

Gaerwen Wind Farm
Environmental Statement
Chapter 12: Other Issues

May 2025

RWE Renewables UK Onshore Wind Ltd

Gaerwen Wind Farm Environmental Statement
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FS566056
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Chapter 12
Other Issues

Introduction

12.1 This chapter presents the findings of the assessment of likely significant effects of the Proposed Development on the following topics:

- Climate Change Mitigation (including carbon balance) and Adaptation;
- Shadow Flicker;
- Telecommunications;
- Aviation;
- Human Health; and
- Major Accidents and Disasters.

12.2 These assessments have been undertaken by LUC (Climate Change Mitigation and Adaptation, Shadow Flicker, Telecommunication, Human Health, and Major Accidents and Disaster), OWC Ltd (Carbon Balance) and Coleman Aviation (Aviation). Further details on expertise of the authors are provided in **Chapter 1: Introduction** and **Appendix 1.1: Statement of Expertise**.

12.3 The assessment of effects is based on the proposed layout as outlined in **Chapter 3: Proposed Development**. Unless otherwise stated, potential effects identified are considered to be adverse.

12.4 A number of additional potential effects have been scoped out of the assessment, including Forestry, Air Quality, Socio-Economics, Tourism and Recreation as detailed in **Chapter 2: Approach to EIA**.

12.5 The following appendices are also referred to throughout the chapter:

- **Appendix 12.1: Carbon Balance Assessment**

- **Appendix 12.2: Aviation Lighting Report**
- **Appendix 12.3: Technical and Operational Assessment**
- **Appendix 12.4: Pre-Planning Application Assessment (MOD)**
- **Appendix 12.5: Wind Farm Lighting CAA Approval Letter**

Climate Change

Introduction

12.6 This assessment considers the potential effects of the Proposed Development on climate change mitigation (including carbon balance) and adaptation and has been undertaken in accordance with the latest good practice guidance[1].

12.7 Climate change poses a serious threat to the global economy, environment and society. It is therefore essential to take it into account in project assessment and decision-making. One of the main drivers of climate change is the increase in Greenhouse Gases (GHGs) in the atmosphere, which is largely caused by burning fossil fuels for electricity production. The Proposed Development aims to produce electricity from a renewable energy source, reducing the reliance on fossil fuel combustion. Consequently, the electricity that will be generated and distributed by the Proposed Development will result in a saving in emissions of Carbon Dioxide (CO_2) with associated environmental benefit. The climate change assessment therefore draws largely on this premise. However, no form of electricity generation is completely carbon free; for onshore there will be emissions resulting from the manufacture of components, as well as emissions from both construction and decommissioning activities and transport.

12.8 This assessment is informed by **Appendix 12.1**. This provides an estimate of the benefit of displacing conventionally generated electricity in the grid, compared to the predicted direct and indirect emissions of carbon resulting from the construction and operation of the Proposed Development over its 35-year lifetime, including losses of stored carbon from felled

[1] Institute of Environmental Management and Assessment (IEMA) (2020) The Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation

forestry. The Scottish Government Carbon Calculator Tool[2,3] provides an estimate of the carbon payback time for the Proposed Development over its lifetime.

Scope of the Assessment

Effects Assessed in Full

12.9 The following effects have been considered:

- Direct CO_2 and nitrogen oxide (NO_X) emissions during construction (including cumulatively);
- Other carbon emissions in the materials and systems which form temporary and permanent structures, arising as a result of the extraction and manufacture of materials, fabrication, transportation to Site, waste and the future demolition and potential re-use;
- The positive contribution that the Proposed Development will make to offsetting CO_2 emissions (CO_2e) arising from construction and decommissioning (including peat and forestry loss) once operational (including cumulatively) (climate mitigation); and
- The ability of receptors, such as species and habitats, to adapt to climate change (climate adaptation) during operation of the Proposed Development, and whether the effects of the Proposed Development on those receptors assessed under the current climate baseline will change with a future climate, i.e. in-combination effects.

Effects Scoped Out

12.10 On the basis of the desk based and field survey work undertaken, the professional judgement of the EIA team, experience from other relevant projects and policy guidance or standards, and feedback received from consultees, the following topic areas have been 'scoped out' of detailed assessment:

- Direct CO_2 and NO_X emissions from vehicles during operation (and cumulatively) as movements associated with turbine maintenance are considered to be minimal;

[2] It should be noted the 'excel spreadsheet tool' has been used in this instance, due to the unsuitability of the online tool on sites where the average peat depth approaches zero. Detailed methodology is provided in **Appendix 12.1**.
[3] As there is no Welsh tool, the Scottish Government tool is considered the accepted standard, and the most relevant and reliable tool to assist with the assessment.

- The ability of receptors to adapt to climate change during construction of the Proposed Development as these effects are assessed over a term longer than the construction period, i.e. over the 35-year operational period;
- The ability of receptors to adapt to climate change during operation of the Proposed Development in combination with other nearby wind farms as this is largely a matter relating to the project itself, namely the project's resilience to climate change and the extent to which projected climate change could alter the predicted effect judgements; and
- Indirect emissions arising from the demand for energy produced using fossil fuels (e.g. electricity for heating, cooling and lighting).

Assessment Methodology

Legislation and Guidance

Guidance

12.11 This assessment is carried out in accordance with the principles contained within the following documents:

- IEMA (2022) Assessing Greenhouse Gas Emissions and Evaluating their Significance (2nd Edition)[4]; and
- IEMA (2020) The Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation[5].

Consultation

12.12 In undertaking the assessment, consideration has been given to the scoping responses and other consultation which has been undertaken as detailed in **Table 12.1**.

[4] Institute of Environmental Management and Assessment (IEMA) (2022) Assessing Greenhouse Gas Emissions and Evaluating their Significance (2nd Edition)
[5] Institute of Environmental Management and Assessment (IEMA) (2020) The Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation

Table 12.1 Consultation Responses

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
Planning and Environment Decisions Wales (PEDW) 16.09.2021	Scoping	The Inspectorate welcomes the inclusion of a carbon balance assessment within the ES. Vulnerability of the proposal to climate change/extreme climate events should also be covered in aspect chapters of the ES where relevant and a summary table to draw this information together should be included.	A carbon balance assessment has been included as **Appendix 12.1**. The individual topic chapters are concerned with the receptors relevant to the topic in question. These are generally receptors other than the Proposed Development itself, and in these cases the implications of climate change for the Proposed Development's effects have been considered. However, where relevant to the topic-based assessments, the vulnerability of the Proposed Development to the consequences of climate change has been taken into account. Key examples in this respect include flood risk and peat landslide. A summary in both respects has been provided below.
Denbighshire County Council 09.08.2021	Scoping	Due to the increased incidence of extreme weather as a result of climate change, the Council also disagree	Major Accidents and Disasters as a result of climate change has been addressed in the **Adaptation** section of this chapter.

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		that vulnerability of the proposed development to risks of major accidents and/or disasters should be scoped out as the development could be exposed to extreme storm events.	

Study Area

12.13 The study area for calculating environmental carbon stores of relevance to the Proposed Development in **Appendix 12.1** has been the Site under existing conditions. The assessment considers the effects of the Proposed Development on the global climate, with specific reference to the climate changes expected in the UK. These have been defined using the UK's climate change projections (UKCP18)[6], which allows climate change to be projected at the regional level, in this case, Wales. The effects of climate change on the Proposed Development have largely been assessed in relation to the Site and its immediate surroundings.

12.14 The carbon payback assessment considers both the emissions and savings of greenhouse gases that are linked to the Proposed Development, regardless of where they occur. The Site footprint affects the land-based emissions from peat and habitat losses, but other factors, such as the emissions from the steel production for turbines, also contribute to the carbon payback, even if they occur in other locations.

Desk Based Research and Data Sources

12.15 The following data sources have informed the assessment:

[6] Met Office (2018) UK Climate Projections (UKCP)

- UK Climate Projections (UKCP18)[6];
- Department for Business, Energy and Industrial Strategy (BEIS): National Statistics publication Energy Trends. Table 6.1. Renewable Electricity Capacity and Generation[7];
- Scottish Government Carbon Calculator Tool[8]; and
- RenewableUK Wind Energy Statistics**.**

Field Survey

12.16 The assessment was desk based, drawing largely from published guidance and data. Peat depth probing was undertaken to inform the layout of the Proposed Development, and this data was also used to inform the carbon balance assessment (see **Appendix 9.5: Peat Management Plan**).

Assessing Significance

Contribution to the Mitigation of Climate Change

12.17 All emissions contribute to climate change. However, specifically in the EIA context, the IEMA guidance[4] provides relative significance descriptions to assist with assessments. A number of distinct levels of significance have been defined, which are not solely based on whether a project emits GHG emissions alone, but how the project makes a relative contribution towards achieving a 1.5°C aligned transition towards net zero.

12.18 The UK has set a legally binding GHG emission reduction target for 2050, which is a commitment to ensure a reduction a GHG emissions by 100% from levels recorded in 1990 with interim five-yearly carbon budgets which define a trajectory towards net zero. The IEMA guidance states (in Section 6) *"The 2050 target (and interim budgets set to date) are… compatible with the required magnitude and rate of GHG emissions reductions required in the UK to meet the goals of the Paris Agreement, thereby limiting severe adverse effects… To meet the 2050 target and interim budgets, action is required to reduce GHG emissions from all*

[7] Department for Business, Energy and Industrial Strategy (2021) National Statistics Publication – Energy Trends – Table 6.1: Renewable electricity capacity and generation
[8] Smith et al. (2011) Carbon Implications of Windfarms Located on Peatlands – Update of the Scottish Government Carbon Calculator Tool (Version 2 (as updated))

sectors, including projects in the built and natural environment. EIA for any proposed project must therefore give proportionate consideration to whether and how that project will contribute or jeopardise the achievement of these targets" (page 23).

12.19 Furthermore, the guidance also states the following *"The crux of significance therefore is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050"* (page 24).

12.20 The IEMA guidance also states that further budgets are set by the devolved administration in Wales, which is also consistent with a achieving a 1.5°C aligned transition towards net zero.

Significance

12.21 For the purposes of this assessment, this guidance has been interpreted as outlined in **Table 12.2** and has been used to determine significance of effects.

Table 12.2 Significance Criteria

Significance of Effect	Description
Adverse (major or moderate)	The Proposed Development is not compatible with the UK's and Wales' budgeted net zero trajectory. Further evaluation will be required to determine whether this is of Major or Moderate significance.
Adverse (minor or negligible)	The Proposed Development will be a net generator of GHG emissions but is compatible with the UK and Wales' budgeted net zero trajectory. Further evaluation will be required to determine whether this is of Minor or Negligible significance.
Positive (major, moderate or minor)	The net GHG emissions associated with the Proposed Development will be negative. Further evaluation in the context of the UK and Wales' budgeted net zero trajectory will be required to determine whether this is of Major, Moderate or Minor significance.

Climate Change Adaptation

12.22 The purpose of the in-combination climate assessment is to determine whether the significance of effects of the Proposed Development on a given receptor (under the existing climate baseline) are likely to be changed by future climatic conditions and whether the Proposed Development is likely to affect a receptor's ability to adapt. Significance of effects are determined through the following steps:

- Receptors identified and assessed in the topic chapters of the ES under the current climate baseline are evaluated to determine whether the susceptibility and vulnerability as well as their value/importance will change with the future climatic conditions defined. A high value receptor that has very little resilience to changes in climatic conditions should be considered more likely to be significantly affected than a high value receptor that is very resilient to changes in climatic conditions.
- The magnitude of the effects on the receptors under the existing climate baseline is evaluated to determine whether the probability and/or consequence of the effect changes with the future climatic conditions.
- Building on the evaluation of sensitivity and magnitude of the effect, an assessment is undertaken to identify whether the additional effects of future climate impacts alter the sensitivity and/or magnitude of the effect so that the level of significance of the effects within other topics identified against baseline conditions changes. The assessment uses the significance criteria used by other topics assessed in the ES i.e. if a Minor (adverse) effect on direct habitat loss is not likely to change under a future climatic scenario, then the in-combination effect (effect of the Proposed Development with future climate change) remains as Minor (adverse).

