GARREG LWYD HILL WIND FARM

2014 SEI

Volume 2 Text, Figures and Appendices

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PREFACE

This Supplementary Environmental Information (SEI) has been prepared in support of a planning appeal for a proposed wind farm on Garreg Lwyd Hill, between Felindre and Llanbadarn Fynydd in Radnorshire, Powys, (**APP/T/6850/A/13/229593**) and is supplementary to the original Environmental Statement submitted with the application in 2008 (2008 ES) and subsequent SEI submitted in 2013 (2013 SEI)

The SEI is contained within two volumes:

- Volume 1:Non Technical Summary
- Volume 2: Written Statement, Figures and Supporting Appendices

The SEI has been prepared by RES UK & Ireland Ltd (RES) in collaboration with the following specialist consultants:

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Copies of the full SEI and original Environmental Statement (ES) may be viewed during normal opening hours at the following locations:

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Hard copies of the SEI are available from RES priced at £75 each. Electronic copies of the SEI are available on CD-ROM for £25.

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TABLE OF CONTENTS

LIST OF FIGURES

No.	Figure
Figure 5.4B	Blade Tip ZTV (126.5m) – Bryngydfa Wind Farm (10km buffer)
Figure 5.5.1	Viewpoint 1: Shropshire Way, Long Mynd
Figure 5.5.2	Viewpoint 2: Two Crosses
Figure 5.5.3	Viewpoint 3 Kerry Ridgeway, Ceri Forest
Figure 5.5.4	Viewpoint 4: Bettws-y-Crwyn
Figure 5.5.5	Viewpoint 5: Offa's Dyke Path, Llanfair Hill
Figure 5.5.6	Viewpoint 6: Felindre
Figure 5.5.7	Viewpoint 7: Beacon Hill
Figure 5.5.8	Viewpoint 8: A488 near Pant Farm
Figure 5.5.9	Viewpoint 9: Llandrindod Wells
Figure 5.5.10	Viewpoint 10: Kerry Ridgeway, Two Tumps
Figure 5.5.11	Viewpoint 11: Minor Road north of Llanbadarn Fynydd
Figure 5.5.12	Viewpoint 12: Minor Road north of Llanbadarn Fynydd
Figure 5.5.13	Viewpoint 13: Glyndwr's Way new Bryn-Mawr Cottage
Figure 5.5.14	Viewpoint 14: A483, Llanbister Bridge
Figure 5.5.15	Viewpoint 15: North of Llaethdy
Figure 5.5.16	Viewpoint 16: Carn Gafallt
Figure 5.5.17	Viewpoint 17: Aberystwyth Mountain Road
Figure 5.5.18	Viewpoint 18: Nantypyllau
Figure 5.5.19	Viewpoint 19: Rhos Fiddle Nature Reserve
Figure 5.5.20	Viewpoint 20: Shropshire Way, Colebatch Hill
Figure 5.5.21	Viewpoint 21: Hopesay Common
Figure 5.5.22	Viewpoint 22: Glyndwr's Way between turbines 21 and 22 (now deleted)
Figure 5.5.23	Viewpoint 23: Junction of Glyndwr's Way and PROW in Valley of Gwenlas Brook
Figure 6.1	Survey Areas April –June 2014
Figure 6.2	Survey Area July 2014
Figure 6.3	Transect Route and Location of Bat Passes in Survey Area 1 (April – June) 2014
Figure 6.4	Transect Route and Location of Bat Passes in Survey Area 2 (April – June) 2014
Figure 6.5	Transect Route and Location of Bat Passes in Survey Area 3 (April – June) 2014
Figure 6.6	Transect Route and Location of Bat Passes in Survey Area 1 (July) 2014
Figure 6.7	Transect Route and Location of Bat Passes in Survey Area 2 (July) 2014
Figure 6.8	Proportion of Bat Activity (By Species) at Automated Survey Locations in 2014
Figure 6.9	Noctule Activity (B/H) at Automated Survey Locations in 2014
Figure 6.10	Noctule Activity (B/H) at Automated Survey Locations in April and May 2014
Figure 6.11	Noctule Activity (B/H) at Automated Survey Locations in June and July 2014
Figure 6.12	Common Pipistrelle Activity (B/H) at Automated Survey Locations in 2014
Figure 6.13	Common Pipistrelle Activity (B/H) at Automated Survey Locations in April and May 2014
Figure 6.14	Common Pipistrelle Activity (B/H) at Automated Survey Locations in June and July 2014
Figure 6.15	Soprano Pipistrelle Activity (B/H) at Automated Survey Locations in 2014
Figure 6.16	Soprano Pipistrelle Activity (B/H) at Automated Survey Locations in April and May 2014
Figure 6.17	Soprano Pipistrelle Activity (B/H) at Automated Survey Locations in June and July 2014
Figure 6.18	Myotis Species Activity (B/H) at Automated Survey Locations in 2014
Figure 7.1	Cultural Heritage Wireline Overview
Figure 7.2	Wireline view from Blaen-nant-du
Figure 7.3	Wireline view from SAM RD084 to SAM RD104
Figure 7.4	Wireline view from SAM RD084 to SAM RD104
Figure 7.5	Photo and Wireframe Viewpoint Location from Cwm yr Hob
Figure 7.6	Photo and Wireframe View from Cwm yr Hob
Figure 9.1	Predicted Noise Footprint for Proposed Garreg Lwyd Hill Wind Farm
Figure 9.2	Cumulative Noise Footprint for Proposed Wind Farms

LIST OF APPENDICES

No.	Appendix
	Supplementary Environmental Information Appendices
5.1	Status of ES & SEI Information
5.2	Method of Assessment, Glossary & Abbreviations
5.3	Wind Turbine Data
6.1	Bat Survey Methodology, Results and Photographs
7.1	Assessing Likely Development Effects on Cultural Heritage Assets
7.2	Recent Email Correspondence with Cultural Heritage Consultees
7.3	Castell y Blaidd Background Data
7.4	Listed Buildings Background Data
8.1a	Strategic Traffic Management Plan Section 6 Rev T (March 2014)
8.1b	Welsh Government 13 March 2014 Letter Approving STMP Section 6
8.2	Road Safety Audit Mid Wales Wind Farms Sections 2 to 5 (August 2013)
8.3	Road Safety Audit Mid Wales Wind Farms Section 6 (May 2014)
8.4	Cumulative Impact Assessment of Non-AIL Construction Traffic
8.5	Garreg Lwyd Non-AIL Transport Assessment on the Strategic Road Network (July 2014)
8.6a	Site Entrance Drawings (7 August 2013)
8.6b	Site Entrance Drawing (23 August 2013)
8.6c	Site Entrance Correspondence (August 2013)
8.7a	Nant Oer Rail Bridge Drawing 1
8.7b	Nant Oer Rail Bridge Drawing 2
8.7c	Nant Oer Rail Bridge Vertical Review File Note
8.7d	Nant Oer Rail Bridge Correspondence (2014)
8.8	Agreed Statement on the AIL Delivery Process (29 Jan 2014)
8.9	Water Preferred Policy Assessment (February 2014)
8.10a	AMEC December 2013 Environmental Assessment of Transport Route
8.10b	AMEC February 2014 SEI of Transport Route
8.11	July 2014 Planning Application Drawings
9.1	Background Noise Survey Photos
9.2	Charts

1. INTRODUCTION

1.1 About the Development

1.1.1 In May 2008, a full planning application with an ES was submitted by RES UK & Ireland Ltd ('RES') to Powys County Council (PCC) for a wind energy development of 23 turbines and associated infrastructure on land at Garreg Lwyd Hill between Felindre and Llanbadarn Fynydd, Powys. The site covers approximately 440 hectares (ha) and mainly consists of improved grassland, primarily used for grazing sheep, horses and cattle.

1.1.2 The planning application (number P2008/0785) included the erection of wind turbines and associated infrastructure, including electricity trsnformers, access tracks, watercourse crossings, underground cabling, crane hardstandings, anemometry mast, public car park, control building and substation compound.

1.1.3 An Environmental Statement (ES) was prepared alongside the planning application which reports the outcome of a formal Environmental Impact Assessment (EIA) of the proposed Garreg Lwyd Hill Wind Fram, hereafter referred to as the 'Proposed Development'.

1.1.4 The ES addresses the predicted likely signifiant positve and negative effects on the enviornment during the construction, operation and decommissioning of the Proposed Development. SEI was also submitted to PCC in June 2013 to present any additional environmental information in response to PCC comments and to provide points of clarification on the original ES

1.1.5 The planning application was refused by PCC in September 2013. RES submitted an appeal against the refusal in November 2013 and this appeal is the subject of a Public Inquiry to be held in October 2014. This Supplementary Environmental Information (SEI) has been prepared in support of this appeal.

1.1.6 A separate access route planning application (number P/2013/0733) for highway upgrades and associated works to facilitate deliveries of abnormal indivisible loads was submitted in July 2013 and refused by PCC in September 2013. This refusal was also appealed in November 2013 (**APP/T/6850/A/2209595)** and is also the subject of the same Public Inquiry in October 2014. A separate ES and SEI has been prepared in respect of that access route appeal.

1.2 Scope of the Supplementary Environmental Information

1.2.1 This SEI presents the findings of additional survey and assessment work submitted in response to the reasons for refusal in PCC's decision notice, issues raised in its Statment of Case dated 15 April 2014 and to comments from consultees.

1.2.2 The principal purpose of this SEI is to present the additional environmental information in response to PCC comments and to provide points of clarification of the original ES and subsequent SEI 2013. This SEI aims to provide all additional information in a manner that facilitates consultation, is accessible, and which summarises the salient information presented in any technical reports contained in the appendices.

1.2.3 It is not the intention of this SEI to repeat information contained within the ES and SEI 2013 which remain valid. The SEI therefore focuses on providing a description of the additional environmental information and an assessment of any revised environmental impacts based on this additional information.

1.3 Structure of the SEI

1.3.1 The SEI comprises a non technical summary (Volume 1) and the written statement (Volume 2), which aims to present the additional environmental information and analysis that has been gathered since PCC's decision in September 2014.

1.3.2 The written statement, following the introductory chapter, is divided into the following further chapters:

- Chapter 2 – Planning and Energy Policies.
- Chapter 3 – Design Development.
- Chapter 4 – Project Description
- Chapter 5 – Landscape and Visual
- Chapter 6 – Bats
- Chapter 7 - Cultural Heritage
- Chapter 8 - Transport and Access
- Chapter 9 - Acoustic

1.3.3 In support of the written statement, figures and appendices are also included in this Volume 2 of this SEI.

2. PLANNING AND ENERGY POLICIES

2.1 Introduction

2.1.1 The background to the current drive to increase the use of renewable sources of energy has its roots in the recognition that the burning of fossil fuels has an adverse effect on the climate of the world as a whole and that global measures are required to deal with it. International, European and UK policies have, over the last 24 years, become ever more focussed on the concerns about global warming. The use of renewable resources as an increasing proportion of our total energy consumption is seen as a key part of the ultimate sustainable solution, alongside energy efficiency and conservation especially as it does not rely on the consumption of fossil fuels for its fuel supply, and needs to be developed alongside a campaign of increasing awareness by the public and industry of the need for energy efficiency. These objectives are defined in both European Union law (for example the Directive on Renewables 2009/28/EC of June 2009), and in UK law and policy such as the UK Government Climate Change Programme, the Climate Change Act 2008[1], the Renewable Energy Strategy 2009[2], the UK Renewable Energy Roadmap 2011[3] and its 2012[4] and 2013[5] Updates.

2.1.2 There are three further benefits of using renewable resources. One is the issue of security of supply, since the creation of electricity from renewable resources within the UK provides a source that is not open to interruption by the actions of foreign governments or others. The ability to ensure electricity supplies from sources that are not open to foreign intervention is one of the key planks of the national energy policy. Another benefit is the creation of further electricity generation capacity at a time when older plant is being decommissioned. The third benefit is the issue of economic development. From its beginnings 23 years ago, the very slow growth in the development of new renewable technologies has meant that other countries which had already branched out into these technologies (with wind energy being the prime example) were able to utilise their established manufacturing capacity to supply the emerging UK wind industry's demands. This is now changing as the recent growth in the number of sites and the number of turbines on each site is creating the potential for the development of a home-based manufacturing industry. All these are benefits identified in the Renewable Energy Strategy published by the Government in July 2009.

2.2 The response to climate change

2.2.1 The response to the issues of climate change can be traced through a series of conventions, directives and policy statements at international, European and national levels over the last 21 years. The result of the latest EU Directives published in March and June 2009 (and endorsed by the UK Government) is that the UK has a binding target to meet 15% of its energy consumption from renewable sources by 2020. Despite many attempts to challenge the theory and science that there is climate change caused by human actions, the latest Reports from the Intergovernmental Panel on Climate Change (IPCC)[6] published as a series of three finalised Working Group Reports in 2014 dispel doubts about the validity of the concerns and the need for action to tackle them.

