMS default setting for minimum turbulence.
* Without calms, with terrain and minimum turbulence set to 0.025 m – 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 the discrete receptors were compiled. Equivalent ammonia concentrations and nitrogen deposition rates are shown in Table 5, below. Note that these are preliminary results for screening and sensitivity testing; because deposition of ammonia and the consequent plume depletion are not accounted for, or not fully accounted for, the results of the preliminary modelling 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, with a lower fixed deposition velocity applied when compared to the detailed modelling where a spatially varying deposition field is used.

Details of the predicted annual mean ammonia concentrations at the discrete receptors are provided in Table 6. In the Table, predicted ammonia concentrations (or concentrations equivalent to deposition rates) that are in excess of the Natural Resources Wales/Environment Agency upper percentage threshold of the Critical Level/Load (in Wales, 8% for a SAC/SSSI/ammonia sensitive AW; in England, 20% for a SAC and 50% for a SSSI; for non-statutory sites, 100% in both countries) are coloured red. Predicted ammonia concentrations (or concentrations equivalent to deposition rates) that are in the range between the Environment Agency’s upper threshold and lower threshold of the relevant Critical Level or Critical Load (in Wales, 8% and 1% for a SAC/SSSI/ammonia sensitive AW; in England 20% and 4% for a SAC and 50% and 20% for a SSSI; for non-statutory sites, 100% to 100% in both countries) are coloured blue. Additionally, process contributions that exceed 1% of the Critical Level or Load at a statutory site in England are highlighted with bold text. For convenience, cells referring to LWSs are shaded yellow, cells referring to AWs are shaded olive, cells referring to SSSIs are shaded green and cells referring to SACs are shaded lilac.

*Table 5. Equivalent ammonia concentrations*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Deposition Velocity (m/s) | Concentration equivalent to X % of Critical Load of 10 kg/ha (µg/m3) | | | | | |
| 100% | 50% | 20% | 8% | 4% | 1% |
| 0.03 | 1.284 | 0.642 | 0.257 | 0.103 | 0.051 | 0.013 |
| 0.02 | 1.925 | 0.963 | 0.385 | 0.154 | 0.077 | 0.019 |

*Table 6. Predicted maximum annual mean ammonia concentration at the discrete receptors*

