A Dispersion Modelling Study of the Impact of Odour from the Existing and Proposed Broiler Chicken Rearing Houses at Neuadd Isaf, Penybont, near Llandrindod Wells in Powys

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Mr. Steve Raasch, on behalf of Mr. William Bedell, to use computer modelling to assess the impact of odour emissions from the existing and proposed broiler rearing houses at Neuadd Isaf, Penybont, Llandrindod Wells, Powys. LD1 5SW.

Odour emission rates from the existing and proposed poultry houses have been assessed and quantified based upon an emissions model that takes into account the likely internal odour concentrations and ventilation rates and also upon an emissions model that estimates emissions from the Inno+ air scrubbing equipment that would be used as the primary ventilation for the proposed poultry houses. The odour emission rates so obtained have then been used as inputs to an atmospheric dispersion model which calculates odour exposure levels in the surrounding area.

This report is arranged in the following manner:

- Section 2 provides relevant details of the site and potentially sensitive receptors in the area.
- Section 3 provides some general information on odour, details of the method used to estimate odour emissions from the poultry houses, relevant guidelines and legislation on exposure limits and where relevant, details of likely background levels of odour.
- Section 4 provides some information about ADMS, the dispersion model used for this study and details the modelling parameters and procedures.
- Section 5 contains the results of the modelling.
- Section 6 provides a discussion of the results and conclusions.

2. Background Details

Neuadd Isaf is in an isolated rural area approximately 2.5 km to the south-west of the village of Penybont and approximately 3.0 km to the east of the town of Llandrindod Wells in Powys. The land surrounding the farm is used primarily for pasture and fodder production and there are areas of semi-natural woodlands nearby. The farm has an elevation of around 250 m in a hilly area and is sited within a loop of the River Ithon.

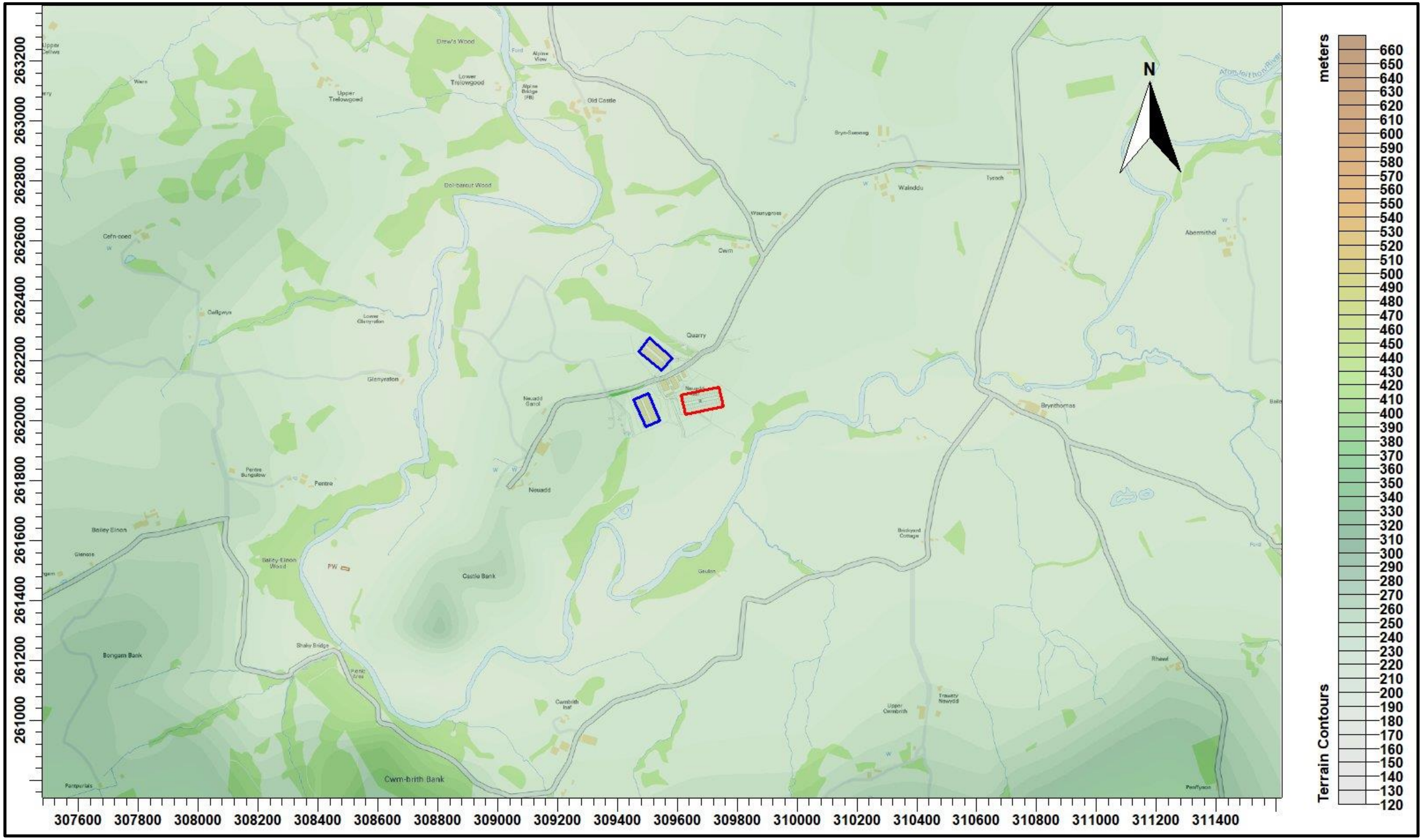
Currently, there are four side fan ventilated poultry rearing houses at Neuadd Isaf. These poultry houses provide accommodation for up to 152,000 broiler chickens. The chickens are raised from day old chicks to up to around 38 days old and there are approximately 7.5 flocks per year.

Under the proposals, two additional poultry houses would be constructed to the south-east of the existing poultry houses at Neuadd Isaf; these new houses would provide accommodation for an additional 106,000 broiler chickens. The primary ventilation for these new poultry houses would be provided by Inno+ air scrubber units, which would provide the majority of the ventilation for the majority of the time. Backup ventilation, in the case of scrubber failure and for supplementary ventilation which would only be required at the end of the crops in warm weather, would be provided by high speed ridge fans, each with a short chimney. The chickens would be reared from day old chicks for 38 days and there would be approximately 7.5 flocks per annum. Additionally, under the proposals, the existing poultry houses would have an indirect heating system installed.