2.2.2 At their Spring Summit in March 2007, European Union leaders agreed to adopt a binding target of 20% of overall energy to be produced from renewables by 2020. Renewable energies were identified as contributing simultaneously to security of supply, competitiveness and sustainability, thus meeting the objectives of the Energy Policy for Europe:

- To increase security of supply;
- To ensure the competitiveness of European economies and the availability of affordable energy;
- To promote environmental sustainability and combat climate change.

2.2.3 Proposals to deliver the EU's commitments were set out in the **EU Climate and Energy package**[7], released in January 2008. The measures would dramatically increase the use of renewable energy in each country and set legally enforceable targets for governments to achieve them. The package sought to reduce greenhouse gas emissions by at least 20% and increase renewable energy to 20% by 2020. The emissions reduction would be increased to 30% by 2020 when a new global climate change agreement is reached. The package included a draft Directive on the Promotion of the Use of Energy from Renewable Sources.

2.2.4 The **EU Climate and Energy Package** was formally agreed in April 2009 and commits the EU to achieving a reduction in EU greenhouse gas emissions of 20% by 2020, increasing to up to 30% in the event of an international agreement on climate change, compared to 1990 levels. The package includes a binding renewables target of 20%. The UK's share of this target is to deliver 15% renewable energy by 2020.

2.2.5 At the end of October 2013, EU climate change Ministers set their vision for a low carbon economy at the European Green Growth Summit in Brussels. The report 'Going Green for Growth'[8], issued following the Summit, makes an overarching economic and strategic case for early and ambitious EU low carbon action to deliver cost efficient and cost effective EU decarbonisation that delivers maximum economic and wider benefits for Europe. Three immediate priority EU actions are identified within the report, namely (i) to agree an ambitious target-based post 2020 policy framework in line with the EU Low Carbon and Energy Roadmaps; (ii) to reform the EU Emissions and Trading System in order to cut emissions cheaply and further incentivise low carbon investments; and (iii) to be in a position to make an ambitious EU emissions reduction offer at the World Leader's Climate Change Summit in Autumn 2014. Furthermore, the report makes the clear statement that *"...Modern energy assets and infrastructure built today could provide decades of economic benefits to the EU. Energy investments represent one of the most productive forms of infrastructure investment available..."* (page 16). The report goes on to say that *"...Yearly average oil prices have risen by over 200% since 2003 alone while EU oil import dependency has risen to 85%...The Commission estimates that reaching our 20% energy saving target by 2020 could reduce EU oil imports by 2.6bn barrels of oil per year…"* (pages 20-21). In addition, the report outlines wider co-benefits and policy synergies for decarbonisation, including health through cutting pollution, as well as biodiversity and nature conservation.

2.3 The UK Government

2.3.1 The Government announced a review of its energy policy in November 2005, and its subsequent report, The Energy Challenge[9], was published in July 2006. The Review Report re-affirms that renewable energy is an integral part of the Government's strategy for tackling climate change and a range of measures – "the big push for renewables" - are proposed to promote the growth of renewable electricity to achieve 20% of electricity coming from renewable sources by 2020.

2.3.2 Significantly, the Review Report identifies the planning system as being a particular constraint to the deployment of renewable energy generation. In order to assist the planning determination process, the Report makes a Statement of Need for renewable energy (Annex D), stating at paragraph 7.27 that it *"…is to be used as a material consideration…"*

2.3.3 The most salient parts of the Statement of Need are:

"…Renewable energy as a source of low-carbon, indigenous electricity production is central to reducing emissions and maintaining the reliability of our energy supplies at a time when our indigenous fossil fuels are declining more rapidly than expected. A regulatory environment that enables the development of appropriately sited renewable projects and allows the UK to realise its extensive renewable resources, is vital if we are to make real progress towards our challenging goals…"

"…New renewable projects may not always appear to convey any particular local benefit, but they provide crucial national benefits. Individual renewable projects are part of a growing proportion of low-carbon generation that provides benefits shared by all communities both through reduced emissions and more diverse supplies of energy, which helps the reliability of our supplies. This factor is a material consideration to which all participants in the planning system should give significant weight when considering renewable proposals. These wider benefits are not always immediately visible to the specific locality in which the project is sited. However, the benefits to society and the wider economy as a whole are significant and this must be reflected in the weight given to these considerations by decision makers in reaching their decisions…"

2.3.4 The **Energy White Paper, Meeting the Challenge**[10] (May 2007), set out the Government's international and domestic energy strategy to respond to the two main energy challenges of climate change and energy security. Support for renewable energy is strengthened as its provision meets the twin strategic goals of attaining a low carbon economy and security of supply. One of the key elements of the strategy was to provide legally binding carbon targets for the whole UK economy to progressively reduce emissions (through the draft Climate Change bill).

2.3.5 The Paper reported that despite good progress to date in renewables provision, there were barriers slowing the rate of renewables deployment in the UK in both the short and long term.

2.3.6 The Paper sought to overcome these barriers and aims to increase the proportion of energy from renewable sources, predominantly through the Renewables Obligation, which is to be strengthened by increasing the Obligation up to 20%; through reform of the planning system; and by removing barriers to decentralised electricity generation.

2.3.7 On 26th November 2008, three bills which seek to tackle climate change received Royal Assent: the Climate Change Act 2008, the Energy Act 2008 and the Planning Act 2008.

2.3.8 The key provisions of the Climate Change Act 2008[1] are:

- **Legally binding targets**: Greenhouse gas emission reductions of at least 80% by 2050, and reductions in CO2 emissions of at least 26% by 2020, against a 1990 baseline. The 2020 target will be reviewed soon after Royal Assent to reflect the move to all greenhouse gases and the increase in the 2050 target to 80%.
- A **carbon budgeting system** which caps emissions over five year periods, with three budgets set at a time, to set out the trajectory to 2050. The first three carbon budgets will run from 2008-12, 2013-17 and 2018-22, and must be set by 1 June 2009.
- The creation of the Committee on Climate Change, a new independent, expert body to advise Government on the **level of carbon budgets** and where cost effective savings could be made. The Committee gained statutory status on 1 December 2008, and has issued its first report, "Building a Low Carbon Economy - the UK's contribution to tackling climate change".
- The aviation and shipping industries to be accountable for their UK greenhouse gas emissions.
- Five gases other than carbon dioxide, including methane, to be classified as greenhouse gases.
- Government to report back every five years.

2.3.9 The **Energy Act 2008**[11] implements the legislative aspects of the 2007 Energy White Paper: Meeting the Energy Challenge. The Act strengthens the Renewables Obligation to drive greater and more rapid deployment of renewables in the UK with the aim of increasing the diversity of the UK's electricity mix, improving the reliability of energy supplies and helping to lower the carbon emissions from the electricity sector.

2.3.10 The **Planning Act 2008**[12] provides for the Government to produce National Policy Statements (NPS). The Overarching Electricity Infrastructure NPS EN-1[18] and the renewables specific NPS EN-3[19] were designated by Parliament on 19 July 2011. The Coalition Government has confirmed that its policy on the need for renewable energy is clear and that local planning authorities and decision-makers may treat NPSs as a material consideration when dealing with smaller infrastructure projects (such as wind farms below 50MW).

2.3.11 In July 2009, the **Renewable Energy Strategy**[2] was published, which sets out the means by which the UK will meet its legally-binding targets under the EU Renewable Energy Directive. The UK's contribution to the EU target is to increase the share of renewables in the energy mix to 15% by 2020, which represents a seven-fold increase in UK renewable energy production from 2008 levels. A key element of the new strategy is the EU requirement that there will be reporting steps every two years in which the achievement of delivery against the trajectory set for the 2020 targets has to be tested and reported to the EU.

2.3.12 The **Renewable Energy Strategy** sets out the Government's comprehensive action plan for delivering the "renewables revolution". The document sets out the balance of fuels and technologies that is most likely to achieve this challenging goal and the strategic role that the UK Government will adopt and the specific actions intended to lead delivery.

2.3.13 The UK Government is committed to ensuring that the appropriate regulatory and financial frameworks are in place to enable the market to deliver the required increase in renewable energy. This includes:

- Extending and expanding the long-term incentive for major renewable electricity developments, the Renewables Obligation, to ensure that it can deliver more than 30% of electricity generated from renewables (it is anticipated that about two thirds of this will come from on and offshore wind projects). Renewable energy developments currently (i.e. in 2009) deliver around 5.5% of electricity.
- Establishing the Office for Renewable Energy Development to work with all relevant stakeholders in the planning system, supply chain, connection to the grid and bioenergy supply. The relevant stakeholders include the Planning Inspectorate, local and regional authorities, Government offices and bodies such as the Carbon Trust.
- Ensuring a strategic approach to planning, working with regional authorities to develop robust evidence-based strategies for delivering each region's renewable energy potential in line with the 2020 target.
- Supporting swifter delivery of renewable and low carbon energy applications.
- Investing in the UK renewables industry to develop the wider renewables supply chain and to develop next-generation technology development and generation.
- More strategic investment in the grid.
- Developing a system for a quicker and fairer connection to the grid.
- Highlighting the new requirement of the EU Directive that there will be two year reporting stages to the EU to show that each country is on target to meet the trajectory for the 2020 targets – it is no longer a case of working towards a distant target, as there are effectively now several closely spaced interim targets to be met.

2.3.14 The Renewable Energy Strategy 2009 is also intended to tackle climate change, reducing the UK's emissions of carbon dioxide by over 750 million tonnes between now and 2030. It will also promote the security of the UK's energy supply, reducing overall fossil fuel demand by around 10% and gas imports by 20–30% against what they would have been in 2020.

2.3.15 This Renewable Energy Strategy is an integral part of the UK Government's overall UK **Low Carbon Transition Plan**[13] to ensure delivery of the clean, secure and affordable energy of the future. The UK Low Carbon Transition Plan establishes a roadmap for the decarbonisation of the UK. The White Paper sets out the actions the Government is going to take to achieve this in practice while maximising economic opportunities, spreading the costs fairly, and keeping energy supplies safe and secure. The approach will be based around measures to promote a competitive energy market, making polluters pay for the carbon they use, supporting technological development and helping people make low carbon choices.

2.3.16 The **Renewable Energy Action Plan**[14] (July 2010) reiterates support for renewable energy and reinforces the need to meet the EU targets through development of renewable energy sources. The Government's commitment extends to engaging with the independent UK Committee on Climate Change to advise on scope for a more ambitious target for renewables.

2.3.17 In the **Annual Energy Statement**[15] published by the Department of Energy and Climate Change on 27 July 2010, the Coalition Government confirmed that it is committed to being the greenest Government ever, which includes a firm commitment to renewable energy. This will include engaging with the independent UK Committee on Climate Change to advise on scope for a more ambitious target for renewables. The Energy Statement contains a commitment to positive action to drive renewables deployment through the implementation of a robust Delivery Plan for renewables which will set clear priorities, milestones and metrics for monitoring deployment progress.

2.3.18 The Committee on Climate Change published the **Renewable Energy Review**[16] on 9 May 2011. This expresses the view that whilst the UK Government's 2020 ambition is appropriate, its achievement will require large-scale investment and new policies to help support technology innovation and to address barriers to uptake in order to suitably develop renewables as an option for future decarbonisation. The Renewable Energy Review also acknowledges that, compared with onshore wind, most other renewable energy generation technologies are expensive and likely to remain so until at least 2020, and in some cases, considerably later.

2.3.19 As a result, onshore wind is a key element of the portfolio of low carbon generation technologies which the Climate Change Committee says is required to ensure that the UK's renewable energy targets and climate change commitments are met.

2.3.20 The Government issued the **Electricity Market Reform White Paper**[17] (EMR) on 12 July 2011. The White Paper sets out a package of key measures to attract investment, reduce the impact on consumer bills and create a secure mix of electricity sources including gas, new nuclear, renewables and carbon capture and storage. Government intends to legislate for the "key elements" of this package and it is anticipated that the first low carbon projects to be supported under such provisions will occur in 2014.

2.3.21 Onshore wind is described as a "mature technology" (paragraph 2.3.25), in which the market can be prepared to invest with some certainty.

