# PROPOSED POULTRY UNITS, DOLIDRE FARM

# ODOUR IMPACT ASSESSMENT

April 2020

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**Isopleth Ltd.**
Registered in England and Wales No. 9150373

**CONTENTS**

# 1.0 INTRODUCTION

Isopleth Ltd has been commissioned by Ian Pick Associates Ltd, on behalf of Mr Edward Morgan and Mr James Morgan, to carry out a detailed assessment of odour impacts associated with a proposed extension to their poultry unit at Dolidre (Dol-Y-Dre) Farm, Llanddewi, Llandrindod Wells LD1 6SE. A site location plan is shown in Figure 4-1 of this report.

## 1.1 Background

The potential odour impacts on local residents associated with the development of an extension to an existing poultry (broiler) farm at Dolidre Farm has been assessed.

The site lies within the administrative area of Powys County Council (planning) and Natural Resources Wales are responsible for regulating the site under an Environmental Permit.

The new facility would consist of 3 new broiler houses housing approximately 150,000 birds, in addition to the existing 3 houses which typically house 130,000 birds. The existing houses are ventilated by uncapped high speed ridge mounted fans, with exhaust via a single chimney per ridge fan. Whilst under the proposed scenario the new houses would include odour (and ammonia) control scrubbers which would also be fitted to one of the existing sheds.

## 1.2 Previous Applications / Assessments

The existing site benefits from planning permission for a total of 3 broiler houses, the most recent of which was approved on 17th March 2016 (Application P/2015/0457).

The current application (Reference: 19/0178/PRE) relates to the erection of 3 broiler chicken units. The site already holds an Environmental Permit for this scheme (Permit number EPR/MP3130TW), the application having been supported by detailed modelling submitted with the application, the findings relevant to odour described in the NRW Decision Document for the scheme:

> *'Ventilation in the new houses and existing house 2 will be drawn through the gable end air scrubbing systems reducing ammonia release by 90% and a reduction in odour release of 40%.'*
>
> *.....*
>
> *'The applicant has submitted detailed dispersion modelling of the impact of odour from the proposed facility.'*
>
> *.....*
>
> *'Odours from poultry rearing are usually placed in the moderately offensive category. Therefore for their modelling the applicant has used the benchmark of 3.0 ouE/m3 to assess the potential impact of odour on nearby sensitive receptors.'*
>
> *.....*

> *'The results of the modelling predict the highest maximum odour concentrations at the buildings directly associated with Dolidre. 30 out of the 31 receptors all fall below the benchmark of three odour units. The only receptor to exceed this is Dolidre Farm. As this property has direct connections to the installation we can raise the benchmark to 6 odour units. The next highest odour is 2.33 odour units. The majority of the receptors fall below one odour unit.*
>
> *We are satisfied that the risk of odour pollution at nearby receptors is not significant. NRW has assessed the modelling in detail and is satisfied that it accurately represents the predicted odours. It is recognised that this modelling does only represent the expected odour concentrations for 98% of the time and that odours may be higher for the remaining 2% of the time. NRW is not able to ensure that odour impacts on nearby receptors are reduced to zero, but is determined to ensure that they are minimised.'*

This April 2020 odour assessment represents an update to the detailed modelling submitted in support of the Permit Application and based on the latest scrubber designs.

The Planning and Environmental Permitting processes are separate, but complementary, as discussed further in section 3.2 of this report. Paragraph 5.13.3 of Planning Policy Wales (Edition 10, December 2018) requires that the local planning authority must assume that the Permit will operate effectively in preventing unacceptable levels of odour at relevant receptor locations.

### 1.3 Scope and Limitations

The scope of this OIA is limited to the prediction, through atmospheric dispersion modelling, of odour impacts at local sensitive receptors based on design information and desktop emission rates. The assessment approach used is consistent with that completed in relation to work completed in support of the Environmental Permit application (Reference: 19/0178/PRE). Assessment of impacts associated with emissions of ammonia on sensitive ecological sites is outside the scope of this report, which deals with issues of odour only.

### 1.4 Aims and Objectives

The objectives of the assessment are as follows:

- To identify the odour sources which will be present at the facility;
- To estimate odour emissions from the proposed facility;
- To quantify impacts on sensitive receptors based upon the emission values; and
- To assess the significance of these impacts.

# 2.0 APPROACH

## 2.1 General Approach

The approach taken in this odour impact assessment is consistent with that for the Environmental Permit application (Reference: 19/0178/PRE), where the same general approach was been regarded as acceptable.

## 2.2 Assessment of Odour Exposure

In the UK, odour assessments for poultry facilities are most commonly undertaken using the concept of the European Odour Unit ($ou_E$), as defined in BS EN 13725[1]. This approach allows impact assessment of any odorous gas as it is independent of chemical constituents and centres instead on multiples of the detection threshold of the gas in question.

As the odour unit is a Standard Unit in the same way as gram or milligram, the notation used in odour assessment follows the conventions of any mass emission unit as follows:

- concentration: $ou_E/m^3$
- emission: $ou_E/s$
- specific emission (emission per unit area): $ou_E/m^2/s$

Like air quality standards for individual pollutants, exposure to odour is given in terms of a percentile of averages over the course of a year. The exposure criteria most accepted in the UK at present is given in terms of (concentration) European Odour Units as a 98$^{th}$ percentile ($C_{98}$) of hourly averages. This allows 2% of the year when the impact may be above the limit criterion (175 hours). The notation for impact is therefore: $C_{98,\ 1\ hour}$ X $ou_E/m^3$.

Odour perception, annoyance and nuisance is related to more than simply odour impact, the five 'FIDOL' factors[2] must also be considered when assessing the acceptability of a scheme and the appropriateness of a limit criterion, defined by the IAQM as follows:

- **Frequency:** How often an individual is exposed to odour;
- **Intensity:** The individual's perception of the strength of the odour;
- **Duration:** The overall duration that individuals are exposed to an odour over time;
- **Odour unpleasantness (or 'offensiveness'):** Odour unpleasantness describes the character of an odour as it relates to the 'hedonic tone' (which may be pleasant, neutral or unpleasant) at a given odour concentration/ intensity. This can be measured in the laboratory as the hedonic tone, and when measured by the standard method and expressed on a standard nine-point scale it is termed the hedonic score;

[1] BS EN 13725:2003 *Air Quality – Determination of Odour Concentration by Dynamic Olfactometry.*

[2] The FIDOL factors are defined as **F**requency, **I**ntensity (and therefore concentration), **D**uration, relative **O**ffensiveness (hedonic tone/character) and **L**ocation,

- **Location:** The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The 'Location' factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

## 2.3 Identification of Odour Sources

Potential sources of odorous emissions from the proposed facility have been identified on the basis of a review of the proposed development design. This involves identifying sources of potential releases to atmosphere. The identified potential odour sources are as follows:

- Point sources (from the broiler house ventilation); and
- Waste product handling and spillages etc.

Control of fugitive / intermittent releases of odour will be addressed by a site Odour Management Plan as part of the Permitting process.

## 2.4 Derivation of Emissions

The anticipated odour emissions for the proposal have been estimated using values given in published literature in the UK and Europe for similar facilities. Ventilation flows are based on standard best practice design for UK broiler houses.

The odour emission rates applied should be considered worst case as they have been measured at facilities which do not apply the same odour prevention measures as are adopted at the Dolidre site. In reality emission rates would be expected to be significantly lower as would be expected for this well run operation.

## 2.5 Quantification of Odour Impact

Data derived from the previous stages is input to an atmospheric dispersion model. For this assessment the AERMOD model[3] has been applied with due consideration to relevant guidance[4]. This model is widely used and accepted by the EA and UK planning authorities for undertaking such assessments and its predictions have been validated against real-time monitoring data by the USEPA. It is therefore considered a suitable model for this assessment.

Dispersion modelling guidance indicates that at least 3 (and ideally 5) years of meteorological data should be applied to ensure that infrequent weather conditions do not unduly bias the results. This results in a range of predicted impacts for different years of meteorological data and the average value is used to assess compliance, with the range of impacts used to assess likely variation between years and the risk of shorter-term impacts. This is particularly important in relation to odour, where acceptability of impacts is assessed by receptor over long time periods rather than as a result of infrequent or unusual meteorological conditions.

[3] Software used: BREEZE AERMOD Pro, v8.1.0.17

[4] USEPA, Aermod Implementation Workgroup, Aermod Implementation Guide, (EPA-454/B-18-003 April, 2018).

## 2.6 Assessment Scenarios

The new facility would consist of 3 new broiler houses housing approximately 150,000 birds, in addition to the existing 3 houses which typically house 130,000 birds. The existing houses are ventilated by uncapped high speed ridge mounted fans, with exhaust via a single chimney per ridge fan. Whilst under the proposed scenario the new houses would odour (and ammonia) control scrubbers which would also be fitted to one of the existing sheds. Two assessment scenarios have been modelled to represent the typical operation of the existing and proposed facilities.

Scenario 1 impacts relate to 3 existing sheds, stocking a maximum of 130,000 birds. None of the sheds are fitted with odour scrubbers.