| Receptor number | X(m) | Y(m) | Designation | Maximum annual mean ammonia concentration - (µg/m3) | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Existing | | | | | Proposed | | | | |
| GFS No Calms No Terrain | GFS Calms No Terrain | GFS No Calms Terrain | GFS No Calms Terrain Default min turb | GFS No Calms Terrain Fixed depo 0.003 m/s | GFS No Calms No Terrain | GFS Calms No Terrain | GFS No Calms Terrain | GFS No Calms Terrain Default min turb | GFS No Calms Terrain Fixed depo 0.003 m/s |
| 1 | 327514 | 254685 | River Arrow LWS | **8.143** | **7.974** | **9.439** | **9.719** | **9.079** | **3.890** | **3.810** | **4.510** | **4.643** | **4.338** |
| 2 | 327540 | 254731 | River Arrow LWS | **10.051** | **9.935** | **11.045** | **11.469** | **10.595** | **4.802** | **4.747** | **5.277** | **5.480** | **5.062** |
| 3 | 327573 | 254768 | River Arrow LWS | **9.342** | **9.272** | **9.791** | **9.937** | **9.499** | **4.463** | **4.430** | **4.678** | **4.748** | **4.539** |
| 4 | 327645 | 254832 | River Arrow LWS | **6.027** | **5.969** | **7.088** | **7.234** | **6.880** | **2.880** | **2.852** | **3.386** | **3.456** | **3.287** |
| 5 | 327444 | 254653 | River Arrow LWS | **3.555** | **3.539** | **3.370** | **3.576** | **3.262** | **1.698** | **1.691** | **1.610** | **1.708** | **1.558** |
| 6 | 327427 | 254553 | River Arrow LWS | **2.824** | **2.809** | **3.301** | **3.763** | **3.125** | **1.349** | **1.342** | **1.577** | **1.798** | **1.493** |
| 7 | 327456 | 254449 | River Arrow LWS | **2.090** | **2.078** | **2.393** | **2.751** | **2.206** | 0.999 | 0.993 | **1.143** | **1.315** | **1.054** |
| 8 | 327788 | 254933 | River Arrow LWS | **2.511** | **2.488** | **3.095** | **3.307** | **2.938** | **1.200** | **1.189** | **1.479** | **1.580** | **1.404** |
| 9 | 327963 | 255046 | River Arrow LWS | **1.270** | **1.259** | **1.467** | **1.615** | **1.362** | 0.607 | 0.602 | 0.701 | 0.771 | 0.651 |
| 10 | 328227 | 255314 | River Arrow LWS | 0.550 | 0.540 | 0.609 | 0.696 | 0.548 | 0.263 | 0.258 | 0.291 | 0.333 | 0.262 |
| 11 | 328598 | 255735 | River Arrow LWS | 0.278 | 0.273 | 0.283 | 0.334 | 0.242 | 0.133 | 0.130 | 0.135 | 0.160 | 0.116 |
| 12 | 327254 | 254167 | River Arrow LWS | 0.619 | 0.615 | 0.706 | 0.863 | 0.595 | 0.296 | 0.294 | 0.337 | 0.412 | 0.284 |
| 13 | 326913 | 253637 | River Arrow LWS | 0.235 | 0.233 | 0.280 | 0.339 | 0.210 | 0.112 | 0.111 | 0.134 | 0.162 | 0.100 |
| 14 | 327354 | 254556 | Gladestry Brook LWS | **1.767** | **1.760** | **1.892** | **2.240** | **1.757** | 0.844 | 0.841 | 0.904 | **1.070** | 0.839 |
| 15 | 326918 | 254475 | Gladestry Brook LWS | 0.383 | 0.382 | 0.329 | 0.510 | 0.268 | 0.183 | 0.183 | 0.157 | 0.244 | 0.128 |
| 16 | 326496 | 254460 | Gladestry Brook LWS | 0.189 | 0.185 | 0.163 | 0.250 | 0.116 | 0.090 | 0.089 | 0.078 | 0.119 | 0.055 |
| 17 | 326262 | 254523 | Gladestry Brook LWS | 0.166 | 0.162 | 0.111 | 0.175 | 0.078 | 0.079 | 0.077 | 0.053 | 0.084 | 0.037 |
| 18 | 327344 | 254727 | Land near Lower Way Farm LWS | **1.366** | **1.348** | **1.092** | **1.477** | **1.007** | 0.653 | 0.644 | 0.522 | 0.706 | 0.481 |
| 19 | 327448 | 254805 | Land near Lower Way Farm LWS | **2.194** | **2.160** | **1.957** | **2.661** | **1.793** | **1.048** | **1.032** | 0.935 | **1.271** | 0.857 |
| 20 | 327463 | 255124 | Land near Lower Way Farm LWS | 0.890 | 0.875 | 0.635 | 0.885 | 0.522 | 0.425 | 0.418 | 0.303 | 0.423 | 0.249 |
| 21 | 327331 | 254902 | Land near Lower Way Farm LWS | 0.892 | 0.880 | 0.808 | **1.184** | 0.664 | 0.426 | 0.420 | 0.386 | 0.566 | 0.317 |
| 22 | 327955 | 255381 | Unnamed LWS | 0.528 | 0.519 | 0.646 | 0.765 | 0.571 | 0.252 | 0.248 | 0.309 | 0.366 | 0.273 |
| 23 | 327753 | 255399 | Unnamed LWS | 0.539 | 0.529 | 0.525 | 0.644 | 0.438 | 0.257 | 0.253 | 0.251 | 0.308 | 0.209 |
| 24 | 328115 | 255430 | Unnamed LWS | 0.481 | 0.472 | 0.565 | 0.670 | 0.504 | 0.230 | 0.225 | 0.270 | 0.320 | 0.241 |
| 25 | 328303 | 255120 | Unnamed LWS | 0.715 | 0.708 | 0.632 | 0.713 | 0.573 | 0.342 | 0.338 | 0.302 | 0.341 | 0.274 |
| 26 | 328565 | 255124 | Unnamed LWS | 0.519 | 0.514 | 0.392 | 0.469 | 0.347 | 0.248 | 0.246 | 0.187 | 0.224 | 0.166 |
| 27 | 328537 | 255434 | Unnamed LWS | 0.376 | 0.369 | 0.360 | 0.421 | 0.313 | 0.180 | 0.176 | 0.172 | 0.201 | 0.150 |
| 28 | 328464 | 254346 | Unnamed LWS | 0.629 | 0.624 | 0.563 | 0.623 | 0.486 | 0.301 | 0.298 | 0.269 | 0.298 | 0.232 |
| 29 | 328516 | 253799 | Unnamed LWS | 0.250 | 0.248 | 0.203 | 0.231 | 0.173 | 0.119 | 0.118 | 0.097 | 0.110 | 0.083 |
| 30 | 328279 | 253437 | Unnamed LWS | 0.170 | 0.166 | 0.172 | 0.222 | 0.119 | 0.081 | 0.080 | 0.082 | 0.106 | 0.057 |
| 31 | 328335 | 253238 | Unnamed LWS | 0.141 | 0.138 | 0.150 | 0.184 | 0.101 | 0.068 | 0.066 | 0.072 | 0.088 | 0.048 |
| 32 | 326401 | 254563 | Unnamed LWS | 0.186 | 0.182 | 0.125 | 0.202 | 0.091 | 0.089 | 0.087 | 0.060 | 0.096 | 0.044 |
| 33 | 326286 | 254571 | Unnamed LWS | 0.170 | 0.166 | 0.106 | 0.172 | 0.080 | 0.081 | 0.079 | 0.051 | 0.082 | 0.038 |
| 34 | 326126 | 254637 | Unnamed LWS | 0.149 | 0.145 | 0.090 | 0.135 | 0.067 | 0.071 | 0.069 | 0.043 | 0.064 | 0.032 |
| 35 | 325752 | 254658 | Unnamed LWS | 0.118 | 0.114 | 0.065 | 0.095 | 0.046 | 0.056 | 0.055 | 0.031 | 0.045 | 0.022 |
| 36 | 326289 | 253413 | Unnamed LWS | 0.127 | 0.123 | 0.183 | 0.191 | 0.120 | 0.061 | 0.059 | 0.087 | 0.091 | 0.058 |
| 37 | 325854 | 255284 | Unnamed LWS | 0.102 | 0.101 | 0.056 | 0.066 | 0.035 | 0.049 | 0.048 | 0.027 | 0.031 | 0.017 |
| 38 | 326408 | 255716 | Unnamed LWS | 0.118 | 0.116 | 0.101 | 0.106 | 0.059 | 0.056 | 0.055 | 0.048 | 0.051 | 0.028 |
| 39 | 327007 | 255995 | Unnamed LWS | 0.177 | 0.174 | 0.110 | 0.129 | 0.070 | 0.085 | 0.083 | 0.052 | 0.061 | 0.034 |
| 40 | 327617 | 256524 | Unnamed LWS | 0.167 | 0.164 | 0.145 | 0.143 | 0.092 | 0.080 | 0.078 | 0.069 | 0.068 | 0.044 |
| 41 | 327812 | 256012 | Unnamed LWS | 0.237 | 0.232 | 0.195 | 0.226 | 0.143 | 0.113 | 0.111 | 0.093 | 0.108 | 0.068 |
| 42 | 328066 | 255869 | Unnamed LWS | 0.255 | 0.251 | 0.264 | 0.307 | 0.211 | 0.122 | 0.120 | 0.126 | 0.147 | 0.101 |
| 43 | 328955 | 255800 | Unnamed LWS | 0.222 | 0.217 | 0.203 | 0.239 | 0.169 | 0.106 | 0.104 | 0.097 | 0.114 | 0.081 |
| 44 | 327345 | 254774 | Unnamed AW | **1.309** | **1.291** | 1.043 | **1.444** | 0.936 | 0.625 | 0.617 | 0.498 | 0.690 | 0.447 |
| 45 | 327309 | 254732 | Unnamed AW | 1.125 | 1.111 | 0.875 | 1.218 | 0.798 | 0.538 | 0.531 | 0.418 | 0.582 | 0.381 |
| 46 | 327244 | 254693 | Unnamed AW | 0.833 | 0.822 | 0.663 | 0.961 | 0.595 | 0.398 | 0.393 | 0.317 | 0.459 | 0.284 |
| 47 | 326722 | 254453 | Unnamed AW | 0.262 | 0.261 | 0.230 | 0.353 | 0.169 | 0.125 | 0.125 | 0.110 | 0.169 | 0.081 |
| 48 | 326551 | 254552 | Unnamed AW | 0.212 | 0.207 | 0.156 | 0.251 | 0.113 | 0.101 | 0.099 | 0.074 | 0.120 | 0.054 |