2.3.22 It is stated that, "*The policy proposals within this White Paper form part of a much wider DECC agenda aimed at energy decarbonisation and security of supply*". The decarbonisation of electricity generation informs one of the three "key objectives" of the EMR (1.3) and it is acknowledged that such an objective is implicitly linked to the issue of climate change and the achievement of national and European renewable energy targets. At chapter 1 is described the "vision" to be achieved by 2030 in Box 1:

"…By 2030, we will have achieved a reduction in our greenhouse gas emissions across the whole economy in line with our carbon budgets and will be firmly on track to achieving at least an 80 per cent reduction by 2050. We have substantially decarbonised electricity supply and also get more than one third of electricity generation from renewable sources…Wind power forms a substantial part of our generation mix with cost competitive wind turbines both on and offshore…" (emphasis added).

2.3.23 "*Ensuring the future security of electricity supplies*" is the first of the primary objectives in the EMR. Wind power is seen as being a reliable and stable future technology, which should inform part of the "*generation mix*" in accordance with a range of advancing and currently infant renewable technologies. It is acknowledged that onshore wind will only form part of a series of technologies.

2.3.24 Key to both investment and security supply rests in certainty. At 1.6 it is stated that "*investors also need to have confidence in the planning system for major infrastructure projects…This means giving developers greater certainty on the policy framework for decision-making on major infrastructure projects. The Government has therefore put before Parliament six energy National Policy Statements (NPSs) for approval*". The EMR is considered to form "*part of a much wider DECC agenda*" aimed at energy decarbonisation. The Renewables Roadmap (see below) is considered a parallel, complimentary publication to the EMR (stated to be "*published alongside this white paper*") and outlines the strategy for deployment, in accordance with the challenge of overcoming the non-financial barriers (as opposed to the consideration of overcoming financial challenges in the EMR) (see paragraph 1.43).

2.3.25 The EMR is an expression of Government policy and illustrates a direction of travel intended by Government.

2.3.26 The Department of Energy and Climate Change (DECC) issued the '**UK Renewable Energy Roadmap**'[3] in July 2011, alongside the Government's Electricity Market Reform White Paper. The foreword explains that the document is "*the UK's first Renewable Energy Roadmap*" and that it "*sets out our shared approach to unlocking our renewable energy potential*".

2.3.27 The introduction explains that the goal is to ensure that 15% of UK energy demand is met from renewable sources by 2020. At 1.3 it explains that the ambition extends beyond 2020 and there is reference to the recent advice from the Committee on Climate Change (CCC) which has concluded that there is scope for penetration of renewable energy to meet 30 – 45% of all energy consumed in the UK by 2030.

2.3.28 The document sets out analysis of recent trends in renewables deployment and the pipeline of projects that could come forward before 2020, as well as barriers to be overcome and sets out a targeted programme of action that the Government is taking to increase renewables deployment (paragraph 1.8).

2.3.29 The Roadmap sets out a delivery plan to achieve the UK's renewable energy target over the next decade, based upon potential deployment levels and current constraints. In the main the "*actions to address barriers*" summarise policy measures already being undertaken, with some new ones. The foreword states the actions are intended to "accelerate renewable energy in the UK" (page 4).

2.3.30 The more significant parts of the document relate to forecast costs and deployment levels. The document will be reviewed and refreshed annually.

2.3.31 The **2nd Annual Energy Statement**[20] was delivered as an oral statement to Parliament on 23 November 2011. The Statement confirmed the Government's commitment to delivering clean energy for the future and tackling climate change. It also recognised the need for the UK to build a new energy portfolio: one that is equal to the Country's changing needs and its ambitious carbon targets, with a view to realising the Government's vision of a thriving, competitive low carbon economy with cleaner energy, more efficient homes and lower energy bills.

2.3.32 The Coalition Government issued the Carbon Plan '**Delivering our Low Carbon Future**'[21] in December 2011. It sets out the Government's plans for achieving the emissions reductions committed to in the first four Carbon Budgets covering the overall period from 2008 to 2027. These are related to the legally binding targets to reduce the UK's greenhouse gas emissions as set out in the Climate Change Act 2008. The Plan also sets out how the UK will achieve de-carbonisation within the framework of the Government's overall energy policy.

2.3.33 The vision, summarised at paragraph 10 (page 4) states: "*…if we are to cut emissions by 80% by 2050, there will have to be major changes in how we use and generate energy… electricity will need to be decarbonised through renewable and nuclear power, and the use of carbon capture and storage (CCS)…*".

2.3.34 With regard to electricity, paragraph 16 sets out the three parts of the Government's expected generation portfolio, namely renewable power, nuclear and coal and gas fired power stations fitted with CCS. Paragraph 43 states that the power sector accounts for some 27% of UK total emissions by source and that by 2050, emissions from the sector need to be close to zero. Added to this, with the potential electrification of heating, transport and industrial processes it is estimated that electricity demand may rise between 30 and 60% and in such circumstances, "*…we may need as much as double today's electricity capacity to deal with peak demand…*" (paragraph 44).

2.3.35 Paragraph 45 reiterates that while the overall direction is clear, there are major uncertainties over both the most cost effective mix of technologies and the pace of transition. It adds that "*…the Government is committed to ensuring that the low carbon technologies with the lowest costs will win the largest market share…*". Therefore, whilst there is some flexibility in the overall eventual mix that will constitute the future UK generation platform, wind energy as a low cost renewable technology has an important place.

2.3.36 The **Energy Security Strategy**[22] of November 2012 recognised the important and far greater role which electricity will play in the future, not least as the use of electric transport increases. As a result, the Strategy emphasised the need for frameworks to be put in place to encourage the market to shape a broad spread of generation, including renewables, gas and nuclear. Furthermore, the Strategy commented that "*...The substantial investment required will be attracted from private funds, with consumers paying only on delivery. This investment will help get our economy moving, spurring the development of new markets, and will help insulate consumers from volatile global fossil fuel prices. Energy security is central to ensuring that the UK remains an attractive place to live and do business...*"

2.3.37 The **Energy Bill**[23] and **Annual Energy Statement 2012**[24] were introduced into Parliament on 29 November 2012. The Energy Act completed its parliamentary passage in December 2013, and is intended to implement the key aspects of Electricity Market Reform by introducing major reforms that will result in greater stability and certainty for investors in energy infrastructure. The Annual Energy Statement discusses how the Government will deliver a balanced energy policy and that this will necessitate more investment in renewables.

2.3.38 As regards renewable energy, the Statement records (at paragraph 2.16) that "*...increasing the amount of renewable energy deployed in the UK will diversify our energy supply and improve our energy security by reducing our exposure to fossil fluctuations...*". It adds that increasing the supply of renewable energy is also critical to keeping the UK on a low carbon pathway and helping to meet legally binding carbon targets as well as the EU legal commitment to source 15% of energy from renewable sources by 2020. Turning to the matter of planning policy, the Statement refers to the NPPF and, as regards this document, states (at paragraph 2.19) that:

"*...it confirms planning's important role in tackling climate change and making the transition to a low carbon economy. It looks to local planning authorities, who have responsibility for considering proposals for renewable energy infrastructure of 50MW or less to have a positive strategy to promote energy from renewable and low carbon sources in their local plans...*"

2.3.39 The Statement adds importantly that, with regard to local planning authorities, "*...they are also expected to approve applications if the impacts are (or can be made) acceptable...*". It is notable that the Statement emphasises this aspect of the policy guidance contained in the NPPF.

2.3.40 The Annual Energy Statement is an important material consideration which sets out the leading edge of Government policy. The policy is clear in that it is underpinned by an objective to address climate change and to move the UK electricity generation platform to one which has renewable energy as a key component. The new fiscal support mechanism will implement electricity market reform and is intended to establish investor confidence in renewable energy. The fiscal support amounts to a figure of some £7.6bn of a financial commitment by 2020.

2.3.41 The first **UK Renewable Energy Roadmap Update**[4] was published on 27 December 2012. It sets out the progress and changes delivered in the renewables sector over the past year and sets out certain challenges and actions for the year ahead. The Executive Summary states (at page 6) that the Coalition Government "*...is committed to increasing the deployment of renewable energy across the UK...*". It remains the case that encouraging a diverse mix of energy sources including renewables is the best way to meet the UK's decarbonisation ambitions. Whilst the current pipeline for onshore wind is likely to have the potential to provide the appropriate quantity of development (a capacity of around 10-13GW), the Update expressly recognises that "*...we cannot be certain how much of the capacity in the pipeline projects will go forward as not everything in the pipeline will be consented and not everything consented will be built...*".

2.3.42 As regards onshore wind, the Update records (at page 36) that "*...the Government is committed to onshore wind as part of a diverse energy mix contributing to a security of supply and carbon reduction targets...*". It adds that onshore wind provides substantial economic benefits and that the Government is seeking to remove barriers to the development of appropriately sited projects, whilst giving local communities more influence. There remains an urgent need for new large scale projects to come forward to ensure that the 2020 target is met (i.e. 15% of UK energy consumption to come from renewable sources, with the contribution made by renewables to UK electricity generation being 30%), together with the Government's wider decarbonisation objectives.

2.3.43 A second **Update to the Roadmap**[5] was published in November 2013. Much has been made at recent public inquiries in both England and Wales about the issue of some form of capacity of 13GW having been set for onshore wind for 2020. No such "capacity" has ever existed and what the Renewable Energy Strategy of 2009 (with a 14GW figure) and the Roadmap of 2011 (with a figure of 13GW) were doing were showing how a total amount of energy from renewable sources of all kinds could be achieved by taking predictions of possible delivery from each technology and bringing them together into a final table. The 2011 and 2012 Roadmaps made very clear that none of the targets was technology specific and that there would be a great deal of fluidity as time moved on. It is also very evident from the latest 2013 Update just how much flexibility is needed. Despite having had a massive boost in renewable electricity in the twelve months to June 2013, it remains the fact that the amount of extra renewable energy (across all three of the main sectors of electricity generation, heat and transport) in the last two years up to 2020 has to be greater than has been achieved in the entire period to date – the graph at Figure 5 on page 15 shows that by the end of 2012 there had been the equivalent generated of 64TWh of renewable electricity, heat and transport, and yet the increase needed in the period 2018 to 2020 is itself of the order of 70TWh, because the graph is a compounded growth scenario. Indeed, one of the big concerns in the Roadmap is that whereas renewable electricity has grown very successfully, so that at one stage it was providing over 15% of the total electricity supply (half way to its indicative 2020 target), other sectors such as heating and transport still lag far behind and it will need major structural changes to the market to deliver those in time. There are also a number of key factors which will constrain the renewable electricity market in coming years – the loss of the 750MW Tilbury biomass plant, and the fact that the Government is limiting new biomass support to just 400MW of new plant up to 2020. Offshore wind is expected to take a loss in its subsidy support as the decade progresses; Centrica have already announced possible withdrawal from the Race Bank project, RWE npower have announced that they have withdrawn their 1.2GW project in the Bristol Channel while Celtic Array, a partnership of Centrica and Dong Energy, recently announced that they have withdrawn their 2.2GW Rhiannon Wind Farm in the Irish Sea. These withdrawals are a massive blow to offshore developments.

2.3.44 Not only does the achievement of the 2020 target involve a massive scaling up of renewables across all three sectors, but even in renewable electricity, there is effectively a need to double what we have achieved to date if the contribution anticipated from this sector is to be met. As the 2013 Update acknowledges, there remain so many uncertainties and economic issues to be addressed for much of the overall pattern of supply that we have to continue to place great weight on the ability to deliver from the onshore wind sector without the need for the enhanced levels of support that other sectors are getting now or will need into the future.

2.3.45 The 5th Progress Report of the **UK Committee on Climate Change**[25] of October 2013 reiterates that a "step change" in the pace of emissions reductions is required to meet carbon budgets and the implementation of measures designed to deliver "*a sustainable, low carbon economy which contributes to the global imperative to limit climate change*" and that a significant increase in the rate of decarbonisation is required if we are to deliver against future carbon budgets.

2.3.46 In summary, these latest European and UK Government policies establish a strategic need for renewable energy provision in the UK to assist in tackling climate change and ensuring security of energy supply. There is a clear acknowledgement of the key role which onshore wind will play in the portfolio of renewable energy technologies required to be deployed to meet UK targets. The policies are generally permissive in respect of renewable energy proposals in appropriate locations.

2.4 The position in Wales

2.4.1 The National Assembly for Wales had already begun its own contribution to the debate on renewable energy in the 1990s. The Assembly's Economic Development Committee published its Final report on Renewable Energy in January 200326, identifying a benchmark for production of electricity from renewable sources of 4 TWh per year by 2010 which equated to a little over 10% of Welsh electricity production.

2.4.2 This was carried forward into **TAN8**[27] in July 2005, with its approach to the identification of seven Strategic Search Areas (SSAs) for a further 800MW of additional onshore wind by 2010.

2.4.3 Since 2005, there have been further policy pronouncements including **"One Wales"**[28] in which the Welsh Assembly Government (WAG) set out its strong commitment to tackling climate change and the **New Renewable Energy Route Map** published in February 2008[29].