Scenario 2 impacts relate to:

- 3 existing sheds, stocking a maximum of 130,000 birds; and
- 3 new sheds, stocking a maximum of 150,000 birds.

One of the existing shed (shed 2) and all 3 of the new sheds are fitted with scrubbers.

The results of the dispersion modelling have been presented in the form of:

- illustrations of the odour footprint as isopleths (contours of concentration) for the criteria selected enabling determination of impact at any locations within the study area; and
- tabulated odour concentrations ($C_{98,\ 1\text{-hour}}$ X $ou_E/m^3$) at discrete receptor locations to facilitate the discussion of results.

# 3.0 REGULATORY STANDARDS AND GUIDELINES

Currently, in the UK there are no statutory numerical standards for assessing the acceptability of predicted odour impacts from quantitative odour impact assessments. On this basis, odour impact criteria are typically based upon guideline documents (predominately based on research from outside of the UK), case law and research which differ depending on the regime i.e. planning (to avoid significant detriment to amenity) or permitting (to avoid unacceptable pollution).

The numerical limits applied have largely been derived from the findings of a limited number of epidemiological assessments where modelled odour impacts have been compared to the findings of quality of life surveys; a dose-effect study. These dose-effect studies have only been undertaken for a limited number of odour types; however they have been used as the foundation for the setting of acceptable odour standards in many countries.

The actual acceptable level of impact will be dependent on the nature (offensiveness) of the odour and the broad sensitivity of the population. To account for this differing numerical limits are often set not only depending on the offensiveness of the odour but also the broad sensitivity of the environment, through consideration of the FIDOL factors.

## 3.1 UK Guidance

UK guidance identifies a range of odour impact criteria depending primarily on the nature of the odour (i.e. its pleasantness/unpleasantness) and the likelihood of causing unacceptable impacts based on the 98$^{th}$ percentile of predicted hourly average concentrations over a year.

It is therefore evident that such criteria apply only to locations where an individual's exposure is likely to occur for prolonged periods of time i.e. residential properties. Where exposure is more transient (i.e. roads, footpaths etc.) the direct application of such criteria should be treated with caution and further consideration should be given to how the duration and frequency of exposure of the individual will influence the acceptability of the predicted impact.

## 3.2 Planning vs. Permitting: PPW

The Welsh Government released Planning Policy Wales (Edition 10) in December 2018. As described above, this includes information for sites which will fall under the Environmental Permitting regime, regulated by NRW:

> *'5.13.3 Planning authorities, other relevant local authority departments and Natural Resources Wales (NRW) must work closely together to ensure that conditions attached to planning permissions and those attached to Environmental Permits are complementary and do not duplicate one another. Sufficient information should accompany development proposals in order for planning authorities to be satisfied that proposals are capable of effective regulation. NRW should assist the planning authority in establishing this position through the provision of appropriate advice. The parallel tracking of planning and environmental permitting applications should be the*

*preferred approach, particularly where proposals are complex, so as to assist in mitigating delays, refusal of applications or conditions which may duplicate the permit/licence.'*

This is the approach that has been adopted in relation to similar applications in Powys.

### 3.3 H4 guidance

The Environment Agency and Natural Resources Wales have published a number of guidance documents relating to odour assessment. These include the Horizontal Guidance EPR H4 – Odour Management[5].

The H4 guidance proposes the use of installation-specific exposure criteria (benchmarks) on the basis that not all odours are equally offensive, and not all receptors are equally sensitive. The conditions of a Permit will balance these installation-specific odour exposure criteria against what is realistically achievable in accordance with the concept of Best Available Techniques (BAT).

The Guidance states:

*'..benchmarks are based on the 98th percentile of hourly average concentrations of odour modelled over a year at the site/installation boundary. The benchmarks are:*

*1.5 odour units for most offensive odours;*

*3 odour units for moderately offensive odours;*

*6 odour units for less offensive odours.'*

Examples of these three categories are:

***'Highly offensive:***

*processes involving 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'*

5 H4 Odour Management: How to comply with your environmental permit.

These benchmark limits are precautionary and may be relaxed in cases where the source is familiar to the location. This is particularly the case in relation to intensive agriculture in a rural setting. For example, research relating to broiler farms indicates that a more representative nuisance threshold for an agricultural area should be anywhere from 3.3 – 8.8 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means[6], or even 9.7 $ou_E/m^3$ (as a 98$^{th}$ percentile)[7]. This is consistent with guidance published in relation to nuisance thresholds as a function of site setting[8,9] and also regulation applied in Ireland, where the Environmental Protection Agency (EPA, Ireland) recommended criterion is 6.0 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means for proposed units. The H4 (and IPPC SRG 6.02) benchmarks should therefore be seen as a guide of the relative likelihood of an odour issue being caused rather than an absolute limit value, particularly in an agricultural setting.

Natural Resources Wales has accepted that the use of the 3.0 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means is acceptable in this case.

### 3.4 IAQM Odour Guidance[10]

On 20$^{th}$ May 2014 the Institute of Air Quality Management released guidance on the assessment of odour for planning. This was updated in 2018.

The guidance is for assessing odour impacts for planning purposes. It provides background information relating to requirements for odour impact assessments and suitable impact criteria and draws from other sources of information such as that described in the H4 guidance (Section 3.3, above).

The IAQM odour guidance requires a degree of professional judgement when considering potential effects of environmental odours. Given the site setting and the number of residences potentially affected, the IAQM odour guidance may be used to classify to the impact from an intensive agricultural facility (i.e. for a 'moderately offensive odour') in an agricultural setting as:

- 'negligible' at, or below 3 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means; or
- 'slight adverse' from 3 $ou_E/m^3$ - 5 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means; or
- 'moderate adverse' impact above from 5 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means.

Only a moderate impact (or greater) would be regarded as 'significant' for purposes of environmental assessment when considering the overall planning balance.

[6] Misselbrook, Clarkson and Pain (1993) *Relationship between concentration and intensity of odours for pig slurry and broiler houses.*
[7] Hayes, E.T., Curran, T.P and Dodd, V.A. (2006) *Odour and ammonia emissions from intensive poultry units in Ireland*. Bioresource Technology 97 pp933-939
[8] EPA (2001) Odour Impacts and Odour Emission Control Measures for Intensive Agriculture. R&D REPORT SERIES No. 14. pp31.
[9] Environment Agency (2002) Assessment of Community Response to Odorous Emissions. R&D Technical Report P4-095/TR. pp63
[10] IAQM (2018) *Guidance on the assessment of odour for planning*

It must be noted that the IAQM Odour Guidance makes it clear that transient receptors (i.e. those walking or driving past the site) or workplaces would not be regarded as 'high' sensitivity receptors and the same odour effect criteria above would not therefore apply to them as should be applied to residences:

**Table 3-1**
**IAQM Sensitivity Classes**

| Sensitivity Class | Description |
|---|---|
| High Sensitivity | Surrounding land where:<br>• users can reasonably expect enjoyment of a high level of amenity; and<br>• people would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land.<br>*Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.* |
| Medium Sensitivity | Surrounding land where:<br>• users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or<br>• people wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.<br>*Examples may include places of work, commercial/retail premises and playing/recreation fields* |
| Low Sensitivity | Surrounding land where:<br>• the enjoyment of amenity would not reasonably be expected; or<br>• there is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.<br>*Examples may include industrial use, farms, footpaths and roads.* |

The IAQM document is not intended to provide guidance on odour for environmental protection regulatory purposes (e.g. Environmental Permitting).