Assessment Assumptions

12.23 In considering future climate change scenarios, IEMA guidance recommends the use of the UK Climate Projections (UKCP18) website. It provides 'probabilistic' projections for various variables such as temperature, precipitation and sea level rise. Wind speed and storm

frequency/intensity are not included in the probabilistic projections because global modelling data is not readily available.

12.24 The current projections, UKCP18[9], updated in August 2022, are now the most up to date climate change projections available. They were released to replace the dataset from November 2018. The climate projections website states that UKCP18 provides a valid assessment of the UK's future climate over land, but that when considering decisions that are sensitive to projected future changes in summer rainfall, additional information should also be used.

12.25 The UKCP18 projections for temperature and precipitation are presented for the UK as a whole and also on a regional basis. The UK projections consider three variables:

- Timeframe: The projections are presented for four overlapping time periods (2020s, 2040s, 2060s and 2080s).
- Probability: The projections are provided as probability distributions rather than single values, with figures provided for 5, 10, 50, 90 and 95% probability.
- Representative Concentration Pathways (RCP): Four pathways have been adopted; RCP2.6, RCP4.5, RCP6.0 and RCP8.5. These pathways describe different greenhouse gas (GHG) and air pollutant emissions as well as their atmospheric concentrations and land use with each one resulting in a different range of global mean temperature increases over the 21st Century. RCP2.6 represents a scenario which aims to keep global warming likely below 2°C compared to pre-industrial temperatures. RCP4.5 and RCP6.0 represent intermediate scenarios while RCP8.5 is the highest impact emission scenario. All scenarios are considered to be equally plausible.

12.26 **Table 12.3** below explains the assumptions made in applying the UKCP18 projections to the assessment of the Proposed Development. The IEMA guidance states *"Recommended best practice is to use the higher emissions scenario (RCP 8.5 in the latest UKCP18 projections) at the 50th percentile, for the 2080s timelines, unless a substantiated case can be made for not doing this (e.g. anticipated lifespan of the project is shorter than 2080s)"* (page 44).

[9] Department for Environment, Food and Rural Affairs, Department for Business, Energy and Industrial Strategy, Met Office and Environment Agency (2022) UKCP18 Key Results

Table 12.3 Climate change assessment assumptions

Variable	Assumptions	Rationale
Timeframe	2060-2079	This is considered a realistic timeframe given the anticipated operational lifespan (35 years) of the Proposed Development.
Probability	50th percentile used to establish what is projected as the central estimate with consideration given to the lowest (5th) and highest (95th) percentiles to determine the lowest and highest projections that could happen within the timeframe.	Rather than a single best estimate value, a range of possible results are presented to provide a clearer picture regarding the level of confidence in different outcomes.
RCP	RCP8.5	RCP8.5 is selected as recommended in the IEMA guidance and allows for a worst-case scenario future climate to be defined resulting in a conservative assessment.

12.27 All key assumptions made with input data for the carbon calculator are set out in **Appendix 12.1**.

Limitations

12.28 The key limitations to the assessment of effects in this sub-topic are as follows:

- Estimated carbon losses in the calculator are a conservative worst case.
- The carbon calculator does not account for carbon emissions and direct CO_2 and NO_X emissions from Heavy Goods Vehicles (HGV) (including cumulatively) transporting

components, materials and their production (including stone, concrete, solar panels and batteries) and staff to Site during construction, but rather only emissions associated with turbine life and emissions associated with their production, and so a qualitative approach has been used in regards to transport emissions in the assessment. This effect can therefore only be assessed qualitatively in the absence of a whole life cycle carbon assessment.

- The carbon calculator does not account for emissions associated with the working of machinery onsite such as excavators and generators.
- It is beyond the scope of this assessment to quantitively assess the cumulative offsetting effects of other schemes, and so any other positive effects identified are qualitative and based on professional judgement.

12.29 Whilst some information gaps have been identified, it is considered that there is sufficient information to enable an assessment of likely significant environmental effects of the Proposed Development with respect to climate change to be undertaken in an appropriately informed, reasoned and transparent manner.

Baseline Conditions

12.30 **Table 12.4** below outlines the summary of climate change projections in relation to temperature, precipitation, wind speed and storms. This data has been provided to authors to consider in the individual topic chapters (**Chapters 5-12**) to consider when describing baseline conditions.

Table 12.4 Projected Climate Change

Climate Variable	Projected Change
Temperature	Temperatures in Wales are projected to increase, with projected increases in summer temperatures greatest. The central estimate of increase in winter mean temperature is 2.2ºC; it is very unlikely to be less than 0.2ºC and is very unlikely to be more than 4.3ºC. The central

Climate Variable	Projected Change
	estimate of increase in summer mean temperature is 3.3ºC; it is very unlikely to be less than 0.8ºC and is very unlikely to be more than 5.9ºC.
Precipitation	Winter rainfall is projected to increase, and summer rainfall is most likely to decrease. The central estimate of change in winter mean precipitation is 15%; it is very unlikely to be less than -7% and is very unlikely to be more than 43%. The central estimate of change in summer mean precipitation is -25%; it is very unlikely to be less than -55% and is very unlikely to be more than 7%. The UKCP18 projections show a general trend towards warmer, wetter winters and hotter, drier summers. However, it should be noted that rainfall patterns across the UK are not consistent and will vary dependent on seasonal and regional scales and will continue to vary in the future.
Wind Speed and Storms	The projections for wind speed changes at the regional level are still uncertain and currently unavailable. However, some small changes in wind speed have been projected (Defra, DECC and Met Office, 2010). The UK is likely to experience higher near surface wind speeds in the latter half of the 21st century, especially in winter (Met Office, 2018). Winter storms over the UK are also expected to become more frequent. The projected increase in wind speeds, however, is modest.

Implications of Climate Change for the Proposed Development's Effects and Vulnerability of the Proposed Development to Climate Change

12.31 It is considered that baseline conditions will not be influenced by the climate change projections for the following assessments:

- Access, Traffic and Transport: It is considered that climate change projections will not have a discernible impact on the baseline conditions for road traffic within the timescales of the Proposed Development. It is assumed that, at regional level, appropriate measures will be put in place to ensure flood risk is managed and does not have long term effects on transport infrastructure.
- Aviation: It is considered that climate change projections will not have a discernible impact on the baseline aviation receptors considered and their operation. It is assumed that appropriate measures will be put in place to ensure that aviation radar installations will be able to withstand and adapt to changes in climate given the importance of maintaining civil and military air safety and defence.
- Shadow Flicker: Effects due to shadow flicker are intrinsically linked to weather; therefore, there is the potential that the current baseline sunny daylight hours could be affected in the future due to climate change. The baseline percentage of sunny daylight hours per year is, however, not expected to change over the 35-year operational life of the Proposed Development to such a degree that the assessment of effects of shadow flicker will be materially affected.
- Telecommunications: The future climate scenario is not expected to alter the existing siting and maintenance of utilities or telecoms infrastructure (including known links).
- Noise and Vibration: The climate change projections over the operational period of the Proposed Development highlight that summer and winter temperatures are likely to be greater than the current baseline (greater for summer), with winter rainfall increasing and summer rainfall decreasing. Section 4.3 of **Appendix 11.1: Environmental Noise Assessment** explains that the background noise survey has endeavoured to minimise the influence of increased water flow in the current background noise environment. Accordingly, it is considered the baseline background noise levels would remain representative for the purposes of an ETSU-R-97 assessment when considering the potential effects of climate change.
- Major Accidents and Disasters: The future climate scenario is not expected to alter any risks identified relating to accidents and disasters.

12.32 Further consideration has been given to baseline conditions likely to be influenced by projected climate change in the following assessments:

- **Landscape and Visual Amenity**: UKCP18 projections highlight that in the 2060s, summer and winter temperatures are likely to be greater than the current baseline (greater for summer), with winter rainfall increasing and summer rainfall decreasing. The Landscape Institute's Position Statement on Climate Change acknowledges that changes in average temperatures, precipitation and extreme weather events will have an effect on the landscape. Whilst there appears to be no certainty of what the impacts of such climatic changes will be in the future, it is clear that these changes will affect the landscape, including the landscape of the study area.
- **Hydrology, Hydrogeology, Geology and Peat**: In line with climate change projections, the Site is likely to get wetter with higher peak flows in the watercourses in the future. Site drainage and watercourse crossing designs will consider future estimates of increased precipitation and flows and will follow an adaptive approach, as per relevant guidance. Climate change will also affect the water quantity and quality of water resources used for PWSs and public drinking water supplies. Increased seasonal aridity and wetness as a result of climate change also poses risks to soils including changes in ALC grades, loss of soil structural stability, loss of soil carbon/organic matter and increased erosion of soil. This will have a higher effect on organic/peat soils than mineral soils. The scope of mitigation set out in **Chapter 9: Geology, Hydrology, Hydrogeology and Peat** has been provided taking these changes into consideration.

  A flood consequence assessment has also been carried out which considers all potential flood risks to and from the Proposed Development. Following current guidance and the Development Advice Map (DAM), it is understood that as the Proposed Development falls within 'Flood Zone A' it is at little or no risk of flooding due to extreme climate change events. Increases in rainfall intensity have been factored into calculations for surface water runoff for the Site. Further details are set out in **Appendix 9.7: Flood Conditions Assessment** and **Appendix 9.9: Outline Drainage Strategy**.

  With respect to peat, a review has been undertaken as to whether prior incidences of instability have occurred at the Site and whether contributory factors that might lead to

instability in the future are present across the Site (**Appendix 9.10: Peat Landslide Hazard and Risk Assessment**). Several factors that may trigger a peat landslide are linked either directly or indirectly to climate e.g. earthquakes and intense rainfall. The results of the assessment indicate that the landslide susceptibility of majority of the peat within the Site has a 'Low' likelihood with only isolated pockets of 'Very Low' likelihood and areas of Moderate likelihood focused primarily in areas of steeper slope. There are no areas identified with 'High' or 'Very High' landslide susceptibility.

- **Ecology**: The predicted effects of climate change are likely to have a bearing on the future ecological status of the Site. The UK Climate Projections generally predict hotter, drier summers and milder, wetter winters, with an increase in the number of heavy rain days and the frequency of winter storms. These predicted changes in climate may result in changes to vegetation assemblages and there is a general trend towards species moving northwards and upslope as the climate warms. Where species are unable to disperse and shift their range, they will be at risk of localised extinctions. Extreme weather events are also likely to compound this effect; heat stress in particular has been shown to lead to community composition changes in macro-invertebrates in headwater streams; it also affects livestock physiology and behaviours such that the effects of grazing may alter.
- **Ornithology**: The predicted effects of climate change are likely to have a bearing on the future ornithological community at the Site and in the wider region. The warmer, drier summers and milder, wetter, winters may result in changes to bird distribution and bird behaviour in the longer-term; however, the baseline bird community detailed here is considered to provide a valid description of the ornithological assemblage over the lifespan of the Proposed Development. For birds in general, climate change has shifted the time of bird breeding and migration, with both these events becoming earlier. There are concerns that changes in the timings of key events between different taxa will become misaligned (e.g. the peak leaf eating caterpillar emergence will not align with the peak demand for breeding songbirds).

  An assessment of climate change impacts on upland bird species (i.e. the habitat present at the Site), identified that 19 UK upland bird species are vulnerable to climate change,16 are at high risk of climate-related declines, and none are likely to increase in response to

climate change. For upland breeding waders that rely on wet habitats for foraging and prey resources, increases in spring and summer temperature and drought frequency due to climate change may reduce prey abundance, which correlates with observed population declines. For species such as curlew, the negative effects of climate warming have been demonstrated, although there are other factors such as an increase in generalist predators, intensive agriculture and forestry in the uplands that are linked to the decline in curlew numbers. For raptors, whilst typical upland species are at risk of decline, with warmer temperatures, species such a hobby are colonising areas further north than their range has typically covered, increasing their likelihood of presence at or close to the Site. Overall, the Proposed Development will have no significant effects on ornithological species' ability to adapt to climate change.

- **Cultural Heritage**: It is likely that any (known and unknown) preserved archaeological remains present within the Site may become damaged through natural erosion, including as a result of increased rainfall through climate change.

