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Powys Poultry Pilot Study: an assessment of cumulative atmospheric releases

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Natural Resources Wales

Evidence Report No: 218

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Contents

- 1. Crynodeb Gweithredol5
- 2. Executive Summary7
- 3. Introduction.....9
 - 3.1. Background.....9
 - 3.2. The Issue10
- 4. Method10
- 5. Results11
- 6. Conclusions13
 - 6.1. Recommendations14
- 7. References19
- Data Archive Appendix20

List of Figures

Figure 1.	Study Area	16
Figure 2.	AST calculated total ammonia concentrations from poultry farm units	17
Figure 3.	Detailed ADMS modelled ammonia concentrations from poultry farm units	18

List of Tables

Table 1.	Data used for AST calculations of predicted ammonia (NH ₃) concentrations from farm units being assessed	11
Table 2.	Distances to where farm unit contribution and background ammonia equal the selected ammonia concentrations (µg/m ³)	12

1. Crynodeb Gweithredol

Yn y blynyddoedd diwethaf, mae ehangu parhaus datblygiadau amaethyddol dwys yn rhannau o Bowys wedi achosi pryder mawr i'r cyhoedd. Amlygwyd y mater hwn drwy wrthwynebiad i gais cynllunio cyflwynwyd ar gyfer uned magu 80,000 o gywion dofednod fyddai'n cael ei reoleiddio gan CNC. Cyflwynwyd gwybodaeth ar nifer o unedau dofednod llai i CNC yn uniongyrchol o gofrestr cynllunio'r awdurdod cynllunio. Defnyddiwyd y data hwn i weld faint o allyriadau amonia o'r awyr oedd yn cael ei greu gan yr unedau dofednod a nodi eu proffiliau allyriadau amonia (ôl troed allyriad).

Dangosodd yr ymchwiliad rhagarweiniol fod yr unedau llai, oedd heb eu rheoleiddio, ond wedi'u cynnwys yn y ddeddfwriaeth cynllunio yn cael fwy o effaith ar y crynodiadau ammonia lleol, na'r uned ddwys reoledig llawer mwy. Mae'r ffaith fod 12,000 o ieir buarth sy'n dodwy yn cael fwy o effaith ar yr amgylchedd na 80,000 o frwyliaid (dan do mewn dau adeilad) yn ymddangos yn wrthreddfol a gall hyn fod yn anodd i gynllunwyr ac aelodau o'r cyhoedd ei ddeall.

Mae'r astudiaeth hon yn dangos yn glir os yw clystyrau o unedau fferm yn cael eu grwpio'n agos at safleoedd cadwraeth sensitif yna gall eu heffeithiau achosi niwed sylweddol. Felly, mae angen roi ystyriaeth gofalus i'r broses cynllunio cyn lleoli unrhyw unedau anifeiliaid fferm mewn unrhyw ardal, yn unigol neu gyda'i gilydd.

Caiff y wybodaeth ei ddefnyddio i helpu cefnogi rôl CNC fel rheolyddion (o'r unedau mwyaf) a bod yn sail i'r cyngor statudol mae'n cyflwyno i'r awdurdodau cynllunio. Bydd y wybodaeth hefyd ar gael i bartïon â diddordeb er mwyn helpu ehangu'r diwydiant mewn modd cynaliadwy yng Nghymru yn y dyfodol, yn unol â dull Rheoli Adnoddau Naturiol (NRM).

Argymhellion:

- Cyfrannu at ymatebion chynllunio a thrwyddedu CNC .
- Integreiddio'r penderfyniadau trwyddedu CNC gydag ymatebion i awdurdodau lleol tan gynllunio i gefnogi ymagwedd SMNR i ansawdd aer yng Nghymru.
- Gwaith pellach i gynnwys anifeiliaid fferm eraill, megis gwartheg (llaeth/cig eidion) a moch.
- Gellir defnyddio'r gwaith hwn i roi gwybodaeth i'r sector reoledig a'r awdurdod cynllunio ar sut gall datblygiadau amaethyddol effeithio'n gynyddol ac yn integredig yng nghefn gwlad. Astudio'r effeithiau mae allyriadau atmosfferig o unedau anifeiliaid fferm (rheoledig a heb ei reoleiddio) yn ei gael ar gynefin sensitif (e.e. ACA Mwsogl Fenn's, Whixall, Bettisfield, Wem a Cadney).
- Angen integreiddio ffynonellau llygredd aer a dŵr mewn dull integredig o drin llygredd gwasgaredig.
- Gall data gael ei ddefnyddio i gyfrannu at gynllunio tirwedd yn gynaliadwy.
- Gall y gwaith ddarparu gwybodaeth hanfodol ar sut i gyflawni dull reoli ar lefel ecosystem integredig sy'n gynaliadwy a fydd yn cynnal ein hymrwymiad â Rheoli Adnoddau Naturiol.