There are some residences and commercial properties in the area surrounding Neuadd Isaf. Excluding the farmhouse at Neuadd Isaf, the closest residences are at: Neuadd Ganol, approximately 295 m to the west; three residences at Neuadd, the closets of which is approximately 380 m to the west-south-west; Cwm, approximately 430 m to the north-east; Waunygroes, approximately 550 m to the north-east and Geulan, approximately 550 m to the south.

A map of the surrounding area is provided in Figure 1; in the figure, the sites of the existing poultry houses are outlined in blue and the site if the proposed poultry houses is outlined in red.

Figure 1. The area surrounding the site of the existing and proposed poultry houses at Neuadd Isaf



3. Odour, Emission Rates, Exposure Limits & Background Levels

3.1 Odour concentration, averaging times, percentiles and FIDOR

Odour concentration is expressed in terms of European Odour Units per metre cubed of air (ou_E/m^3). The following definitions and descriptions of how an odour might be perceived by a human with an average sense of smell may be useful, however, it should be noted that within a human population there is considerable variation in acuity of sense of smell.

- 1.0 ou_E/m^3 is defined as the limit of detection in laboratory conditions.

- At 2.0 – 3.0 ou_E/m^3, a particular odour might be detected against background odours in an open environment.

- When the concentration reaches around 5.0 ou_E/m^3, a particular odour will usually be recognisable, if known, but would usually be described as faint.

- At 10.0 ou_E/m^3, most would describe the intensity of the odour as moderate or strong and if persistent, it is likely that the odour would become intrusive.

The character, or hedonic tone, of an odour is also important; typically, odours are grouped into three categories.

Most offensive:
- Processes involving decaying animal or fish remains.
- Processes involving septic effluent or sludge.
- Biological landfill odours.

Moderately offensive:
- Intensive livestock rearing.
- Fat frying (food processing).
- Sugar beet processing.
- Well aerated green waste composting.

Less offensive:
- Brewery.
- Confectionery.
- Coffee roasting.
- Bakery.

Dispersion models usually calculate hourly mean odour concentrations and Environment Agency guidelines and findings from UK Water Industry Research (UKWIR) are also framed in terms of hourly mean odour concentration.

The Environment Agency guidelines and findings from UKWIR use the 98th percentile hourly mean; this is the hourly mean odour concentration that is equalled or exceeded for 2% of the time period considered, which is typically one year. The use of the 98th percentile statistic allows for some consideration of both frequency and intensity of the odours.

At some distance from a source, it would be unusual if odour concentration remained constant for an hour and in reality, due to air turbulence and changes in wind direction, short term fluctuations in concentration are observed. Therefore, although average exposure levels may be below the detection threshold, or a particular guideline, a population may be exposed to short term concentrations which are higher than the hourly average. It should be noted that a fluctuating odour is often more noticeable than a steady background odour at a low concentration. It is implicit that within the model's hourly averaging time and the Environment Agency guidelines and findings from UKWIR that there would be variation in the odour concentration around this mean, i.e. there would be short periods when odour concentration would be higher than the mean and lower than the mean.

The FIDOR acronym is a useful reminder of the factors that will determine the degree of odour pollution:

- **F**requency of detection.
- **I**ntensity as perceived.
- **D**uration of exposure.
- **O**ffensiveness.
- **R**eceptor sensitivity.

3.2 Environment Agency guidelines (adopted by Natural Resources Wales)

In April 2011, the Environment Agency published H4 Odour Management guidance (H4). In Appendix 3 – Modelling Odour Exposure, benchmark exposure levels are provided. The benchmarks are based on the 98th percentile of hourly mean concentrations of odour modelled over a year at the site/installation boundary. The benchmarks are:

- 1.5 ou_E/m^3 for most offensive odours.
- 3.0 ou_E/m^3 for moderately offensive odours.
- 6.0 ou_E/m^3 for less offensive odours.

Any modelled results that project exposures above these benchmark levels, after taking uncertainty into account, indicates the likelihood of unacceptable odour pollution.

3.3 UK Water Industry Research findings

The main source of research into odour impacts in the UK has been the wastewater industry. An in-depth study of the correlation between modelled odour impacts and human response was published by UKWIR in 2001. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to nine wastewater treatment works in the UK with on-going odour complaints. The findings of this research and subsequent UKWIR research indicated the following, based on the modelled 98th percentile of hourly mean concentrations of odour:

- At below 5.0 ou_E/m^3, complaints are relatively rare at only 3% of the total registered.
- At between 5.0 ou_E/m^3 and 10.0 ou_E/m^3, a significant proportion of total registered complaints occur, 38% of the total.
- The majority of complaints occur in areas of modelled exposures of greater than 10.0 ou_E/m^3, 59% of the total.

3.4 Choice of odour benchmarks for this study

Odours from poultry rearing are usually placed in the moderately offensive category. Therefore, for this study, the Environment Agency's benchmark for moderately offensive odours, a 98th percentile hourly mean of 3.0 ou_E/m^3 over a one year period, is used to assess the impact of odour emissions from the existing and proposed poultry houses at potentially sensitive receptors in the surrounding area. The UKWIR research is also considered.

3.5 Quantification of odour emissions

3.5.1 Emissions from the existing poultry houses (and the bypass system of the proposed houses)

Odour emission rates from broiler houses depend on many factors and are highly variable. At the beginning of a crop cycle, when chicks are small, litter is clean and only minimum ventilation is required, the odour emission rate may be small. Towards the end of the crop, odour production within the poultry housing increases rapidly and ventilation requirements are greater, particularly in hot weather, therefore emission rates are considerably greater than at the beginning of the crop.

Peak odour emission rates are likely to occur when the housing is cleared of spent litter at the end of each crop. There is little available information on the magnitude of this peak emission, but it is likely to be greater than any emission that might occur when there are birds in the house. The time taken to perform the operation is usually around two hours per shed and it is normal to maintain ventilation during this time. There are measures that can be taken to minimise odour production whilst the housing is being cleared of spent litter and there is usually some discretion as to when the operation is carried out; therefore, to avoid high odour levels at nearby sensitive receptors, it may be possible to time the operation to coincide with winds blowing in a favourable direction.

To calculate an odour emission rate, it is necessary to know the internal odour concentration and ventilation rate of the poultry houses. For the calculation, the internal concentration is assumed to be a function of the age of the crop and the stocking density. The internal concentrations used in the calculations increase exponentially from 300 ou_E/m^3 at day 1 of the crop, to approximately 700 ou_E/m^3 at day 16 of the crop, to approximately 1,800 ou_E/m^3 at day 30 of the crop and approximately 2,300 ou_E/m^3 at day 34 of the crop. These figures are obtained from measured values available to AS Modelling & Data Ltd. and review of available literature and are based primarily on Robertson *et al.* (2002).