2.4.4 The publication of the March 2010 **Energy Policy Statement**[30] (EPS) by the WAG radically changed the position on targets. Whereas the position since 2005 had been that the target for 2020 was set at 7TWh of electricity output from renewables, the EPS set out the potential for a new, greatly enhanced figure for 2025 of 22,500MW of installed capacity of renewables. Of this, 8,000MW of onshore and offshore wind is expected to be provided by 2015-17, which can be compared with the 800MW of strategic onshore wind envisaged to be installed between 2005 and 2010 under TAN8 on top of about 300MW which was already in place by 2005.

2.4.5 This can be seen as a formal response by the WAG to the UK Government's publication of the Renewable Energy Strategy in 2009 with its greatly increased UK national figure of, at least, 30% of electricity from renewables by 2020, and this was later confirmed by a written statement from the WG in June 2010.

2.4.6 A new version of Planning Policy Wales (PPWales) was published in 2011 and has since been revised twice more (Version 6, February 2014[31]), restating the figure of 2GW of onshore wind to be secured by 2015-2017. PPWales also states that it remains the policy of the Welsh Government (WG) that the indicative boundaries of the SSAs in TAN8 should not be amended significantly and in a written statement by John Griffiths AM of July 2011[32] he confirms that he expects a maximum of about 1666MW of onshore wind to be installed in the seven SSAs by the end of 2017.

2.4.7 Finally, the WG published in March 2012 **"Energy Wales: A low Carbon Transition"**[33] in which the First Minister set out that Wales was rich in energy resources and need to harness these to fuel the drive for a fairer and more prosperous Wales and to achieve a better quality of life for this and future generations. He went on in the Foreword to state:

"*This means harnessing our energy potential in a way that creates a sustainable, low carbon economy for Wales. We face major challenges: climate change and energy security. But these challenges are also a golden opportunity for Wales, particularly in the current economic climate. We are therefore focused on leading the transition to low carbon - to lay the foundations for a better future and maximise the long term benefits to Wales along the way. I am determined that within our responsibilities we will do all that we can. The actions in Energy Wales show how we will act to make it happen - by providing leadership and a stable framework; by maximising the benefits of all energy development and energy efficiency; and by positioning Wales at the forefront of harnessing energy from the sea and the move to smart living.*"

2.5 Planning Policy Wales Version 6 - 2014[31]

2.5.1 PPWales sets out the principles of sustainable development whereby the needs of the present generation for development should be met without compromising the ability of future generations to meet their own needs. This seeks to achieve economic development to secure rising standards of living while protecting and enhancing the environment for future generations. It also reiterates that the Assembly is promoting sustainable development by placing it at the heart of its decision-making processes (Section 4) and sets out the need to tackle climate change as a fundamental part of delivering sustainable development.

2.5.2 It sets out the basic principles in the Planning and Compulsory Purchase Act of 2004 that where regard has to be had to the development plan in making a decision, the determination of the application shall be in accordance with the plan unless other material considerations indicate otherwise. This is so that developers and communities can be given a degree of certainty as to whether a particular development may be permitted at a given location.

2.5.3 Advice on landscape and nature conservation issues is taken together in Section 5. It states that a key role of the planning system is to ensure that society's requirements are met in a way that does not impose unnecessary constraints on development while ensuring that all reasonable steps are taken to safeguard or enhance the environment. On local non-statutory designations it states that these should be applied to areas of substantive landscape or nature conservation value where there is good reason to believe that normal planning policy cannot provide the necessary protection. Such designations should not unduly restrict acceptable development. The use of LANDMAP as a tool to assist with assessment is referred to in the advice.

2.5.4 Section 6 deals with the historic environment and covers issues relating to archaeology, historic landscapes and conservation areas. It states that Local Planning Authorities (LPAs) have an important role in securing the conservation of the historic environment whilst ensuring that it accommodates and remains responsive to present day needs.

2.5.5 Sustainable energy is tackled in PPWales at paragraphs 12.8-12.10. The advice emphasises the WG's commitment to playing its part by delivering an energy programme which contributes to reducing carbon emissions. This revised version of PPWales repeats the figures in the 2010 Energy Policy Statement (EPS) of 2000MW of onshore wind by 2015-2017 in place of the figures of 4TWh of renewable electricity production by 2010 and 7TWh for 2020 which had appeared in versions of PPWales as recently as June 2010. It states that planning policy at all levels should facilitate delivery of both the WG's overall EPS and UK and European targets on renewable energy. Renewable energy generation is a key aim to be optimised (12.8.8), and we already know that 83% of the onshore wind element which is one of the key energy resources has to come from the SSAs.

2.5.6 The key issue that now has to be addressed is that of the accelerating need for delivery since PPWales indicates that it is still looking for a total of 2000MW of installed capacity of onshore wind to be delivered "in the main" by 2015/17.

2.5.7 There is also an element of "local electricity generation" to the tune of 1000MW by 2020 provided for elsewhere in the EPS of 2010 referred to here which was stated to be mainly PV, wind and hydro, so the real level of onshore wind supply by the end of the decade will need to be higher, and perhaps considerably higher, than the 2000MW figure.

2.5.8 PPWales then goes on to restate the approach to the SSAs (paragraphs 12.8.13-14) confirming that almost all developments of over 25MW will be regarded as strategic and should be located within one of the seven SSAs which are set out in TAN8. It goes on to state that:

"…Within the SSAs, whilst cumulative impact can be a material consideration, it must be balanced against the need to meet the Welsh Government's aspirations for energy in Wales and the conclusions reached fully justified in any decision taken. Developers will need to be sensitive to local circumstances, including siting in relation to local landform and other planning considerations."

2.5.9 The role of onshore wind is emphasized in paragraph 12.8.12 which states that:

"…the introduction of new, often very large, structures for onshore wind needs careful consideration to avoid and where possible minimise their impact... However, the need for wind turbine energy is a key part of meeting the Assembly Government's vision for future renewable energy production as set out in the Energy Policy Statement (2010) and should be taken into account by decision makers when determining such applications."

2.5.10 Para. 12.8.15 advises that renewable energy projects require different policy and development management considerations depending on their type, location and scale. The proposed Garreg Lwyd Hill wind farm requires a strategic decision-making approach that gives full weight to the array of international, European, UK and Welsh policy concerning the need to bring forward renewable energy projects as a means of reducing greenhouse gas emissions and enhancing energy security. The proposals should be viewed in the context of a decision-making approach to identifying large-scale wind energy developments across the whole of Wales that had identified seven areas that are intended to deliver more than three quarters of Wales' renewable energy contribution from onshore wind by 2017.

2.5.11 This concern is highlighted also by PPWales section 12.10, which provides guidance for local planning authorities on development management for renewable and low carbon energy projects. Para. 12.10.1 identifies a list of matters that should be taken into account in determining applications for such projects, the first two of which are:

- *The contribution a proposal will play in meeting identified national, UK and European targets and potential for renewable energy, including the contribution to cutting greenhouse gas emissions; and*
- *The wider environmental, social and economic benefits and opportunities from renewable and low carbon energy development.*

2.5.12 This balancing exercise is crucial to providing the means whereby the inevitable effects that will arise from major renewable energy projects such as onshore wind farms are set in the proper context of assessing the wider benefits that will arise from such benefits against the degree of local harm which may arise.

2.6 TAN8[27]

2.6.1 TAN8, published in July 2005, set out the policy context for the then current position on renewable energy and the target figures for 2010 and 2020, although whereas those for 2010 were expressed both in total output (4TWh) and additional installed capacity of renewables (about 1000MW), those for 2020 were given only as output (7TWh). It is critical at the outset to review what TAN8 was seeking to do. It was a means of delivering the targets for Wales adopted by the WAG for the year 2010.

2.6.2 The clear belief of the WAG in publishing the TAN8 in 2005 was that an additional 800MW of installed capacity of onshore wind by 2010 could indeed be met from the seven SSAs that the document went on to define. Many of the SSAs contained large areas of land owned by the Forestry Commission, i.e. by the WAG itself, and there has been a long drawn out process since then of selecting potential tenderers from within the wind industry to develop this Forestry Commission land in the SSAs. Sites outside the SSAs which were consented under other categories (brownfield sites up to 25MW, extensions to existing wind farms, repowering of existing wind farms and smaller sites up to about 5MW) were assumed to count towards the balance of a further 200MW that was expected to come from other sources including offshore wind. It can be noted that PPWales now contains separate and specific figures for technologies other than onshore wind.

2.6.3 Following the final publication of TAN 8, Local Planning Authorities (LPAs) throughout Wales which had SSAs within their areas commissioned a series of studies by ARUP to refine the boundaries of the relevant SSA. As a result of this, they produced a series of rankings of sites with recommendations as to which sites in each SSA performed best against their criteria and should be used to deliver the installed capacity needed by 2010. The result of this was that the SSAs have generally been reduced in area by as much as two thirds of their size. This was however not what TAN8 envisaged as it makes it clear that LPAs may:

"*...make minor adjustments to the SSA boundaries when translated into their local planning documents. This will facilitate the inclusion of development on the margins of SSAs where local conditions recommended (Annex D paragraph 1.3).*" (emphasis added)

2.6.4 Although the refinement exercises led a number of LPAs to prepare, and in some cases adopt, interim or supplementary planning guidance based on them, the shortcomings of them were highlighted at one of the first appeals where one of them was tested. This was at Wern Ddu in Denbighshire[34] on a site for five turbines which straddled the boundary of SSA A and had not been included as one of the sites needed to meet the SSA target in the ARUP refinement exercise. The Inspector in that case criticised the ARUP work and found flaws in its approach to determining the rankings to such an extent that he allowed the appeal. That decision subsequently led to Denbighshire abandoning their Interim Guidance that had been based on the ARUP work. It also appears to have been at least in part responsible for the further refinement work commissioned from ARUP by Powys and carried out in 2007-8. A similar finding was made by an Inspector on a much more recent appeal at Llynfi Afan in Neath Port Talbot in 2013[35].

2.6.5 SSA C, in which the proposed Garreg Lwyd Hill Wind Farm site is located, was indicated in TAN8 as being intended to deliver in the order of 70MW of installed capacity of onshore wind by 2010, although these were only ever indicative targets (paragraph 2.5 of TAN 8) and were never seen as the definitive capacity for the area. The total for all the SSAs was in fact 1120MW rather than the 800MW that TAN8 required for 2010 so as to give some flexibility. Indeed, TAN8 actually stated at the foot of that paragraph that the figures in the Table had already been reduced by a third from the maximum capacities identified by Garrad Hassan a couple of years earlier. The boundaries of the SSAs were always shown to be "broad-brush" and one of the purposes of the broad-brush approach to the definition of the SSAs was that land within and immediately outside (within 5km of the boundary) the defined areas would be able to be assessed in refinement exercises to see whether it should be included within the SSA, as finally defined in greater detail.

2.6.6 The position in respect of Area C was that ARUP completed a first refinement exercise in January 2006[36] and made significant changes to its original boundary. However, the site of the proposed Garreg Lwyd Hill wind farm remained entirely within the "refined" area in this report. As a result of that exercise, PCC prepared draft Interim Development Control Guidance[37] (IDCG) in which they indicated their support for the refined areas identified by ARUP. However, a further study was made looking in more detail at a number of topics and this led to a second ARUP report in 2008[38], followed by a second draft IDCG[39] later that year.

2.6.7 The proposed Garreg Lwyd Hill Wind Farm remained within the refined area in this new report and IDCG. However, even though it had been intended to be used for development control purposes, the IDCG was never adopted as formal SPG, for technical and legal reasons relating to the degree of consultation and the possible need for Strategic Environmental Assessment before adoption. That remains the case today. As far as the original TAN8, the first ARUP refinement, the first IDCG, the second ARUP refinement and the second IDCG are concerned, the proposed Garreg Lwyd Hill Wind Farm site was and is still within the SSA, both original and in its various refinement guises.

2.6.8 The capacity sought for SSA C has now changed since the 2010 first target date has been passed. The EPS of 2010 set out a new figure of 2000MW of onshore wind not by 2020 but by 2015-17. A year later, the Energy Minister John Griffiths sent out a letter to planning authorities in which he advised that in the context of PPWales and its new figures for onshore wind, the emphasis on development in the SSAs would remain but "new" maximum figures for each SSA were included within his letter. In fact all that he had done was to take the original Garrad Hassan figures of capacity (reduced by a third for TAN8) and restore them to their original level prior to TAN8. Hence, instead of an "indicative total capacity target" for each of the SSAs set out in TAN8 of 1120MW we now have a new figure of 1666MW which simply restores the one third reduction. The figure for SSA C is now given as 98MW. The actual tables in TAN8 showing the indicative capacities for each of the SSAs have now been deleted from the document along with a number of other changes consequential on the EPS and other policy and procedural changes that have occurred over the last eight years.