Future Baseline in the Absence of the Proposed Development

12.33 The UKCP18 projections indicate that the UK will generally have warmer and wetter winters, as well as hotter and drier summers. However, the amount and distribution of rainfall per season will vary by region across the UK, as well as between individual years.

Design Considerations (Embedded Mitigation)

12.34 The Proposed Development aims to produce electricity from a renewable energy source, reducing the reliance on fossil fuel combustion for power generation. This will lead to lower CO_2 emissions and environmental benefits. The design process has considered all the environmental constraints, while maximising the renewable energy output from the Site.

12.35 The following modifications and design considerations have been made during the iterative EIA process, and relate to the issues considered in this assessment:

- Two temporary borrow pits will be created to extract stone for construction purposes, such as tracks, hard standings and compounds. This will reduce the amount of construction traffic and emissions estimated in **Chapter 10: Traffic and Transport**.
- New woodland planting proposals (set out in **Appendix 3.3: Forestry** and **Appendix 7.7: Outline Habitat Management Plan**) will act as a means of sequestering and storing carbon and will help to intercept heavy rainfall and reduce associated flooding risks.
- Requirements to excavate and relocate peat have been avoided.
- Modern turbines are designed and constructed to withstand the forces likely to be exerted on them, often in remote environments which are regularly subject to high wind speeds. Adherence to relevant design and safety standards ensures that there is extremely limited risk of structural failure of turbines or foundations from high winds or temperatures.

Micrositing

12.36 The Proposed Development seeks a general 50 m micrositing allowance where feasible to adjust the layout in case of poor ground conditions during construction. This chapter's assessment of the magnitude and significance of effects will not change due to this allowance.

Assessment of Construction Effects

12.37 The assessment of effects is based on the project description as outlined in **Chapter 3**. Unless otherwise stated, potential effects identified are considered to be negative.

Predicted Construction Effects

Carbon Emissions including Direct CO_2 and NO_x Emissions

12.38 The life cycle of a wind turbine involves various stages that contribute to carbon dioxide emissions. These stages include production, transportation, erection, concrete production, operation, dismantling and removal of the turbine and its foundation at the end of its life.

12.39 The Proposed Development will have its highest level of vehicle movements during the construction period. The peak construction time will be Month 6 of 15-month construction programme, with 116 vehicles per day (34 cars and 82 HGVs) as stated in **Chapter 10**.

12.40 The emissions from these vehicles are not estimated in the carbon balance assessment, but the emissions associated with construction are considered to be substantially reduced, due to the use of an onsite borrow pit for stone and concrete batching taking place onsite. This would substantially reduce the need for HGV deliveries (82 HGVs) and associated emissions.

12.41 Overall, the Proposed Development will be a net generator of GHG emissions during construction. Based on qualitative consideration of the likely scale of emissions, and in accordance with the assessment methodology, a **Minor (negative)** effect is predicted which will be **Not Significant**.

Proposed Mitigation (Additional Mitigation)

12.42 No specific mitigation measures are proposed in relation to climate change although, **Chapter 10** highlights the implementation of a Construction Traffic Management Plan (CTMP) that will be followed as a good practice during the construction phase. The CTMP aims to reduce the environmental impact of traffic by implementing efficient strategies and avoiding unnecessary trips.

Residual Construction Effects

12.43 All residual effects are considered to be **Minor (negative)** and **Not Significant**.

Assessment of Operational Effects

12.44 The assessment of effects is based on the project description as outlined in **Chapter 3** and related assumptions in the carbon balance assessment. Unless otherwise stated, the potential effects are considered to be negative.

Predicted Operational Effects

Carbon Losses and Savings

12.45 The Proposed Development will produce renewable electricity from wind power, reducing reliance on fossil fuels and contributing also to the low-carbon transition of heat and transport sectors. Based on the candidate turbine detailed in **Chapter 3**, the wind farm will have a maximum capacity of up to 59.4 MW and supply electricity to the equivalent of approximately 52,600[10] households per year. The Proposed Development will lower combined CO_2 emissions from grid-connected energy generation during its operation.

12.46 One purpose of **Appendix 12.1** was to estimate how long it would take for the Proposed Development to offset its CO_2 emissions. The payback time is a measure of how long (in years) it takes for the Proposed Development to change from being a net source of emissions to a net reducer of emissions. It is calculated by dividing the net carbon emissions (the difference between carbon losses and gains) by the annual carbon savings from the Proposed Development.

12.47 The expected carbon payback period, assuming that the Proposed Development will offset the emissions associated with the current grid-mix of electricity generation is estimated at approximately 1.1 years, or 0.6 years (assuming a fossil fuel grid mix) – see Table 12.7 of **Appendix 12.1**.

12.48 Based on an overall expected annual carbon saving of approximately 70,000 tonnes (t)CO_2e per year through the displacement of grid electricity, assuming a fossil fuel grid mix; or 34,000 tCO_2e per year, through the displacement of grid electricity, assuming the current grid mix is maintained; and a total carbon loss (during both construction and operation) of around 39,000 tCO_2e. The Proposed Development would lead to a total saving over an assumed 35 year operational lifespan of approximately between 1 million and 2 million tCO_2e (carbon savings x 35 minus the carbon loss).

[10] The equivalent homes supplied figure is based on an annual mean domestic electricity consumption of 3,125 kWh per household in Wales from the latest statistics from the Department for Energy Security and Net Zero (2013, updated 2024) Regional and local authority electricity consumption statistics – Subnational electricity consumption, Great Britain, 2005-2022. Figures are rounded up.

12.49 Whilst it has not been possible to calculate construction traffic emissions for HGVs and personnel, these will be offset during the Proposed Development's operational life along with any backup generation, and overall that a **Moderate (Positive)** and **Significant** effect is likely on balance. Carbon emissions savings due to the Proposed Development will also contribute positively to meeting Wales' net zero greenhouse gas emissions targets.

Adaptation

12.50 Taking account of those receptors identified above under 'baseline conditions' as potentially susceptible to a changing climate, this section gives further consideration as to whether or not the introduction of the Proposed Development is likely to affect judgements of effects and/or the ability of the receptors within or close to the Site to adapt to climate change. Topics considered are:

- **Landscape and Visual Assessment**: It is anticipated that the introduction of the Proposed Development will have no significant effects on the landscape's capability to adapt to climate change. It is also unlikely that the susceptibility/vulnerability and value/importance of the receptors will materially change, neither will the magnitude of the predicted effects of the Proposed Development under the existing baseline, such that the in-combination climate effects are considered to remain as those set out in **Chapter 5: Landscape and Visual Assessment**.
- **Geology, Hydrology, Hydrogeology and Peat**: Appropriate infrastructure design (including maintaining up to a 50 m buffer around watercourses where possible) and the incorporation of applied mitigation and good practice measures for site drainage into the infrastructure design (including SuDS principles) will limit any increases in flows and runoff rates to pre-development levels. Embedded, applied and additional mitigation has been designed inclusive of an allowance for climate change. All watercourse crossings will be designed to meet required flood exceedance standards inclusive of climate change allowances. These measures will help to ensure that the Proposed Development has no significant effects on the ability of potential flood risk receptors to adapt to climate change.
- **Ecology**: It is possible that species currently found within and around the Site will decline in numbers, should climate changes occur as predicted. However, with the implementation of

the applied mitigation and good practice measures, it is not considered likely that the introduction of the Proposed Development will contribute materially to climate change-related habitat loss (e.g. through effects such as increased flooding) or species displacement within the Site. Climate change pressures on habitats will be the same within and in the wider surroundings of the Site, and climate change would not be expected to render the habitats within the Site more ecologically important for the species they support relative to the same habitat types in the wider surroundings, in the absence of the Proposed Development. It is also proposed to compensate for habitat loss due to the Proposed Development, resulting in no net habitat loss from the Proposed Development within the Site. The Proposed Development is therefore not predicted to have significant adverse effects on species' ability to adapt to climate change, over and above the effects of the Proposed Development set out in **Chapter 7: Ecology**. The proposed enhancement measures undertaken as detailed in **Chapter 7** and **Appendix 7.7** may in fact increase the Site's resilience to the ecological effects of climate change in certain respects, although it is not possible to predict at present that this will constitute a significant positive effect in its own right. On this basis, the in-combination climate effects of the Proposed Development are considered to remain as those set out in **Chapter 7**.

- **Ornithology**: It is possible that bird species currently found within and around the Site will decline in numbers, should climate changes occur as predicted. However, with the implementation of the applied mitigation and good practice measures, it is not considered likely that the introduction of the Proposed Development will contribute materially to climate change-related habitat loss within the Site, nor climate change-related species displacement (i.e. displacement not due directly to the presence of turbines, but due to influences such as habitat loss via increased flooding). As climate pressures on habitats will be the same within and in the wider surroundings of the Site, the Proposed Development is not predicted to have significant effects on bird species' ability to adapt to climate change, over and above the effects set out in **Chapter 8: Ornithology**. It is also proposed to compensate for habitat loss and displacement effects due to the Proposed Development, within and adjacent to the Site. On this basis, the in-combination climate effects of the Proposed Development are considered to remain as those set out in **Chapter 8**.

- **Cultural Heritage**: It is anticipated that the introduction of the Proposed Development will have no significant effects on the historic environment's ability to adapt to climate change. It is also unlikely that the susceptibility/vulnerability and value/importance of the receptors will materially change, neither will the magnitude of the predicted effects of the Proposed Development under the existing baseline, such that the in-combination climate effects are considered to remain as those set out in **Chapter 6: Cultural Heritage**.

Proposed Mitigation

12.51 Other than the proposed mitigation measures set out above and in the respective chapters, no other mitigation measures are proposed to address in-combination effects of the Proposed Development in respect to climate change adaptation for the receptors assessed.

Residual Operational Effects

12.52 All effects remain as discussed above.

Cumulative Effects

Predicted Cumulative Effects During Construction

12.53 Climate change results from the accumulation of emissions from various sources, including new development. Projects other than the Proposed Development will also produce direct and embodied emissions during construction. However, it is expected that any other approved and built projects will implement reasonable measures to minimise, reduce and/or offset their emissions, especially from construction traffic. Therefore, a **Minor (negative)** cumulative effect from construction is predicted, which is **not significant**.

Proposed Mitigation

12.54 No mitigation measures are proposed in relation to cumulative climate change effects during construction of the Proposed Development.

Residual Cumulative Effects During Construction

12.55 As no mitigation is proposed, the effect remains as **Minor (negative)** and **Not Significant**.

Predicted Cumulative Effects During Operation

Carbon Losses and Offsetting

12.56 It is beyond the scope of this chapter to provide a quantitative estimate of the cumulative effects of all wind farms in the UK on carbon savings. However, the Proposed Development in combination with other onshore wind projects will reduce emissions from fossil fuels. This is a **Major (positive)** and **Significant** effect.

Adaptation

12.57 With respect to in-combination climate effects, this is largely a project specific consideration, namely the ability of assessed receptors to adapt to future climatic conditions, and the extent to which projected climate change could alter the predicted effect judgements. Effects are considered to be **Not Significant**.

Proposed Mitigation

12.58 No mitigation is proposed in relation to cumulative effects on climate change or in relation to adaptation of receptors during the operation of the Proposed Development.

Residual Cumulative Effects During Operation

12.59 As no mitigation is proposed, the effects remain as noted above, i.e. **Positive (Significant)** for carbon reductions, and **Not Significant** in relation to climate change adaptation.

Summary of Significant Effects

12.60 **Table 12.5** below summarises the predicted effects of the Proposed Development on climate change mitigation and adaptation.

Table 12.5 Summary of significant effects

Predicted Effect	Significance	Mitigation	Significance of Residual Effect
Operation			
Carbon Losses and Carbon Offsetting (climate change mitigation)	Positive (Significant)	None	Positive (Significant)
Cumulative Operation			
Carbon Losses and Carbon Offsetting (climate change mitigation)	Positive (Significant)	None	Positive (Significant)

Shadow Flicker

Introduction

12.61 This section considers the potential shadow flicker effects of the Proposed Development on residential properties.

12.62 Shadow flicker occurs when a wind turbine blade blocks the sunlight from reaching a window of a nearby building, creating a flickering shadow effect. Its occurrence is influenced by the location of building windows with respect to wind turbines as well as the time and season of the year, and it can have negative effects on residents and occupants of the affected buildings.