The ventilation rates used in the calculations are based on industry practices and standard bird growth factors. It is assumed that a continuous minimum ventilation rate is maintained, which provides for 2 to 3 air changes per hour of the poultry house, in order to maintain negative pressure and minimise fugitive emissions. Minimum ventilation rates are as those of an operational poultry house and maximum ventilation rates are based on Defra guidelines. Target internal temperature is 33 Celsius at the beginning of the crop and is decreased to 22 Celsius by day 34 of the crop. If the external temperature is 7 Celsius, or more, lower than the target temperature, minimum ventilation only is assumed for the calculation. Above this, ventilation rates are increased in proportion to the difference between ambient temperature and target internal temperature. A maximum transitional ventilation rate (35% of the maximum possible ventilation rate) is reached when the ambient temperature is equal to the target temperature. A high ventilation rate (70% maximum possible ventilation rate) is reached when the temperature is 4 degrees above target and if external temperature is above 33 Celsius the maximum ventilation rate is assumed.

At high ventilation rates, it is likely that internal odour concentrations fall because odour is extracted much faster than it is created. Therefore, if the calculated ventilation rate exceeds that required to replace the volume of air in the house every 5 minutes, internal concentrations are reduced (by a factor of the square root of 7.5 times the shed volume/divided by the ventilation rate as an hourly figure).

Based upon these principles, an emission rate for each hour of the period modelled is calculated by multiplying the concentration by the ventilation rate. Both the crop length and period the housing is empty can be varied. An estimation of the emission during the cleaning out process can also be included. In this case, it is assumed that the houses are cleared sequentially and each house takes 2 hours to clear.

It is assumed for the calculations that the crop length is 38 days, with 20% thinning of the birds at day 33 to 35, and that there is an empty period of 10 days after each crop. To provide robust statistics, three sets of calculations were performed: the first with the first day of the meteorological record coinciding with day 1 of the crop cycle; the second coinciding with day 15 of the crop and the third coinciding with day 30 of the crop. As an example, a graph of the specific emission rate for over the first year of the meteorological record, for each of the three cycles, is shown in Figure 2a. Please note that these figures are expressed as the specific emission rate from the number of birds initially stocked and not as the actual number of birds present; therefore, thinning and reduction of the actual bird numbers shows as a step change.

3.5.1 Emissions from the existing poultry houses

To account for the effects of the air scrubber units, the concentration of emissions from the air scrubbers are restricted to a maximum of 1,200 ou_E/m^3; this figure is obtained from information supplied to AS Modelling & Data Ltd. by the manufacturers of the air scrubbers. Emissions from the bypass system, which would occur when the capacity of the scrubber unit is exceeded (as calculated by the ventilation model above), are unabated; the capacity of the Inno+ air scrubbers would be 333,900 m^3/h (92.75 m^3/s). As an example, a graph of the specific emission rate for over the first year of the meteorological record, for each of the three cycles, is shown in Figure 2a. Please note that these figures are expressed as the specific emission rate from the number of birds initially stocked and not as the actual number of birds present; therefore, thinning and reduction of the actual bird numbers shows as a step change.

Figure 2a. Specific (as initially stocked) emission rates over the first year meteorological data - existing standard broiler houses

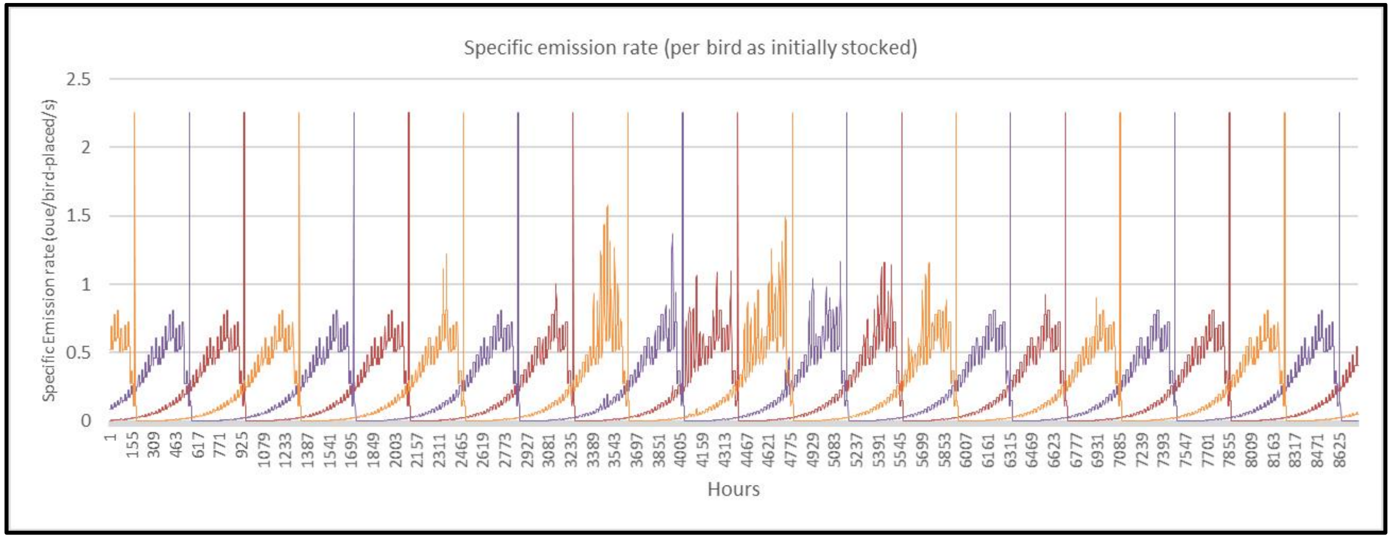
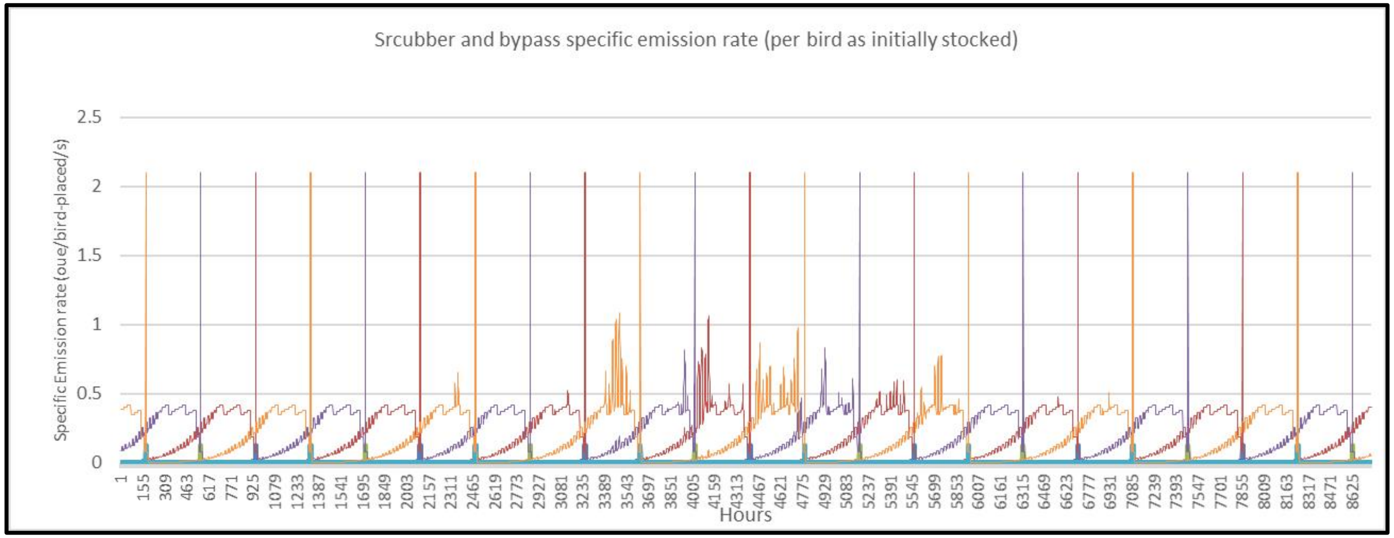