| 49 | 326383 | 254402 | Unnamed AW | 0.165 | 0.163 | 0.149 | 0.219 | 0.103 | 0.079 | 0.078 | 0.071 | 0.105 | 0.049 |
| 50 | 327650 | 254143 | Unnamed AW | 0.558 | 0.555 | 0.614 | 0.788 | 0.528 | 0.267 | 0.265 | 0.293 | 0.377 | 0.252 |
| 51 | 327836 | 254086 | Unnamed AW | 0.366 | 0.365 | 0.434 | 0.614 | 0.370 | 0.175 | 0.175 | 0.207 | 0.293 | 0.177 |
| 52 | 327386 | 254110 | Unnamed AW | 0.635 | 0.631 | 0.566 | 0.686 | 0.480 | 0.303 | 0.302 | 0.270 | 0.328 | 0.229 |
| 53 | 326995 | 253933 | Unnamed AW | 0.306 | 0.304 | 0.401 | 0.512 | 0.315 | 0.146 | 0.145 | 0.191 | 0.245 | 0.150 |
| 54 | 326893 | 253957 | Unnamed AW | 0.269 | 0.264 | 0.362 | 0.457 | 0.281 | 0.129 | 0.126 | 0.173 | 0.219 | 0.134 |
| 55 | 327374 | 253828 | Unnamed AW | 0.356 | 0.354 | 0.301 | 0.362 | 0.243 | 0.170 | 0.169 | 0.144 | 0.173 | 0.116 |
| 56 | 327857 | 253759 | Unnamed AW | 0.240 | 0.238 | 0.296 | 0.380 | 0.235 | 0.115 | 0.114 | 0.141 | 0.182 | 0.112 |
| 57 | 327452 | 255687 | Unnamed AW | 0.363 | 0.357 | 0.251 | 0.311 | 0.175 | 0.174 | 0.170 | 0.120 | 0.149 | 0.084 |
| 58 | 328968 | 255209 | Unnamed AW | 0.348 | 0.346 | 0.257 | 0.295 | 0.199 | 0.166 | 0.165 | 0.123 | 0.141 | 0.095 |
| 59 | 329109 | 255152 | Unnamed AW | 0.323 | 0.320 | 0.265 | 0.296 | 0.199 | 0.154 | 0.153 | 0.127 | 0.142 | 0.095 |
| 60 | 329388 | 255137 | Unnamed AW | 0.258 | 0.256 | 0.257 | 0.265 | 0.172 | 0.123 | 0.122 | 0.123 | 0.127 | 0.082 |
| 61 | 329340 | 254786 | Unnamed AW | 0.279 | 0.272 | 0.356 | 0.328 | 0.217 | 0.133 | 0.130 | 0.170 | 0.157 | 0.104 |
| 62 | 328458 | 253684 | Unnamed AW | 0.226 | 0.222 | 0.163 | 0.222 | 0.135 | 0.108 | 0.106 | 0.078 | 0.106 | 0.064 |
| 63 | 327722 | 253507 | Unnamed AW | 0.199 | 0.197 | 0.212 | 0.262 | 0.159 | 0.095 | 0.094 | 0.101 | 0.125 | 0.076 |
| 64 | 327067 | 253549 | Unnamed AW | 0.248 | 0.246 | 0.227 | 0.262 | 0.173 | 0.118 | 0.117 | 0.109 | 0.125 | 0.082 |
| 65 | 326917 | 253495 | Unnamed AW | 0.218 | 0.216 | 0.234 | 0.271 | 0.173 | 0.104 | 0.103 | 0.112 | 0.130 | 0.083 |
| 66 | 328121 | 255921 | Unnamed AW | 0.240 | 0.236 | 0.252 | 0.295 | 0.201 | 0.115 | 0.113 | 0.120 | 0.141 | 0.096 |
| 67 | 327902 | 256080 | Unnamed AW | 0.217 | 0.213 | 0.180 | 0.210 | 0.135 | 0.104 | 0.102 | 0.086 | 0.100 | 0.064 |
| 68 | 325714 | 257504 | Ammonia sensitive AW (Wales) | **0.053** | **0.052** | **0.047** | **0.035** | **0.026** | **0.025** | **0.025** | **0.022** | **0.017** | **0.012** |
| 69 | 326227 | 257862 | Ammonia sensitive AW (Wales) | **0.065** | **0.064** | **0.056** | **0.047** | **0.034** | **0.031** | **0.031** | **0.027** | **0.022** | **0.016** |
| 70 | 325016 | 258785 | Ammonia sensitive AW (Wales) | **0.036** | **0.035** | **0.038** | **0.023** | **0.019** | **0.017** | **0.017** | **0.018** | **0.011** | 0.009 |
| 71 | 325867 | 259251 | Ammonia sensitive AW (Wales) | **0.046** | **0.046** | **0.042** | **0.030** | **0.022** | **0.022** | **0.022** | **0.020** | **0.014** | **0.010** |
| 72 | 329722 | 254120 | Birches SSSI | **0.203** | **0.198** | **0.211** | **0.195** | **0.135** | **0.097** | **0.095** | **0.101** | **0.093** | **0.065** |
| 73 | 329575 | 253830 | Birches SSSI | **0.184** | **0.183** | **0.169** | **0.162** | **0.128** | **0.088** | **0.088** | **0.081** | **0.077** | **0.061** |
| 74 | 329527 | 253711 | Birches SSSI | **0.176** | **0.175** | **0.157** | **0.150** | **0.120** | **0.084** | **0.084** | **0.075** | **0.072** | **0.058** |
| 75 | 330101 | 252188 | Quebb Meadow SSSI | **0.076** | **0.074** | **0.052** | **0.050** | **0.033** | **0.036** | **0.036** | 0.025 | 0.024 | 0.016 |
| 76 | 330494 | 252169 | Queestmoor Meadow SSSI | **0.072** | **0.070** | **0.048** | **0.047** | **0.034** | **0.034** | **0.034** | 0.023 | 0.022 | 0.016 |
| 77 | 329239 | 251636 | Upper Welson Marsh SSSI | **0.065** | **0.063** | **0.069** | **0.055** | **0.037** | **0.031** | **0.030** | **0.033** | 0.026 | 0.018 |
| 78 | 328807 | 251452 | Bushy Hazels & Cwmma Moors SSSI | **0.052** | **0.051** | **0.066** | **0.053** | **0.036** | **0.025** | **0.024** | **0.031** | **0.026** | **0.017** |
| 79 | 328275 | 251046 | Bushy Hazels & Cwmma Moors SSSI | **0.051** | **0.051** | **0.060** | **0.045** | **0.034** | **0.025** | **0.024** | **0.029** | **0.022** | **0.016** |
| 80 | 328996 | 257682 | Bradnor Hill Quarry SSSI | 0.075 | 0.074 | 0.049 | 0.052 | 0.031 | 0.036 | 0.035 | 0.023 | 0.025 | 0.015 |
| 81 | 326328 | 258295 | Stanner Rocks SSSI (Wales) | **0.065** | **0.064** | **0.054** | **0.044** | **0.031** | **0.031** | **0.030** | **0.026** | **0.021** | **0.015** |
| 82 | 324274 | 257658 | Dolyhir Quarry SSSI (Wales) | 0.036 | 0.035 | 0.038 | 0.020 | 0.018 | 0.017 | 0.017 | 0.018 | 0.010 | 0.009 |
| 83 | 324339 | 258078 | Dolyhir Meadows SSSI (Wales) | **0.033** | **0.033** | **0.038** | 0.020 | 0.018 | 0.016 | 0.016 | 0.018 | 0.010 | 0.009 |
| 84 | 331621 | 258788 | Flintsham & Titley Pools SSSI | 0.044 | 0.044 | 0.043 | 0.042 | 0.028 | 0.021 | 0.021 | 0.021 | 0.020 | 0.013 |
| 85 | 333558 | 248301 | The Sturts SSSI | 0.025 | 0.025 | 0.017 | 0.016 | 0.010 | 0.012 | 0.012 | 0.008 | 0.008 | 0.005 |
| 86 | 333408 | 247831 | The Sturts SSSI | 0.024 | 0.024 | 0.018 | 0.016 | 0.009 | 0.011 | 0.011 | 0.009 | 0.008 | 0.004 |
| 87 | 327437 | 260928 | Burfa Boglands SSSI (Wales) | **0.037** | **0.037** | **0.027** | **0.021** | **0.014** | **0.018** | **0.018** | **0.013** | **0.010** | 0.007 |
| 88 | 321531 | 255342 | Glascwm And Gladestry Hills SSSI (Wales) | **0.030** | **0.029** | **0.018** | **0.014** | 0.009 | **0.014** | **0.014** | 0.009 | 0.007 | 0.004 |
| 89 | 320589 | 253759 | Glascwm And Gladestry Hills SSSI (Wales) | **0.030** | **0.029** | **0.016** | **0.012** | 0.007 | **0.014** | **0.014** | 0.008 | 0.006 | 0.003 |
| 90 | 318513 | 251640 | Glascwm And Gladestry Hills SSSI (Wales) | **0.018** | **0.017** | **0.012** | 0.006 | 0.005 | 0.008 | 0.008 | 0.006 | 0.003 | 0.002 |
| 91 | 324741 | 247531 | River Wye SSSI/SAC | **0.025** | **0.025** | **0.024** | **0.015** | **0.011** | **0.012** | **0.012** | **0.012** | 0.007 | 0.005 |
| 92 | 326539 | 247531 | River Wye SSSI/SAC | **0.024** | **0.024** | **0.022** | **0.015** | **0.011** | **0.012** | **0.011** | **0.011** | 0.007 | 0.005 |
| 93 | 328957 | 246354 | River Wye SSSI/SAC | **0.019** | **0.019** | **0.026** | **0.018** | **0.012** | 0.009 | 0.009 | **0.013** | 0.009 | 0.006 |
| 94 | 332317 | 246996 | River Wye SSSI/SAC | **0.022** | **0.021** | **0.024** | **0.017** | **0.010** | **0.011** | **0.010** | **0.011** | 0.008 | 0.005 |
| 95 | 320204 | 248858 | Rhos Goch SSSI/SAC (Wales) | **0.018** | **0.017** | **0.019** | 0.009 | 0.008 | 0.008 | 0.008 | 0.009 | 0.004 | 0.004 |