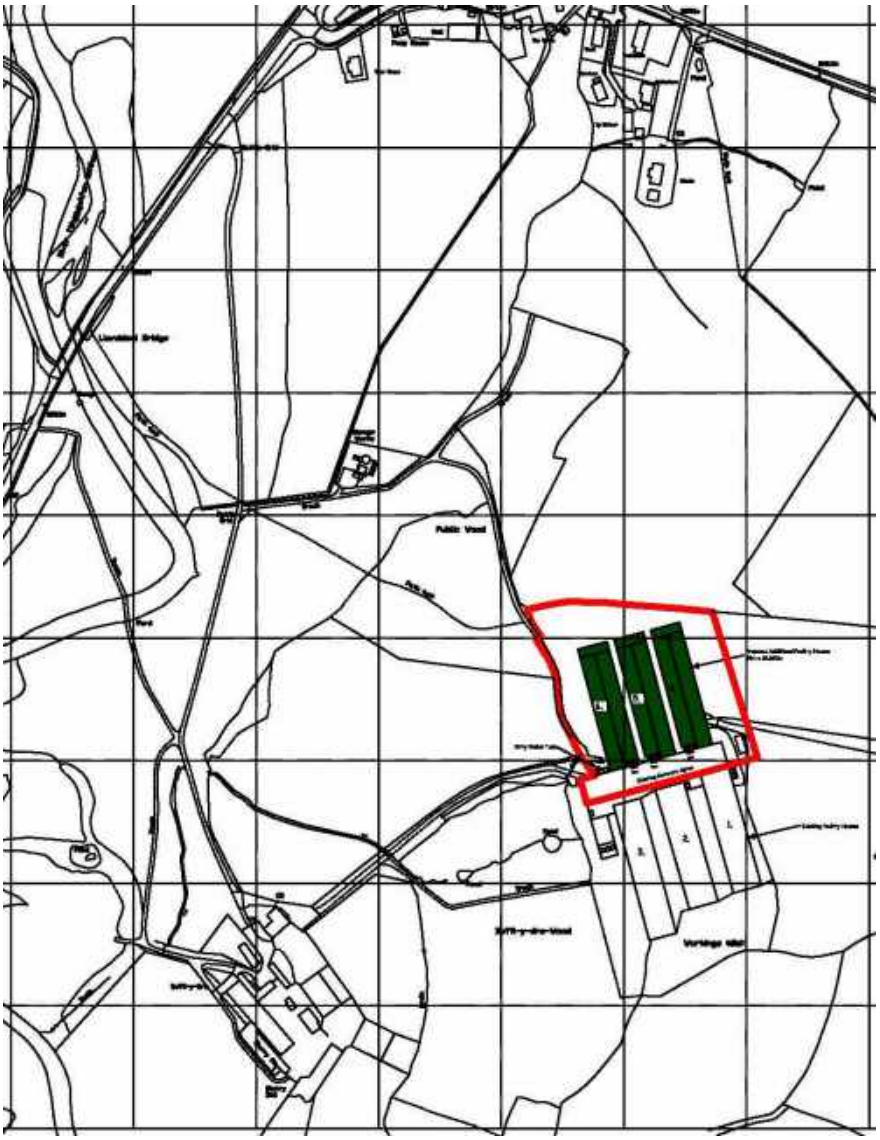
# 4.0 SITE SETTING AND DEVELOPMENT DESCRIPTION

## 4.1 Location

The applicant operates an existing broiler unit farming enterprise at Dolidre (Dol-Y-Dre) Farm. The site lies to the south of Llanddewi Ystradenni, Powys, approximately 8.3km North East of Llandrindod Wells. The surrounding area is hilly with some woodland. The predominant land use is grassland and grazing.

The site is located at approximate site grid reference OS GR 310940, 267920 as shown in Figure 4-1 below.

**Figure 4-1: Site Location**



- *Drawing reproduced with permission from Ian Pick associates*

## 4.2 Site Setting

Discrete receptor locations have been selected for comparative purposes to facilitate the discussion of predicted odour impacts; in general they represent the closest residential locations in each direction. These are as presented in Table 4-1 and shown in Appendix B, Drawing AQ1.

**Table 4-1**
**Discrete Receptor Locations Modelled**

| Reference | Description | National Grid Reference | |
|---|---|---|---|
| | | OS Xm | OS Ym |
| HR1 | Dol-Y-Dre | 310603.7 | 267834.3 |
| HR2 | Gravesend | 310699.7 | 267373.5 |
| HR3 | Briddell | 310315.9 | 267114.6 |
| HR4 | Blaen-Y-Cwm Bungalow | 310882.7 | 266909.9 |
| HR5 | Blaen-Y-Cwm | 310769.6 | 266871.9 |
| HR6 | Hill House | 311732.4 | 266937.6 |
| HR7 | Cwmwrach | 312026.7 | 266927.1 |
| HR8 | The Oaks | 311816.5 | 267464.3 |
| HR9 | Caergyant | 311945.2 | 267732.3 |
| HR10 | Rhosview | 311900.6 | 267951.7 |
| HR11 | Penrhos | 311333.1 | 268193.3 |
| HR12 | Wood Cottage | 311837.5 | 268603.2 |
| HR13 | Cwm_swrw | 312034.5 | 268680.7 |
| HR14 | The Firs | 310097.0 | 267422.4 |
| HR15 | Sunnybank Bungalow | 310027.7 | 267572.3 |
| HR16 | Cae Glas | 309981.5 | 267633.2 |
| HR17 | Rhos-Lauddu | 310107.5 | 267714.4 |
| HR18 | Mayfield | 309965.4 | 267743.8 |
| HR19 | The Brackens | 310191.5 | 268070.8 |
| HR20 | The Retreat | 310356.8 | 268216.4 |
| HR21 | The Retreat (west) | 310334.4 | 268200.3 |
| HR22 | Cartref | 310338.6 | 268567.9 |
| HR23 | Gaer House | 310680.2 | 268560.2 |
| HR24 | The Walsh | 310824.5 | 268594.5 |
| HR25 | Cilcain | 310921.8 | 268457.9 |
| HR26 | Ty Unllawr | 310902.2 | 268514.0 |
| HR27 | Mathafarn | 310920.4 | 268537.1 |
| HR28 | Trefechan | 310912.7 | 268579.8 |
| HR29 | Toll House | 310692.1 | 268616.9 |

In addition to assessment of impact at discrete receptors, a receptor grid has been used to allow the production of an odour isopleth drawing.

### 4.3 Description of Development

The proposal seeks full planning consent for the erection of 3 additional poultry rearing units with associated infrastructure. A site layout plan in shown in Appendix A to this report.

The 3 existing sheds are currently fan ventilated with a fully littered floor equipped with non-leaking drinking systems. In each of the existing broiler houses ventilation is provided by side inlets and high velocity ridge extract fans. Gable end fans on each house are fitted to provide additional cooling during times of extreme hot weather.

Ventilation in the new houses and existing house 2 will be drawn through the gable end air scrubbing systems reducing odour release by 40%.

Each of the sheds is operated in accordance with best practice and BAT standards in EPR 6.09.

- A computer automatically controls ventilation and heating so that heat is not wasted by being drawn out of the building.
- Litter is kept loose and friable. The quality is regularly inspected to ensure it does not become excessively wet or dry.
- Birds are fed a minimum of three diets during their cycle, with gradually reducing levels of protein and phosphorous as bird age increases. Feed is delivered from a UKASTA accredited feed mill and blown into bulk feed bins situated adjacent to the houses, from the feed bins the feed is piped into the houses and distributed to the birds via a pan feeding system.
- Fallen stock will be recorded daily and securely stored in vermin proof containers awaiting regular collection by a licenced renderer.

Odour emissions will be reduced by reduced protein feed, maintaining good litter conditions with dry matter content above 60%.

### 4.4 Stocking

The Environmental Permit for the site allows for a maximum of 280,000 birds distributed across the 6 sheds. For purposes of this odour assessment, this distribution has been assumed as follows:

- Sheds 1 and 2 (existing): 40,000 birds per shed;
- Shed 3 (existing): 50,000 birds; and
- Sheds 4-6 (proposed): 50,000 birds per shed.

The proposed poultry unit will produce standard birds, based on a 38 day growing cycle, with an empty period at the end of each cycle for cleanout and preparation of the buildings for the incoming flock. The unit will operate with approximately 7.5 flocks per annum.

During the growing cycle temperature is controlled within the buildings. The buildings are pre-warmed to a temperature of 32ºC on day 1 of the cycle typically reducing to approximately 18ºC at clear-out of the crop.

### 4.5 Ventilation flows

Ventilation is important for the birds' health and will therefore affect production levels. It is applied when cooling is required, and for maintaining the composition of the indoor air at the required levels. Directive 2007/43/EC lays down minimum requirements for environmental parameters that need to be ensured, namely:

- $NH_3$ concentration not exceeding 20 ppm;
- $CO_2$ concentration not exceeding 3000 ppm;
- indoor temperature, when the outside temperature measured in the shade exceeds 30 ºC, not exceeding this outside temperature by more than 3 °C; and
- indoor average humidity, measured over 48 hours, not exceeding 70 % when the outdoor temperature is below 10 °C.

Design ventilation flows are based on typical industry standards. The roof ridge fans per building will typically operate at low extraction rates on cool days and when the birds are young.

Gable end tunnel fans are available in the event that the temperature within the house may not be maintained by the ridge fans. This is therefore a back-up system only for use on the hottest days and towards the latter stages of the crop.

# 5.0 ODOUR IMPACT ASSESSMENT

The dispersion model was constructed based on the input parameters described below.

## 5.1 Dispersion Modelling Inputs

Detailed dispersion modelling has been completed using the BREEZE AERMOD model.

### *5.1.1 Buildings*

The movement of air over and around buildings and other structures generates areas of flow re-circulation that can lead to increased ground level concentrations of pollutants close to the source. Where the stack height is less than 2.5 times the height of any nearby building (within 5 stack heights), downwash effects and entrainment can be significant.

The Dolidre Farm site details have been provided by the applicant and the specifications for the new buildings are consistent with those submitted for the planning application. A detailed dispersion model constructed on this basis.