Figure 2b. Specific (as initially stocked) emission rates over the first year meteorological data - scrubber and bypass system emissions



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 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 (FLOWSTAR[1]). 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 3a and the terrain and roughness length modified wind rose for the location of the poultry houses at Neuadd Isaf is shown in Figure 3b. Note that elsewhere in the modelling domain, the modified wind roses may differ more markedly and that the resolution of the wind field is approximately 150 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[2].

1. Note that FLOWSTAR 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). In general, it is scientifically wrong to drive any model with sub-domain scale data as boundary conditions.

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 elevated point sources emissions, may cause over prediction of ground level concentrations in stable weather conditions and light winds (Steven R. Hanna & Biswanath Chowdhury, 2014); for non-elevated sources marked underprediction of ground level concentrations is likely. 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 3a. The wind rose. Raw GFS derived data, for 52.183 N, 2.971 W, 2017–2020

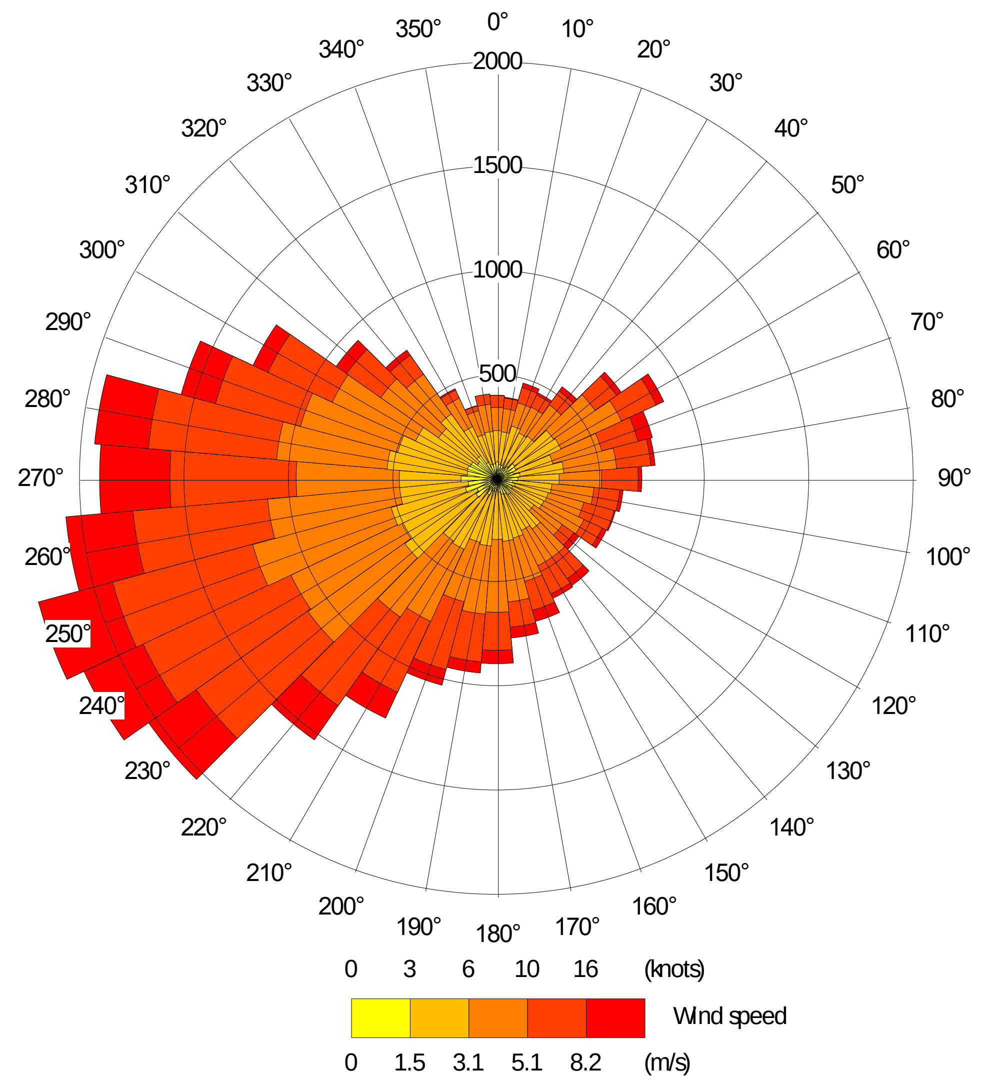
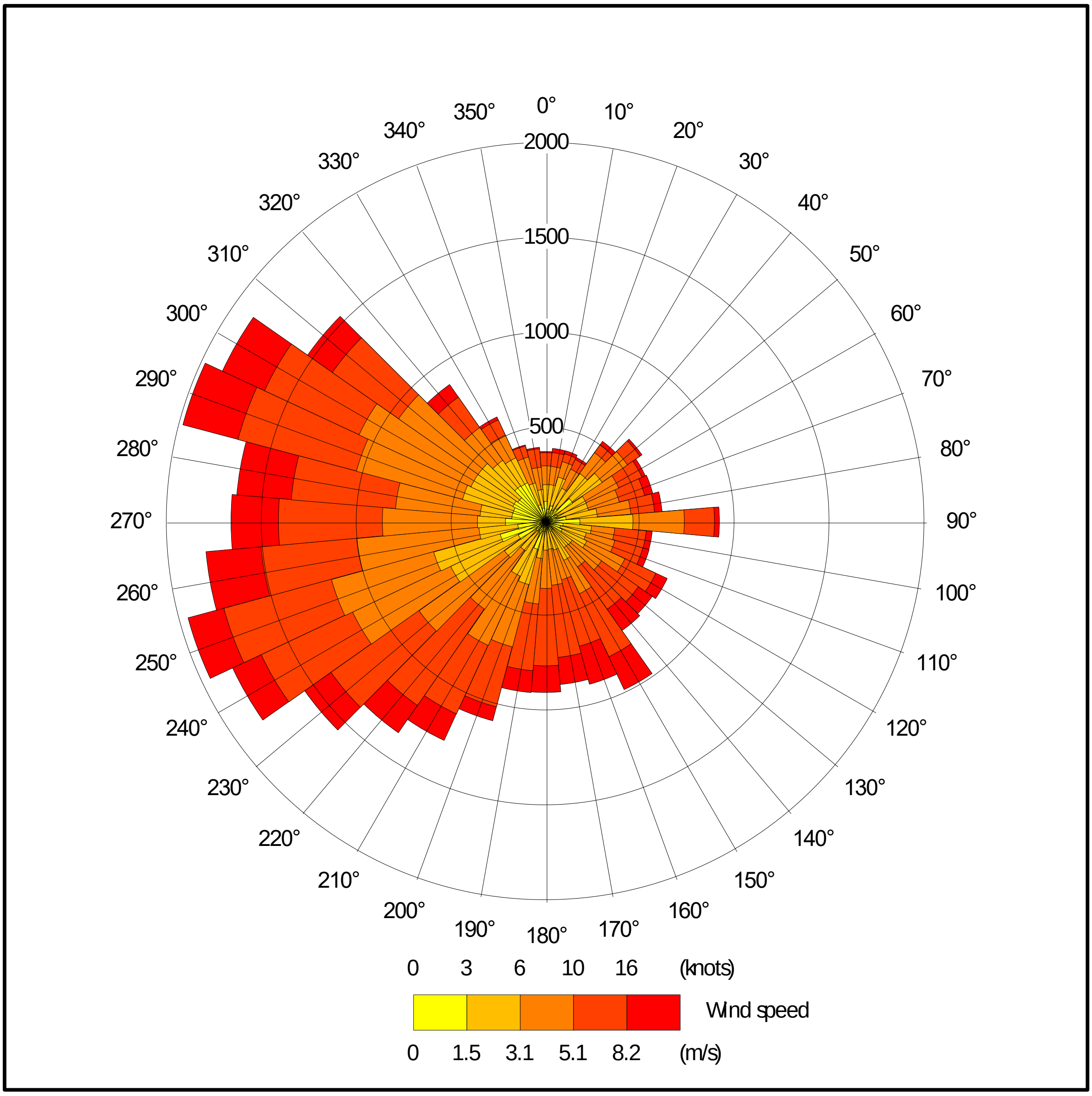


Figure 3b. The wind rose. FLOWSTAR modified GFS derived data for NGR 334400, 253700 (Green Farm), 2017–2020



4.2 Emission sources

Emissions from the side fans that are used to ventilate the existing poultry houses are represented by one volume source per house within ADMS (EX1_vol to EX4_vol).

Emissions from the air scrubbers and the chimneys of the high speed ridge fans that would be used as bypass or backup ventilation on the proposed houses are represented by six point sources per house within ADMS (PR5_BYP 1, 2 & 3 and PR6_BYP 1, 2 & 3 and PR5_SCR 1, 2 & 3 and PR6_SCR 1, 2 & 3).