## 5.2 Detailed deposition modelling

The detailed modelling was carried out for all of the discrete receptors located at all of the wildlife sites identified for the modelling. Spatially varying deposition was defined for two domains, both of which include the poultry houses at Hergest Camp Farm. Where discrete receptors are located beyond these two domains, a fixed deposition velocity of 0.003 m/s has been assumed.

Details of the predicted process contribution from the existing and proposed poultry houses to annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors are provided in Table 7. In the Table, predicted ammonia concentrations or concentrations equivalent to deposition rates that are in excess of the Environment Agency upper percentage threshold of the Critical Level/Load (20% for a SAC, 50% for a SSSI and 100% for non-statutory sites) are coloured red. Predicted ammonia concentrations or concentrations equivalent to deposition rates that are in the range between the Environment Agency’s upper threshold and lower threshold of the relevant Critical Level or Critical Load (20% and 4% for a SAC, 50% and 20% for a SSSI and 100% to 100% for non-statutory sites)) are coloured blue. Additionally, process contributions that exceed 1% of the Critical Level or Load at a statutory site are highlighted with bold text. For convenience, cells referring to LWSs are shaded yellow, cells referring to AWs are shaded olive, cells referring to SSSIs are shaded green and cells referring to SACs are shaded lilac.

Contour plots of the predicted process contribution of the poultry houses to ground level maximum annual ammonia concentrations and nitrogen deposition rates, for the detailed modelling runs at 50 m and 500 m are provided in Figures 6a, 6b, 6c and 6d for the existing poultry houses and Figures 7a, 7b, 7c and 7d for the proposed poultry houses.