2.6.9 Before looking at the detailed position in SSA C, it is useful to consider the overall position for the seven SSAs against the target figure first for 2010 and then for 2015-17.

2.6.10 In respect of the former, the position can only be described as very disappointing. The target set out in TAN8 at para 1.4 was for 800MW of additional installed capacity (after July 2005) to come forward by 2010 from onshore wind sources. In respect of the forestry sites which were to provide the key land areas across several of the SSAs, it was only in November 2007 that the final announcement was made by the First Minister of the successful tenderers, and none were producing electricity by 2010, due in part of course to the selection process that had been undertaken. The subsequent refinement process in which ARUP were commissioned to undertake further studies to identify the final boundaries of each SSA, and the preferred zones within them to meet the indicative targets, have also resulted in lengthy delays in delivering sites. A large number of proposals in SSAs B and C, both at the Section 36 level of 50MW or more, and at the planning application level, remain undetermined, and no scheme has even been submitted for the 200MW of further capacity set out for SSA D, with the intended Forestry Commission land scheme at Nant y Moch now having been abandoned by SSE Renewables.

2.6.11 By July 2005, there had been 254.8MW of onshore wind installed in Wales, including Tir Mostyn which started generating in July 2005, with two more sites consented and under construction at Mynydd Clogau and Ffynnon Oer (14.5 and 32MW respectively) taking the effective pre-TAN8 figure up to 301.3MW. By contrast, the number of new permissions in the SSAs that were given post TAN8 and implemented by 2010 amounted to only 110.45MW of the 800MW target. What TAN8 was all about was delivering a stated amount of electricity to the grid, and not a stated amount of planning permissions by the end date of 2010, and so TAN8 effectively only delivered 14% of its intended target. Given the lead-in time for major infrastructure projects even after planning permission has been obtained, this is a crucial key to understanding where we are today.

2.6.12 In terms of the movement towards the nationally set targets, the figures for built, under construction and consented wind farm developments across Wales, at the end of 2013 including all sites with turbines in excess of 100kW, reveal the following:

SSA	G. Hassan (Griffiths)	Built / Under Construction	Consented	Total for SSA
A	212MW	30.5MW	90.5MW	121MW
B	430MW	79MW	30MW	109MW
C	98MW	0MW	0MW	0MW
D	212MW	0MW	0MW	0MW
E	152MW	60.5MW	48MW	108.5MW
F	430MW	131MW	250.8MW	381.8MW
G	132MW	23MW	84MW	107MW
Total	**1666MW**	**324MW**	**503.3MW**	**827.3MW**

2.6.13 This table reveals that the position today is that within the SSAs the total of built and consented projects is 827MW with a further 270MW on sites that are not within the SSAs. The strategic picture still reveals a very significant shortfall against the 1666MW which is required to be built in the SSAs within at the very most three and a half years, especially given that only 324MW of that 827MW figure has actually been built to date and no less than 384MW of the consents are derived from three recent permissions at Brechfa West (Area G) Mynydd y Gwair (Area E) and Pen y Cymoedd (Area F).

2.6.14 It is also known that almost all of the 212MW required capacity from Area D is likely to come from a single wind farm (Nant y Moch) which has yet to be submitted for approval; and that there are no less than five Section 36 proposals in Areas B and C which did not complete their public inquiry until May 2014, seeking permission for the 419MW of available capacity in these SSAs under current guidance (the difference between the left hand column of figures and the right hand column in the table above).

2.6.15 On the sites outside the SSAs, the figure of 229MW of built and consented schemes is a little over two thirds of the way towards the 334MW which when added to the 1666MW in the SSAs would take the figure to 2000MW, but again this takes no account of the split which has to be made between the purely onshore wind element and the local electricity generation element as set out in PPWales. It also needs to be borne in mind that a large slice of this 229MW figure is derived from three 1990s permissions on Anglesey with 72 turbines and the Section 36 consent at Cefn Croes, altogether totalling 92MW – not the sort of permissions that would be replicated under current planning policy having regard to the advice in TAN8 and PPWales about the location of major wind farm sites (i.e. over 25MW).

2.6.16 Having noted the overall position in the SSAs which points to a very significant shortfall against the 1666MW target envisaged in PPWales, it is necessary to look in more detail at the figures for Area C. Here there are no sites built or with planning permission at the present time, because the Llandinam site which has an installed capacity of just under 31MW is not within the SSA as defined in TAN8 and the WG advised the recent Mid Wales inquiry that, for the purposes of assessing the SSAC figures, Llandinam and its proposed repowering would not be counted as part of the 98MW figure set out for Area C. There are nevertheless two other sites in the Mid Wales inquiry seeking Section 36 consents and these are Llaithddu at a maximum of 62.1MW and Llanbadarn Fynydd at a maximum of 59.5MW. In addition there are three other planning applications awaiting decision in and around Area C of which Neuadd Goch is now understood to have gone to appeal following non-determination.

2.6.17 One key factor that has to be taken into account in the context of the proposed Garreg Lwyd Hill Wind Farm is that whereas all the projects in the Mid Wales inquiry are dependent on grid upgrades which are themselves all still awaiting grid connections and upgrades, the proposed Garreg Lwyd Hill Wind farm is not dependent on linking in to the Mid Wales grid upgrade system. It already has a grid offer taking the power eastwards to Knighton, and as such it is capable, if the wind farm is consented under this appeal, of being built in time to contribute to the 2015-2017 figures in the EPS and PPWales.

2.7 Other national planning advice

2.7.1 With regard to issues relating to archaeology, there is advice in PPWales and also in Circular 60/96 on Planning and the Historic Environment: Archaeology[40]. The site is not within a Landscape of Special Historic Interest as identified on the Registers published by CADW. This non-statutory Register of Landscapes, Parks and Gardens of Special Historic Interest in Wales is intended to inform those involved in the management of land in Wales about the significance of these aspects of cultural heritage. Finally, TAN5[41] updates the advice on nature conservation and planning, and specifically the position with regard to non-statutory nature conservation and biodiversity sites (also referred to in the new PPW).

2.8 Development Plan in Powys

2.8.1 The position on the adopted Development Plan is straightforward in Powys since their UDP was adopted in March 201042, and thus there is a single set of policies that may be relevant to the proposed development. It is intended to '*guide development during the plan period until mid-2016. It provides a policy framework for positive forward planning, proposals and allocations for future developments and the basis on which consistent development control decisions can be made*' (UDP para. 1.4.1).

2.8.2 Where there is a specific policy in a development plan dealing with a particular type of development, that should be taken as a starting point for the assessment of the proposal in the context of development plan policy. In this case the key policy is E3 and reads as follows:

2.8.3 Applications for windfarms including extensions to existing sites and individual wind turbines generators will be approved where:

1. They do not unacceptably adversely affect the environmental and landscape quality of Powys, either on an individual basis or in combination with other proposed or existing similar developments. Where the cumulative impact of proposals in combination with other approved or existing windfarms would be significantly detrimental to overall environmental quality they will be refused.

2. They do not unacceptably adversely affect wildlife habitats or species that are of international, national or local importance in accordance with policies ENV3-7.

3. They do not unacceptably adversely affect the occupants or users of sensitive properties (usually dwellings), or their amenities by reason of noise, vibration, shadow flicker or reflected light.

4. They do not unacceptably impact on any buildings or features of conservation or archaeological interest.

5. They do not unacceptably adversely affect the enjoyment and safe use of highways and the public rights of way network, especially bridleways (including during the construction phase).

6. They would be capable of being served by an acceptable means of highway access and any new roads and accesses required would not have unacceptable environmental impacts.

7. Applicants are able to demonstrate through land management schemes that there would be adequate mitigation or compensation for any adverse impact on environmental quality, wildlife habitats or heritage features.

8. Any ancillary structures or buildings are so sited and designed including the use of locally appropriate construction materials so as to adequately blend into their setting.

2.8.4 A further policy (E4) requires the removal of turbines if they cease to operate for a period of more than six months, while policy E5: Off-site works states that '*planning obligations or other appropriate legally binding agreements will be sought to ensure the implementation of offsite works where these are necessary in order to facilitate wind turbine development proposals or to ameliorate their impact*'. There is also Policy DC12: Overhead lines and pipelines which has implications for a wind energy development, although the grid connection itself is not covered by the appeal.

2.8.5 As a full criteria-based policy, there is no need to test the proposal against a range of other policies dealing with the specific topics that are addressed in E3. There is reference to ENV3-7 which covers a range of nature conservation and biodiversity issues, and engages international and national obligations on these topics in addition to local ones. The development of a wind farm still has to meet the statutory tests engaged by effects on habitats and species and, where necessary, Appropriate Assessment will have to be carried out as a separate issue to development plan policy. However, even here there are issues of the potential for the need for a nationally significant development to be considered sufficient to override the nature conservation interests.

2.8.6 However, it is necessary to consider the status of EN14 which covers listed buildings. The text of this reads as follows:

Proposals for development unacceptably adversely affecting a listed building or its setting will be refused. In considering proposals for development affecting a listed building and it's (sic) setting, account will be taken of the following:

1. The desirability of preserving the listed building and its setting;
2.The importance of the building, its intrinsic architectural and historic interest and rarity;
3. The effect of the proposals on any particular features of the building which justified its listing;
4. The building's contribution to the local scene and its role as part of an architectural composition;
5. The condition of the building and the benefit that the proposals would have to its state of repair;
6. The merits of the proposals in securing an alternative use for the building;
7. The need for proposals to be compatible with the character of the building and its surroundings and to be of high quality design, using materials in keeping with the existing building.

2.8.7 A number of these criteria clearly only refer to works which directly affect the listed building. It should also be noted that criterion 1 is a slight misquotation from Section 66 of the Listed Buildings Act since (as correctly set out in the preamble before the criteria) the test is affecting a listed building OR its setting. The supporting text for the policy does however make it clear that when considering proposals for development the presumption will be in favour of the preservation of listed buildings and their settings and permission will only be granted where a strong case can be made for doing so. The use of the word "unacceptably" in this context can be seen as a reference to the balancing exercise that is also found in E3 (cited above) and the presence of a separate policy test for listed buildings in this sense is unnecessary. In any event, what is clear is that there is no reference in either E3 or EN14 to the "substantial harm" or "less than substantial harm" scenarios that are referred to in English planning guidance, or to the advice in the National Policy Statements that accepting "substantial harm" to heritage assets would be wholly exceptional. The Section 38 (6) tests which apply to this planning application are therefore different to those for an NSIP under the Planning Act 2008 where the National Policy Statements have primacy in both England and Wales over the Development Plan. The advice in the NPSs may be a material consideration once the tests in the Development Plan have been undertaken and does not in itself inform the process of testing the proposals under E3 or any of the other policies in the plan.

2.8.8 The text supporting E3 makes it clear that PCC was looking to encourage the WG to undertake some form of review of the SSA position in TAN8 even though it was confirmed only in March 2010 in the EPS. This may be due to the fact that they have all of two of the SSAs in their area as well as part of SSA D. This concern may explain why there is no mention of the SSA issues in their policy at all, which originally emerged at about the time of the draft TAN8 in 2004.

2.8.9 The response to TAN8 as noted above was to commission refinement studies of the SSAs, following which PCC issued the first and second draft IDCG based on the refined boundaries, in 2006 and 2008. It remains the case that the IDCG is not moving forward to adoption and thus there is only limited weight that can be given to this IDCG at the present time.

2.8.10 PCC has now published the consultation draft of its Local Development Plan[43], with any objections received during the consultation period which runs until early September being taken forward to an Inquiry, which is likely to be held in 2015. Given the early stage of the process towards adoption, no material weight can be given to the policies in the emerging plan since the decision on the appeal will be taken well before any inquiry into objections takes place.