Details of the point and volume source parameters are shown in Tables 1a and 1b. The positions of the sources may be seen in Figure 4.

Table 1a. Point source parameters

Source ID (Scenario)	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (˚C)	Emission rate per source (g-NH_3/s)
PR5_BYP and PR6 _BYP 1, 2 & 3	6.5	0.8	11.0	Variable [1]	Variable [1]
PR1_SCR and PR2_SCR 1, 2 & 3	5.5	Variable [1 & 2]	7.0	Variable [1]	Variable [1]

Table 1b. Volume source parameters

Source ID	Length (m)	Width (m)	Depth (m)	Base height (m)	Emission temperature (°C)	Emission rate per source (g-NH_3/s)
EX1_vol and EX4_vol	5.0	25.0	3.0	2.0	Ambient	Variable [2]

1. Dependent on crop stage and ambient temperature.
2. Inno+ velocity control equipment is assumed.

4.3 Modelled buildings

The structure of the existing and proposed poultry houses and other farm buildings may affect the plumes from the point sources. Therefore, the buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 4, marked by grey rectangles.

4.4 Discrete receptors

Twenty-two discrete receptors have been defined at a selection of nearby residences and commercial properties. The receptors are defined at 1.5 m above ground level within ADMS and their positions may be seen in Figure 5, where they are marked by enumerated pink rectangles.

4.5 Nested Cartesian grid

To produce the contour plots presented in Section 5 of this report, a nested Cartesian grid has been defined within ADMS. The grid receptors are defined at 1.5 m above ground level within ADMS. The positions of the grid receptors may be seen in Figure 5, where they are marked by green crosses.

4.6 Terrain data

There are some slopes that may affect wind flow and dispersion of odour in the area around the site; therefore, terrain has been considered in the modelling. The terrain data used are derived from the Ordnance Survey 50 m Digital Elevation Model. The terrain domain is 10.0 km by 10.0 km and FLOWSTAR is run at a resolution of 64 by 64 points; therefore, the effective model resolution is approximately 150 m.