**Table 3-1**
**Building Details**

| Building | Width (m) | Length (m) | Basal Height (mAoD) | Angle (°) | No. of stacks |
|---|---|---|---|---|---|
| Shed 1 | 101.4 | 24.0 | 273 | 74.0 | 6 |
| Shed 2 (exist) | 101.4 | 24.0 | 270 | 75.0 | 6 |
| Shed 2 (proposed) | 101.4 | 24.0 | 267 | 75.0 | 3 (scrubber) |
| Shed 3 | 112.8 | 21.8 | 265 | 75.1 | 17 |
| Shed 4 | 95.0 | 24.7 | 265 | 75.1 | 3 (scrubber) |
| Shed 5 | 95.0 | 24.7 | 265 | 75.1 | 3 (scrubber) |
| Shed 6 | 95.0 | 24.7 | 273 | 74.0 | 3 (scrubber) |

The heights of the buildings have been taken as 3.79m for the existing buildings and 5.082m for the new buildings purposes of downwash with these figures calculated as 75% of the average of eaves to ridge taken from the existing and proposed elevations for the site.

### *5.1.2 Meteorology*

In accordance with current guidance, 5 years of meteorological data has been used (2014 – 2018). The site at Shobdon is the closest representative site with a >90% complete data set.

### *5.1.3 Topography*

Elevated terrain reduces the distance between the plume centre line and the ground level, thereby increasing ground level concentrations. Elevated terrain can also increase turbulence and, hence, plume mixing with the effect of increasing concentrations near to a source and reducing concentrations further away. The site is set on sloping ground between 265 and 273m AOD. Information relating to the topography of the area surrounding the site has been used to assess the impact of terrain features on the dispersion of emissions from the site.

Topographical data has been obtained in digital (.ntf) format and incorporated into the assessment.

### *5.1.4 Model Domain*

Modelling was carried out at 25m resolution over a 0.85 km by 0.85 km grid. In addition, the identified potentially sensitive locations, detailed in Table 4-1, were modelled as discrete receptors.

### *5.1.5 Source Parameters*

Modelling inputs for the proposed Dolidre Farm broiler buildings are shown in Appendix C. The emission parameters are as shown in Table 3-1 below and they are identical for all stacks detailed in Appendix C:

**Table 3-1**
**Stack Details**

| Building | Stack height (m) | Stack diameter (m) | Velocity (m/s) |
|---|---|---|---|
| Shed 1 | 5.3 | 1.0 | 10.0 |
| Shed 2 (exist) | 5.3 | 1.0 | 10.0 |
| Shed 2 (proposed) | 3.8 | 2.0 | 5.0 |
| Shed 3 | 5.3 | 1.0 | 10.0 |
| Shed 4 | 5.1 | 2.0 | 5.0 |
| Shed 5 | 5.1 | 2.0 | 5.0 |
| Shed 6 | 5.1 | 2.0 | 5.0 |

The temperature of all emissions has been taken as 22°C for all hours of the year.

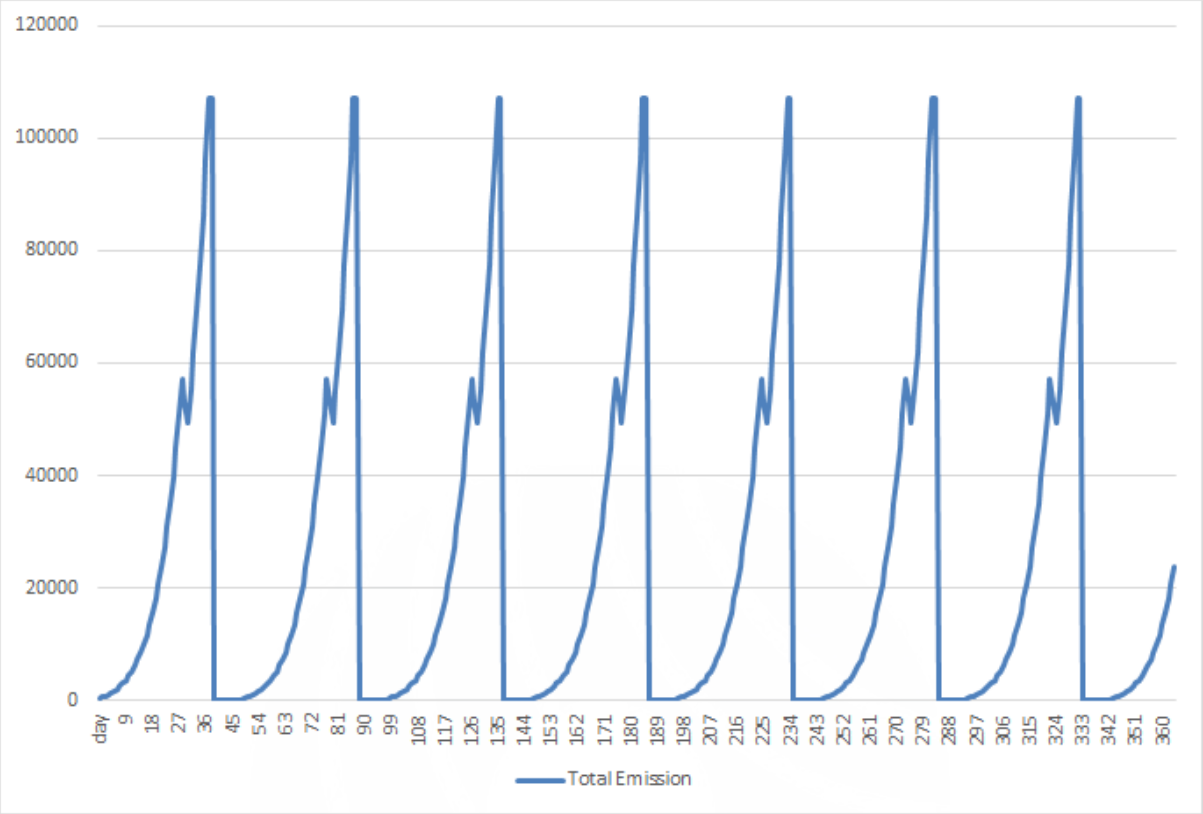
### *5.1.6 Emission Rate*

The emission rates used are calculated from an internal concentration of odour taken from published values which indicate a likely range for a well run modern farm of 300$ou_E/m^3$ – 2600 $ou_E/m^3$ across a 38 day growth cycle.

The time varying emission rates used represent the emissions for each shed housing 50,000 birds) is as shown in Figure 4-1. This is based on a transitional ventilation rate, which is approximately the average of the lowest and highest rates for broiler facilities. It can be seen in Figure 4-1 that the relative proportion of emissions will vary across the cycle, with the peak during the last day of the cycle and clearing out (as would be expected). The drop in the mid cycle relates to the time in the cycle where the flock is thinned.

Research has shown that the use of indirect heating, will result in a significantly improved building environment and lower emissions, particularly of ammonia and carbon dioxide. This in turn improves the growth rate and performance of the birds. The quality of the litter and in particular the moisture content, will also determine the overall odour emission. No quantitative odour reduction factor has been applied in this case to represent indirect heating benefits.

**Figure 4-1**
**Emission rate ($ou_E$/s per 50k bird shed)**




## 5.2 Model Assumptions

The temperature of the flows from the fan units has been assumed at 22ºC, which is at the lower end of the range for the entire cycle (the younger birds will typically be housed at a temperature slightly above this). As the gable end fans are for back-up only, they have not been considered as odour sources given that odour assessment works on the basis of the 98$^{th}$ percentile impact (unlike ammonia ecological impacts, for example, which are calculated as an annual average). This approach has been accepted by NRW for the Permit Application.

## 5.3 Meteorology

### *5.3.1 Local Wind Speed and Direction Data*

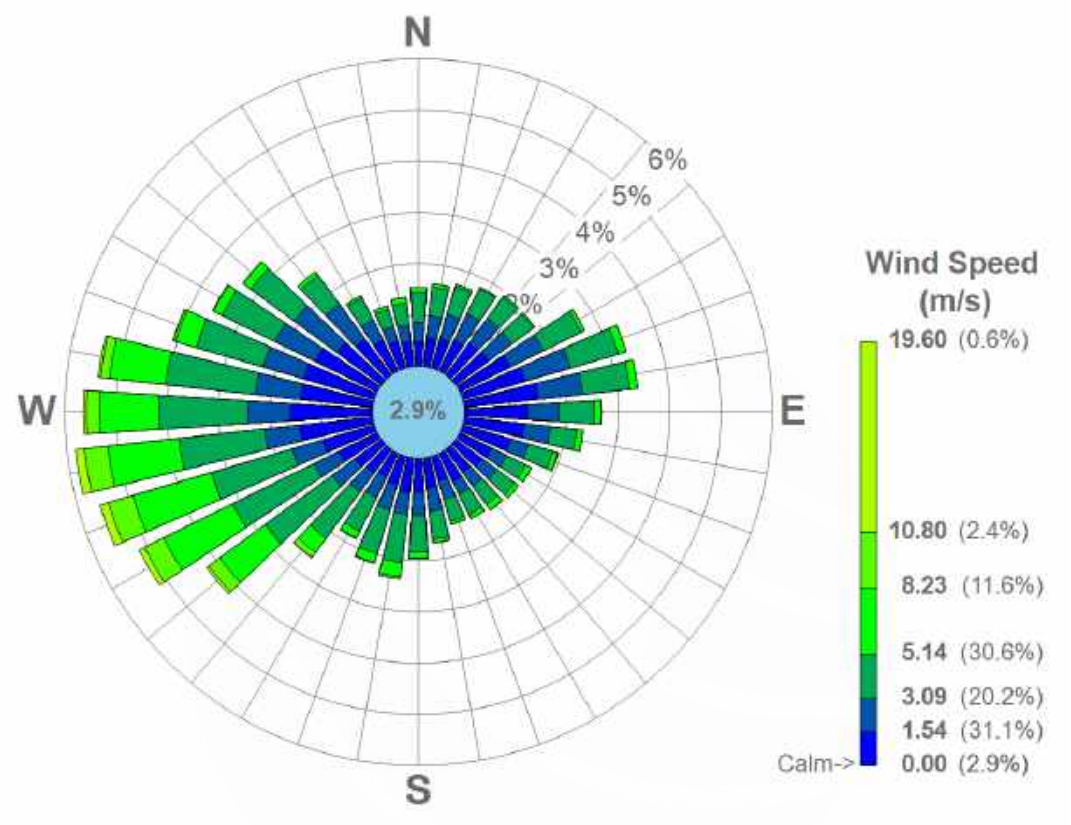
The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability.