*Table 7. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors*

| Receptor number | X(m) | Y(m) | Name | Site Parameters | | | Maximum annual ammonia concentration | | | | Maximum annual nitrogen deposition rate | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Existing | | Proposed | | Existing | | Proposed | |
| Deposition Velocity | CLe (µg/m3) | CLo (kg/ha) | PC (µg/m3) | %age of CLe | PC (µg/m3) | %age of CLe | PC (kg/ha) | %age of CLo | PC (kg/ha) | %age of CLo |
| 1 | 327514 | 254685 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 9.312 | **310.4** | 4.449 | **148.3** | 72.553 | **725.5** | 34.664 | **346.6** |
| 2 | 327540 | 254731 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 10.014 | **333.8** | 4.784 | **159.5** | 78.019 | **780.2** | 37.276 | **372.8** |
| 3 | 327573 | 254768 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 9.108 | **303.6** | 4.351 | **145.0** | 70.957 | **709.6** | 33.902 | **339.0** |
| 4 | 327645 | 254832 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 5.854 | **195.1** | 2.797 | 93.2 | 45.605 | **456.0** | 21.789 | **217.9** |
| 5 | 327444 | 254653 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 3.239 | **108.0** | 1.548 | 51.6 | 25.236 | **252.4** | 12.057 | **120.6** |
| 6 | 327427 | 254553 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 3.264 | **108.8** | 1.559 | 52.0 | 25.427 | **254.3** | 12.149 | **121.5** |
| 7 | 327456 | 254449 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 1.802 | 60.1 | 0.861 | 28.7 | 14.036 | **140.4** | 6.706 | 67.1 |
| 8 | 327788 | 254933 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 2.658 | 88.6 | 1.270 | 42.3 | 20.708 | **207.1** | 9.894 | 98.9 |
| 9 | 327963 | 255046 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 1.388 | 46.3 | 0.663 | 22.1 | 10.816 | **108.2** | 5.168 | 51.7 |
| 10 | 327540 | 254731 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 0.521 | 17.4 | 0.249 | 8.3 | 4.061 | 40.6 | 1.940 | 19.4 |
| 11 | 327573 | 254768 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 0.186 | 6.2 | 0.089 | 3.0 | 1.447 | 14.5 | 0.691 | 6.9 |
| 12 | 327645 | 254832 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 0.492 | 16.4 | 0.235 | 7.8 | 3.837 | 38.4 | 1.833 | 18.3 |
| 13 | 327444 | 254653 | River Arrow LWS | 0.03 | 3.0 | 10.0 | 0.167 | 5.6 | 0.080 | 2.7 | 1.304 | 13.0 | 0.623 | 6.2 |
| 14 | 327354 | 254556 | Gladestry Brook LWS | 0.03 | 3.0 | 10.0 | 1.840 | 61.3 | 0.879 | 29.3 | 14.334 | **143.3** | 6.848 | 68.5 |
| 15 | 326918 | 254475 | Gladestry Brook LWS | 0.03 | 3.0 | 10.0 | 0.256 | 8.5 | 0.122 | 4.1 | 1.996 | 20.0 | 0.954 | 9.5 |
| 16 | 326496 | 254460 | Gladestry Brook LWS | 0.03 | 3.0 | 10.0 | 0.095 | 3.2 | 0.046 | 1.5 | 0.743 | 7.4 | 0.355 | 3.5 |
| 17 | 326262 | 254523 | Gladestry Brook LWS | 0.03 | 3.0 | 10.0 | 0.063 | 2.1 | 0.030 | 1.0 | 0.492 | 4.9 | 0.235 | 2.4 |
| 18 | 327354 | 254556 | Land near Lower Way Farm LWS | 0.03 | 3.0 | 10.0 | 0.948 | 31.6 | 0.453 | 15.1 | 7.385 | 73.9 | 3.529 | 35.3 |
| 19 | 327344 | 254727 | Land near Lower Way Farm LWS | 0.03 | 3.0 | 10.0 | 1.234 | 41.1 | 0.590 | 19.7 | 9.617 | 96.2 | 4.595 | 45.9 |
| 20 | 327448 | 254805 | Land near Lower Way Farm LWS | 0.03 | 3.0 | 10.0 | 0.597 | 19.9 | 0.285 | 9.5 | 4.655 | 46.6 | 2.224 | 22.2 |
| 21 | 327463 | 255124 | Land near Lower Way Farm LWS | 0.03 | 3.0 | 10.0 | 0.503 | 16.8 | 0.240 | 8.0 | 3.920 | 39.2 | 1.873 | 18.7 |
| 22 | 327955 | 255381 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.552 | 55.2 | 0.263 | 26.3 | 4.297 | 43.0 | 2.053 | 20.5 |
| 23 | 327753 | 255399 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.414 | 41.4 | 0.198 | 19.8 | 3.226 | 32.3 | 1.542 | 15.4 |
| 24 | 328115 | 255430 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.483 | 48.3 | 0.231 | 23.1 | 3.762 | 37.6 | 1.797 | 18.0 |
| 25 | 328303 | 255120 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.481 | 48.1 | 0.230 | 23.0 | 3.744 | 37.4 | 1.789 | 17.9 |
| 26 | 328565 | 255124 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.286 | 28.6 | 0.137 | 13.7 | 2.228 | 22.3 | 1.064 | 10.6 |
| 27 | 328537 | 255434 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.245 | 24.5 | 0.117 | 11.7 | 1.907 | 19.1 | 0.911 | 9.1 |
| 28 | 328464 | 254346 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.461 | 46.1 | 0.220 | 22.0 | 3.588 | 35.9 | 1.714 | 17.1 |
| 29 | 328516 | 253799 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.142 | 14.2 | 0.068 | 6.8 | 1.103 | 11.0 | 0.527 | 5.3 |
| 30 | 328279 | 253437 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.091 | 9.1 | 0.043 | 4.3 | 0.709 | 7.1 | 0.339 | 3.4 |
| 31 | 328335 | 253238 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.073 | 7.3 | 0.035 | 3.5 | 0.568 | 5.7 | 0.271 | 2.7 |
| 32 | 326401 | 254563 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.076 | 7.6 | 0.036 | 3.6 | 0.595 | 5.9 | 0.284 | 2.8 |
| 33 | 326286 | 254571 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.066 | 6.6 | 0.032 | 3.2 | 0.514 | 5.1 | 0.246 | 2.5 |
| 34 | 326126 | 254637 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.055 | 5.5 | 0.026 | 2.6 | 0.427 | 4.3 | 0.204 | 2.0 |
| 35 | 325752 | 254658 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.037 | 3.7 | 0.018 | 1.8 | 0.292 | 2.9 | 0.139 | 1.4 |
| 36 | 326289 | 253413 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.090 | 9.0 | 0.043 | 4.3 | 0.698 | 7.0 | 0.333 | 3.3 |
| 37 | 325854 | 255284 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.032 | 3.2 | 0.015 | 1.5 | 0.252 | 2.5 | 0.121 | 1.2 |
| 38 | 326408 | 255716 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.053 | 5.3 | 0.025 | 2.5 | 0.413 | 4.1 | 0.197 | 2.0 |
| 39 | 327007 | 255995 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.064 | 6.4 | 0.030 | 3.0 | 0.497 | 5.0 | 0.237 | 2.4 |
| 40 | 327617 | 256524 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.080 | 8.0 | 0.038 | 3.8 | 0.623 | 6.2 | 0.298 | 3.0 |
| 41 | 327812 | 256012 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.112 | 11.2 | 0.053 | 5.3 | 0.870 | 8.7 | 0.416 | 4.2 |
| 42 | 328066 | 255869 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.191 | 19.1 | 0.091 | 9.1 | 1.487 | 14.9 | 0.710 | 7.1 |
| 43 | 328955 | 255800 | Unnamed LWS | 0.03 | 1.0 | 10.0 | 0.126 | 12.6 | 0.060 | 6.0 | 0.984 | 9.8 | 0.470 | 4.7 |
| 44 | 327345 | 254774 | Unnamed AW | 0.03 | 3.0 | 10.0 | 0.961 | 32.0 | 0.459 | 15.3 | 7.485 | 74.8 | 3.576 | 35.8 |
| 45 | 327309 | 254732 | Unnamed AW | 0.03 | 3.0 | 10.0 | 0.816 | 27.2 | 0.390 | 13.0 | 6.357 | 63.6 | 3.037 | 30.4 |