12.63 The shadow flicker assessment considers which properties close to the Proposed Development could theoretically experience shadow flicker.

12.64 This chapter is supported by **Figure 12.1: Maximum Theoretical Shadow Flicker and Assessment Properties** in **Volume 2** of the ES.

Scope of the Assessment

Effects Assessed in Full

12.65 The following effects have been considered:

- Operational effects from shadow flicker.

Effects Scoped Out

12.66 On the basis of the desk-based work undertaken, the professional judgement of the EIA team, and experience from other relevant projects, the following topic areas have been 'scoped out' of detailed assessment, as proposed in the Scoping Report:

- Construction effects, as shadow flicker only occurs from operational turbines.
- Operational effects on residential properties outside the shadow flicker study area, where significant effects from shadow flicker are not expected to occur (see the description of the study area below).

- Operational effects on non-habitable properties.
- Potential effects relating to epilepsy. Over 600,000 people in the UK have epilepsy; this equates to approximately 1 in every 100 people. Up to 3% of people with epilepsy are affected by flashing lights (this is called 'photosensitive epilepsy'). According to the Epilepsy Society[11] *"between 3-30 hertz (flashes per second) are the common rates to trigger seizures but this varies from person to person. While some people are sensitive at frequencies up to 60 hertz, sensitivity under 3 hertz is not common"*. Quoting evidence[12], the National Policy Statement (NPS) for Renewable Energy Infrastructure (EN-3) (2011)[13] states that *"the maximum frequency of the shadowing effect from commercial scale wind turbines is less than 1 hertz… Therefore, shadow flicker frequencies are not in the region known to induce seizures in sufferers of epilepsy"* (page 72). Therefore, any potential shadow flicker effects arising from the Proposed Development are effects on residential amenity only, rather than having the potential to affect the health or well-being of residents.

Assessment Methodology

Guidance

12.67 This assessment is carried out in accordance with the principles contained within the following documents:

- Department of Energy and Climate Change (DECC) (2011) Update of UK Shadow Flicker Evidence Base;
- Department of Northern Ireland (2009) Practice Guidance for Planning Policy Statement 18 (PPS18); and
- UK Government's Planning Practice Guidance for Renewable and Low Carbon Energy (2013).

[11] Epilepsy Society (undated) Photosensitive epilepsy
[12] Harding, G., Harding, P. and Wilkins, A. (2008) Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them
[13] Department of Energy and Climate Change (2011) National Policy Statement for Renewable Energy Infrastructure (EN-3)

Consultation

12.68 In undertaking the assessment, consideration has been given to the scoping responses and other consultation which has been undertaken as detailed in **Table 12.6**.

Table 12.6 Consultation Responses

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
Planning and Environment Decisions Wales (PEDW)	Scoping	The Inspectorate notes that in 'Review of Light and Shadow Effects from Wind Turbines in Scotland' (LUC for climateXchange, 2017) it was found that *"there is a lack of evidence to support the use of ten rotor diameters as a cut off, and this is entirely down to misinterpretation of the original reference to this distance"*. The ES should provide a clear rationale as to the methodology adopted, and why it is considered appropriate given the scale of turbines proposed and the requirement for more nuanced assessment suggested by the concerns raised in the above document.	The study area has been defined on the basis of the potential range of significant effects on an iterative basis (see further below). A shadow flicker figure for the final study area (**Figure 12.1**) has been prepared using a combination of Windfarm Resoft and ArcGIS.

Study Area

12.69 In the UK, shadow flicker effects are only likely to be experienced in buildings located within a distance of 10 times the rotor diameter of a wind turbine[14], but they can occur beyond this range. Therefore, the present assessment has adopted a flexible and iterative approach to study area definition, based on initial consideration of potential effects up to a 10x (ten times) rotor diameter distance with the outcome of this assessment being used to evaluate whether an extension to the study area is merited. The maximum rotor diameter of the Proposed Development's turbines has been assumed for the purposes of this assessment to be 155 m. Properties which are beyond 130 degrees either side of north relative to any turbine were excluded, following the UK Government's Planning Practice Guidance for Renewable and Low Carbon Energy (2013)[15]. This is because turbines in the UK do not cast long shadows on their southern side due to the angle of the sun.

Desk Based Research and Data Sources

12.70 The following data sources have informed the assessment:

- OS AddressBase data;
- Google Maps aerial imagery;
- Met Office Data: Sunshine at Bala Climate Station[16];
- National Oceanic and Atmospheric Administration (NOAA) Data: Global Monitoring Laboratory Sunrise and Sunset at the Proposed Development[17]; and
- Local Planning Registers[18][19].

[14] 10 times the rotor diameter is used as a general rule in the UK as shadow flicker should have no effect on properties located further than this distance (Scottish Government (2014) Onshore Wind Turbines: Planning Advice).
[15] Department for Levelling Up, Housing and Communities (2015, updated 2023) Renewable and low carbon energy
[16] Met Office (undated) UK climate averages – Bala – Climate Station (Gwynedd)
[17] National Oceanic and Atmospheric Administration (NOAA) (2024) Global Monitoring Laboratory – Sunrise Table for 2024 – Location: Latitude 52.91700 Longitude -3.58300
[18] Gwynedd Council Planning Portal
[19] Denbighshire County Council Planning Portal

Field Survey

12.71 The assessment was primarily desk-based. Field work (including reconnaissance by the Applicant, and survey to inform the Residential Visual Amenity Assessment (RVAA)) was undertaken to verify the properties included in the assessment.

Assessing Significance

12.72 The Proposed Development's shadow flicker assessment has measured the impact of shadow flicker, but there is no official guidance (as of writing this) on how much shadow flicker is acceptable or not in Wales. In the absence of this, the Department of Environment Northern Ireland (2009) Best Practice Guidance for Planning Policy Statement 18 (PPS18): Renewable Energy[2021] provides an indication of what may be an acceptable duration of shadow flicker, stating that *"It is recommended that shadow flicker at neighbouring offices and dwellings… should not exceed 30 hours per year or 30 minutes per day"* (page 29).

12.73 These thresholds have also been utilised in the Republic of Ireland, Germany and Belgium.

12.74 These thresholds are considered an appropriate basis for judgements as to the significance or otherwise of the Proposed Development's effects according to the EIA regulations. Predicted effects have been judged as being **significant** if shadow flicker occurrence is estimated to exceed either of the thresholds. Any values below these thresholds are deemed **not significant**. It should be noted, however, that that this approach is based on professional judgement and common practice, as there is no formal guidance available on this topic within the UK or Wales.

[20] Department of the Environment (2009) Best Practice Guidance for Planning Policy Statement 18 (PPS18) 'Renewable Energy'

[21] No formal guidance is available (at the time of writing) as to what levels of shadow flicker are considered to be acceptable in Wales. Therefore, in the absence of any specific guidance for Wales, the PPS18 is considered to be a valid reference for determining the significance of shadow flicker effects.

Assessment Assumptions and Limitations

12.75 The shadow flicker assessment has been undertaken using ReSoft Windfarm Shadow Flicker module ('ReSoft model' or 'ReSoft modelling'). As explained above, the study area has been identified on an iterative and flexible basis.

12.76 This chapter provides a 'precautionary realistic' scenario of shadow flicker occurrence: the assumptions applied are generally 'worst case' (as detailed further below) but with the resulting predications modified to take account of potential hours of sunlight vs. hours of daylight.

'Worst Case' Assumptions

12.77 In the ReSoft modelling, the following worst-case assumptions have been used:

- All properties within the study area are assumed to have a specified window size (in this case 1.5 m x 2 m) facing directly on to each turbine that has the potential to cause an effect;
- The wind turbine blades are assumed to be rotating for 365 days per year;
- The wind turbine blades are assumed to always be positioned so that their full face will be between the sun and each property;
- The sun always shines in a clear sky on every day of the year, i.e. there are no periods of cloud cover or low visibility due to fog, mist and haze etc;
- A human receptor is deemed to be present in all affected rooms at all times;
- No account is taken of the potential screening by trees or vegetation; and
- Curtains or blinds are assumed not to be fitted to windows.

12.78 These assumptions will result in an overestimate of shadow flicker occurrence: shadow flicker is only possible during the operation of the wind turbines (i.e. when the rotor blades are turning), when the sun is shining and when the sky is clear enough to cast shadows, and therefore the real-life instances of shadow flicker will always be less than that predicted by the ReSoft model applying the above assumptions.

Adjustment for Sunlight Hours

12.79 The modelled occurrence of shadow flicker applying the assumptions above has been adjusted to take account of the average percentage of time the sun may be expected to shine during the daytime in this part of Wales. This adjustment takes into account that the sun is not always shining (e.g. due to cloud cover) and does not shine every day of the year. It is based on data for the nearest Met Office climate station to the Site (Bala Climate Station located approximately 7 km from the Site)[16], and has been set at 34.3% of estimated shadow flicker occurrence generated via application of the worst-case assumptions detailed above. The adjustment is still precautionary to the extent that it is based on the sunniest month of the year (May), as detailed in **Table 12.7** below.

Table 12.7 Monthly Percentage of Sunny Daylight Hours

Month	Typical Daylight Hours (per month)	Typical Sunshine Hours (per month)	Monthly % of Sunny Hours
January	8.22	30.96	12.2%
February	9.89	53.49	18.7%
March	11.93	94.82	25.6%
April	14.02	141.98	33.7%
May	**15.86**	**168.6**	**34.3%**
June	16.83	157.17	31.1%
July	16.31	152.46	30.2%
August	14.65	135.83	29.9%
September	12.63	109.31	28.9%
October	10.55	76.25	23.3%
November	8.68	41.05	15.8%

Month	Typical Daylight Hours (per month)	Typical Sunshine Hours (per month)	Monthly % of Sunny Hours
December	7.68	23.55	9.9%
Annual	12.27	1185.47	26.4%

Baseline Conditions

12.80 There are 27 individual properties and one caravan park located within 1.55 km (10x the rotor diameter distance) and within 130 degrees either side of north, relative to the proposed wind turbines. These are listed in **Table 12.8** below and shown in **Figure 12.1**.

Implications of Climate Change

12.81 The Climate Change Mitigation and Adaptation assessment within this chapter provides details of the climate change projections in Wales for the 2060s, when the operational period of the Proposed Development is likely to end. In summary, the projections highlight that in the 2060s, summer and winter temperatures are likely to be greater than the current baseline, with winter rainfall increasing and summer rainfall decreasing. As shadow flicker effects are inherently linked to weather, there is the potential that the current baseline 'sunny daylight hours' could be affected in the future due to climate change. The baseline percentage of sunny daylight hours per year is, however, not expected to change over the 35-year operational life of the Proposed Development to such a degree that the assessment of effects under the realistic scenario will be materially affected.

12.82 The application and effectiveness of the industry standard mitigation for shadow flicker will also remain the same irrespective of climate change.

Future Baseline in the Absence of the Proposed Development

12.83 In the absence of the Proposed Development, it is likely that the land will continue under the same land use, with no shadow flicker effects being generated as a consequence.

Shadow flicker may be effects on individual properties may be influenced by further wind energy development in the general area, reflecting the transition to a zero carbon economy and related objectives of Future Wales: The National Plan 2040 (2021)[22]. There has been increasing number of operational, consented and proposed domestic wind turbines of varying heights and rotor diameters within the landscape surrounding the Proposed Development; and as farmers diversify income and seek opportunities to generate energy for domestic and commercial use, interest in this type of development is likely to continue. However, beyond the known cumulative baseline in this respect, it is not possible to quantify potential future cumulative effects from proposals that have not yet come forward.

Design Considerations (Embedded Mitigation)

12.84 Shadow flicker was not applied as a constraint to design. However, as part of the design of the Proposed Development, proximity of turbines to properties was considered in relation to reducing effects on residential visual amenity and operational noise. This in turn has helped to reduce the potential for shadow flicker occurrence at certain properties – see **Chapter 4: Site Selection and Design Strategy**. The application and effectiveness of the industry standard mitigation for shadow flicker will also remain the same irrespective of the design layout.