For meteorological data to be suitable for dispersion modelling purposes a number of meteorological parameters need to be measured on a continuous basis. There are only a limited number of sites where the required meteorological measurements are made. In the UK, all of these sites are quality controlled by the Met Office.

In accordance with current guidance, 5 years of meteorological data has been used (2014 – 2018). The site at Shobdon is the closest representative site with a >90% complete data set.

A windrose providing the frequency of wind speed and direction for 5 years of data (2014 – 2018) is presented in Figure 5-1, below.

**Figure 5-1**
**Shobdon Data: Windrose (5 years)**




Meteorological data was obtained in .met format and converted to .sfc and .pfl formats for use in AERMOD using AERMET Pro. Shawbury meteorological data has been processed according to US EPA methodology[11]. Surface roughness length is based upon land use characteristics 1km from the point source.

The determination of Bowen ratio and albedo is defined by a 10km by 10km region around the site. The surrounding land use has been characterised as grassland (80%) and forest (20%) with a surface roughness of 0.2m applied.

[11] US Environmental Protection Agency (April 2018). AERMOD Implementation Guide, AERMOD Implementation Group.

### *5.3.2 Temperature*

Analysis of 5 years (2014-2018) meteorological data recorded at Shobdon (the closest recording site) shows that temperatures very rarely exceed 25°C. Missing data has been excluded.

**Table 5-1**
**Shobdon Meteorological Summary (5 years data)**

| Minimum Temp °C | Maximum Temp °C | Number of Hours | % of year | % of year cumulative | Average hours per year |
|---|---|---|---|---|---|
| | <-10 | 4 | 0.01% | 0.01% | 1 |
| -10 | -5 | 100 | 0.2% | 0.24% | 20 |
| -5 | 0 | 1753 | 4.0% | 4.26% | 351 |
| 0 | 5 | 7198 | 16.5% | 20.80% | 1440 |
| 5 | 10 | 13071 | 30.0% | 50.82% | 2614 |
| 10 | 15 | 12726 | 29.2% | 80.04% | 2545 |
| 15 | 20 | 6914 | 15.9% | 95.92% | 1383 |
| 20 | 25 | 1545 | 3.5% | 99.47% | 309 |
| 25 | 30 | 225 | 0.5% | 99.99% | 45 |
| 30 | | 6 | 0.0% | 100.00% | 1 |
| | **TOTAL** | **43542** | **100%** | | **8708** |

# 6.0 RESULTS

Given the site setting, the IAQM odour guidance would regard the impact as follows for high sensitivity receptors (i.e. residences), values that were accepted by NRW at the Permitting stage:

- 'negligible' at, or below 3 $ou_E/m^3$;
- 'slight adverse' from 3 $ou_E/m^3$ - 5 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means (also the EA benchmark criterion for Permitting); or
- 'moderate adverse' impact above from 5 $ou_E/m^3$ as a 98$^{th}$ percentile of hourly means.

It must be noted that the IAQM Odour Guidance makes it clear that transient receptors (i.e. those walking or driving past the site) or workplaces would not be regarded as 'high' sensitivity receptors and the same odour effect criteria above would not therefore apply to them as should be applied to residences.

## 6.1 Existing Facility

The 5-year average odour exposures predicted as a result of emission from the existing facility are presented in Table 6-1 below.

**Table 6-1**
**Scenario 1: Results ($ou_E/m^3$)**

| Ref | 2014 | 2015 | 2016 | 2017 | 2018 | Ave |
|---|---|---|---|---|---|---|
| HR1 | 2.23 | 1.71 | 2.36 | 1.62 | 2.22 | 2.03 |
| HR2 | 0.67 | 0.62 | 0.59 | 0.46 | 0.86 | 0.64 |
| HR3 | 0.34 | 0.30 | 0.36 | 0.23 | 0.49 | 0.34 |
| HR4 | 0.23 | 0.29 | 0.27 | 0.23 | 0.27 | 0.26 |
| HR5 | 0.25 | 0.30 | 0.24 | 0.20 | 0.28 | 0.25 |
| HR6 | 0.24 | 0.21 | 0.42 | 0.50 | 0.31 | 0.34 |
| HR7 | 0.22 | 0.18 | 0.36 | 0.51 | 0.30 | 0.31 |
| HR8 | 0.71 | 0.68 | 1.29 | 1.80 | 1.00 | 1.10 |
| HR9 | 0.77 | 0.73 | 1.18 | 1.45 | 0.96 | 1.02 |
| HR10 | 0.88 | 1.00 | 1.22 | 1.51 | 1.07 | 1.14 |
| HR11 | 1.73 | 1.82 | 1.59 | 1.81 | 1.39 | 1.67 |
| HR12 | 0.51 | 0.49 | 0.40 | 0.49 | 0.34 | 0.44 |
| HR13 | 0.38 | 0.42 | 0.31 | 0.39 | 0.25 | 0.35 |
| HR14 | 0.61 | 0.49 | 0.94 | 0.42 | 0.73 | 0.64 |
| HR15 | 0.82 | 0.65 | 1.24 | 0.55 | 0.89 | 0.83 |
| HR16 | 0.79 | 0.69 | 1.19 | 0.58 | 0.90 | 0.83 |
| HR17 | 0.92 | 0.76 | 1.26 | 0.66 | 1.03 | 0.93 |
| HR18 | 0.69 | 0.65 | 1.00 | 0.60 | 0.85 | 0.76 |
| HR19 | 0.58 | 0.45 | 0.65 | 0.55 | 0.65 | 0.58 |

| Ref | 2014 | 2015 | 2016 | 2017 | 2018 | Ave |
|---|---|---|---|---|---|---|
| HR20 | 0.54 | 0.35 | 0.51 | 0.33 | 0.64 | 0.47 |
| HR21 | 0.58 | 0.38 | 0.54 | 0.35 | 0.63 | 0.49 |
| HR22 | 0.40 | 0.18 | 0.20 | 0.22 | 0.27 | 0.25 |
| HR23 | 0.51 | 0.31 | 0.28 | 0.34 | 0.34 | 0.35 |
| HR24 | 0.59 | 0.40 | 0.35 | 0.42 | 0.41 | 0.43 |
| HR25 | 0.92 | 0.68 | 0.59 | 0.69 | 0.76 | 0.73 |
| HR26 | 0.76 | 0.58 | 0.50 | 0.58 | 0.64 | 0.61 |
| HR27 | 0.74 | 0.56 | 0.49 | 0.55 | 0.61 | 0.59 |
| HR28 | 0.66 | 0.51 | 0.45 | 0.49 | 0.54 | 0.53 |
| HR29 | 0.45 | 0.28 | 0.29 | 0.31 | 0.33 | 0.33 |

Notwithstanding HR1 Dolidre Farm itself, the maximum odour impact at an assessed receptor is predicted to be at HR11 Penrhos, with the concentration for the worst year predicted to be 1.82 $ou_E/m^3$ as a 98$^{th}$ percentile at this location and 1.67 $ou_E/m^3$ as an average across the 5 years of data. The impact would be regarded as 'slight adverse' at this receptor and 'not significant'.

## 6.2 Expanded Facility

The 5-year average odour exposures predicted as a result of emission from the expanded facility (i.e. 6 houses total, of which 3 are new) are presented in Table 6-2 below and Figure 6-1, overleaf.