2.9 References

[1] UK Government - Climate Change Act 2008

[2] UK Government - Renewable Energy Strategy 2009

[3] UK Government - Renewable Energy Roadmap 2011

[4] UK Government - Roadmap Update 2012

[5] UK Government – Renewable Energy Update 2013

[6] IPCC Working Party Reports 2014

[7] EU Climate and Energy Package 2008

[8] EU Going Green for Growth 2013

[9] UK Government - The Energy Challenge 2006

[10] UK Government - White Paper Meeting the Energy Challenge 2007

[11] UK Government - Energy Act 2008

[12] UK Government - Planning Act 2008

[13] UK Government - Low Carbon Transition Plan 2010

[14] UK Government - National Renewable Energy Action Plan July 2010

[15] UK Government - Annual Energy Statement 2011

[16] UK Government - Committee on Climate Change - Renewable Energy Review May 2011

[17] UK Government - Electricity Market Reform White Paper July 2011

[18] UK Government - National Policy Statement EN-1

[19] UK Government - National Policy Statement EN-3

[20] UK Government - 2nd Annual Energy Statement

[21] UK Government - The Carbon Plan 2011

[22] UK Government - Energy Security Strategy 2012

[23] UK Government - Energy Act 2013

[24] UK Government - Annual Energy Policy Statement 2012

[25] 5th Progress Report of the UK Committee on Climate Change

[26] Welsh Assembly Government - Economic Development Committee Final Report on Renewable Energy 2003

[27] Welsh Assembly Government - TAN8 2005

[28] Welsh Assembly Government - One Wales 2006

[29] Welsh Assembly Government - New Renewable Energy Route Map for Wales 2008

[30] Welsh Assembly Government - Energy Policy Statement March 2010

[31] Welsh Government - PPWales Version 6 2014

[32] Letter from John Griffiths AM July 2011 on wind farm developments

[33] Welsh Government - Energy Wales - A Low Carbon Transition 2012

[34] Planning Inspectorate appeal decision APP/R6830/A/05/1185359 – Wern Ddu, Denbighshire

[35] Planning Inspectorate appeal decision APP/Y6930/A/12/2181883 – Llynfi Afan, Neath Port Talbot

[36] ARUP SSAs B and C Refinement Exercise Final report 2006

[37] PCC Draft Interim Development Control Guidance 2006

[38] ARUP SSAs B and S Further Refinement Exercise Final Report 2008

[39] PCC Interim Development Control Guidance 2008

[40] Welsh Office Circular 60/96

[41] Welsh Assembly Government TAN5

[42] PCC Adopted Unitary Development Plan March 2010

[43] Deposit draft of the PCC Local Development Plan 2014

3. DESIGN DEVELOPMENT

3.1 Reduction in Number of Turbines

3.1.1 Following receipt of PCC's Appeal Statement of Case in April 2014, RES has considered PCC comments and consultee responses, which has led to RES reviewing the design of the wind farm.

Turbines T20, T21, T22

3.1.2 The PCC Statement of Case lists a number of cultural heritage assets that it feels would be unacceptably affected by the proposed development. Further details of the cultural heritage assets are included in Chapter 7 of this SEI.

3.1.3 Whilst RES maintains that the original Wind Farm layout would not result in unacceptable effects on cultural heritage assets, in an effort to address PCC's concerns, it is proposed to remove turbine T20 due to its proximity to the Cwm Rhos Goch round barrow.

3.1.4 The removal of turbine T20 causes turbines T21 and T22 to look somewhat isolated within the landscape in relation to the remaining turbines and it is proposed that these two turbines also be removed to avoid any additional landscape and visual effects caused by the removal of T20.

Turbine 7

3.1.5 The list of cultural heritage assets in PCC's Statement of Case also includes listed buildings at Cwm yr Hob. The proposed turbine most visible at these listed buildings is T7.

3.1.6 Whilst not required to make the proposed wind farm development acceptable, removal of T7 would reduce the impact of the wind farm on the listed buildings. In order to address PCC's concerns, it is therefore proposed to remove turbine T7.

Turbines T12, T19

3.1.7 PCC's Statement of Case identifies unacceptable landscape and visual impacts of the proposed development on the Shropshire Hills Area of Outstanding Natural Beauty (AONB).

3.1.8 Turbines T12 and T19 are the closest turbines to the AONB. Again, whilst it is considered that the impact is acceptable, it is proposed to remove turbines T12 and T19 to address the concerns of PCC and to reduce the impact on the AONB.

3.1.9 The removal of turbine T7 would further reduce the impact on the AONB.

3.2 Grid Connection Route

3.2.1 In 2014 the network distribution operator, Western Power Distribution (WPD) made a new grid connection offer. The new connection follows the same Route 1 for the majority of the route and then Route 3 for the final section, both of which are shown in the Grid Route Assessment report document SEI12 included in the 2013 SEI. The length of the new connection route is 23.5 km, compared with the previous offer which was 26.7 km.

3.2.2 The main difference in the new connection route is that the majority, some 19.5 km, is now proposed to be installed using underground cable and three short sections, totalling 4 km would be installed overhead on wooden poles.

3.2.3 Following submission of the 2008 ES, the Countryside Council for Wales (CCW) (now Natural Resources Wales (NRW)) had no objection to the use of Route 1 for the grid connection, when the majority of this connection was proposed to be carried on overhead lines.

3.2.4 Following the network distribution operator's amended proposal in 2010 to utilise Route 3, CCW objected on the grounds of landscape and visual impact. These objections were the only objections to the proposed grid connection route and these objections were included in the Reasons for Refusal 1 and 2.

3.2.5 The current (2014) offer, which proposes to install most of the connection underground, rather than overhead, will substantially reduce the landscape and visual impact of the connection.

3.2.6 As with the previous connection offer, this grid connection can be installed without extending the construction programme of the Wind Farm. As a result, the proposed Garreg Lwyd Hill Wind Farm can be installed by the autumn of 2017 (unlike most other mid Wales wind farms, which must wait until construction of the substation hub at Cefn Coch in 2019 at the earliest), thereby contributing significant capacity towards Welsh Government renewable energy targets for 2017.

3.2.7 It is important to note that the final route of the connection is still to be determined and will be subject to a separate planning permitting process and appropriate detailed environmental assessments. This process is the responsibility of the distribution network operator WPD, who are expected to await the decision of the Wind Farm appeal before progressing and committing expenditure to the connection.

4. PROJECT DESCRIPTION

4.1 Revised Turbine Layout

4.1.1 As a result of removing turbines T7, T12, T19, T20, T21 and T22, the proposal now comprises 17 turbines, rather than the original proposal for 23 turbines.

4.1.2 The locations of these 17 turbines are shown, with the site boundary, on Figure 4.1: Turbine Layout with Site Boundary, included in this SEI.

4.1.3 The revised infrastructure of the wind farm is shown on Figure 4.2: Site Infrastructure, in this SEI.

4.1.4 Further details and explanations addressing the reduction of the proposal to 17 turbines are included in the following topic chapters of this SEI.

4.2 Grid Connection Route

4.2.1 The revised grid connection is for 19.5 km of the connection to be installed underground and only 4 km to be installed on overhead wooden poles.

4.2.2 The grid connection route is shown on Figure 4.3 - Grid Connection Route 2014, with underground and overhead sections clearly identified.

5. LANDSCAPE AND VISUAL

5.1 Introduction

5.1.1 This Chapter provides an update to the assessment of the landscape and visual effects of the proposed Garreg Lwyd Hill Wind Farm (the proposed Wind Farm), as provided in the ES (RES 2008) and 2013 SEI (RES 2013).

5.1.2 This landscape and visual impact assessment (LVIA) covers all the landscape and visual issues covered in the ES and 2013 SEI, describing the relevant changes to the proposed Wind Farm, baseline and predicted effects of the proposed Wind Farm and referring to the relevant parts of these documents where these matters would remain unchanged.

5.1.3 This LVIA concentrates on the construction, operation and decommissioning of the proposed Wind Farm, as amended, which now consists of the following elements:

- 17 wind turbines, with a maximum overall height to blade tip of up to 126.5 m. This is the previously proposed 23-turbine proposal with the deletion of turbines T7, T12, T19, T20, T21 and T22;
- Access tracks, crane hardstandings, electricity transformers and underground cabling as previously proposed but with the deletion of those associated with turbines T7, T12, T19, T20, T21 and T22;
- Grid connection from the site to Knighton with 4 km on wooden poles and the remainder underground; and
- Borrow pits, public car park, control buildings and substation compound, permanent free-standing wind monitoring masts and temporary works, all as previously proposed.

5.1.4 The details of these amendments to the scheme are provided in Chapter 4: Project Description of this SEI (the *Garreg Lwyd Hill Wind Farm 2014 Supplementary Environmental Information* (2014 SEI), RES 2014).

5.1.5 This Chapter is supported by the Technical Appendices and Figures in Volume 2 of this SEI and refers to the relevant Technical Appendices and Figures in ES Volumes 2 and 3 (RES 2008) and the 2013 SEI (RES 2013) (see Appendix 5.1 for those ES and SEI Figures that are still current).

5.1.6 This update broadly follows the structure of the LVIA in Chapter 5 of the ES (see ES para 5.1.5) as updated by the LVIAs in Appendices SEI 1, SEI 5 - SEI 9 and SEI 12 of the 2013 SEI (RES 2013).

5.2 Scope and Method of Assessment

General Approach and Methodology

5.2.1 This update has been based on a general approach and methodology which are similar to those used in the ES and 2013 SEI (see ES paragraphs 5.2.1 – 5.2.37) but updated to take account of more recent guidance, in particular:

- "*Guidelines for Landscape and Visual Impact Assessment*", 3rd Edition (GLVIA 3, LI/IEMA 2013) (which replaces the 2nd edition, GLVIA2):
- "*Assessing the Cumulative Impact of Onshore Wind Energy Developments*" (SNH 2012) (which replaces SNH 2005);

5.2.2 This updated approach and methodology is provided in Appendix 5.2. The main difference between the approaches advocated in GLVIA2 and GLVIA3 is in relation to the assessment of sensitivity of landscape resources and visual receptors. In GLVIA2, sensitivity is derived from value and several other factors. In GLVIA3, sensitivity is derived from value and susceptibility. The factors that determine susceptibility are not defined in GLVIA3 but these are essentially the "other factors" identified in GLVIA2. Therefore, the assessments of sensitivity under GLVIA2 and GLVIA3 take into account the same factors; the only difference is that, under GLVIA3, levels of susceptibility are separately defined.

5.2.3 The Landscape Institute has advised that, where a proposed development has been assessed using a methodology that is compatible with GLVIA2 then it is acceptable to continue with this methodology, or to re-assess using a GLVIA3 compatible methodology as appropriate.

5.2.4 In this case, the landscape and visual effects of the proposed Wind Farm have been re-assessed using the methodology in Appendix 5.2 which is very similar to that used for the ES but, for consistency and direct comparison with the findings in ES Chapter 5, the susceptibility of the landscape units and visual receptors has not been separately defined.

Scope of Assessment

5.2.5 A desk study, fieldwork and consultations with Powys County Council (PCC) and statutory consultees were undertaken prior to the preparation of the ES to agree the LVIA methodology, scope of the assessment, viewpoint locations and other wind farms to be assessed cumulatively (see ES paragraphs 5.2.3 – 5.2.4). Further consultations were undertaken to inform the scope of the additional landscape and visual assessments included within the 2013 SEI.

5.2.6 Following the refusal of the application and the lodging of the appeal, there have been further discussions with PCC regarding the reduction in turbine numbers. In addition, further desk study and fieldwork observations have been undertaken to update the baseline landscape and visual resources, the wind farms to be considered cumulatively and the assessments of effects (individual and cumulative) on landscape resources and visual receptors. Consequently, this update provides:

- Section 5.3: Baseline landscape and visual resources - reference to the relevant descriptions of the baseline landscape and visual resources in the ES and the 2013 SEI and updates where appropriate, including the operational, permitted and proposed (appealed and in planning) wind farms in SSA C west and east.
- Section 5.4: Mitigation Measures and Layout Design – the reasons for reducing the scale of the proposed Wind Farm;
- Section 5.5: Assessment of Effects at Construction Stage - the effects of the construction stage on landscape and visual amenity;
- Section 5.6: Assessment of Residual Effects – the theoretical visibility of the proposed Wind Farm, an updated viewpoint analysis and the effects (both individual and cumulative) of the operational stage on landscape resources (landscape character, landscape designations and historic landscapes) and visual amenity (of receptors in settlements, on roads, on railway routes and on public rights of way);
- Section 5.7: Cumulative Effects – the additional cumulative effects of the proposed Wind Farm on landscape and visual amenity in the context of the other proposed (appealed and in planning) wind farms in SSA C.
- Section 5.8: Assessment of Effects at Decommissioning Stage – the effects of the decommissioning phase on landscape and visual amenity; and
- Section 5.9: Summary and Conclusions – a summary of the assessments of effects on landscape and visual amenity and conclusions.