Micrositing

12.85 Micrositing of turbines or other infrastructure up to 50 m from their proposed positions is unlikely to result in any effects that are materially different to those described in this assessment. Some restrictions to this allowance are proposed which are outlined in **Chapter 3**. Depending on the direction of any micrositing, shadow flicker occurrence may theoretically increase or decrease depending on the distance and orientation to individual properties; however, such changes are unlikely to result in shadow flicker occurrences which materially change the outcomes of the present assessment with respect to significance or otherwise of effects.

[22] Welsh Government (2021) Future Wales: The National Plan 2040

Assessment of Operational Effects

12.86 The assessment of effects is based on the project description as outlined in **Chapter 3**. Unless otherwise stated, the potential effects are considered to be negative.

Predicted Operational Effects

12.87 Based on the applied assumptions above, estimated shadow flicker occurrence at all properties within the 10x rotor diameter distance are set out in **Table 12.8**.

Table 12.8 Shadow Flicker Occurrence Due to Proposed Development (minutes per day and hours per year)

Property ID (Receptor)	Estimated Minutes of Shadow Flicker per Day	Estimated Hours of Shadow Flicker per Year
Hafoty Wen (1)	9.3	8.1
Gist Faen (2)	10.5	5.7
Y Bwthyn, Tyddyn Dyfi (3)	0.0	0.0
Tyn Y Pistyll (4)	9.1	3.9
Tyddyn Dyfi (5)	0.0	0.0
Merllyn Gwyn (6)	10.9	7.6
Braich Ddu (7)	0.0	0.0
Tyn Y Llwyn (8)	6.0	2.3
Hengaer Isaf (9)	9.7	6.3
Hengaer Uchaf (10)	22.8	21.2
Gelli Griafolen (11)	25.5	28.5
Gelli Gollen (12)	24.1	26.1

Property ID (Receptor)	Estimated Minutes of Shadow Flicker per Day	Estimated Hours of Shadow Flicker per Year
Pen Y Gelli (13)	22.6	24.8
Pant Teg (14)	12.3	14.8
Bronguddio (15)	12.3	7.6
Blaen Gwnodl Uchaf (16)	15.2	13.0
Siamberwen (17)	9.9	3.0
Bwthyn Siamberwen (18)	9.7	4.0
Ty Isaf (19)	11.3	14.5
Peniel (20)	10.1	4.9
Blaen Gwnodl Isaf (21)	13.0	14.7
Pen Y Geulan (22)	7.6	5.1
Pen Y Geulan Barn (23)	6.2	2.5
Sarn Helen (24)	12.5	12.5
Tyfos (25)	11.9	12.4
1, Tyfos Cottages (26)	18.3	15.7
2, Tyfos Cottages (27)	18.5	16.1
Caravan M, Hendwr Caravan Park (28)	9.1	10.1

12.88 In relation to the thresholds used for the present assessment, **no significant effects** have been predicted at any property from the Proposed Development.

Proposed Mitigation

12.89 As described above, maximum theoretical or reasoned occurrences of shadow flicker assessed in this chapter are also dependent on a number of other factors including wind speed and direction, potential shielding/screening effects of buildings, trees, vegetation or other obstacles, orientation for both the property windows and turbines, or whether a room is occupied at the time of occurrence.

12.90 Should any of the residents' experience shadow flicker effects at their property, mitigation will be explored to limit shadow flicker at that location, such as vegetation planting to shield the property from the turbine(s). If other measures do not satisfactorily mitigate effects, then the relevant turbines can be shut down at appropriate times and conditions. This approach will ensure that residents do not experience negative shadow flicker effects, while also reducing unnecessary turbine shutdowns that could be the result of the worst-case scenario modelling.

Residual Operational Effects

12.91 Taking into consideration the application of mitigation measures as outlined above, the residual effects of shadow flicker will be **Not Significant**.

Cumulative Effects

12.92 There are two operational wind farm developments in close proximity to the Proposed Development. Syrior wind farm is an operational two-turbine development located approximately 500 m to the nearest turbine south of the Site boundary. A cumulative shadow flicker assessment has been carried out using the methodology outlined above to assess the potential cumulative effects of the Proposed Development in combination with these developments.

12.93 A shadow flicker assessment was submitted with the planning application for Syrior wind farm which identified that no dwellings will be affected by shadow flicker effects. This has been confirmed by the cumulative modelling carried out for the Proposed Development.

12.94 The ES for Braich Ddu was unavailable; however, a cumulative assessment has been carried out using available data (as-built information) on turbine dimensions and location which predicts **no significant cumulative effects** on any property within the study area.

12.95 As no significant effects are predicted within the initial 10x rotor diameter study area, and all properties near the edge of the study area appeared to be substantially beyond the range of significant effects (See **Figure 12.2**). It was not considered necessary to extend the analysis to a wider area.

Combined Effects

12.96 Shadow flicker affects residential amenity. Wind farms also have the potential to affect residential amenity due to visual effects and noise, and combined effects on individual properties could occur in principle.

12.97 With respect to the Proposed Development, there are no significant effects predicted in relation to shadow flicker, and while some properties will experience a high magnitude of impact i.e. significant effects in relation to residential visual amenity, they are not such that will be judged as overbearing or inescapable thereby breaching the threshold (see **Appendix 5.6: Residential Visual Amenity Assessment (RVAA)**) or proposed operational noise limits (see **Chapter 11: Noise and Vibration**) for the properties assessed. However, taking account of the amenability of shadow flicker effects to mitigation, there are no significant effects predicted due to the interrelationship between shadow flicker and any other effects relating to residential amenity.

Summary of Significant Effects

12.98 The potential shadow flicker effects from the Proposed Development on residential receptors is considered to be **not significant** in the context of the EIA Regulations.

Telecommunications

Introduction

12.99 This section of the chapter presents the findings of the assessment of effects of the Proposed Development in relation to telecommunication.

12.100 Consultation was undertaken directly with relevant[23] operators to obtain telecommunication link details at two stages (see **Table 12.9** below for consultation details). Vodafone, MBNL, BT, JRC, Virgin Media (O2), Airwave and Ofcom confirmed they do not operate any telecommunication links within the Site and therefore have no concerns regarding the Proposed Development on both occasions.

12.101 Arqiva expressed concerns over some turbines (T1, T2 and T3 in the design iteration of layout 1), which were close to an existing television RBK path from Moel-y-Parc to Llanderfel. These turbines were dropped in a later iteration of the design and Arqiva have since confirmed no adverse effects upon its infrastructure are expected to occur as a result of the Proposed Development.

Consultation

12.102 **Table 12.9** below provides details of consultation that has been used to inform the assessment related to telecommunication within this chapter.

Table 12.9 Consultation Responses

Consultee	Consultation	Issue Raised	Action Taken
Ofcom	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	No objection raised.	N/A.
Airwave	Layout 1: 12.05.2022	No objection raised.	N/A.

[23] Based on LUC's experience and contact database.

Consultee	Consultation	Issue Raised	Action Taken
	Design Freeze Layout: 06.06.23		
Arqiva	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	For layout V1 Arqiva raised concerns over T1, T2 and T3 which are close to an existing television RBL path from Moel-y-Parc to Llandderfel. No objection was raised to design freeze layout, with the nearest link being over 800 m away from nearest turbine.	T1, T2, and T3 from layout V1 were dropped when considered against other environmental and technical constraints.
Virgin Media (O2)	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	No objection raised.	N/A.
BT	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	No objection raised.	N/A.
MBNL	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	No objection raised.	N/A.
JRC	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	No objection raised.	N/A.
Vodafone	Layout 1: 12.05.2022 Design Freeze Layout: 06.06.23	No objection raised.	N/A.

Assessment of Effects

12.103 Given the findings of the requests as detailed above, the Proposed Development is not predicted to have a significant effect on telecommunication infrastructure.

12.104 Analogue television broadcast has now been phased out and replaced by digital television, which is less likely to be affected by a variety of potential signal interferences including those related to wind development. It is anticipated that an appropriate condition will be attached to the planning permission, if granted, which will require the Applicant to provide mitigation in the event that effects on television reception occur as a consequence of the operation of the Proposed Development. It is also not considered likely that radio broadcasting signals will be affected by the Proposed Development once operational. This is because the length of radio broadcast signal wavelengths are such that interference from wind turbines is unlikely and any interference to the radio signal is unlikely to noticeably affect the audio signal.

Aviation

Introduction

12.105 This section of the chapter considers the potential effects of the Proposed Development on aviation during construction and operation.

12.106 This chapter outlines the methodology employed in this assessment, identifies the baseline conditions in terms of aviation in the vicinity of the Proposed Development, addresses potential cumulative impacts with other relevant projects and provides an assessment of the potential effects on aviation. The potential mitigation requirements are outlined, and the overall risks are then categorised to provide a summary of the potential impact on aviation receptors.

12.107 The aviation assessment was undertaken by Coleman Aviation Limited.

12.108 In general terms, the potential effects of wind turbines on aviation are widely understood. However, the primary concern in assessing the effect of a wind farm is to ensure that the safety of aircraft is not compromised. In essence, there are two dominant scenarios that lead to potential effects on aviation:

- Physical obstruction – where turbines can create physical obstructions to aircraft in flight; and
- Aviation radar systems – where wind turbines can create unwanted interference with radar systems such that 'radar clutter' can appear on radar displays; this can seriously affect air traffic controllers' ability to provide Air Traffic Services (ATS) in a safe and effective manner.

12.109 This chapter is supported by **Figure 12.3** which is referenced throughout the text, and which can be found in **Volume 2: Figures**.

12.110 The following appendices are also referred to throughout the chapter:

- **Appendix 12.2: Aviation Lighting Report for Gaerwen Wind Farm** – Wind Farm Low Flying Aviation Consultants Limited (WFLFAC) (23 July 2023)
- **Appendix 12.3: Technical and Operational Assessment (TOPA) for Gaerwen Wind Farm** – National Air Traffic Services Limited (NATS) (22 May 2022)

- **Appendix 12.4: Pre-Planning Application Assessment for Gaerwen Wind Farm** – Ministry of Defence (MoD) (15 June 2022)
- **Appendix 12.5: Response to Proposed Obstacle Lighting Scheme for Gaerwen Wind Farm** – Civil Aviation Authority (CAA) (19 October 2023)

Scope of the Assessment

12.111 A desk-based review of literature and available data sources has been undertaken to support this ES. The potential aviation issues considered for the Proposed Development assessment were as follows:

- Civil airport Instrument Flight Procedures (IFPs) (including navigation aids (NAVAIDS));
- Military aerodrome IFPs (including NAVAIDS);
- Civil Air Traffic Control (ATC) radar;
- Military ATC radar;
- Military Air Defence (AD) radar;
- Low flying (military and civilian Emergency Helicopter Support Units (EHSUs));
- Local minor aerodromes;
- Local airspace restrictions (Prohibited/Restricted/Danger Areas and Military Exercise and Training Areas (MEXAs); and
- Meteorological (Met) Office radars.

Effects Assessed in Full

- Direct effects during construction on aviation:
  - Potential effects on military low flying and civilian EHSU operations due to installation of wind turbines creating obstacles to low flying aircraft.