**Table 6-2**
**Scenario 2: Results ($ou_E/m^3$)**

| Ref | 2014 | 2015 | 2016 | 2017 | 2018 | Ave |
|---|---|---|---|---|---|---|
| HR1 | 2.76 | 2.25 | 3.13 | 1.92 | 2.81 | 2.57 |
| HR2 | 0.84 | 0.82 | 0.76 | 0.60 | 1.10 | 0.82 |
| HR3 | 0.42 | 0.41 | 0.47 | 0.31 | 0.65 | 0.45 |
| HR4 | 0.28 | 0.37 | 0.31 | 0.27 | 0.35 | 0.32 |
| HR5 | 0.31 | 0.38 | 0.31 | 0.25 | 0.34 | 0.32 |
| HR6 | 0.30 | 0.28 | 0.52 | 0.61 | 0.40 | 0.42 |
| HR7 | 0.31 | 0.27 | 0.56 | 0.69 | 0.42 | 0.45 |
| HR8 | 0.91 | 0.84 | 1.62 | 2.20 | 1.15 | 1.34 |
| HR9 | 1.05 | 1.02 | 1.68 | 2.12 | 1.31 | 1.44 |
| HR10 | 1.16 | 1.32 | 1.75 | 1.96 | 1.51 | 1.54 |
| HR11 | 2.82 | 2.98 | 2.93 | 3.11 | 2.57 | 2.88 |
| HR12 | 0.84 | 0.85 | 0.74 | 0.93 | 0.62 | 0.80 |
| HR13 | 0.68 | 0.72 | 0.57 | 0.74 | 0.48 | 0.64 |
| HR14 | 0.79 | 0.63 | 1.18 | 0.57 | 0.98 | 0.83 |
| HR15 | 0.96 | 0.87 | 1.50 | 0.68 | 1.21 | 1.05 |
| HR16 | 1.06 | 0.93 | 1.59 | 0.76 | 1.23 | 1.11 |

| Ref | 2014 | 2015 | 2016 | 2017 | 2018 | Ave |
|---|---|---|---|---|---|---|
| HR17 | 1.29 | 1.06 | 1.76 | 0.86 | 1.39 | 1.27 |
| HR18 | 1.13 | 0.94 | 1.51 | 0.78 | 1.24 | 1.12 |
| HR19 | 0.98 | 0.74 | 1.02 | 0.85 | 0.94 | 0.91 |
| HR20 | 0.92 | 0.67 | 0.76 | 0.64 | 0.95 | 0.79 |
| HR21 | 0.93 | 0.67 | 0.82 | 0.67 | 0.96 | 0.81 |
| HR22 | 0.56 | 0.24 | 0.29 | 0.31 | 0.43 | 0.37 |
| HR23 | 0.83 | 0.45 | 0.37 | 0.54 | 0.57 | 0.55 |
| HR24 | 0.92 | 0.64 | 0.60 | 0.71 | 0.74 | 0.72 |
| HR25 | 1.63 | 1.15 | 1.11 | 1.27 | 1.42 | 1.32 |
| HR26 | 1.36 | 0.94 | 0.89 | 1.02 | 1.16 | 1.07 |
| HR27 | 1.30 | 0.91 | 0.86 | 0.97 | 1.11 | 1.03 |
| HR28 | 1.16 | 0.81 | 0.76 | 0.86 | 0.96 | 0.91 |
| HR29 | 0.71 | 0.44 | 0.37 | 0.50 | 0.53 | 0.51 |

As with Scenario 1, notwithstanding HR1 Dolidre Farm itself, the maximum odour impact at an assessed receptor is predicted to be at HR11 Penrhos, with the concentration for the worst year predicted to be 3.11 $ou_E/m^3$ as a 98$^{th}$ percentile at this location and 2.88 $ou_E/m^3$ as an average across the 5 years of data. The impact would be regarded as 'moderate adverse' for the worst year at this receptor and 'slight adverse' for all other years.

The increase in odour (i.e. difference between existing and expended) is as follows:

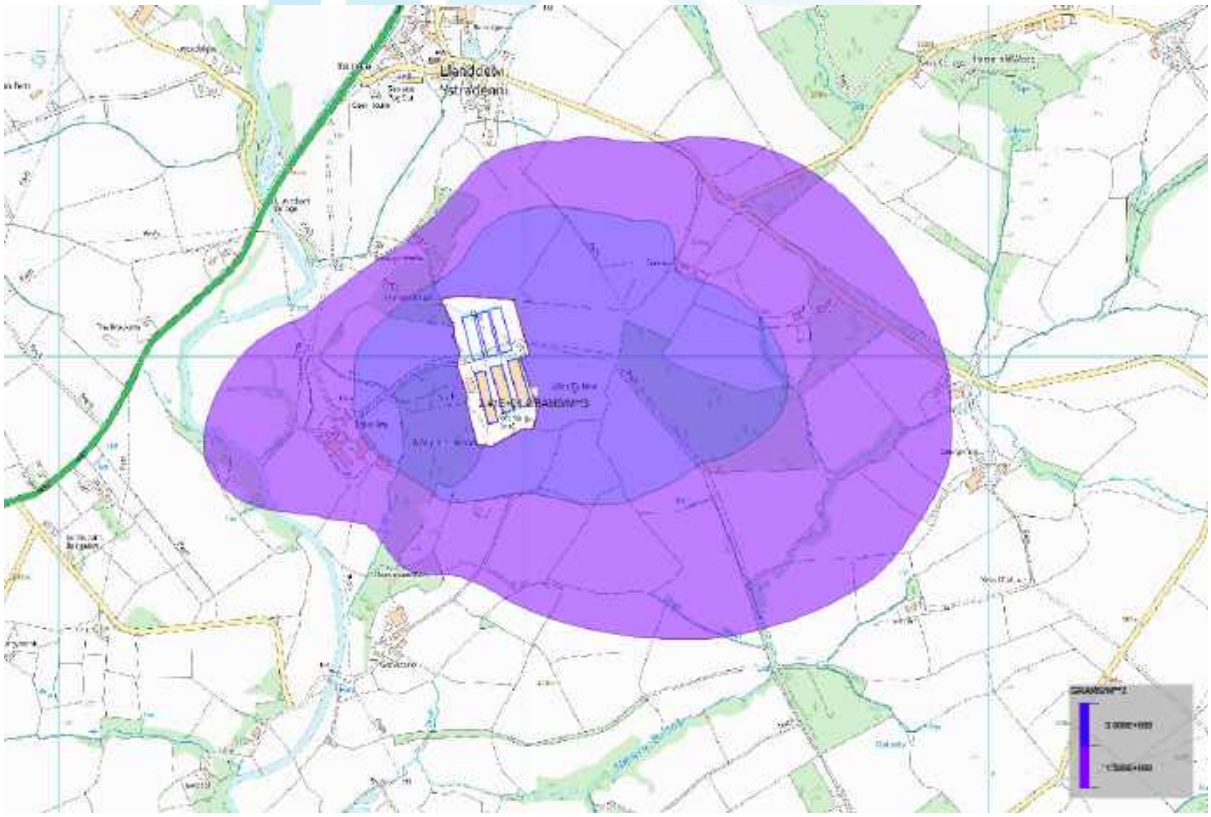
**Table 6-3**
**Increase ($ou_E/m^3$)**

| Ref | 2014 | 2015 | 2016 | 2017 | 2018 | Ave |
|---|---|---|---|---|---|---|
| HR1 | 0.53 | 0.54 | 0.77 | 0.30 | 0.58 | 0.54 |
| HR2 | 0.17 | 0.20 | 0.17 | 0.14 | 0.24 | 0.18 |
| HR3 | 0.09 | 0.11 | 0.11 | 0.08 | 0.17 | 0.11 |
| HR4 | 0.05 | 0.07 | 0.04 | 0.04 | 0.08 | 0.06 |
| HR5 | 0.05 | 0.08 | 0.08 | 0.05 | 0.06 | 0.06 |
| HR6 | 0.06 | 0.07 | 0.10 | 0.11 | 0.09 | 0.09 |
| HR7 | 0.10 | 0.08 | 0.20 | 0.18 | 0.12 | 0.14 |
| HR8 | 0.20 | 0.16 | 0.34 | 0.40 | 0.15 | 0.25 |
| HR9 | 0.29 | 0.29 | 0.50 | 0.67 | 0.35 | 0.42 |
| HR10 | 0.28 | 0.32 | 0.53 | 0.44 | 0.44 | 0.40 |
| HR11 | 1.09 | 1.16 | 1.34 | 1.30 | 1.18 | 1.22 |
| HR12 | 0.34 | 0.36 | 0.34 | 0.45 | 0.28 | 0.35 |
| HR13 | 0.30 | 0.30 | 0.26 | 0.35 | 0.23 | 0.29 |
| HR14 | 0.18 | 0.14 | 0.24 | 0.15 | 0.25 | 0.19 |
| HR15 | 0.14 | 0.22 | 0.26 | 0.13 | 0.33 | 0.22 |
| HR16 | 0.26 | 0.24 | 0.40 | 0.17 | 0.32 | 0.28 |

| Ref | 2014 | 2015 | 2016 | 2017 | 2018 | Ave |
|---|---|---|---|---|---|---|
| HR17 | 0.37 | 0.31 | 0.50 | 0.21 | 0.36 | 0.35 |
| HR18 | 0.44 | 0.29 | 0.51 | 0.18 | 0.38 | 0.36 |
| HR19 | 0.40 | 0.28 | 0.37 | 0.30 | 0.29 | 0.33 |
| HR20 | 0.39 | 0.31 | 0.25 | 0.31 | 0.31 | 0.32 |
| HR21 | 0.35 | 0.29 | 0.27 | 0.32 | 0.33 | 0.31 |
| HR22 | 0.17 | 0.06 | 0.09 | 0.09 | 0.16 | 0.11 |
| HR23 | 0.32 | 0.14 | 0.09 | 0.20 | 0.23 | 0.20 |
| HR24 | 0.33 | 0.24 | 0.25 | 0.29 | 0.33 | 0.29 |
| HR25 | 0.70 | 0.47 | 0.52 | 0.58 | 0.66 | 0.59 |
| HR26 | 0.60 | 0.36 | 0.39 | 0.44 | 0.52 | 0.46 |
| HR27 | 0.55 | 0.35 | 0.37 | 0.41 | 0.50 | 0.44 |
| HR28 | 0.50 | 0.31 | 0.31 | 0.37 | 0.41 | 0.38 |
| HR29 | 0.26 | 0.16 | 0.08 | 0.19 | 0.20 | 0.18 |