4.7 Other model parameters

A fixed surface roughness length of 0.3 m has been applied over the entire modelling domain. 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 4. The positions of modelled buildings and sources at Nueadd Isaf

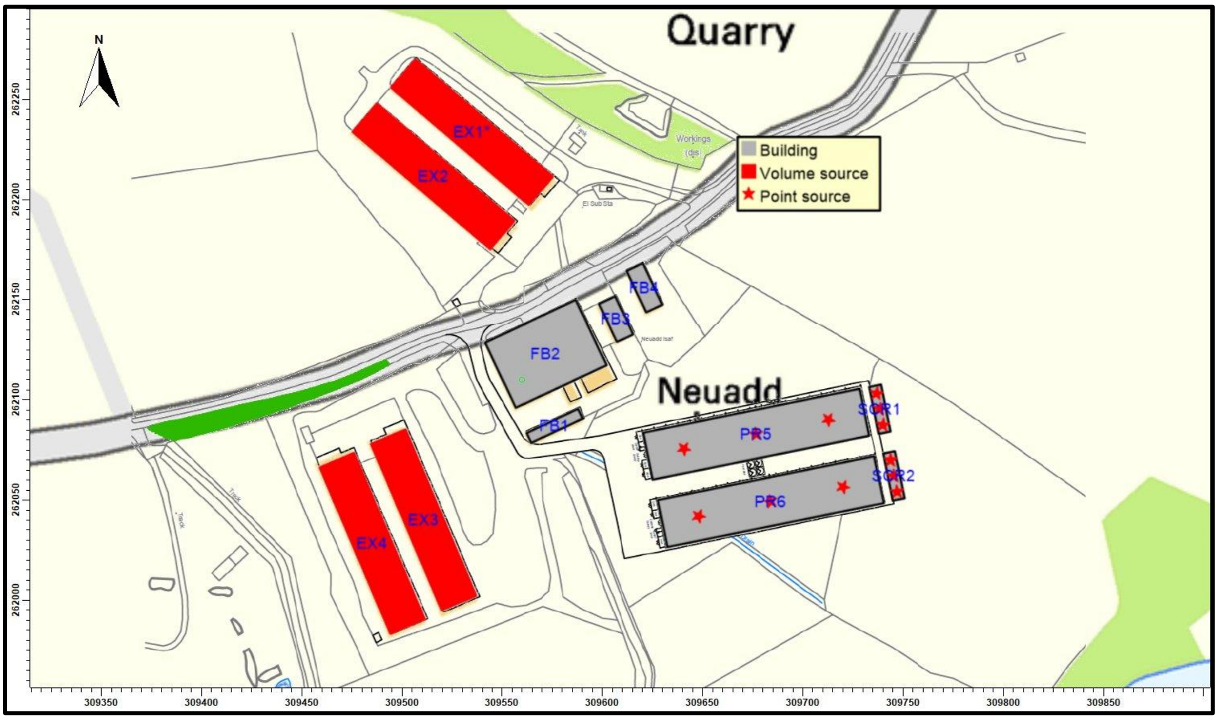
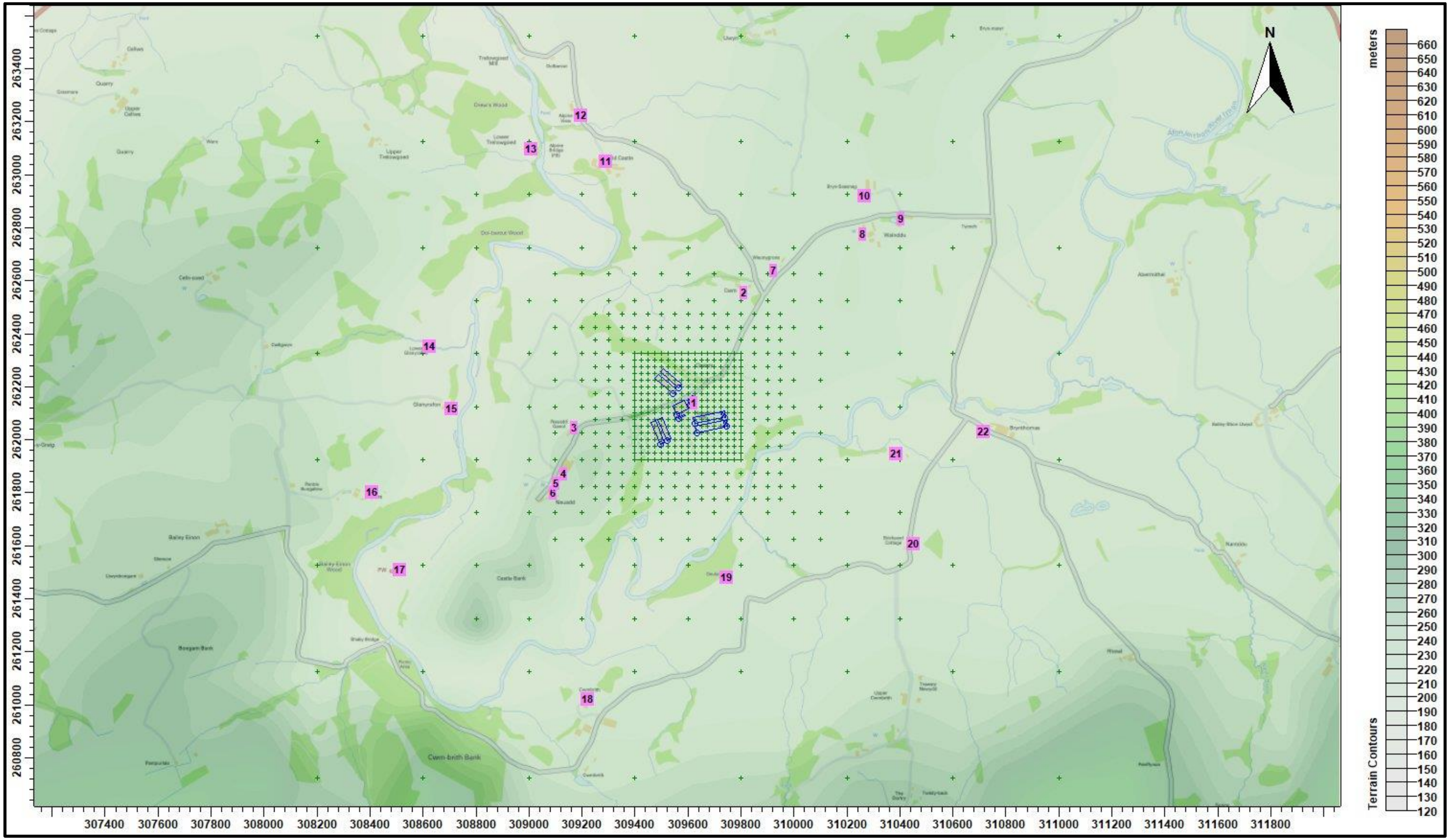


Figure 5. The discrete receptors and nested Cartesian grid receptors



5. Details of the Model Runs and Results

For this study ADMS was run with the terrain module of ADMS (FLOWSTAR) and with the calms module of ADMS.