5.2.7 There is one operational wind farm (Llandinam P&L) and also several other proposed (appealed and in planning) wind farms in SSA C (west and east), any one or more of which could be operational during the life of the proposed Wind Farm. Accordingly, the individual and cumulative effects of the proposed Wind Farm, in conjunction with the operational and other proposed Wind Farms have been considered in terms of four scenarios:

- Scenario 1 – the individual and additional cumulative effects of the proposed Wind Farm in the context of the operational Llandinam P&L wind farm in SSA C west;
- Scenario 2 – the individual and additional cumulative effects of the proposed Wind Farm in the context of the Section 36 Applications relating to Llandinam Repowering and Llaithddu wind farms in SSA C west (the operational Llandinam P&L wind farm would be decommissioned if the Llandinam Repowering scheme is permitted and built);
- Scenario 3 - the individual and additional cumulative effects of the proposed Wind Farm in the context of the Section 36 Applications relating to Llandinam Repowering and Llaithddu wind farms in SSA C west and the Section 36 Application for Llanbadarn Fynydd wind farm in SSA C east; and
- Scenario 4 - the individual and additional cumulative effects of the proposed Wind Farm in the context of the Section 36 Applications relating to Llandinam Repowering and Llaithddu wind farms in SSA C west and the Section 36 Application for Llanbadarn Fynydd wind farm and the proposed (appealed) Neuadd Goch and (in planning) Bryngydfa wind farms in SSA C east.

5.2.8 Scenario 1 is considered in Section 5.6: Assessment of Residual Effects, and Scenarios 2, 3 and 4 are considered in Section 5.7: Cumulative Effects.

5.3 Baseline Landscape and Visual Resources

The Site

5.3.1 The site remains as described in ES paragraphs 5.3.1 – 5.3.4.

The Study Area

General Description

Topographical and Natural Heritage Features

5.3.2 The extent of the 30km radius study area and its main topographical and natural heritage features remain as described in ES paragraphs 5.3.5 – 5.3.11.

Archaeological and Cultural Heritage Features

5.3.3 The archaeological and cultural heritage features are described in more detail in SEI Chapter 7: Cultural Heritage Assessment (Volume 2 of 2014 SEI).

Existing/Proposed Wind Farms

5.3.4 The operational wind farms in the study area remain as described in ES paragraph 5.7.3, listed in ES Table 5.15 and illustrated on ES Figure 5.11. The current status and scale of the operational and proposed wind farms in SSA C (west and east) are listed in Table 5.1 below.

Table 5.1: Operational, Permitted and Proposed Wind Farms in SSA C (West and East)

Wind Farms - SSA C West	Scale	Status
Llandinam (P&L)	103 turbines, 45.5 m to tip	Operational and without a time limit on the permission – to be decommissioned if Llandinam re-powering is permitted and built.
Llandinam re-powering	34 turbines, 121.2 m to tip	Appealed – considered at con-joined public inquiry 2013 – 2014.
Llaithddu	27 turbines, 115.5 m/ 99.5 m to tip	Appealed – considered at con-joined public inquiry 2013 – 2014.
Hirddywel	9 turbines, 125 m to tip	In planning.
Wind Farms - SSA C East	**Scale**	**Status**
Llanbadarn Fynydd	17 turbines, 126.5 m to tip	Appealed – considered at con-joined public inquiry 2013 – 2014.
Garreg Lwyd Hill	17 turbines, 126.5 m to tip	Appealed.
Neuadd Goch	9 turbines, 126 m to tip	Appealed against non-determination - additional information requested by PINs, no date set for inquiry.
Bryngydfa	12 turbines, 126.5 m to tip	In planning – additional information requested by Powys County Council.

Landscape Resources

Strategic Landscape Character Types

5.3.5 The landscapes within the study area were characterised in a consistent way in the ES by defining strategic landscape character types (LCTs), based on the landscape types defined in *"The Montgomeryshire Landscape Assessment"* (Montgomeryshire District Council, 1992), in *"The Shropshire Landscape Typology"* (SCC 2006) and fieldwork observations, as described in ES paragraphs 5.3.17 – 5.3.22, ES Table 5.5 and associated Tables and illustrated on ES Figure 5.3.

LANDMAP Aspect Areas - Powys, Wales

5.3.6 The landscapes within the part of the study area that is within Powys, Wales are also characterised by way of LANDMAP data, as illustrated on Figures 1.1 – 1.5 and 2.1 – 2.5 in Appendix SEI 8 (Volume III of the 2013 SEI).

Landscape Designations

National landscape designations - Shropshire Hills AONB, England

5.3.7 The only national landscape designation in the study area is the Shropshire Hills Area of Outstanding Natural Beauty (AONB), as described in ES paragraph 5.3.24 and Section 1.4 of Appendix SEI 1 (2013 SEI) and illustrated on ES Figure 5.2.1. The proposed Wind Farm would be located 3.1 km west of the AONB boundary.

5.3.8 The statutory purpose of AONBs is "*to conserve and enhance the natural beauty of the area*" (see Appendix 5.2, paragraph A5.2.126). In addition, through the National Association of AONBs, the following high level objectives have been adopted by the "AONB family" (p 6, SHAONB Partnership 2014):

- To conserve and enhance the natural and cultural heritage of the UK's AONBs, ensuring they can meet the challenges of the future;
- To support the economic and social well-being of local communities in ways which contribute to the conservation and enhancement of natural beauty;
- To promote public understanding and enjoyment of the nature and culture of AONBs and encourage people to take action for their conservation; and
- To value, sustain, and promote the benefits that the UK's AONBs provide for society, including clean air and water, food, carbon storage and other services vital to the nation's health and well-being.

5.3.9 The special qualities of the Shropshire Hills AONB were described in the 2nd edition of the *Shropshire Hills AONB Management Plan 2009 - 2014* (SHAONB Partnership 2009) (see Table 1.3 in Appendix SEI 1, 2013 SEI) and are similarly described in the more recent 3rd edition *Shropshire Hills AONB Management Plan 2014 - 2019* (p 9 – 10, SHAONB Partnership 2014) as follows:

- The diversity and contrast of its landscape – its hills, farmed countryside, woodlands, rivers and valleys;
- The important geology, wildlife and heritage aspects of the landscape;
- Scenic quality and panoramic views;
- Tranquillity – peace and quiet, dark skies and unspoilt views, plus modest visitor numbers; and
- Culture and opportunities for enjoyment – cultural settings including urban fringes of Telford and Ironbridge, and the rural hinterlands of market towns such as Church Stretton, Ludlow, Craven Arms and Much Wenlock, plus public access via the rights of way network, open access land and outdoor activities.

Local Landscape Designations

5.3.10 The special landscape areas (SLAs) illustrated on ES Figure 5.2.1 are not included in the Adopted Powys UDP (Powys 2010) and so no longer apply and there are no local landscape designations within the parts of the study area that extend into Shropshire and Herefordshire as defined in the South Shropshire District Local Development Plan (SSDC 2004) and in the Herefordshire UDP (HCC 2007).

Historic Landscapes

Landscapes, Parks and Gardens of Historic Interest

5.3.11 The Parks and Gardens of Historic Interest included in the Register of Landscapes, Parks & Gardens of Special Historic Interest in Wales (by CADW), and in England on the Register of Historic Parks and Gardens of National Importance (by English Heritage) within the study area remain as described in ES paragraphs 5.3.30 – 5.3.38, listed in ES Table 5.6 and illustrated on ES Figure 5.2.2. As shown in ES Table 5.6, these are all located more than 10 km from the proposed Wind Farm.

Settlements

5.3.12 The settlements in the study area remain as described in ES paragraph 5.3.65.

Main Roads

5.3.13 The primary road routes in the study area remain as described in ES paragraph 5.3.66 and include A483, A470, A458 and A44.

Railway Lines

5.3.14 The railway lines in the study area remain as described in ES paragraph 5.3.67.

Public Rights of Way

5.3.15 The long distance recreational routes in the study area remain as described in ES paragraph 5.3.68 and include Glyndŵr's Way and Offa's Dyke Path (both National Trails) and also the Shropshire Way, Jack Mytton Way, Severn Way, Wye Valley Walk and Kerry Ridgeway. The routes of all these paths through the study area are illustrated on ES Figure 5.2.3 with the exception of the Kerry Ridgeway. The Kerry Ridgeway runs for 15 miles (24 km) from Cider House on the B4355 south of Dolfor eastwards to Bishops Castle and a section of the route comes within 5 km north of the proposed Wind Farm.

Visual Resources - Viewpoint Locations

5.3.16 The viewpoint locations selected to illustrate the changes to views in the study area are:

- Viewpoints 1 – 17 – these are ES viewpoints 1 – 17, as described in ES paragraphs 5.3.69 – 5.3.71, listed in ES Table 5.8 and previously illustrated for the original 23-turbine scheme in ES Figures 5.10.1 – 5.10.17 (in ES Volume 3);
- Viewpoint 18 – this is SEI Vp 1, as previously illustrated for the original 23-turbine scheme in Figure 2.4 in Appendix SEI 6 (in Volume II in the 2013 SEI);
- Viewpoints 19 – 21 – these are SEI Vps 2, 3 and 4, as previously illustrated for the original 23-turbine scheme in Figures 1.3 – 1.5 in Appendix SEI 1 –(in Volume II in the 2013 SEI)and
- Viewpoints 22 and 23 – these are SEI Vps B and C, as previously illustrated for the original 23-turbine scheme in Figures 6.2 and 6.3 in Appendix SEI 9 –(in Volume II in the 2013 SEI).

5.3.17 The views of the Garreg Lwyd Hill Wind Farm as now proposed (with 17 turbines) from these viewpoints, in conjunction with the operational and other proposed wind farms in SSA C (Scenarios 1 – 4), are illustrated by the wireframes in Figures 5.5.1 – 5.5.23 (in Volume 2 of the 2014 SEI). These should be used in conjunction with the panoramic photographs of the existing views from these locations provided in the ES and 2013 SEI figures listed above. The viewpoint analysis for Scenario 1 is presented in Table 5.2 and discussed in Section 5.6 below and the viewpoint analysis for Scenarios 2, 3 and 4 is presented in Table 5.3 and summarised in Section 5.7 below.

5.4 Mitigation Measures and Layout Design

Wind Farm

5.4.1 As discussed in paragraph 5.1.3 above and illustrated on Figures 4.1 and 4.2, the layout has been modified by the deletion of turbines T7, T12, T19, T20, T21 and T22 and the deletion of the access tracks, crane hardstandings, electricity transformers and underground cabling associated with these turbines.

5.4.2 Turbine T20 was deleted for cultural heritage reasons (affects on a heritage asset) and it was decided, for landscape and visual reasons, to also delete T21 and T22 as, without T20, these two wind turbines would appear visually separated from the remainder of the wind farm in some views. T7 was also deleted for cultural heritage reasons (affects on Cwm yr hob) and T12 and T19 have been deleted as their removal increases the separation distances of the proposed Wind Farm from properties to the east of the site and from the Shropshire Hills AONB.

5.4.3 The deletion of these six wind turbines reduces the number of wind turbines in the proposed Wind Farm by approximately 26% with a consequential reduction in the number of turbines and array width in most views. This further mitigates the predicted effects of the proposed Wind Farm on landscape resources and visual amenity, as described in Sections 5.5 – 5.8 below.

Grid Connection

5.4.4 Figure 4.3 shows the grid connection route currently proposed by Western Power Distribution (WPD). This consists of 4km of overhead lines on wooden poles which follow parts of previous Route 3 with the majority laid as underground cables following most of the previous Route 1 (see Figure 2.1 in Appendix SEI 12, 2013 SEI). Route 3 was entirely overhead lines and was assessed in Appendix SEI 12, 2013 SEI. This assessment identified potential adverse impacts on receptors on Glyndŵr's Way, Offa's Dyke Path and in the settlement of Knighton.

5.4.5 The two overhead sections are a 2km section on the site and a just under 2km section between Knucklas and Knighton. Both sections cross open countryside and follow around the contours on Hillslopes such that the poles and wires would tend to be backgrounded by rising land. Both overhead sections avoid crossing Glyndŵr's Way and Offa's Dyke Path (which are crossed by underground sections) and end at least 1km from Knighton, such that they are unlikely to have any significant effects on landscape and visual amenity. The underground sections would not have any effects on landscape character or visual amenity.

5.4.6 Accordingly, the effects of this route on landscape and visual amenity would be less than for previously proposed routes and are not considered in any further detail.

5.5 Assessment of Effects at Construction Stage

5.5.1 The construction stage of the proposed Wind Farm would take approximately 18 months and would be similar to the construction stage for the previously proposed 23-turbine wind farm, albeit with a slight reduction in the extent of the disturbed areas and permanent land take. Accordingly, the effects of the construction stage on landscape and visual amenity would be similar in nature to those described in ES paragraphs 5.5.1 – 5.5.5 but would be less in extent.

5.6 Assessment of Residual Effects

5.6.1 This section considers the individual and additional cumulative effects of the proposed Wind Farm on landscape and visual amenity in the context of the existing baseline, that is the existing landscape and visual baseline including the operational wind farms, in particular, the operational Llandinam P&L Wind Farm (Scenario 1).