- Rhannu'r adroddiad hwn gydag awdurdod cynllunio Powys a'r rhai eraill sydd â diddordeb i'w hysbysu o effeithiau cymharol EPR a chynllunio unedau anifeiliaid fferm unigol a gyda'i gilydd.

2. Executive Summary

In recent years, there has been increasing public concern regarding the continued expansion of intensive agricultural development in parts of Powys. This issue was highlighted through an objection to a planning application for a new 80,000 broiler poultry unit which would be regulated by NRW. Information on several smaller poultry units taken directly from the planning authority's planning register was provided to NRW. These data were used to model the aerial ammonia emissions from these poultry units and determine their ammonia emission profiles ("emission footprints").

The preliminary investigation showed that the smaller, non-regulated, but covered under planning, poultry units have a greater impact on the local ammonia concentrations than the much larger regulated intensive unit. The fact that 12,000 free range laying hens have a greater environmental impact than 80,000 meat birds (housed in two buildings) seems counter intuitive and may be hard to understand by planners and members of the public.

This study clearly demonstrates that if clusters of farm units are grouped close to sensitive conservation sites their impacts could cause significant damage. Therefore, careful consideration through the planning process needs to be given to the location of further livestock unit developments in any area, alone and cumulatively.

The information will be used to help support NRW's role as a regulator (of the larger units) and inform the statutory advice it gives to planning authorities. The information will also be available to interested parties to help inform a more sustainable approach to the future expansion of the industry in Wales in line with a Natural Resource Management (NRM) approach.

Recommendations:

- Inform NRW permitting and planning responses.
- Integrate NRW permitting decisions with responses to local authorities under planning to support an SMNR approach to air quality in Wales.
- Further work to include other livestock units, such as cattle (dairy/beef) and pigs.
- This work can be used to inform both the regulated sector and the planning authority of the cumulative and in combination impact of agricultural developments in the countryside.
- Study the impacts of atmospheric emissions from livestock units (regulated and non-regulated) on a sensitive habitat (e.g. Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC).
- Need to integrate air and water pollution sources in an integrated diffuse pollution approach.
- Data can be used to inform sustainable landscape planning.
- This work can provide vital information on implementing an integrated ecosystem approach that is sustainable and will support our involvement with Natural Resources Management.

- Share this report with Powys planning authority and interested parties to inform them of the relative impacts of EPR and Planning livestock units alone and cumulatively.

3. Introduction

3.1. Background

Since 2007 the Countryside Council for Wales (CCW) had raised concerns about the potential cumulative impacts of ammonia emissions from intensive farming (mostly poultry) developments in close proximity to each other. These were formally expressed in planning consultation responses to local authorities in areas where “clusters” of such units occurred. The ammonia originates from the waste produced by livestock and concentrations are very high close to livestock units often exceeding thresholds (critical levels) set to protect sensitive vegetation. Ammonia is also deposited around the unit and can damage plant habitats.

Where a proposal was close enough to a protected habitat to directly damage it CCW would object to it being granted planning permission or an environmental permit from Environment Agency Wales (EAW). However, as developers and planners became aware of potential objection (depending on location) this has rarely occurred recently. It has become apparent that in some locations a number of units were being developed over time that were close together. Each application was treated by the planning authority on its own merits without regard to the numbers already granted approval in the same area.

There was concern that in certain sensitive locations there was a potential threat from overlapping and accumulative releases of ammonia, which over time could lead to amounts that would exceed thresholds set to protect vegetation. In these cases the carrying capacity of the local environment is being exceeded.