| 46 | 327244 | 254693 | Unnamed AW | 0.03 | 3.0 | 10.0 | 0.611 | 20.4 | 0.292 | 9.7 | 4.760 | 47.6 | 2.274 | 22.7 |
| 47 | 326722 | 254453 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.158 | 15.8 | 0.075 | 7.5 | 1.229 | 12.3 | 0.587 | 5.9 |
| 48 | 326551 | 254552 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.104 | 10.4 | 0.050 | 5.0 | 0.814 | 8.1 | 0.389 | 3.9 |
| 49 | 326383 | 254402 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.084 | 8.4 | 0.040 | 4.0 | 0.653 | 6.5 | 0.312 | 3.1 |
| 50 | 327650 | 254143 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.436 | 43.6 | 0.208 | 20.8 | 3.398 | 34.0 | 1.623 | 16.2 |
| 51 | 327836 | 254086 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.303 | 30.3 | 0.145 | 14.5 | 2.361 | 23.6 | 1.128 | 11.3 |
| 52 | 327386 | 254110 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.395 | 39.5 | 0.189 | 18.9 | 3.078 | 30.8 | 1.471 | 14.7 |
| 53 | 326995 | 253933 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.287 | 28.7 | 0.137 | 13.7 | 2.233 | 22.3 | 1.067 | 10.7 |
| 54 | 326893 | 253957 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.257 | 25.7 | 0.123 | 12.3 | 2.004 | 20.0 | 0.957 | 9.6 |
| 55 | 327374 | 253828 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.192 | 19.2 | 0.092 | 9.2 | 1.496 | 15.0 | 0.715 | 7.1 |
| 56 | 327857 | 253759 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.188 | 18.8 | 0.090 | 9.0 | 1.468 | 14.7 | 0.701 | 7.0 |
| 57 | 327452 | 255687 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.159 | 15.9 | 0.076 | 7.6 | 1.240 | 12.4 | 0.592 | 5.9 |
| 58 | 328968 | 255209 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.158 | 15.8 | 0.075 | 7.5 | 1.228 | 12.3 | 0.587 | 5.9 |
| 59 | 329109 | 255152 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.152 | 15.2 | 0.072 | 7.2 | 1.182 | 11.8 | 0.565 | 5.6 |
| 60 | 329388 | 255137 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.133 | 13.3 | 0.064 | 6.4 | 1.040 | 10.4 | 0.497 | 5.0 |
| 61 | 329340 | 254786 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.175 | 17.5 | 0.084 | 8.4 | 1.362 | 13.6 | 0.651 | 6.5 |
| 62 | 328458 | 253684 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.110 | 11.0 | 0.053 | 5.3 | 0.861 | 8.6 | 0.411 | 4.1 |
| 63 | 327722 | 253507 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.126 | 12.6 | 0.060 | 6.0 | 0.983 | 9.8 | 0.470 | 4.7 |
| 64 | 327067 | 253549 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.136 | 13.6 | 0.065 | 6.5 | 1.061 | 10.6 | 0.507 | 5.1 |
| 65 | 326917 | 253495 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.136 | 13.6 | 0.065 | 6.5 | 1.060 | 10.6 | 0.507 | 5.1 |
| 66 | 328121 | 255921 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.182 | 18.2 | 0.087 | 8.7 | 1.421 | 14.2 | 0.679 | 6.8 |
| 67 | 327902 | 256080 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.106 | 10.6 | 0.050 | 5.0 | 0.823 | 8.2 | 0.393 | 3.9 |
| 68 | 325714 | 257504 | Ammonia sensitive AW (Wales) | 0.03 | 1.0 | 10.0 | 0.020 | **2.0** | 0.009 | 0.9 | 0.155 | **1.5** | 0.074 | 0.7 |
| 69 | 326227 | 257862 | Ammonia sensitive AW (Wales) | 0.03 | 1.0 | 10.0 | 0.027 | **2.7** | 0.013 | **1.3** | 0.211 | **2.1** | 0.101 | **1.0** |
| 70 | 325016 | 258785 | Ammonia sensitive AW (Wales) | 0.03 | 1.0 | 10.0 | 0.014 | **1.4** | 0.007 | 0.7 | 0.111 | **1.1** | 0.053 | 0.5 |
| 71 | 325867 | 259251 | Ammonia sensitive AW (Wales) | 0.03 | 1.0 | 10.0 | 0.016 | **1.6** | 0.008 | 0.8 | 0.125 | **1.3** | 0.060 | 0.6 |
| 72 | 329722 | 254120 | Birches SSSI | 0.02 | 3.0 | 15.0 | 0.102 | **3.4** | 0.049 | **1.6** | 0.528 | **3.5** | 0.252 | **1.7** |
| 73 | 329575 | 253830 | Birches SSSI | 0.02 | 3.0 | 15.0 | 0.094 | **3.1** | 0.045 | **1.5** | 0.490 | **3.3** | 0.234 | **1.6** |
| 74 | 329527 | 253711 | Birches SSSI | 0.02 | 3.0 | 15.0 | 0.094 | **3.1** | 0.045 | **1.5** | 0.487 | **3.2** | 0.233 | **1.6** |
| 75 | 330101 | 252188 | Quebb Meadow SSSI | 0.02 | 3.0 | 20.0 | 0.024 | 0.8 | 0.011 | 0.4 | 0.123 | 0.6 | 0.059 | 0.3 |
| 76 | 330494 | 252169 | Queestmoor Meadow SSSI | 0.02 | 3.0 | 20.0 | 0.025 | 0.8 | 0.012 | 0.4 | 0.128 | 0.6 | 0.061 | 0.3 |
| 77 | 329239 | 251636 | Upper Welson Marsh SSSI | 0.02 | 3.0 | 15.0 | 0.027 | 0.9 | 0.013 | 0.4 | 0.138 | 0.9 | 0.066 | 0.4 |
| 78 | 328807 | 251452 | Bushy Hazels & Cwmma Moors SSSI | 0.03 | 1.0 | 10.0 | 0.029 | **2.9** | 0.014 | **1.4** | 0.223 | **2.2** | 0.107 | **1.1** |
| 79 | 328275 | 251046 | Bushy Hazels & Cwmma Moors SSSI | 0.03 | 1.0 | 10.0 | 0.023 | **2.3** | 0.011 | **1.1** | 0.182 | **1.8** | 0.087 | 0.9 |
| 80 | 328996 | 257682 | Bradnor Hill Quarry SSSI | - | - | - | 0.023 | - | 0.011 | - | - | - | - | - |
| 81 | 326328 | 258295 | Stanner Rocks SSSI (Wales) | 0.03 | 1.0 | 10.0 | 0.024 | **2.4** | 0.012 | **1.2** | 0.190 | **1.9** | 0.091 | 0.9 |
| 82 | 324274 | 257658 | Dolyhir Quarry SSSI (Wales) | - | - | - | 0.015 | - | 0.007 | - | - | - | - | - |
| 83 | 324339 | 258078 | Dolyhir Meadows SSSI (Wales) | 0.02 | 3.0 | 20.0 | 0.014 | 0.5 | 0.007 | 0.2 | 0.073 | 0.4 | 0.035 | 0.2 |
| 84 | 331621 | 258788 | Flintsham & Titley Pools SSSI | 0.03 | 3.0 | 10.0 | 0.023 | 0.8 | 0.011 | 0.4 | 0.179 | **1.8** | 0.085 | 0.9 |
| 85 | 333558 | 248301 | The Sturts SSSI | 0.02 | 3.0 | 15.0 | 0.006 | 0.2 | 0.003 | 0.1 | 0.032 | 0.2 | 0.015 | 0.1 |
| 86 | 333408 | 247831 | The Sturts SSSI | 0.02 | 3.0 | 15.0 | 0.006 | 0.2 | 0.003 | 0.1 | 0.029 | 0.2 | 0.014 | 0.1 |
| 87 | 327437 | 260928 | Burfa Boglands SSSI (Wales) | 0.03 | 1.0 | 10.0 | 0.010 | 1.0 | 0.005 | 0.5 | 0.075 | 0.7 | 0.036 | 0.4 |
| 88 | 321531 | 255342 | Glascwm And Gladestry Hills SSSI (Wales) | 0.02 | 1.0 | 5.0 | 0.007 | 0.7 | 0.003 | 0.3 | 0.034 | 0.7 | 0.016 | 0.3 |
| 89 | 320589 | 253759 | Glascwm And Gladestry Hills SSSI (Wales) | 0.02 | 1.0 | 5.0 | 0.005 | 0.5 | 0.002 | 0.2 | 0.025 | 0.5 | 0.012 | 0.2 |
| 90 | 318513 | 251640 | Glascwm And Gladestry Hills SSSI (Wales) | 0.02 | 1.0 | 5.0 | 0.004 | 0.4 | 0.002 | 0.2 | 0.018 | 0.4 | 0.009 | 0.2 |
| 91 | 324741 | 247531 | River Wye SSSI/SAC | - | 1.0 | - | 0.007 | 0.7 | 0.004 | 0.4 | - | - | - | - |
| 92 | 326539 | 247531 | River Wye SSSI/SAC | - | 1.0 | - | 0.007 | 0.7 | 0.003 | 0.3 | - | - | - | - |
| 93 | 328957 | 246354 | River Wye SSSI/SAC | - | 1.0 | - | 0.007 | 0.7 | 0.003 | 0.3 | - | - | - | - |
| 94 | 332317 | 246996 | River Wye SSSI/SAC | - | 1.0 | - | 0.006 | 0.6 | 0.003 | 0.3 | - | - | - | - |
| 95 | 320204 | 248858 | Rhos Goch SSSI/SAC (Wales) | 0.03 | 1.0 | 10.0 | 0.005 | 0.5 | 0.002 | 0.2 | 0.038 | 0.4 | 0.018 | 0.2 |