The 5-year average odour impact at all locations with respect to the limit criteria are shown in Figure 6-1. The odour isopleths shown are $C_{98}$ 10ou$_E$/m$^3$, $C_{98}$ 1.5ou$_E$/m$^3$.

**Figure 6-1**
**Odour Impacts: Scenario 2**



It must be noted that the facility will not be odour free. Odour will be perceived at locations such as Penhros, however in the average year this will not be at a level which would normally be considered unacceptable at this location according to IAQM Guidance or that from NRW.

Similarly, odour may be perceived by users of the roads alongside the site however these would be of low sensitivity and the perception would be short term.

Furthermore, if additional measures are taken to mitigate this odour, particularly in relation to prevention of odour within the houses through effective litter management (particularly when cleaning out the buildings at the end of the cropping cycle) this would be reduced still further.

These additional operational measures (i.e. control of processes or emissions) remain matters for the environmental permitting process and therefore regulated through the Environmental Permit as detailed in the site Odour Management Plan.

# 7.0 CONCLUSIONS

Isopleth Ltd has been commissioned by Ian Pick Associates Ltd, on behalf of Mr Edward Morgan and Mr James Morgan, to carry out a detailed assessment of odour impacts associated with a proposed extension to their poultry unit at Dolidre (Dol-Y-Dre) Farm, Llanddewi, Llandrindod Wells LD1 6SE.

The type, source and significance of potential impacts have been identified and detailed modelling undertaken in line with guidance issued by Natural Resources Wales.

Dispersion modelling has been completed, which predicts that whilst odour may be perceived the closest locations at the end of the cropping cycle, the proposed development is unlikely to lead to odour impacts at a level which would be regarded by the IAQM or the NRW as unacceptable, when operated in accordance with best practice. This finding is consistent with that of NRW during the Permitting process:

> *'We are satisfied that the risk of odour pollution at nearby receptors is not significant. NRW has assessed the modelling in detail and is satisfied that it accurately represents the predicted odours. It is recognised that this modelling does only represent the expected odour concentrations for 98% of the time and that odours may be higher for the remaining 2% of the time. NRW is not able to ensure that odour impacts on nearby receptors are reduced to zero, but is determined to ensure that they are minimised.'*

Should the odour control measures detailed in the site odour management plan be followed during typical operation and abnormal events, these potential impacts will be reduced even further.

# APPENDIX A


This drawing is to be read in conjunction with the schedule of works

Ian Pick Associates Ltd
Specialist Agricultural & Rural Planning Consultants

Station Farm Offices
Wansford Road
Nafferton
Driffield
East Yorkshire
YO25 8NJ
Tel/Fax (01377) 253363
Mobile 07702814950

CLIENT
**E & J Morgan**
**Poultry Site**
**Dolidre**
**Llandewi**
**Llandrindod Wells**
**Powys, LD1 6SE**

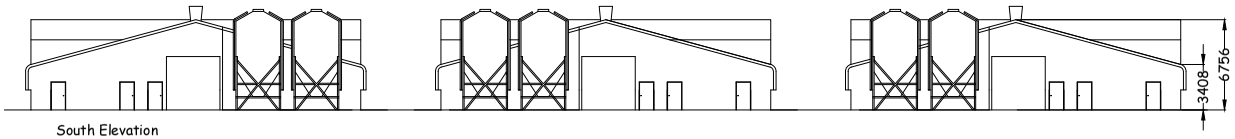
JOB TITLE
**Proposed Poultry Unit Expansion**

DWG. TITLE
**Site Plan**

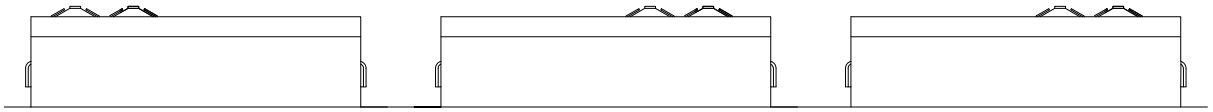
| SCALE | DRN |
|---|---|
| 1=500 | IP |

| DATE | ALTERATION | REV |
|---|---|---|
| --/--/-- | | |

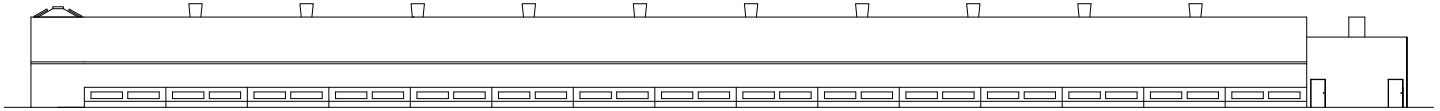
| DWG. NUMBER | DATE | REV |
|---|---|---|
| IP/EJM/02 | Mar 20 | - |



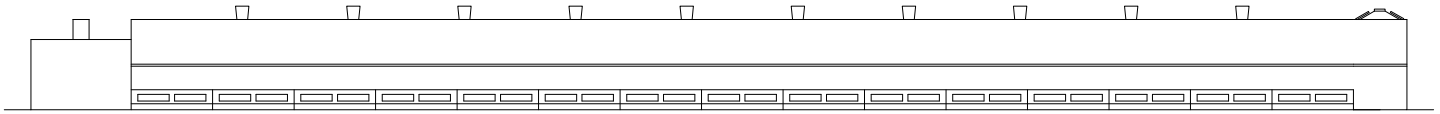

South Elevation



North Elevation



East Elevation



West Elevation

This drawing is to be read in conjunction with the schedule of works

Ian Pick Associates Ltd
Specialist Agricultural & Rural Planning Consultants

Station Farm Offices
Wansford Road
Nafferton
Driffield
East Yorkshire
YO25 8NJ
Tel/Fax (01377) 253363
Mobile 07702814950

CLIENT
**E & J Morgan**
**Poultry Site**
**Dolidre**
**Llandewi**
**Llandrindod Wells**
**Powys, LD1 6SE**