ADMS was effectively run twenty-four times, once for each year of the four year meteorological record and for each of the three crop cycles, in the following two modes:

- Scenario 1: Minimum turbulence length is set at 0.025m for realistic treatment of stable weather conditions. In this scenario, stable solutions are allowed in ADMS, with the consequent suppression of vertical dispersion in such conditions.
- Scenario 2: As per Natural Resources Wales' erroneous guidance, ADMS default minimum turbulence length is unamended. Stable solutions in ADMS are effectively prevented. This is an unrealistic assumption for the majority of, if not all of, the domain modelled in this case and these results should be discarded as unreliable.

Statistics for the annual 98th percentile hourly mean odour concentration at each receptor were compiled for both scenarios.

A summary of the results of the modelling at the discrete receptors is provided in Table 2, where the maximum predicted annual 98th percentile hourly mean odour concentrations for each scenario are shown. Contour plots of the maximum annual 98th percentile hourly mean odour concentrations are shown in Figure 6a (Scenario 1) and Figure 6b (Scenario 2).

In Table 2, predicted odour exposures in excess of the Environment Agency's benchmark of 3.0 ou_E/m^3 as an annual 98th percentile hourly mean are coloured blue; those in the range that UKWIR research suggests gives rise to a significant proportion of complaints, 5.0 ou_E/m^3 to 10.0 ou_E/m^3 as an annual 98th percentile hourly mean, are coloured orange and predicted exposures likely to cause annoyance and complaint are coloured red.

Table 2. Predicted maximum annual 98th percentile hourly mean odour concentrations at the discrete receptors

Receptor number	X(m)	Y(m)	Name	Maximum annual 98th percentile hourly mean odour concentration (ou_E/m^3)	Maximum annual 98th percentile hourly mean odour concentration (ou_E/m^3)
				GFS Calms Terrain Min_Turb_Len at 0.025 m (ASMODATA)	GFS Calms Terrain Min_Turb_Len at ADMS default (NRW)
1	309622	262138	Neuadd Isaf	**36.01**	**16.41**
2	309809	262556	Cwm	2.67	1.80
3	309170	262043	Neuadd Ganol	**6.44**	**3.61**
4	309129	261871	Neuadd	**3.63**	2.13
5	309103	261834	Neuadd	**3.19**	1.82
6	309090	261796	Neuadd	2.76	1.65
7	309921	262636	Waunygroes	1.84	1.25
8	310259	262774	Wainddu	1.15	0.78
9	310404	262833	Wainddu	0.90	0.67
10	310266	262920	Bryn-Saesneg	0.86	0.58
11	309288	263051	Old Castle	1.32	0.72
12	309195	263222	Alpine View	0.95	0.54
13	309007	263098	Lower Trelowgoed	0.90	0.56
14	308625	262353	Lower Glanyrafon	1.08	0.61
15	308707	262116	Glanyrafon	1.70	1.25
16	308407	261802	Pentre	0.72	0.45
17	308513	261509	Church/Chapel	0.75	0.54
18	309220	261021	Cwmbirth Isaf	0.48	0.34
19	309746	261481	Geulan	1.19	0.87
20	310451	261605	Brickyard Cottage	1.03	0.69
21	310388	261945	Lodges	1.75	1.26
22	310714	262029	Brythomas	1.07	0.79

Figure 6a. Predicted maximum annual 98th percentile hourly mean odour concentration - Scenario 1