In cluster areas since 2007 CCW, in its responses, asked Local Authorities for the cumulative impacts of existing livestock units to be assessed along with the new application. CCW believed that this should be part of their statutory duty to enhance biodiversity (as required by Section 40 of the NERC Act 2006). CCW also advised local authorities that livestock units planned close to sensitive sites would require an Environmental Impact Assessment (EIA) if the development exceeded the area threshold set out in Schedule 2 of the Town and Country Planning (EIA) Regulations 1999 (as amended). After the formation of NRW the same issues have been included in our responses to Local Authorities where we are aware of clusters of existing units.

In recent years the proliferation of these units in some areas has led to significant local opposition especially where NRW is permitting the larger units. This has led to NRW spending considerable time addressing the concerns and perceived concerns of the public. To help inform our position NRW has established a multi-disciplined Intensive Farming group to help inform our role as regulator and adviser.

In February 2015 Welsh Government issued a number of screening decisions that stipulated that livestock units proposed close to sensitive sites would require an EIA (under the provisions of Regulation 5(6) of the T&CP (EIA) Regulations 1999). The Minister for Natural Resources agreed to write to local

authorities (Welsh Government, 2015a) to remind them of the need to have regard to the purpose of conserving biodiversity in exercising their functions under Section 40 of the NERC Act 2006. As of May 2015 this duty has been enhanced by the Environment (Wales) Bill Section 6(1) (Welsh Government, 2015b).

3.2. The Issue

Concerns from local residents regarding the continued intensification of agricultural development in certain parts of Powys were brought to NRW's attention. This concern has been centred near central Powys and North Powys. This preliminary report is centred in the St Harmon area, near Rhayadr (Figure 1).

Initially through an objection, from a local resident, to a planning application for a new 80,000 broiler unit, information was provided on several small farm poultry units already operating in the St Harmon area. These smaller farm units do not require a permit under Environmental Permitting Regulations to operate but require planning permission only. These data were taken directly from the planning authority's own planning register and is publicly available. There are 13 small farm units within 10km radius of the larger intensive unit.

It was agreed by Operations Manager (Mid-Wales) that NRW would examine the data supplied by a local resident regarding the potentially cumulative impacts of ammonia emissions of these farm units.

The data supplied was assessed using the Ammonia Screening Tool (AST). AST was initially developed by the Air Quality Modelling Assessment Unit (AQMAU) of the Environment Agency (EA). Since the formation of Natural Resources Wales, its Air Quality Modelling Risk Assessment Unit (AQMRAT) has collaborated with AQMAU to continue to develop and improve AST.

In order to better understand the cumulative and in combination impacts of "clustered" intensive livestock units NRW has undertaken a pilot study using data from the planning register in Powys. The information will be used to help support NRW's role as a regulator (of the larger units) and inform the statutory advice it gives to planning authorities. The information will also be available to interested parties to help inform a more sustainable approach to the future expansion of the industry in Wales in line with the Natural Resource Management approach.

It should be noted that this study focuses exclusively on atmospheric impacts because we have accurate and auditable data sources. There is also huge concern about waste products from these units' polluting watercourses. However, very little reliable data exists that could allow a similar quantifiable estimation.

4. Method

AST4.4 was used for this preliminary investigation.

Data supplied by the resident for 13 farm units was adjusted and validated to enable input into AST4.4 (Table 1). The names of the farm units were removed to maintain anonymity, numbered 1 to 13. Where information on the housing unit was uncertain, such as height, exit velocity, ammonia emission factor; the worst case value was used (low housing height, zero exit velocity, high ammonia emission factor). This was to ensure a precautionary approach to the assessment. These values for each farm unit were entered into the appropriate cells in AST. The information for the permitted intensive unit (No. 14) was already supplied to NRW as part of a pre-application meeting.

Table 1. Data used for AST calculations of predicted ammonia (NH₃) concentrations from farm units being assessed.