*Figure 6a. Maximum annual ammonia concentration – existing poultry houses*

Chart

Description automatically generated

© Crown copyright and database rights. 2021.

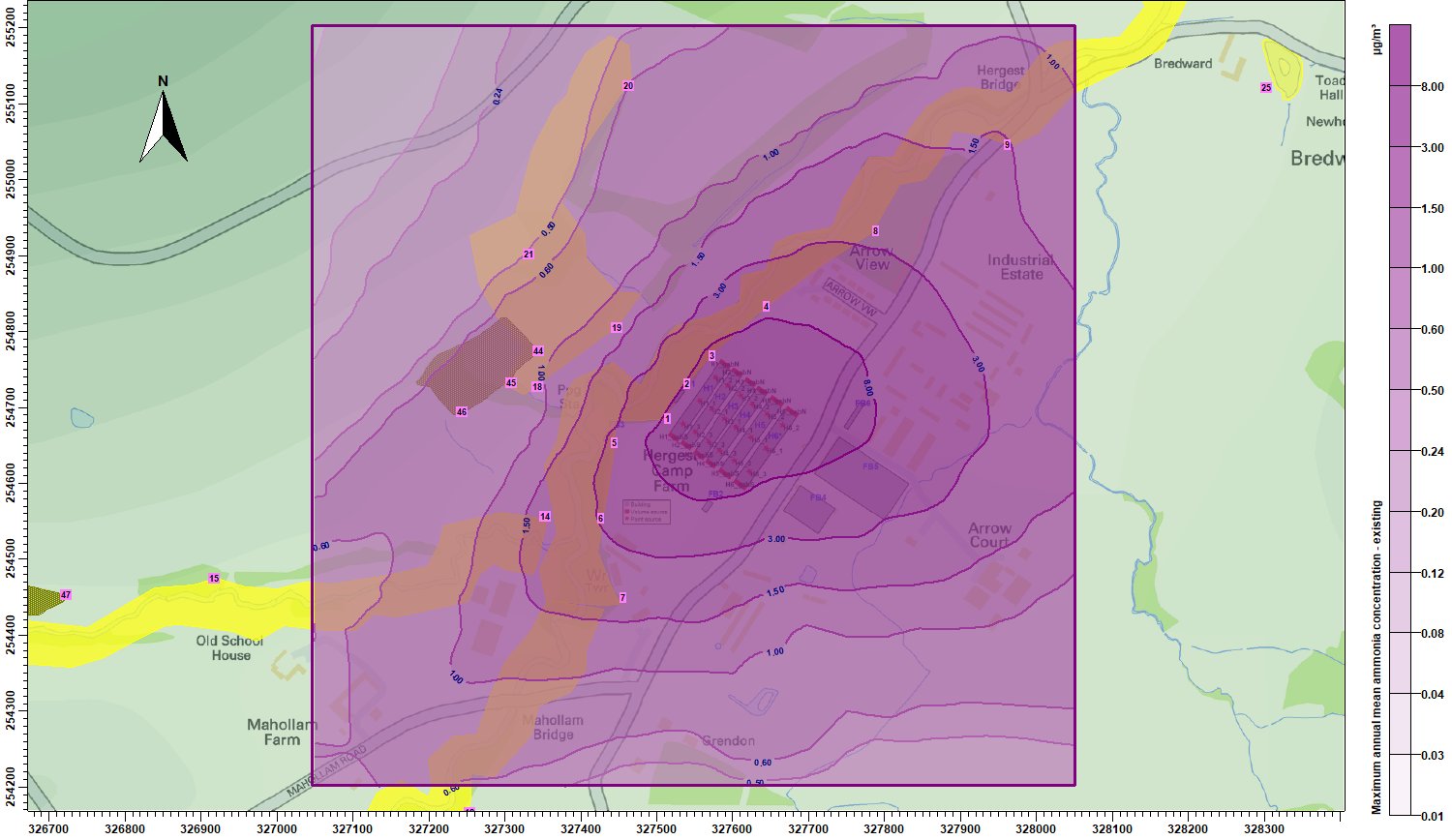
*Figure 6b. Maximum annual nitrogen deposition – existing poultry houses*

Map

Description automatically generated with low confidence

© Crown copyright and database rights. 2021.