JOB TITLE
**Proposed Poultry Unit Expansion**

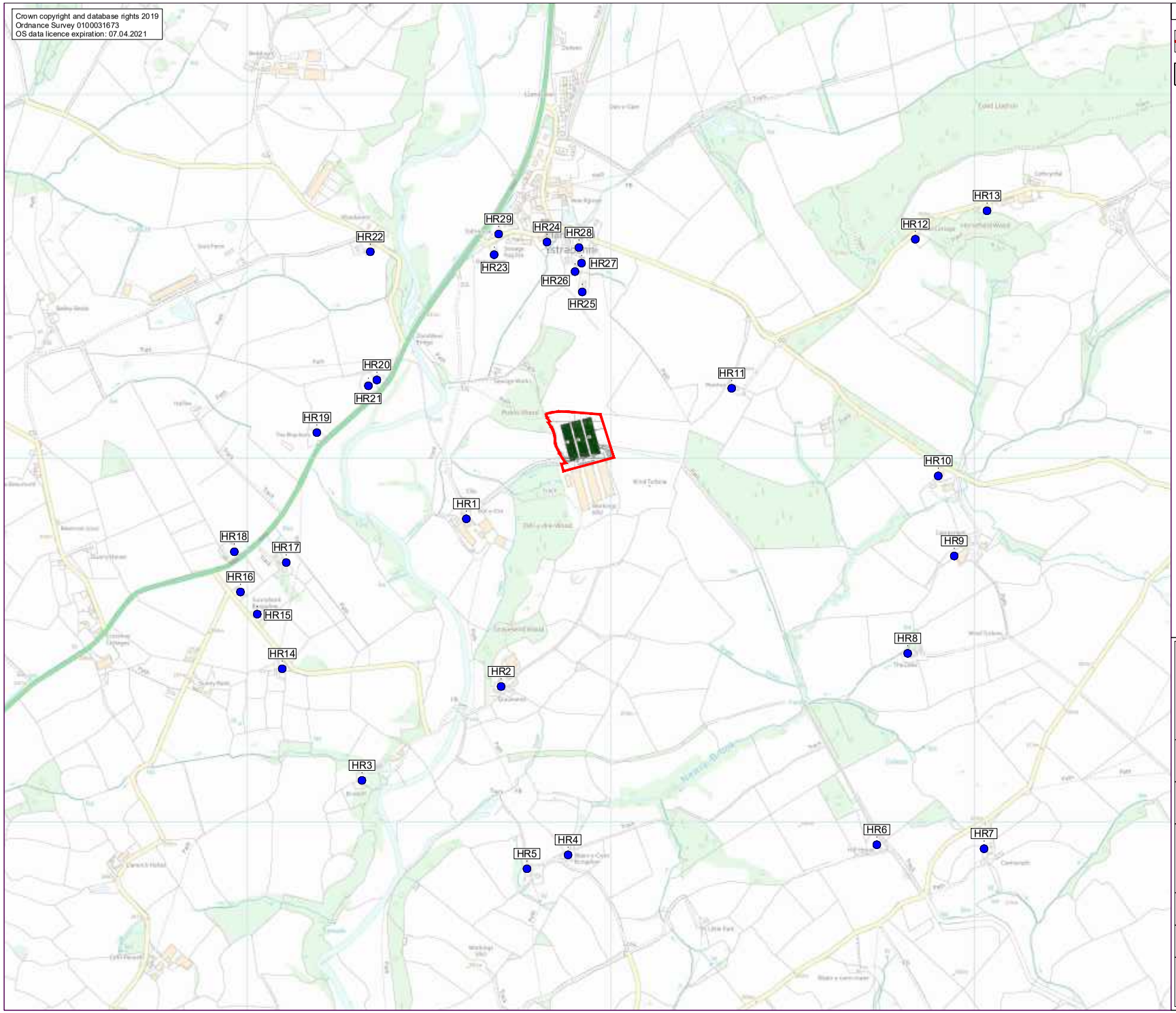
DWG. TITLE
**Elevations**

| SCALE | DRN |
|---|---|
| **1=200** | **IP** |

| DATE | ALTERATION | REV |
|---|---|---|
| --/--/-- | | |

| DWG. NUMBER | DATE | REV |
|---|---|---|
| **IP/EJM/03** | **Mar 20** | **-** |

# APPENDIX B




LEGEND

SITE BOUNDARY

RECEPTOR LOCATION

N
W
E
S

**E&J Morgan**

SITE
**Dol-Y-Dre Farm**

PROJECT
**Air Quality Assessment**

DRAWING TITLE
**Site Setting & Receptors**

| DRAWING NUMBER | REVISION |
|---|---|
| AQ1 | 0 |
| SCALE | DATE |
| 1:10000 @ A3 | 07.04.2020 |

ISOPLETH

# APPENDIX C

**Table C-1**
**Stack Locations: Existing**

| Stack ID | Reference | Location (OS Xm) | Location (OS Ym) | Basal Height (mAoD) |
|---|---|---|---|---|
| B1E1 | Building 1 EXIST | 310974.8 | 267980.8 | 273 |
| B1E2 | Building 1 EXIST | 310991.7 | 267920.3 | 273 |
| B1E3 | Building 1 EXIST | 310982.7 | 267950.7 | 273 |
| B1E4 | Building 1 EXIST | 311002.1 | 267905.3 | 273 |
| B1E5 | Building 1 EXIST | 310992.6 | 267937.3 | 273 |
| B1E6 | Building 1 EXIST | 310983.5 | 267968 | 273 |
| B2E1 | Building 2 EXIST | 310939.3 | 267968.2 | 270 |
| B2E2 | Building 2 EXIST | 310956.2 | 267907.7 | 270 |
| B2E3 | Building 2 EXIST | 310947.2 | 267938.1 | 270 |
| B2E4 | Building 2 EXIST | 310966.6 | 267892.7 | 270 |
| B2E5 | Building 2 EXIST | 310957.1 | 267924.7 | 270 |
| B2E6 | Building 2 EXIST | 310948 | 267955.4 | 270 |
| B3E1 | Building 3 EXIST | 310904 | 267961.4 | 267 |
| B3E2 | Building 3 EXIST | 310905.7 | 267955.2 | 267 |
| B3E3 | Building 3 EXIST | 310907.4 | 267948.9 | 267 |
| B3E4 | Building 3 EXIST | 310909 | 267942.7 | 267 |
| B3E5 | Building 3 EXIST | 310910.7 | 267936.4 | 267 |
| B3E6 | Building 3 EXIST | 310912.4 | 267930.2 | 267 |
| B3E7 | Building 3 EXIST | 310914.1 | 267923.9 | 267 |
| B3E8 | Building 3 EXIST | 310915.7 | 267917.7 | 267 |
| B3E9 | Building 3 EXIST | 310917.4 | 267911.4 | 267 |
| B3E10 | Building 3 EXIST | 310919.1 | 267905.2 | 267 |
| B3E11 | Building 3 EXIST | 310920.8 | 267898.9 | 267 |
| B3E12 | Building 3 EXIST | 310922.4 | 267892.7 | 267 |
| B3E13 | Building 3 EXIST | 310924.1 | 267886.4 | 267 |
| B3E14 | Building 3 EXIST | 310925.8 | 267880.2 | 267 |
| B3E15 | Building 3 EXIST | 310927.5 | 267873.9 | 267 |
| B3E16 | Building 3 EXIST | 310929.1 | 267867.7 | 267 |
| B3E17 | Building 3 EXIST | 310930.8 | 267861.4 | 267 |

**Table C-2**
**Source Locations: Proposed**

| Stack ID | Reference | Location (OS Xm) | Location (OS Ym) | Basal Height (mAoD) |
|---|---|---|---|---|
| B1E1 | Building 1 EXIST | 310974.8 | 267980.8 | 273 |
| B1E2 | Building 1 EXIST | 310991.7 | 267920.3 | 273 |
| B1E3 | Building 1 EXIST | 310982.7 | 267950.7 | 273 |
| B1E4 | Building 1 EXIST | 311002.1 | 267905.3 | 273 |
| B1E5 | Building 1 EXIST | 310992.6 | 267937.3 | 273 |
| B1E6 | Building 1 EXIST | 310983.5 | 267968.0 | 273 |
| B2E1 | Building 2 EXIST | 310975.4 | 267881.6 | 270 |
| B2E2 | Building 2 EXIST | 310967.3 | 267879.1 | 270 |
| B2E3 | Building 2 EXIST | 310958.9 | 267876.7 | 270 |
| B3E1 | Building 3 EXIST | 310904.0 | 267961.4 | 267 |
| B3E2 | Building 3 EXIST | 310905.7 | 267955.2 | 267 |
| B3E3 | Building 3 EXIST | 310907.4 | 267948.9 | 267 |
| B3E4 | Building 3 EXIST | 310909.0 | 267942.7 | 267 |
| B3E5 | Building 3 EXIST | 310910.7 | 267936.4 | 267 |
| B3E6 | Building 3 EXIST | 310912.4 | 267930.2 | 267 |
| B3E7 | Building 3 EXIST | 310914.1 | 267923.9 | 267 |
| B3E8 | Building 3 EXIST | 310915.7 | 267917.7 | 267 |
| B3E9 | Building 3 EXIST | 310917.4 | 267911.4 | 267 |
| B3E10 | Building 3 EXIST | 310919.1 | 267905.2 | 267 |
| B3E11 | Building 3 EXIST | 310920.8 | 267898.9 | 267 |
| B3E12 | Building 3 EXIST | 310922.4 | 267892.7 | 267 |
| B3E13 | Building 3 EXIST | 310924.1 | 267886.4 | 267 |
| B3E14 | Building 3 EXIST | 310925.8 | 267880.2 | 267 |
| B3E15 | Building 3 EXIST | 310927.5 | 267873.9 | 267 |
| B3E16 | Building 3 EXIST | 310929.1 | 267867.7 | 267 |
| B3E17 | Building 3 EXIST | 310930.8 | 267861.4 | 267 |
| B4N1 | Building 4 NEW | 310943.2 | 268107.8 | 265 |
| B4N2 | Building 4 NEW | 310935.3 | 268105.5 | 265 |
| B4N3 | Building 4 NEW | 310926.5 | 268103.1 | 265 |
| B5N1 | Building 5 NEW | 310913.8 | 268099.8 | 265 |
| B5N2 | Building 5 NEW | 310905.4 | 268097.6 | 265 |
| B5N3 | Building 5 NEW | 310896.9 | 268095.3 | 265 |
| B6N1 | Building 6 NEW | 310884.2 | 268092.0 | 265 |
| B6N2 | Building 6 NEW | 310876.1 | 268090.0 | 265 |
| B6N3 | Building 6 NEW | 310867.0 | 268087.2 | 265 |

**Isopleth Ltd**
Ulverston,
53 Englishcombe Lane,
Bath
BA2 2EE
www.isopleth.co.uk

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