Effects Scoped Out

12.112 On the basis of the desk-based work undertaken, the professional judgement of the ES team, experience from other relevant projects and policy guidance or standards, and feedback

received from consultees, the following topic areas have been scoped out of detailed assessment:

- Civil Airport IFPs (including NAVAIDS): The Proposed Development is not within the safeguarding zone of any civilian airports; consequently, there will be no impact on civilian airport patterns and procedures. NATS also confirmed in consultation (**Table 12.10**) and **Appendix 12.3** that there would be no impact on their NAVAIDs or radio communication systems.
- Military Aerodrome IFPs (including NAVAIDS): The Proposed Development is not within the safeguarding zone of any military aerodromes (**Table 12.10** and **Appendix 12.4**); consequently, there will be no impact on military aerodrome patterns and procedures.
- Civil ATC radar: NATS confirmed in their pre-planning assessment (**Table 12.10** and **Appendix 12.3**) that the Proposed Development would not be detectable by any NATS ATC radars.
- Military ATC radar: MoD confirmed in their pre-planning consultation response (**Table 12.10** and **Appendix 12.4**) that the Proposed Development would not be detectable by any MoD ATC radars.
- Military AD radar: MoD confirmed in their pre-planning consultation response (**Table 12.10** and **Appendix 12.4**) that there will be no impact on military AD radar systems.
- Local minor aerodromes: There are no local minor aerodromes in the vicinity of the Proposed Development (see **paragraph 12.142**).
- Local Airspace Restrictions (Prohibited/Restricted/Danger Areas and Military MEXAs): The Proposed Development is situated outside the boundaries of any active Prohibited/Restricted/Danger Areas; consequently, there will be no impact on MoD operations within restricted airspace.
- Met Office radar: The nearest Met Office radar to the Proposed Development is located at Clee Hill, 45 nm (83 km) to the south-east. The Proposed Development is therefore outside the 20 km safeguarding area for radars of this nature.

Assessment Methodology

Legislation and Guidance

Legislation

12.113 The assessment is carried out in accordance with the principles contained within the following legislation:

- Civil Aviation Publication (CAP) 393 The Air Navigation Order (2016) and Regulations, Version 6, 12 February 2021.

12.114 CAP393 regulations stipulate that any en-route structure extending 150 metre (m) or greater must be fitted with medium intensity steady red, visible aviation lighting at the highest practical point. Consequently, the Applicant commissioned an aviation lighting assessment which can be found at **Appendix 12.2**.

Policy

12.115 The Welsh Government document Future Wales: The National Plan 2040[24] Policy 18, states that proposals for renewable and low carbon energy projects (including repowering) qualifying as Developments of National Significance (DNS) will be permitted subject to meeting the criterion that there are no unacceptable impacts on the operations of defence facilities and operations (including aviation and radar) or the Mid Wales Low Flying Tactical Training Area (TTA-7T). The document contains no provisions relating to the impacts of wind energy developments on civil aviation.

12.116 Planning Policy Wales (PPW) Edition 12[25] re-iterates the policy provisions of Future Wales for renewable and low carbon energy but contains no specific policies in relation to potential impacts of such developments on aviation, radar or defence.

12.117 CAA policy on wind turbines is set out in CAP 764 Policy and Guidance on Wind Turbines, Version 6, February 2016. This contains the CAA's position on the impacts of wind turbines on radar, radio navigation aids, physical obstacle hazards to aircraft and turbulence;

[24] Welsh Government (2021) Future Wales: The National Plan 2040
[25] Welsh Government (2024) Planning Policy Wales (Edition 12)

describes a range of mitigations that may be applied; and outlines the process of assessing the aviation impacts of wind energy developments in the planning system.

12.118 The assessment is carried out in accordance with the principles contained within the following policy documents:

- CAP 168 Licensing of Aerodromes, Version 12, 14 January 2022;
- CAP 670 ATS Safety Requirements, Version 3, 7 June 2019;
- CAP 774 UK Flight Information Services, Version 4, 15 December 2021;
- CAP 738 Safeguarding of Aerodromes, Version 3, 29 October 2020;
- CAP 793 Safe Operating Practices at Unlicensed Aerodromes, Edition 1, July 2010;
- CAP 493 Manual of Air Traffic Services Part 1, Edition 10, 8 March 2022; and
- CAP 660 Parachuting, Version 5, March 2020.

Guidance

12.119 This assessment is carried out in accordance with the principles contained within the following guidance documents:

- CAA 1:500,000 Visual Flight Rules (VFR) Aviation Charts;
- Military Aeronautical Information Publication (Mil AIP); and
- United Kingdom (UK) Integrated Aeronautical Information Package (IAIP).

Consultation

12.120 In undertaking the assessment, consideration has been given to the scoping responses and other consultation which has been undertaken as detailed in **Table 12.10**.

Table 12.10 Consultation responses

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
Planning and Environment Decisions Wales (PEDW) 16 September 2021	Scoping Direction	The approach set out in the scoping report is considered appropriate. If further assessment and consultation shows that significant effects are unlikely, then it may be possible to scope this aspect out of the ES. However, given that further assessment is required, the Inspectorate does not agree that aviation can be scoped out at this stage.	Aviation remains scoped into the ES and is assessed in this chapter.
		Should visible aviation obstacle lighting be required, the ES should include a night-time assessment of the impact of aviation lighting. This should also be considered in terms of cumulative impacts.	The Applicant accepts that aviation lighting will be required and has commissioned an aviation lighting report from WFLFAC which can be found at **Appendix 12.2**. Aviation lighting is discussed further in **paragraph 12.124**. The potential visual effects of night-time aviation lighting are covered in **Chapter 5**.

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
NATS 9 May 2022	Pre-planning Consultation	The Applicant submitted a TOPA request to NATS to ascertain any potential effect of the Proposed Development on NATS infrastructure. This assessment was based on an indicative 13 turbine layout with a maximum turbine tip height of 180 metres (m).	NATS responded on 22 May 2022 confirming that none of their radar systems, en-route navigation aids (NAVAIDS) or radio communication systems would be affected. The NATS assessment can be found at **Appendix 12.3**. The Applicant also carried out further consultation with NATS once the Proposed Development's turbine layout was finalised. The results of this consultation are covered later in this table.
MoD 9 May 2022	Pre-planning Consultation	The Applicant submitted a pre-planning request to MoD to ascertain any potential effect of the Proposed Development on MoD operations. This assessment was based on an indicative 13 turbine layout with a maximum turbine tip height of 185 m. MoD responded on 15 June 2022 confirming that the	The Applicant accepts that MoD accredited aviation lighting will be required and has commissioned an aviation lighting report from WFLFAC which can be found at **Appendix 12.2**. Aviation lighting is discussed further in **paragraph 12.124**. The Applicant also carried out further consultation with MoD once the Proposed

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		Proposed Development would potentially impact on MoD low flying operations and that MoD accredited visible or infrared aviation safety lighting was likely to be required.	Development's turbine layout was finalised. The results of this consultation are covered later in this table.
NATS 19 August 2023	Pre-planning Consultation	The Applicant re-consulted NATS following finalisation of the Proposed Development's turbine layout (9 turbines with a maximum tip height of 202 m) in order to confirm that increasing the turbine tip heights by 22 m will not adversely impact NATS infrastructure.	NATS responded by email on 28 August 2023 confirming that increasing the turbine tip heights to 202 m will not adversely impact NATS infrastructure.
MoD 21 August 2023	Pre-planning Consultation	The Applicant re-consulted MoD following finalisation of the Proposed Development's turbine layout (9 turbines with a maximum tip height of 202 m) in order to confirm that increasing the turbine tip heights by 17 m will not adversely impact MoD operations.	MoD responded by email on 4 September 2023 confirming that a full re-assessment of the Proposed Development would be carried out on submission of the Pre-Application Consultation. No additional impact is expected but, in the unlikely event this is the

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
			case, it will be scoped into the final ES.
Hawarden Airport 23 August 2023	Pre-planning Consultation	The Applicant consulted Hawarden Airport following finalisation of the Proposed Development's turbine layout (9 turbines with a maximum tip height of 200 m) in order to confirm that the proposed wind turbines will not adversely impact Hawarden Airport's operations.	Hawarden Airport responded by email on 12 March 2024 confirming that, following assessment of the Proposed Development, no impact on aviation operations at the airport is anticipated.
NATS 06 August 2024	Statutory Pre-Application Consultation	The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal	Noted.
MoD 16 August 2024	Statutory Pre-Application Consultation	The MoD has concerns with this proposal due to the potential impact to low flying aircraft operating in the development area. To	The Applicant accepts that MoD accredited aviation lighting will be required and that the civilian lighting requirements, as set out in

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		address the impact upon low flying given the location and scale of the development, the MOD would require that conditions are added to any consent issued requiring that the development is fitted with aviation safety lighting and that sufficient data is submitted to ensure that structures can be accurately charted to allow deconfliction. The development proposed includes wind turbine generators that exceed a height of 150m agl and are therefore subject to the lighting requirements set out in the Air Navigation Order 2016. In addition to CAA requirements, the MoD will require the submission, approval, and implementation of an aviation safety lighting specification that details the installation of MOD	the Air Navigation Order 2016, will need to be followed. As a result, the Applicant commissioned an aviation lighting report from WFLFAC which can be found at **Appendix 12.2** and has since been accepted and approved by CAA (see **Appendix 12.5**). Aviation lighting is discussed further in **paragraph 12.124** and in the assessment section of this chapter. MoD's requests for aviation safety lighting to be fitted and for sufficient data to be submitted to ensure that structures can be accurately charted also form part of the applied mitigation measures contained in **Table 12.13.** Implementation of the Lighting Plan will be a condition of any planning consent.

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		accredited aviation safety lighting.	

Study Area

12.121 To assess the impact on aviation, a study area has been devised that takes into account the immediate vicinity of the Proposed Development, the consultation criteria for aviation assets as described in CAP 764 (Policy and Guidelines on Wind Turbines) and a wider study area determined by the range of potentially affected radar systems, both ATC and AD radar systems.

12.122 A pictorial representation of the study area is depicted on an aviation chart and shown in **Figure 12.3**.

Desk Based Research and Data Sources

12.123 The desk-based review was conducted using comprehensive aviation documentation and charts to identify potential aviation receptors during the construction, operation and decommissioning phases of the Proposed Development. The set of data sources used is shown in **Table 12.11**.

Table 12.11 Data Sources

Data	Source	Details
CAA 1:500,000 VFR Aviation Chart	CAA (2023)	Designed to assist in the navigation of aircraft. Enables pilots to determine their position, safe altitude and route to a destination, highlighting NAVAIDS along the way, alternative landing areas in case of an in-flight emergency, and other useful information such as radio frequencies and airspace boundaries.

Data	Source	Details
CAP 393 – Air Navigation, The Order and the Regulations, 2016	CAA (Version 6, 12 February 2021)	Contains the Air Navigation Order (ANO) 2016 and Regulations made under the order; and defines the Rules of the Air regarding civil aviation in the UK.
CAP 764 – CAA Policy and Guidelines on Wind Turbines	CAA (Version 6, February 2016)	Provides CAA policy and guidance on a range of issues associated with wind turbines and their effect on aviation that need to be considered by aviation stakeholders, wind energy developers and local planning authorities when assessing the viability of wind turbine developments.
UK IAIP	CAA (2023)	Provides comprehensive information on UK civilian aerodromes and aviation procedures within UK airspace.
UK Mil AIP	MoD (2023)	Provides comprehensive information on UK military aerodromes and guidance to military aircrew on in-flight navigation procedures.
NATS Self-Assessment Maps	NATS (2023)	Designed for applicants to ascertain whether their Proposed Development is anticipated to have an impact upon NATS infrastructure and operations.

Field Survey

12.124 In order to ascertain the exact aviation lighting requirements for the Proposed Development, the Applicant commissioned an aviation lighting assessment from WFLFAC. The assessment proposed the visible and infra-red aviation lights to be installed on the Proposed Development's wind turbines. The WFLFAC report, which can be found at **Appendix 12.2**, has since been accepted and approved by the CAA. The CAA approval letter can be found at **Appendix 12.5**.

12.125 No other site-specific surveys have been undertaken to inform the ES for aviation. This is because the baseline characterisation developed through existing data sources, coupled with ongoing consultation with relevant stakeholders is considered sufficient to inform the aviation chapter.

Assessing Significance

12.126 The methodology used for the aviation assessment is a desk-based review using the data sources as described in **Table 12.11**. However, defining categories of receptor sensitivity and magnitude of impact is not appropriate for aviation as baseline aviation activities and equipment are highly sensitive to impacts and any magnitude of restriction on, or compromise to, activities or equipment (without applied mitigation) is considered to be high. Therefore, the sensitivity of receptor and magnitude of impact have been explained via professional reasoning and judgement rather than via definitions of different categories. These judgements have fed into the determination of significance as shown in **Table 12.12**.