Farm unit	Animal Type	Animal Numbers	NH ₃ Emission Factor (kgNH ₃ /animal/yr) ^b	Roof Height (m)	Fan Speed (m/s)
1	Layer	8,000	0.290	5.364	2
2	Layer	12,000	0.290	5.364	2
3	Broiler	33,086	0.034	4.530	0
4	Broiler	26,800	0.034	4.450	0
5	Broiler	12,500	0.034	4.530	0
6	Layer	16,000	0.200	5.171	2
7	Layer	16,000	0.200	5.360	2
8	Layer	12,000	0.200	5.328	2
9	Layer	12,000	0.290	7.200	0
10	Layer	16,000	0.200	5.446	7
11	Layer	5,000	0.290	4.000	0
12	Layer	8,000	0.290	5.300	2
13	Layer	12,000	0.290	5.360	2
14 ^a	Broiler	80,000	0.034	5.500	7

^a Intensive unit No. 14 is the only unit regulated under EPR

^b Ammonia emission factors taken from EA Pollution Inventory Reporting Guidance [Version 5](#) January 2013

Background ammonia concentration was taken from the APIS website using the 'Search by location' tool (APIS, 2015). To obtain the ammonia background the grid reference of each farm unit was used and the ammonia concentration noted. As presented in Table 2 the background ammonia concentrations range from 0.75 to 1.59µg/m³ with an average across the study area of 1.07µg/m³, this would include inputs from the farm units.

For each farm unit, distances (m) were then entered in the appropriate AST cell and the process contribution (PC) to ammonia was obtained. The distances where the PC in addition to the background ammonia (Predicted Environmental Concentration or PEC) equalled 1µg/m³, 1.5µg/m³, 2µg/m³, 2.5µg/m³ and 3µg/m³ was recorded (Table 2).

5. Results

Table 2 shows the distances (m) to where the farm ammonia contribution added to the background ammonia for the farm unit is equal to a PEC of 1µg/m³, 1.5µg/m³, 2µg/m³, 2.5µg/m³ and 3µg/m³. The ammonia concentration of 1µg/m³ was selected as the lower level because it is the ammonia critical level for the protection of lower plants such as lichens, mosses and liverworts. Distances to 0.5µg/m³ incremental increases to total ammonia up to a maximum of 3µg/m³ were recorded. This maximum total ammonia

concentration ($3\mu\text{g}/\text{m}^3$) was used because it is the ammonia critical level for the protection of higher plants, where lower plants are not integral to the habitat.

Blank cells in Table 2 occur because the background ammonia exceeds the PEC being calculated. For example, the column for the distance to $\text{PEC} = 1\mu\text{g}/\text{m}^3$ for farm units nos. 4 to 10, 12 and 13 are blank because background exceeds $1\mu\text{g}/\text{m}^3$ without any contribution from the farm unit itself.

Table 2. Distances to where farm unit contribution and background ammonia equal the selected ammonia concentrations ($\mu\text{g}/\text{m}^3$).

Farm unit	Background Ammonia ($\mu\text{g}/\text{m}^3$)	Distance (m) to PEC $1\mu\text{g}/\text{m}^3$	Distance (m) to PEC $1.5\mu\text{g}/\text{m}^3$	Distance (m) to PEC $2\mu\text{g}/\text{m}^3$	Distance (m) to PEC $2.5\mu\text{g}/\text{m}^3$	Distance (m) to PEC $3\mu\text{g}/\text{m}^3$
1	0.96	2130	413	273	<250	<250
2	0.96	2755	534	353	275	<250
3	0.96	1997	487	341	276	>250
4	1.09		504	327	257	<250
5	1.09		333	<250	<250	<250
6	1.09		603	364	276	<250
7	1.04		561	352	270	<250
8	1.04		467	293	<250	<250
9	1.05		992	661	526	448
10	1.04		427	264	<250	<250
11	0.75	848	467	354	295	258
12	1.59			492	297	<250
13	1.42		1789	511	344	271
14	0.84	765	303	<250	<250	<250

AST cannot calculate ammonia concentrations at distances below 250m for various reasons. Therefore, where the distance to the above total ammonia concentrations are calculated to be below 250m, this is indicated.

These distances were then mapped using MapInfo (Figure 2) to give a spatial indication of ammonia impact with increased impact closest to the farm unit and decreasing with distance. The greater the distance of the ammonia profile the greater the potential area of ammonia impact from the farm unit.

The results show that the intensive unit (No. 14) that will require a permit from NRW to operate has a smaller impact in relation to ammonia emissions than the other smaller farm units. For each of the distances to the selected total ammonia concentrations the permitted intensive unit contributed the lowest distance.

AST is primarily a screening tool and generally not used to make complex direct comparisons of ammonia impacts between different scenarios. To conduct more robust comparisons of impacts between different housing, bird types detailed modelling, such as ADMS is required. NRW AQMRAT completed detailed modelling using ADMS with the same data that was used to complete the initial AST calculations. The ammonia concentrations and profiles are presented in Figure 3. The ADMS modelling confirms and supports the findings from the AST calculations.