*Figure 6c. Maximum annual ammonia concentration – existing poultry houses*



© Crown copyright and database rights. 2021.

*Figure 6d. Maximum annual nitrogen deposition – existing poultry houses Map

Description automatically generated*

© Crown copyright and database rights. 2021.

*Figure 7a. Maximum annual ammonia concentration – proposed poultry houses*

Map

Description automatically generated

© Crown copyright and database rights. 2021.

*Figure 7b. Maximum annual nitrogen deposition – proposed poultry houses*

Map

Description automatically generated

© Crown copyright and database rights. 2021.

*Figure 7c. Maximum annual ammonia concentration – proposed poultry houses*

A picture containing chart

Description automatically generated

© Crown copyright and database rights. 2021.

*Figure 7d. Maximum annual nitrogen deposition – proposed poultry houses*

Map

Description automatically generated

© Crown copyright and database rights. 2021.

# Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by T. L. Whittall Ltd., the operator, to use computer modelling to assess the impact of ammonia emissions from the existing turkey rearing houses and the proposed broiler chicken rearing houses at Hergest Camp Farm, Lower Hergest, Kington in Herefordshire. HR5 3ER.

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 deposition rates in the surrounding area.

## Existing poultry houses

For the existing poultry houses, which are stocked with 34,000 male turkeys, the modelling predicts that:

* At the River Arrow LWS, process contributions to ammonia concentrations and nitrogen deposition rates exceed the Environment Agency’s upper threshold percentage of the Critical Level of 3.0 µg/m³ and the Critical Load of 10.0 kg/ha.
* At Gladestry Brook LWS, process contributions to ammonia concentrations and nitrogen deposition rates exceed the Environment Agency’s upper threshold percentage of the Critical Level of 3.0 µg/m³.
* At the unnamed Ammonia Sensitive AWs, process contributions to ammonia concentrations and nitrogen deposition rates exceed the Natural Resources Wales threshold percentage (1%) of the Critical Level of 1.0 µg/m³ and the Critical Load of 10.0 kg/ha.
* At Stanner Rocks SSSI, there are exceedances of the Natural Resources Wales threshold percentage (1%) of the Critical Level of 1.0 µg/m³ and the Critical Load of 10.0 kg/ha.
* Process contributions to ammonia concentrations and nitrogen deposition rates exceed the Natural England screening assessment level, which is 4% of the relevant Critical Level or Critical Load, at Birches SSSI and Bushy Hazels And Cwmma Moors SSSI and there is an exceedance of the Natural England screening assessment level of the Critical Load of 10.0 kg/ha at Flintsham And Titley Pools SSSI.
* At other nearby wildlife sites, including the unnamed AWs and LWSs, the other SSSIs and the SACs, there is no exceedance of the Natural Resources Wales or Environment Agency lower threshold percentage of the relevant Critical Level or Critical Load nor the Natural England screening assessment level.

## Proposed poultry houses

Should the proposals proceed and the poultry houses be stocked with 215,000 broiler chickens, the modelling predicts that:

* At the River Arrow LWS, process contributions to ammonia concentrations and nitrogen deposition rates would exceed the Environment Agency’s upper threshold percentage of the Critical Level of 3.0 µg/m³ and the Critical Load of 10.0 kg/ha. However, when compared to the existing poultry houses, the impact of process contributions from the proposed poultry houses is significantly reduced.
* At Gladestry Brook LWS, there would be no exceedance of the Environment Agency’s lower threshold percentage of the Critical Level of 3.0 µg/m³ and the Critical Load of 10.0 kg/ha.
* At the unnamed ammonia sensitive AWs, process contributions to ammonia concentrations and nitrogen deposition rates would exceed the Natural Resources Wales threshold percentage (1%) of the Critical Level of 1.0 µg/m³ and the Critical Load of 10.0 kg/ha. However, when compared to the existing poultry houses, the impact of process contributions from the proposed poultry houses is significantly reduced.
* At Stanner Rocks SSSI, there would also be exceedances of the Natural Resources Wales threshold percentage (1%) of the Critical Level of 1.0 µg/m³. However, when compared to the existing poultry houses, the impact of process contributions from the proposed poultry houses is reduced.
* Process contributions to ammonia concentrations and nitrogen deposition rates would exceed the Natural England screening assessment level, which is 4% of the relevant Critical Level or Critical Load, at Birches SSSI and Bushy Hazels And Cwmma Moors SSSI. However, when compared to the existing poultry houses, the impact of process contributions from the proposed poultry houses is significantly reduced.
* At other nearby wildlife sites, including the unnamed AWs and LWSs, the other SSSIs and the SACs, there is would not be an exceedance of the Natural Resources Wales or Environment Agency lower threshold percentage of the relevant Critical Level or Critical Load nor the Natural England screening assessment level.
* When compared with the existing poultry houses, the modelling predicts that should the proposed changes be undertaken at Hergest Camp Farm, there would be a significant reduction in impacts at all of the wildlife sites included in the modelling.

# References

Cambridge Environmental Research Consultants (CERC) (website).

Environment Agency H1 Risk Assessment (website).

Steven R Hanna, & Biswanath Chowdhury. Minimum turbulence assumptions and u\* and L estimation for dispersion models during low-wind stable conditions.

M. A. Sutton *et al*. Measurement and modelling of ammonia exchange over arable croplands.

Natural Resources Wales. Find protected areas of land and sea (website).

Frederik Schrader and Christian Brümmer. Land Use Specific Ammonia Deposition Velocities: a Review of Recent Studies (2004–2013).

Pre-application Report EPR/BP3003MP/A001 (to Steve Raash, on behalf of T. H. Whittal Ltd.), June 2021.

United Nations Economic Commission for Europe (UNECE) (website).

UK Air Pollution Information System (APIS) (website).