Significance

12.127 The predicted significance of the effect was determined through a standard method of assessment based on professional judgement, considering both sensitivity and magnitude of change as detailed in **Table 12.12** below. Major and moderate effects are considered significant in the context on the EIA Regulations.

Table 12.12 : Determination of Significance

Sensitivity of Receptor	Magnitude of Impact			
	High	Medium	Low	Negligible
High	Major	Moderate	Minor	Negligible
Medium	Moderate	Moderate	Minor	Negligible
Low	Minor	Minor	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

12.128 Each level of significance can be described as follows:

- Major – Regular, frequent or permanent effects which require changes to existing operational and/or technical practice in order to mitigate adequately, or which are not capable of being mitigated adequately.
- Moderate – Periodic effects experienced which may require alterations to existing operational practice.
- Minor – Occasional effects experienced which do not require any alteration of existing operational and technical practice.
- Negligible – Normally no measurable change from baseline conditions which therefore do not require any alteration of existing operational and technical practice.

12.129 For the purposes of this assessment:

- A level of effect of moderate or more will be considered a 'significant' effect; and
- A level of effect of minor or less will be considered 'not significant'.

12.130 Effects of moderate significance or above are therefore considered important in the decision-making process, whilst effects of minor significance or less warrant little, if any, weight in the decision-making process.

Assessment Assumptions and Limitations

12.131 The data used in this chapter are the most up to date publicly available information which can be obtained from the applicable data sources as cited. Information has also been provided through consultation as detailed in **Table 12.10**. It is considered that the data employed in the assessment are robust and sufficient for the purposes of the impact assessment presented.

Baseline Conditions

12.132 This section should be read in conjunction with **Figure 12.3**. The Proposed Development baseline pertinent to aviation is that there will be nine wind turbines with a maximum turbine tip height of 200 m above ground level (agl). There are a number of civilian

and military aviation interests within the vicinity of the Proposed Development which can be described as follows:

Airspace

12.133 The Proposed Development is situated in an area of Class G uncontrolled airspace which is established from the surface up to Flight Level (FL) 195 (19,500 feet (ft)). Above FL195, the airspace is Class C controlled airspace. Within this airspace however, the Valley Aerial Training Area (ATA) has also been established, within which military aircraft can book blocks of airspace between FL100 (10,000 ft) and FL660 (66,000 ft) in order to carry out autonomous operations including air combat training manoeuvres. Within Class C and Class G airspace, the following rules applies:

- Class C airspace: All aircraft operating within Class C controlled airspace (i.e. above FL195) must be in receipt of an ATS from NATS or a separate authorised military service provider.
- Class G airspace: Any aircraft can operate in this area of uncontrolled airspace without any mandatory requirement to be in communication with, or receive a radar service from, any ATC unit. Pilots of aircraft operating under VFR in Class G airspace are ultimately responsible for seeing and avoiding other aircraft and obstructions.

Civil Airport IFPs (including NAVAIDS)

12.134 The nearest major civil airport to the Proposed Development is Hawarden Airport, 20 nm (41 km) to the north-east. The Proposed Development is outside the safeguarded Obstacle Limitation Surfaces (OLS) of this airport; the OLS are a defined volume of airspace around an aerodrome which is kept free of obstacles in order to permit aircraft operations to be conducted. Although no potential impact on the airport IFPs were expected, Hawarden Airport was consulted as part of the preparation of the ES and confirmed that the Proposed Development is not anticipated to have any impact on the airport's operations. Consequently, no impact on Hawarden Airport is expected for the Proposed Development. NATS also confirmed in their TOPA report (see **Table 12.10** and **Appendix 12.3**) that none of their en-route NAVAIDS or radio communication systems would be affected by the Proposed Development.

Military Aerodrome IFPs (including NAVAIDS)

12.135 No military aerodrome IFPs (including NAVAIDS) will be affected by the Proposed Development as confirmed in the MoD consultation response (see **Table 12.10** and **Appendix 12.4**).

Civil ATC Radars

12.136 The Proposed Development is within the operating range of a number of civil ATC radars including Hawarden Airport's ATC radar and NATS' Clee Hill, St Anne's and Great Dun Fell ATC radars. As mentioned above, Hawarden Airport was consulted prior to ES submission and confirmed that the Proposed Development is not anticipated to have any impact on the airport's operations. NATS also confirmed in its TOPA report (**Appendix 12.3**) that none of NATS' ATC radars would be adversely affected by the Proposed Development.

Military ATC Radars

12.137 No military ATC radars will be affected by the Proposed Development; as confirmed in the MoD consultation response (see **Table 12.10** and **Appendix 12.4**).

Military AD Radars

12.138 No military AD radars will be affected by the Proposed Development; as confirmed in the MoD consultation response (see **Table 12.10** and **Appendix 12.4**).

Low Flying (Military and Civilian EHSUs)

12.139 The Proposed Development is located in Low Flying Area (LFA) 7, which covers the geographical area of Wales. Military aircraft can fly down to a minimum of 250 ft (76.2 m) agl and, helicopters normally operate down to 100 ft (30.5 m) agl but due to the nature of their task, and for specific training purposes, are occasionally permitted to fly lower.

12.140 When conducting operational missions, UK Search and Rescue (SAR) helicopters and other emergency helicopter operators, such as the Welsh Air Ambulance unit and the North Wales Police Air Support unit, are not constrained by the normal rules of the air, which allows them flexibility to manoeuvre, as required, for the particular mission being carried out.

12.141 As outlined in **Table 12.13**, a detailed Lighting Plan (LP) has been agreed with CAA and forms the basis of the lighting scheme to be installed. The WFLFAC aviation lighting report is at **Appendix 12.2** and the CAA approval letter is at **Appendix 12.5**.

Local Minor Aerodromes

12.142 No local minor/unlicensed aerodromes are located within the 3 km CAA recommended consultation distance for airfields of this nature; consequently, the Proposed Development is not expected to impact aviation operations at any aerodromes of this nature.

Local Airspace Restrictions (Prohibited/Restricted/Danger Areas and Military MEXAs)

12.143 There are no local airspace restrictions in the vicinity of the Proposed Development therefore the Proposed Development would not impact any local airspace restrictions.

Met Office Radars

12.144 The closest Met Office radar system is located at Clee Hill, 45 nm (83 km) to the south-east of the Proposed Development; which is outside the 20 km safeguarding area for radars of this nature; therefore, the Proposed Development would not impact any Met Office radars.

Implications of Climate Change

12.145 Climate change and natural trends have been considered as part of the aviation assessment however, it is concluded that, due to the unique nature of aviation operations, there will be no implications for aviation operations related to climate and natural trends and is not considered further in this assessment.

Future Baseline in the Absence of the Proposed Development

12.146 There are no anticipated future changes to the airspace and aviation environment in the vicinity of the Proposed Development that affect this assessment of the impact on aviation receptors.

Design Considerations (Applied Mitigation)

12.147 As part of the design process, a number of applied mitigation measures and management plans have been proposed to reduce the potential for impacts on aviation receptors, as summarised in **Table 12.13**. As these measures are considered standard industry good practice for this type of development, they are therefore considered inherently part of the design of the Proposed Development.

Table 12.13 Applied Mitigation Measures Specific to Aviation

Applied Mitigation Measures	Justification/How Mitigation Will Be Secured
Approval and implementation of a Lighting Plan (LP), which will set out specific requirements in terms of aviation lighting to be installed on the wind turbines, as required under CAA (2016). CAP 393, Air Navigation: The Order and the Regulations (2016).	An LP has been prepared (**Appendix 12.2**) and approved by CAA (**Appendix 12.5**) which takes into account requirements for aviation lighting as specified in Article 223 of the UK ANO, 2016 and changes to International Civil Aviation Organisation Annex 14 Volume 2, Chapter 6, paragraph 6.2.4 promulgated in November 2016. Implementation of the LP will be a condition of any planning consent. These measures will ensure that the potential for risk of aircraft collision with the Proposed Development's infrastructure is minimised.
All structures of more than 91.4 m in height will be charted on aeronautical charts and reported to the Defence Geographic Centre, which maintains the UK's database of tall structures (Digital Vertical Obstruction File) at least ten weeks prior to construction.	An LP has been prepared (**Appendix 12.2**) and approved by CAA (**Appendix 12.5**). Implementation of the LP will be a condition of any planning consent. These measures will ensure that the potential for risk of aircraft collision with the Proposed Development's infrastructure is minimised.

Applied Mitigation Measures	Justification/How Mitigation Will Be Secured
Any temporary obstacles associated with wind farms which are of more than 91.4 m in height are to be alerted to aircrews by means of the Notice to Airmen (NOTAM) system.	Consultation with the CAA will be required to ensure that temporary obstacles of more than 91.4 m are identified to aircrews by NOTAM. Notification of temporary obstacles will be a condition of any planning consent. Measures will be adopted to ensure that the potential for risk of aircraft collision with the Proposed Development's infrastructure is minimised.
CAA will be informed of the locations, heights and lighting status of the wind turbines including estimated and actual dates of construction and the maximum heights of any construction equipment to be used, prior to the start of construction.	Consultation with the CAA will be required. Inclusion of locations, heights and lighting status of the wind turbines on aviation charts and in the UK an IAIP will be a condition of any planning consent. Measures will be adopted to ensure that the potential for risk of aircraft collision with the Proposed Development's infrastructure is minimised.

Assessment of Construction Effects

12.148 The assessment of effects is based on the project description as outlined in **Chapter 3**. Unless otherwise stated, potential effects identified are considered to be negative.

Predicted Construction Effects

Potential Impact on Military Low flying and Civilian EHSU Operations

12.149 The installation and presence of wind turbines pose physical obstructions to aviation operations carried out in the vicinity of wind farms. Wind turbines can be difficult to see from the air, particularly in poor meteorological conditions, leading to a potential increase in obstacle collision risk. Furthermore, during the construction phase, the presence and movement of installation vehicles (e.g. cranes) may also present a potential obstacle collision risk to aircraft operations. As explained in **paragraph 12.126**, the sensitivity of aviation receptors is considered

to be high and the magnitude of baseline aviation activities and equipment (without applied mitigation) is considered to be high.

Magnitude of Impact

12.150 The presence of construction infrastructure, more than 91.4 m in height, will be alerted to pilots under the NOTAM system (see **Table 12.13**). The NOTAM will provide details of potential hazards along a flight route, or at a location, that could affect the safety of flight. The cranes will also have appropriate aviation lighting installed.

12.151 In terms of wind turbines creating physical obstacles, aircraft operating at low levels are required to set a Minimum Safe Altitude (MSA); this is the lowest altitude set in areas to ensure safe separation between aircraft and known obstacles. The MSA for aircraft operating in Instrument Meteorological Conditions (i.e. poor weather conditions), enables aircraft to maintain a minimum of 1,000 ft (305 m) clearance between aircraft and known obstacles.

12.152 As detailed in **Table 12.13**, potential impacts to low flying aircraft operating in the vicinity of the Proposed Development will be managed through the agreement of an LP with key aviation stakeholders, and notification of the locations, heights and lighting status of the wind turbines to aviation stakeholders for inclusion in appropriate aviation documentation and charts. This will enable aviation operators to set an appropriate MSA over the Proposed Development. Implementation of the applied mitigation measures (**Table 12.13**) enables the magnitude of impact to be assessed as negligible.

Sensitivity of the Receptor

12.153 Pilots are obliged to plan their flying activities in advance and to be familiar with any en-route obstacles they may encounter; however, during flight, weather conditions or operational requirements may necessitate route adjustments. In Visual Meteorological Conditions (VMC) (i.e. good weather conditions), pilots are ultimately responsible for seeing and avoiding obstructions such as wind turbines and will be aware of their presence through the notification procedures set out in **Table 12.13**.

12.154 The Proposed Development is located within LFA 7. Aircraft completing low flying training in this area would be considered to be operating in VMC. This means that aircraft will be operating in weather conditions in which pilots would have sufficient visibility to maintain visual

separation from terrain, obstacles and other aircraft. The Proposed Development's wind turbines would be additional obstacles that low flying aircraft would have to avoid.