A comparison of Figure 2 (AST results) and Figure 3 (ADMS results) show that the impacts from the non-regulated farm units are spread over a greater distance than the intensive unit No. 14. In Figure 3 the ammonia profile from intensive unit No. 14 is difficult to see compared to farm units 1 and 2, the nearest non-regulated farm units. At farm unit No. 1 (8,000 layers) and 2 (12,000 layers) the ammonia concentration is as high as $5\mu\text{g}/\text{m}^3$ directly at the farm grid reference. For intensive unit No. 14 (80,000 broilers) the highest ammonia concentration at its grid reference is predicted to be $0.3\mu\text{g}/\text{m}^3$. To provide a more direct comparison of ammonia concentrations from the same bird production type as intensive unit No. 14 the non-regulated broiler producers were examined. For farm units No. 3 (33,086 birds), No. 4 (26,000 birds) and No. 5 (12,500 birds) the ammonia concentration at each farm unit grid reference was $3\mu\text{g}/\text{m}^3$.

6. Conclusions

The relationship with the number of birds and the amount of ammonia released is not straight forward. It is dependent on the type of bird being used. For example, the emission factors for broilers are 8x lower than those for layers. Also, the type of housing and manure removal method can have a major influence on the emission factors. Therefore, it is not a simple matter of scaling up of bird numbers to predict the potential ammonia emissions and the overall risk to a sensitive habitat.

Intensive unit No. 14 is a large industrial unit of 80,000 broilers, which will require a permit to operate but its ammonia emission profile and its impact is much less than the smaller farm units. This is partly due to the poultry housing having to meet higher specifications and pollution control requirements (e.g. Best Available Techniques BAT). Poultry units that require planning permission only do not need to meet the high ammonia emission reduction standards. A direct comparison of non-regulated broiler producers (farm unit Nos. 3, 4 and 5) demonstrated that their ammonia concentrations at the farm unit location were 1000% higher than the intensive unit No. 14. In relation to the appropriate ammonia critical levels used in environmental impact assessments, intensive unit No. 14 contributes 30% of the $1\mu\text{g}/\text{m}^3$ and 10% of the $3\mu\text{g}/\text{m}^3$ at the grid reference of the unit. Farm unit Nos. 1 and 2 contribute 500% and 166.7% for the ammonia critical levels; farm unit Nos. 3, 4 and 5 contribute 300% and 100%. This has major implications on the conservation of protected designated sites and the wider countryside when attempting to assess the environmental impacts of new developments.

This preliminary investigation shows that the smaller, non-regulated, poultry units have a greater impact on the local ammonia concentrations than the regulated intensive unit. The fact that 12,000 free range laying hens have a bigger environmental impact than 80,000 meat birds (housed in two buildings) seems counter intuitive and may be hard to understand by planners and members of the public.

This study clearly demonstrates if clusters of farm units are grouped close to statutory sites their impacts could cause significant damage. Therefore,

careful consideration through the planning process needs to be given to the location of further livestock unit developments in any area.

6.1. Recommendations

- Influence NRW permitting and planning responses.
- Integrate NRW permitting decisions with responses to local authorities under planning to support an SMNR approach to air quality in Wales.
- Study the impacts of atmospheric emissions from livestock units (regulated and non-regulated) on a sensitive habitat (e.g. Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC).
- Further work to include other livestock units, such as cattle (dairy/beef) and pigs.
- This work can be used to inform both the regulated sector and the planning authority of the cumulative and in combination impact of agricultural developments in the countryside.
- Need to integrate air and water pollution sources in an integrated diffuse pollution approach.
- Data can be used to inform sustainable landscape planning.
- This work can provide vital information on implementing an integrated ecosystem approach that is sustainable and will support our involvement with Natural Resources Management.
- Share this report with Powys planning authority and interested parties to inform them of the relative impacts of EPR and Planning livestock units alone and cumulatively.