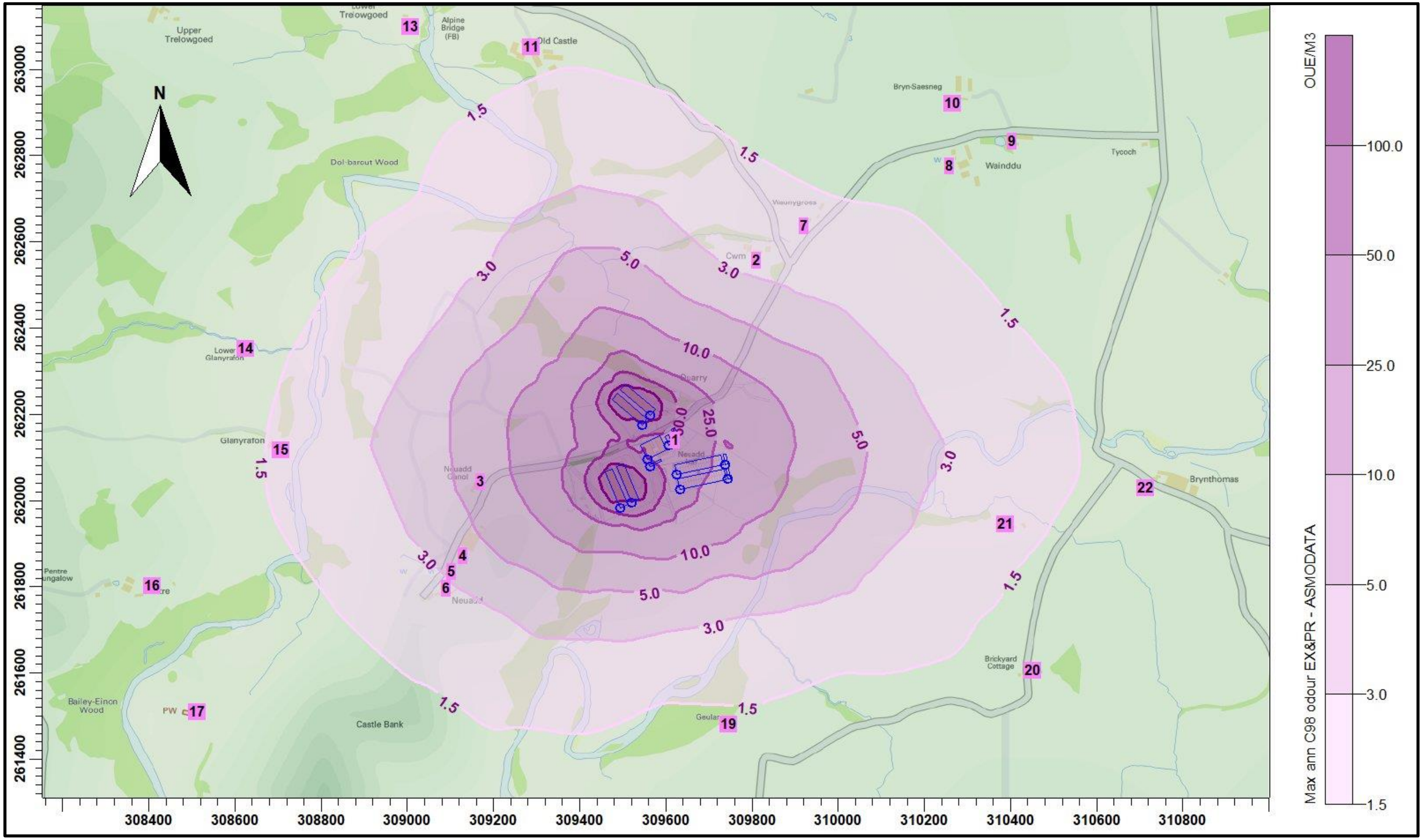
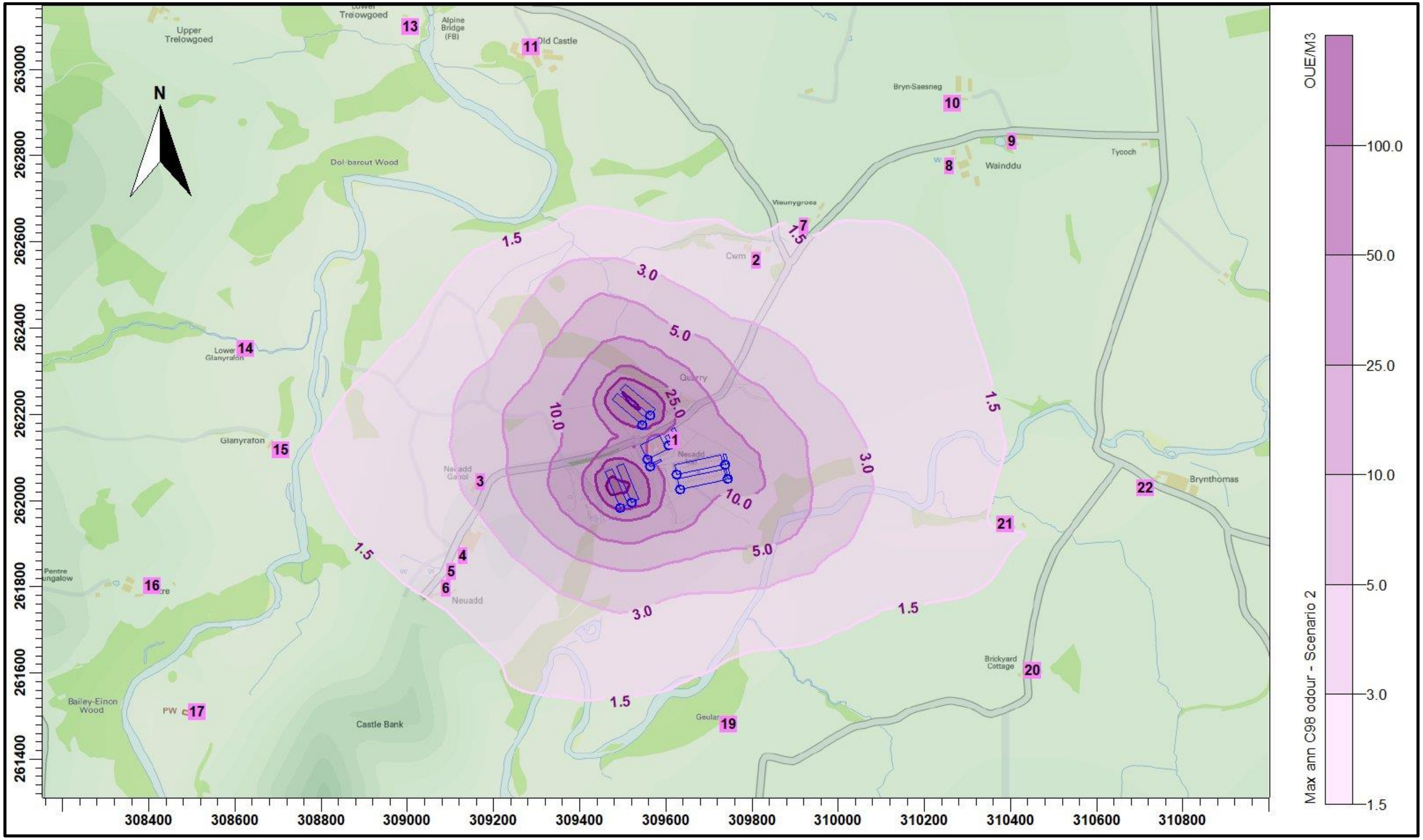


Figure 6b. Predicted maximum annual 98th percentile hourly mean odour concentration - Scenario 2



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Mr. Steve Raasch, on behalf of Mr. William Bedell, to use computer modelling to assess the impact of odour emissions from the existing and proposed broiler rearing houses at Neuadd Isaf, Penybont, Llandrindod Wells, Powys. LD1 5SW.

Odour emission rates from the existing and proposed poultry houses have been assessed and quantified based upon an emissions model that takes into account the likely internal odour concentrations and ventilation rates and also upon an emissions model that estimates emissions from the Inno+ air scrubbing equipment that would be used as the primary ventilation for the proposed poultry houses. The odour emission rates so obtained have then been used as inputs to an atmospheric dispersion model which calculates odour exposure levels in the surrounding area.

The modelling of the air scrubbers refers specifically to Inno+ air scrubbers with velocity control equipment and capacity of 333,900 m^3/h capacity and is unlikely to be applicable to air scrubbers of any other design and specification.

The modelling predicts that:

- Odour emissions from the existing and proposed poultry houses would give rise to exceedance of the Environment Agency's benchmark for moderately offensive odours, a maximum annual 98th percentile hourly mean concentration of 3.0 ou_E/m^3, at Neuadd Ganol and Neuadd. At Neuadd Ganol, the predicted exposures are also in the lower end of the range where UKWIR research suggests that there is an increasing risk of annoyance and complaint. The majority of the odour exposure is likely to be due to emissions from the existing houses.

7. References

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