12.155 The Applicant is committed to lighting and charting the turbines and that, in the interests of air safety, the Proposed Development will be fitted with civilian, and military, accredited aviation safety lighting in accordance with the UK ANO, 2016 and further applied mitigation measures, as outlined in **Table 12.13**, will be implemented to ensure that any potential impacts of the Proposed Development are alleviated. Irrespective of any applied mitigation measures (**Table 12.13**) the sensitivity of the receptor remains high.

Significance of the Effect

12.156 The impact is predicted to be of local spatial extent, short to medium term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The sensitivity of low flying activities to change is considered to be **high** and, following implementation of applied mitigation measures (**Table 12.13**) the magnitude of the impact is assessed as **negligible**. Therefore, any potential effects resulting from the Proposed Development are determined as **negligible** and **not significant**.

Residual Construction Effects

12.157 The effects of the Proposed Development have been minimised, as industry standard risk control measures will be put in place prior to the construction phase of the wind farm. These mitigation measures will further serve to reduce the impact of the Proposed Development and ensure the project conforms to regular requirements and industry good practice. As such, and once all mitigation measures have been implemented, no residual significant effects are expected.

Assessment of Operational Effects

12.158 No effects on aviation are expected during the operational phase further to those impacts assessed for the construction phase.

Cumulative Effects

12.159 In terms of cumulative impact, any potential impact on an aviation receptor is generally treated as a standalone effect. Whilst other wind turbine developments may be located in close proximity, the effect on each receptor is considered on a case-by-case basis and any significant effect is sufficient to trigger an objection from the relevant aviation stakeholder. Although mitigation may have been agreed for other developments, it would still be necessary for negotiations and discussions with aviation stakeholders to be carried out under separate arrangement. As such, no specific cumulative effects on aviation stakeholders/receptors are expected.

Combined Effects

12.160 Combined effects have been considered as part of the aviation assessment however, it is concluded that, due to the unique nature of aviation operations, there will be no combined effects related to aviation operations.

Further Survey Requirements and Monitoring

12.161 The assessment of effects on aviation as a result of the construction and operational phases of the Proposed Development are predicted to be not significant in ES terms. Based on the predicted impacts it is concluded that no further surveys or specific monitoring are required.

Summary of Significant Effects

12.162 **Table 12.14** below summarises the predicted effects of the Proposed Development on aviation.

Table 12.14 Summary of Significant Effects

Predicted Effect	Significance	Mitigation	Significance of Residual Effect
Construction			

Predicted Effect	Significance	Mitigation	Significance of Residual Effect
Installation of wind turbines creating obstacles to military low flying and civilian EHSU operations.	Negligible	Applied mitigation measures (**Table 12.13**) including. Implementation of LP. Site details included on aeronautical charts. Temporary obstacles more than 91.4 m alerted to aircrews by NOTAM.	Negligible – **Not Significant**

Human Health

12.163 This section of the chapter considers the potential for impacts on human health. In considering potential human health effects, it has been important to take into account the significance of primary effects identified throughout the ES to determine if there could be 'secondary effects' on human health. Where primary effects are not predicted to be significant i.e. operational and cumulative noise, then there is not considered to be a potential health effect. Where potential human health impacts have been identified, these are assessed in the relevant topic chapters.

Table 12.15 Consultation Responses

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
Gwynedd Council (GC) 03 September 2024	Pre-Application Consultation	Within the outline CEMP, there is very little information regarding dust especially from the construction of the access track, and use of the access track. During periods of hot weather, it may not be feasible to use a water bowser to dampen the track, in extreme heat, the track may dry up quickly and therefore allowing dust to rise. An alternative option must be explored in these extreme cases. This track will be running close to residential properties for a considerable long period of time.	Further mitigation measures relating to dust have been detailed in **Appendix 3.1**.

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		Within the NTS Section 12.5 Human Health, paragraph 12.5.4 has stated that with respect to dust during the construction and operation of the proposed development, that there are no sensitive receptors within 200m and therefore mitigation not necessary. Gwynedd Council disagree with this statement. During the construction of the access track there are several properties within close proximity to the track who may be affected by dust from the construction and use of the access track, therefore mitigation measures should be implemented.	Subject to the identified mitigation measures detailed in **Appendix 3.1,** no significant effects will occur with respect to dust (see paragraph 12.164 below).

12.164 With respect to dust effects during construction and operation of the Proposed Development, the Design Manual for Roads and Bridges (DMRB) states that the locations of 'sensitive receptors' within 200 metres (m) of construction areas should be identified and mitigation measures to reduce dust effects be applied. Guidance on the assessment of dust from demolition and construction has also been published by the Institute of Air Quality Management (IAQM)[26].The Applicant will commit to adopting good practice measures for dust

[26] IAQM (2024), Assessment of Dust from Demolition and Construction – [Online] (Last accessed: 13/02/2025), Available: https://iaqm.co.uk/wp-content/uploads/2013/02/Construction-Dust-Guidance-Jan-2024.pdf

management during construction and will implement these through a Construction Environmental Management Plan (CEMP), thereby controlling and reducing any potential effects that dust generation may have on health**.** Draft measures in this respect, drawn up with due reference to the DMRB and IAQM guidance, are set out in **Appendix 3.1.** These measures being implemented (or other measures representing best practice at the relevant time), no significant health effects relating to dust are predicted. During operation of the Proposed Development there will be limited dust-raising maintenance activities and vehicular movements to and from the Site will also be limited.

12.165 Health effects that could be a result of construction and operational noise and construction traffic accidents are considered in the relevant chapters of this ES (**Chapter 10** and **Chapter 11**). Health effects as a result of deterioration of water quantity and quality of public and private water supplies are considered further in **Chapter 9**. The Site is not a source zone for public water supply, and effects on private water supplies will be mitigated as detailed in **Chapter 9**.

12.166 The Construction (Design and Management) Regulations 2015 have formed an integral part of the conceptual design of the Proposed Development. Health and safety risks have been taken account of and their consideration reflected in the design. Surveys and investigations have been undertaken throughout the pre-consent phase to, as far as reasonably practicable, identify, manage and if possible, avoid any potential risks during construction.

12.167 All construction activities will be managed within the requirements of the Regulations and will also comply with the requirements of the Health and Safety at Work etc. Act 1974. To further reduce possible health and safety risks, a Health and Safety Plan for the Proposed Development will also be drawn up. All staff and contractors working on the construction will be required to comply with the safety procedures and work instructions outlined in the plan at all times.

12.168 To ensure that hazards are appropriately managed, risk assessments will be undertaken for all major construction activities, with measures put in place to manage any hazards identified.

12.169 With respect to turbine icing, the Welsh Government have previously stated in TAN8 policy that the build-up of ice on turbine blades is unlikely to present problems on the majority of

sites in Wales. Even where icing occurs, the turbines' own vibration sensors are likely to detect the imbalance and inhibit the operation of the machines. Nevertheless, the Applicant will implement measures to ensure the safety of workers and the general public in relation to ice throw and ice fall, including notices throughout the Site alerting members of the public of the possible risk of ice throw and ice fall under certain conditions.

12.170 On the basis that the above good practice measures will be in place for the duration of the construction and operational period, no significant health effects as a result of the Proposed Development are predicted.

12.171 Any areas of common land lost to grazing will be replaced on a like for like basis, and wind farm access tracks within the common will be useable by members of the public. The Proposed Development has also been designed so as to allow the established Public Rights of Way (PRoW) network within the Site to continue to be used during the Proposed Development's operational lifespan. Use of the common and the Site's PRoW network for recreational purposes will be temporarily affected during the construction of the Proposed Development; during the operational phase of the Proposed Development, use of the common and PRoW within and around the Site for recreational purposes may also change due to considerations such as the Proposed Development's visual effects (effects upon visual amenity of people involved in leisure and recreation activities are discussed within **Chapter 5**).

12.172 Altered patterns of recreational use of the Site and surroundings may include a mixture of increases (due to interest in the Proposed Development) and decreases (due to perceived adverse visual effects from the Proposed Development). Recreational opportunities in the wider locality, with varying visibility or lack of visibility of the Proposed Development, will also remain plentiful following the Proposed Development's construction. Overall, therefore, and taking account of the assessment of landscape and visual effects presented in **Chapter 5**, the nature and scale of change in recreational activity at and around the Site due to the construction and operation of the Proposed Development is not predicted to result in significant effects with respect to human health.

Major Accidents and Disasters

12.173 This section of the chapter considers the potential for major accidents and disasters. In accordance with the latest IEMA guidance[27], it has been important to adopt a proportionate approach for this assessment, given that many events which could be classified as 'major accidents and disasters', and which could cause significant effects on the environment, are not relevant to the Proposed Development or its location. The Proposed Development is not located in an area with a history of natural disasters such as extreme weather events, and its construction and operation will be managed within the requirements of a number of health and safety related Regulations, including the Construction (Design and Management) Regulations 2015 and the Health and safety Work etc. Act 1974.

12.174 . The battery energy storage facility (BESS) proposed is expected to make use of modern liquid cooled battery systems to mitigate fire risks. These have been tested and evaluated against the UL 9540A method which assesses fire safety risk when battery cell 'thermal runaway'[28] takes place.

12.175 The internal condition of individual battery cells, stacks and racks will be monitored and managed by a battery management system which detects and mitigates for signs of potential overheating and developing fire risk. In the event of any early warning signs being detected, individual cell stacks can be easily deactivated and replaced as part of regular maintenance. Fire and gas detection and suppression systems will also be implemented and monitor for early warning signs and then try to quell any fires within battery housing. The modular design nature of most battery energy storage facilities also reduces the risk of fire spreading between battery housings by incorporating adequate internal spacing. It is expected that full details of the BESS installation and its management in these and all other respects would be agreed under one or more conditions imposed on any planning consent.

[27] Institute of Environmental Management and Assessment (IEMA) (2020) Major Accidents and Disasters in EIA: A Primer
[28] Thermal runaway is a situation where the current flowing through the cell or battery on charge or overcharge causes the cell temperature to rise.

12.176 Following good practice measures, it is considered that fire risks from the proposed BESS facility are low. However, the final design details of any BESS, including fire monitoring and suppression systems, will be implemented following approval from the local planning authorities via planning condition.

12.177 Specific to the Proposed Development, a major accident can also relate to a failure of the structural integrity of a turbine(s) or a mechanical fault. Modern turbines are fitted with sensors which detect if wind speeds are too high to operate safely, resulting in their shut down. This prevents excessive wear and damage to the gearbox and reduces the risk of turbines catching fire, the occurrence of blade failure or even a failure of the structural integrity of the turbine itself.

12.178 The occurrence of wind turbines catching fire from suspected lightning strikes is also very rare, and there is no evidence that human life has been at risk from such events occurring in the past. Turbines will also be constructed to very high design standards specified by the manufacturer and will be maintained on a regular basis to ensure that they are structurally sound.

12.179 As advised in the guidance, it is also appropriate to scope out highly likely but low consequence events as they will not result in a significant environmental effect, such as heavy rainfall as good practice infrastructure design will ensure that onsite flooding will be minimised, and low likelihood and low consequence events such as minor spills as these events are not considered to result in significant environmental effects and do not fall into the category of major accidents and disasters.

12.180 Turbines and associated equipment will be procured and constructed to comply with both strict UK and internationally recognised health and safety standards, the high design standards specified by the manufacturer and will be maintained on a regular basis in accordance with the high bar for operational maintenance set by Original Equipment Manufacturers specification and SafetyOn's UK Wind Turbine Safety Rules.

12.181 All other effects assessed in the EIA which could be deemed to potentially cause a major accident or disaster have already been assessed elsewhere, and these are deemed to be low likelihood but potentially high consequence events. These relate to potential road traffic

accidents occurring during the proposed development's construction, and land slide risk events and flood risk which have been assessed in **Chapter 10** and **Chapter 9** respectively.

12.182 Whilst there is the possibility of a road traffic accident occurring during construction, all traffic will be carefully managed through the construction traffic management plan (CTMP) and abnormal load transport management plan, such that there is unlikely to be a major road traffic accident which causes major injury or fatality (see **Chapter 10** for further details). Flooding and peat landslide risks as considered in **Chapter 9**, have been assessed to be very low and therefore unlikely to lead to a major accident or disaster.