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Figure 1. Study Area

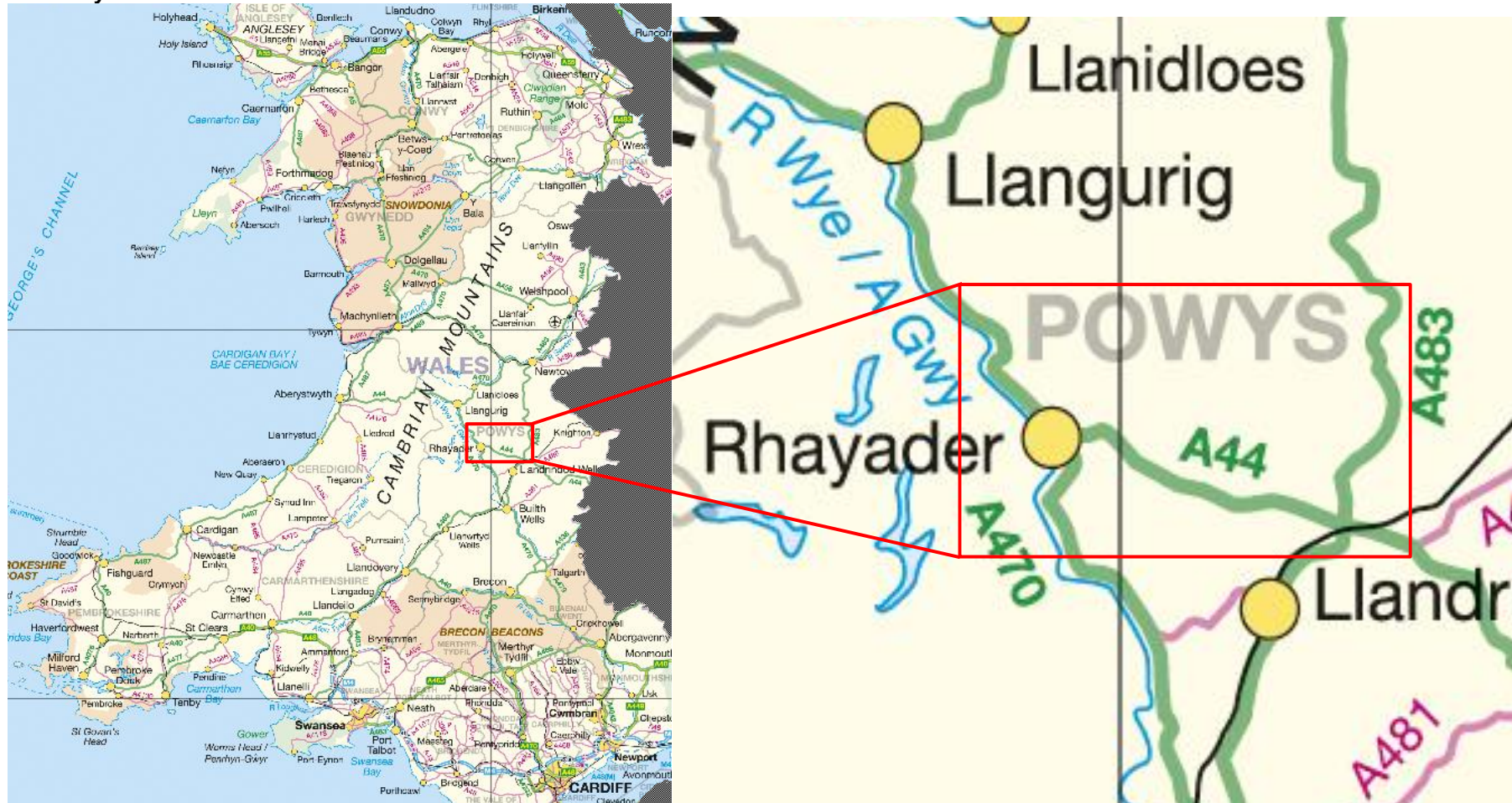
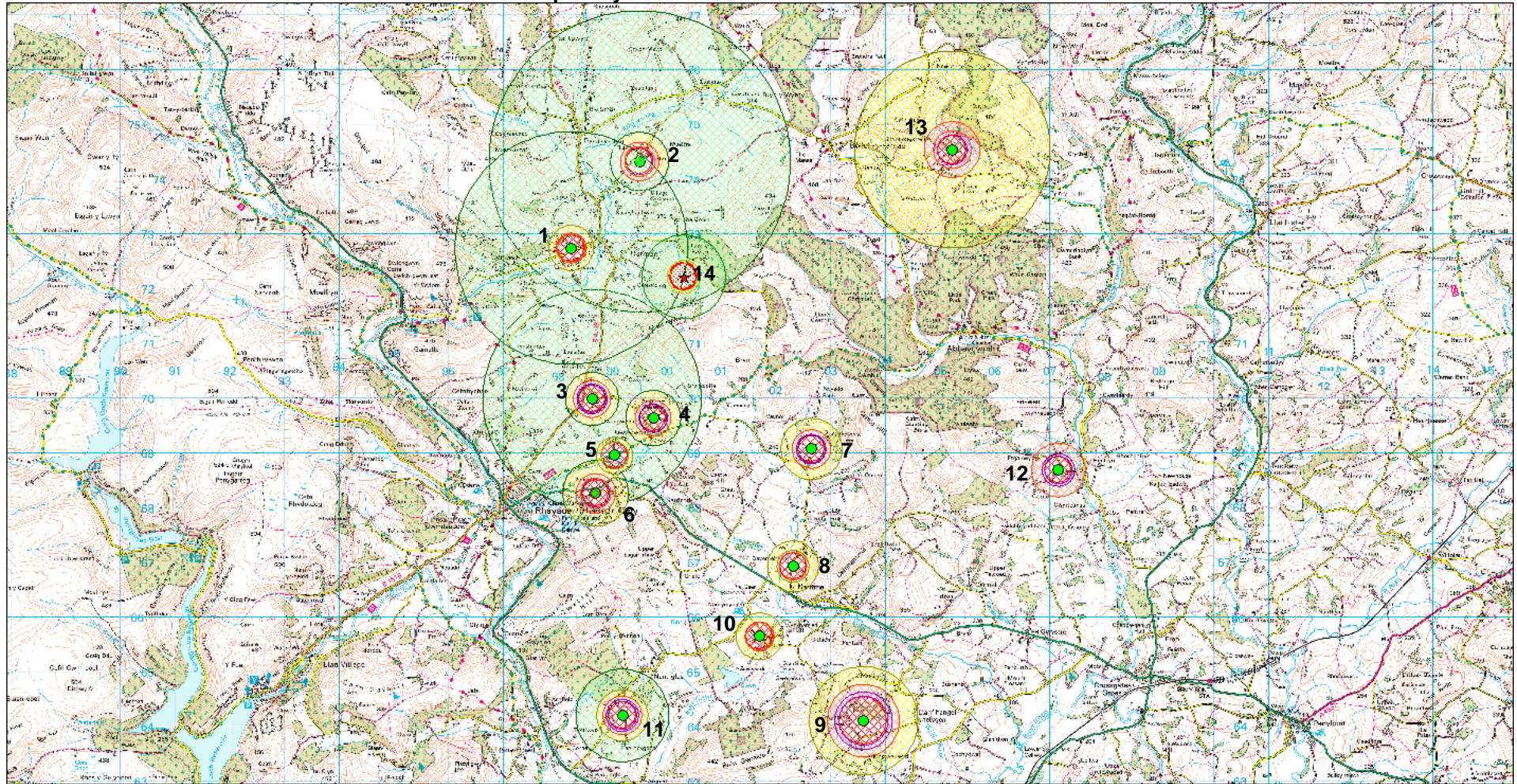


Figure 2. AST calculated total ammonia concentrations from poultry farm units



Key

★.... Permitted Farm

●.... Planning Farms

PEC 1 µg/m³

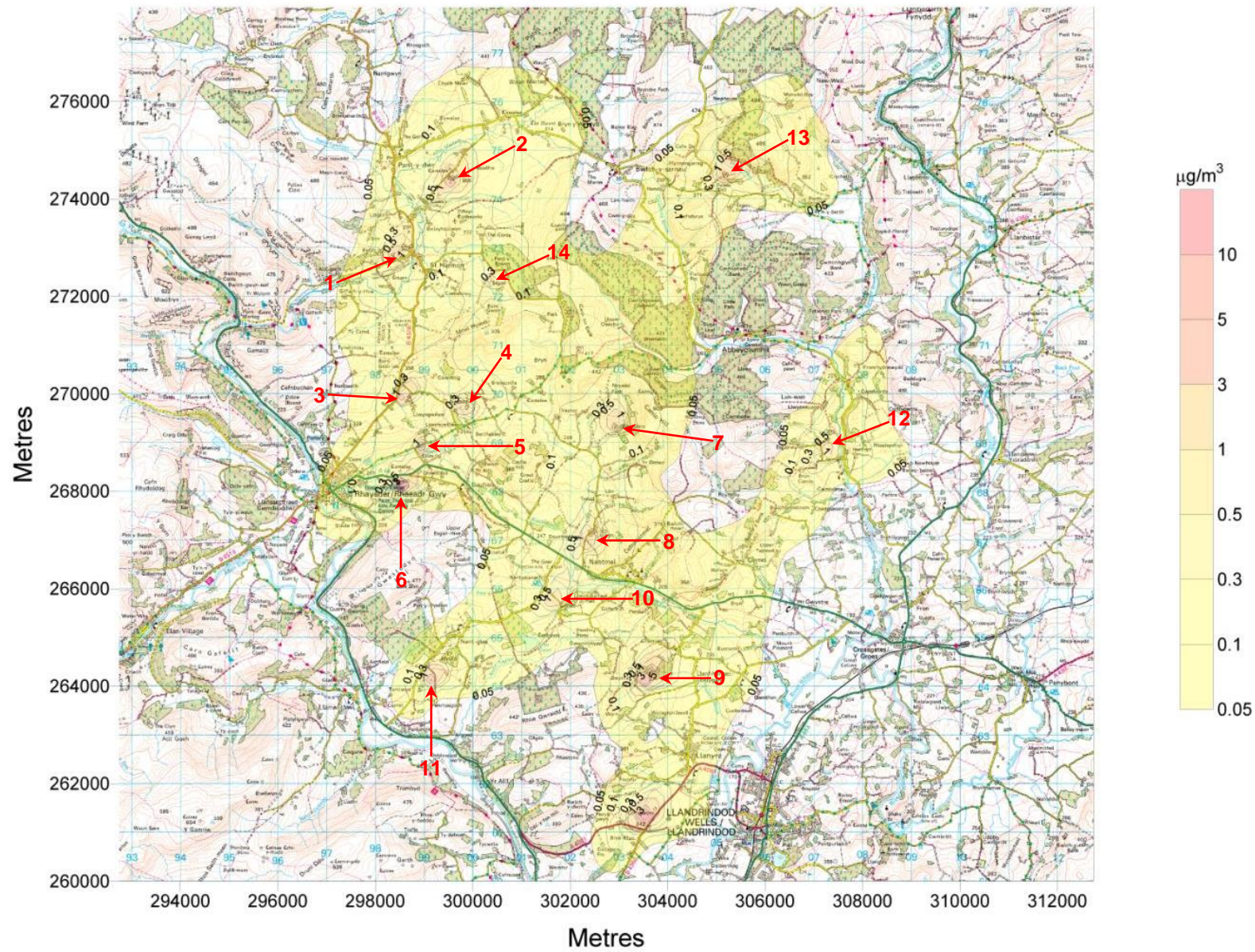
PEC 1.5 µg/m³

PEC 2 µg/m³

PEC 2.5 µg/m³

PEC 3 µg/m³

Figure 3. Detailed ADMS modelled ammonia concentrations from poultry farm units



7. References

Welsh Government. (2015a). *Natural Environment and Rural Communities Act: The Minister for Natural Resources has agreed to write to Local Authorities* (04/02/2015). Welsh Government. Available from: <http://gov.wales/pubdecisionreports/852137/9498874/9566336/cs3801?lang=en> [Accessed 5th June 2015].

Welsh Government. (2015b). *Environment (Wales) Bill 2015*. As introduced 11th May 2015. Welsh Government. Accessed from: <http://www.assembly.wales/laid%20documents/pri-ld10201/pri-ld10201-e.pdf> [Accessed 5th June 2015].

Environment Agency. (2013). *Pollution inventory reporting: intensive farming guidance note. Version 5, January 2013*. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296993/LIT_7807_d074d7.pdf

APIS. (2015). Air Pollution Information System “Search by location” tool. Available from: <http://www.apis.ac.uk/search-location> [Accessed various dates between January to February 2015]

Data Archive Appendix

No data outputs were produced as part of this project.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <https://libcat.naturalresources.wales> (English Version) and <https://catllyfr.cyfoethnaturiol.cymru> (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no [NRW to insert this number]

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