Visibility within 10km of the Proposed Wind Farm

5.6.2 Figure 5.1B: Blade Tip ZTV (126.5m) – Garreg Lwyd Hill Wind Farm (10km buffer) has been generated to illustrate the zones of theoretical visibility, based on terrain data only, for the proposed Wind Farm. Compared with ES Figure 5.8, this illustrates that the extent of the zones of theoretical visibility within 10 km of the 17 wind turbines would be similar to the extent of the zones of theoretical visibility within 10 km of the previously proposed 23 wind turbines, as described in ES paragraphs 5.6.2 – 5.6.5, but the number of wind turbines visible in most of the zones would be reduced as a consequence of the deletion of the 6 turbines.

Visibility within 10-30km of the Proposed Wind Farm

5.6.3 Figure 5.1A: Blade Tip ZTV (126.5m) – Garreg Lwyd Hill Wind Farm (30km buffer) has been generated to illustrate the zones of theoretical visibility, based on terrain data only, for the proposed Wind Farm in the wider study area). Compared with ES Figure 5.5, this illustrates that the extent of the zones of theoretical visibility within 10 - 30 km of the 17 wind turbines would also be similar to the extent of the zones of theoretical visibility within 10 – 30 km of the previously proposed 23 wind turbines, as described in ES paragraphs 5.6.6 – 5.6.8 but, again, the number of wind turbines visible in most of the zones would be reduced as a consequence of the deletion of the 6 turbines.

Viewpoint Analysis

5.6.4 The viewpoint analyses in the ES and 2013 SEI have been reviewed and a new viewpoint analysis undertaken for the proposed Wind Farm. A comparison of the viewpoint analyses for the two schemes is provided in Table 5.2 below. This includes corrections to the distances to the nearest turbine for the originally proposed 23-turbine scheme (at Vps 4, 7, 8, 9, 13 and 14) as these were incorrect on the viewpoint figures in the ES (Figures 5.10.1 – 5.10.17). In addition, the sensitivity of motorists in the AONB has been re-assessed as "*high/medium*" rather than "*medium*" (for Vps 2, 4 and 18) in accordance with the current methodology (Appendix 5.2) and the magnitude of change for the 23-turbine scheme at Vps 8 and 18 have been amended as the levels in the ES viewpoint analysis are considered to be either a slight over or under-estimation. These amendments are highlighted in Table 5.2 below. In addition, Table 5.2 includes an assessment of the 23-turbine scheme at Vps 22 and 23 which were not assessed in relation to the effects of the turbines in the 2013 SEIs (these are SEI Vps B and C which were used for the purpose of illustrating the effects of the on-site access route in Appendix SEI 9 in the 2013 SEI but which also illustrate views of the turbines from Glyndŵr's Way close to the turbines).

5.6.5 The viewpoint analysis in Table 5.2 below suggests that, compared with the originally proposed 23-turbine scheme, the proposed Wind Farm would be further from receptors in many of the views, as a consequence of the deletion of T7, T12 and T19 (in views from the east and northeast) and the deletion of T20, T21 and T22 (in views from the north, northwest and west). This includes views from the AONB (Vps 1, 2, 3, 5, 18, 19, 20 and 21), from parts of Glyndŵr's Way (Vps 6, 12, 13, 22 and 23), from the Kerry Ridgeway (Vps 3 and 10), and also from Vps 11, 15, 17 (although the distance to the visible turbines from Vp 17 would remain the same).

5.6.6 In the more distant views, there would also be a slight reduction in both the number of turbines visible and the array width of the proposed turbines, mainly as a consequence of the deletion of T20, T21 and T22. This is noticeable, in particular, in views from the AONB (Vps 1, 2, 5, 20 and 21) and from Vps 16 and 17.

5.6.7 The most noticeable differences between the originally proposed 23-turbine scheme and the proposed Wind Farm of 17-turbines would be in the near and medium distance views as a consequence of the deletion of the 6 turbines. In these views, there would also be a slight reduction in the number of turbines visible and a more noticeable difference in the array width of the proposed turbines, in particular, from the AONB (Vps 3, 4, 18 and 19), from parts of Glyndŵr's Way (Vps 6, 12, 13, 22 and 23), from the Kerry Ridgeway (Vps 3 and 10), and at Vps 7, 11 and 15.

5.6.8 The only viewpoint where these differences would result in the visual effects no longer being significant is Vp 15. However, the increase in the distance of the turbines from receptor locations, the reduction in the number of turbines visible and, in some locations, the quite substantial reduction in array widths would be noticeable from most viewpoints and would result in a reduction in the visual effects and effects on visual amenity at all these locations.

Table 5.2: Viewpoint Analysis – Comparison of 23T and 17T Schemes – Scenario 1

VP no	Viewpoint	Visual Receptors		To 23Ts (km)	ES/2013 SEI – 23Ts		To 17Ts (km)	2014 SEI – 17Ts		Visible differences between 23T and 17T schemes
		Receptor type	Sensitivity		Magnitude	Visual effect		Magnitude	Visual effect	
1	Shropshire Way, Long Mynd (AONB)	AONB visitors	High	28.5km	Slight/ moderate	Moderate (not significant)	29.9km	Slight	Moderate (not significant)	Slight increase in distance to turbines, slight reduction in number of turbines visible and array width reduced c25%.
2	Two Crosses (AONB)	Minor road users in AONB	High/ medium	11.1km	Moderate	Moderate (not significant)	11.4km	Moderate	Moderate+ (not significant)	Slight increase in distance to turbines, slight reduction in number of turbines visible and array width reduced c25%.
3	Kerry Ridgeway, Ceri Forest (AONB)	Walkers on Kerry Ridgeway	High	7.8km	Moderate	Major/ moderate (significant)	8.1km	Moderate	Major/ moderate (significant)	Slight increase in distance to turbines, slight reduction in number of turbines visible and array width reduced c25%.
4	Bettws-y-Crwyn (AONB)	Minor road users in AONB	High/ medium	6.0km	Substantial /moderate	Major/ moderate (significant)	6.0km	Substantial /moderate	Major/ moderate (significant)	Similar distance to turbines, slight reduction in number of turbines visible and array width reduced c10%.
5	Offa's Dyke Path, Llanfair Hill (AONB)	Walkers on Offa's Dyke	High	10.6km	Moderate	Moderate (not significant)	10.6km	Moderate/ slight	Moderate+ (not significant)	Very slight reduction in number of turbines visible and in array width.

VP no	Viewpoint	Visual Receptors		To 23Ts (km)	ES/2013 SEI - 23Ts		To 17Ts (km)	2014 SEI - 17Ts		Visible differences between 23T and 17T schemes
		Receptor type	Sensitivity		Magnitude	Visual effect		Magnitude	Visual effect	
6	Felindre	Walkers on Glyndŵr's Way	High	2.8km	Substantial /moderate	Major/ moderate (significant)	3.2km	Substantial /moderate	Major/ moderate+ (significant)	Slight increase in distance to turbines, slight reduction in number of turbines visible and array width reduced c15%.
7	Beacon Hill	Walkers on Glyndŵr's Way	High	2.5km	Substantial	Major (significant)	2.5km	Substantial /moderate	Major/ moderate+ (significant)	Noticeable reduction in number of turbines visible and array width reduced c15%.
8	A488 near Pant Farm	Road users	Medium	12.8km	Slight	Moderate/ minor (not significant)	12.8km	Slight/ negligible	Moderate/ minor (not significant)	Overall effects very similar.
9	Llandrindod Wells	Residents	High	17.8km	Negligible	Minor/ none (not significant)	17.8km	None	No effect	Blade tip would not be visible at this distance.
10	Kerry Ridgeway, Two Tumps	Walkers on Kerry Ridgeway	High	4.4km	Moderate	Major/ moderate (significant)	4.9km	Moderate	Major/ moderate (significant)	Slight increase in distance to turbines, noticeable reduction in number of turbines and array width reduced c45%.
11	Minor Road north of Llanbadarn Fynydd	Residents	High	2.0km	Substantial	Major (significant)	2.5km	Substantial /moderate	Major/ moderate+ (significant)	Slight increase in distance to turbines, noticeable reduction in number of turbines and array width reduced c35%.

VP no	Viewpoint	Visual Receptors		To 23Ts (km)	ES/2013 SEI – 23Ts		To 17Ts (km)	2014 SEI – 17Ts		Visible differences between 23T and 17T schemes
		Receptor type	Sensitivity		Magnitude	Visual effect		Magnitude	Visual effect	
12	Fron Top	Residents, Walkers on Glyndŵr's Way	High	1.2km	Substantial	Major (significant)	1.4km	Substantial	Major (significant)	Slight increase in distance to turbines, noticeable reduction in number of turbines and array width reduced c30%.
13	Glyndŵr's Way near Bryn Mawr Cottage	Walkers on Glyndŵr's Way	High	1.0km	Substantial	Major (significant)	1.3km	Substantial	Major (significant)	Slight increase in distance to turbines, noticeable reduction in number of turbines and array width reduced c35%.
14	A483 Llanbister Bridge	Road users	Medium	7.0km	None	No effect	7.0km	None	No effect	No turbines visible.
15	North of Llaethdy	Residents	High	5.2km	Moderate	Major/ moderate (significant)	5.8km	Moderate/ slight	Moderate+ (not significant)	Slight increase in distance to turbines, very slight reduction in number of turbines and array width reduced c10%.
16	Carn Gafallt	Walkers	Medium/ high	23.4km	Slight/ moderate	Moderate/ minor (not significant)	23.4km	Slight	Moderate/ minor+ (not significant)	Slight reduction in turbines and array width reduced c25%.
17	Aberystwyth Mountain Road	Road users	Medium/ high	22.3km	Negligible	Minor (not significant)	22.7km	Negligible	Minor+ (not significant)	Distance to visible turbines, number of turbines and array width unchanged.
18	Nantypyllau (AONB) (SEI Vp 1)	Road users in AONB	High/ medium	4.9km	Substantial /moderate	Major/ moderate (significant)	5.2km	Substantial /moderate	Major/ moderate (significant)	Slight increase in distance to turbines, noticeable reduction in number of turbines and array width reduced c20%.

VP no	Viewpoint	Visual Receptors		To 23Ts (km)	ES/2013 SEI – 23Ts		To 17Ts (km)	2014 SEI – 17Ts		Visible differences between 23T and 17T schemes
		Receptor type	Sensitivity		Magnitude	Visual effect		Magnitude	Visual effect	
19	Rhos Fiddle Nature Reserve (AONB) (SEI Vp 2)	AONB and NR visitors	High	8.1km	Moderate	Major/ moderate (significant)	8.4km	Moderate	Major/ moderate (significant)	Slight increase in distance to turbines, noticeable reduction in number of turbines and array width reduced c25%.
20	Shropshire Way, Colebatch Hill (AONB) (SEI Vp 3)	Walkers in AONB	High	16.4km	Slight	Moderate (not significant)	16.7km	Slight/ negligible	Moderate/ minor+ (not significant)	Slight increase in distance to turbines, very slight reduction in number of turbines and array width reduced c35%.
21	Hopesay Common (AONB) (SEI Vp 4)	Walkers in AONB	High	26.2km	Slight	Moderate (not significant)	26.6km	Slight	Moderate (not significant)	Slight increase in distance to turbines, very slight reduction in number of turbines and array width reduced c15%.
22	Glyndŵr's Way between T21 and T22 (now deleted) (SEI Vp B)	Walkers on Glyndŵr's Way	High	0.21km	Very substantial	Major++ (significant)	0.65km	Substantial	Major (significant)	Over 3 x increase in distance to turbines, clearly visible reduction in number of turbines and array width reduced c70%.
23	Junction of Glyndŵr's Way and PROW in Valley of Gwenlas Brook (SEI Vp C)	Walkers on Glyndŵr's Way	High	0.56km	Substantial	Major (significant)	1.3km	Substantial /moderate	Major/ moderate+ (significant)	Over 2 x increase in distance to turbines, clearly visible reduction in number of turbines and array width reduced c40%.

Effects on Landscape Resources

Strategic Landscape Character Types

5.6.9 The assessment of effects of the original 23-turbine scheme on the character of the strategic LCTs is provided in ES paragraphs 5.6.9 – 5.6.53. This concluded that there would be significant effects on part of the Hillslopes and Saddles LCT in which the proposed Wind Farm would be located (within the Beacon Hill unit), part of the Plateau LCT in Shropshire (Clun Forest Unit), part of the Wooded Hills and Farmlands LCT to the east of the site (within the Teme Valley Farmlands unit) and in part of the Narrow Valleys LCT to the west of the site (within the Aran/Ithon unit).

5.6.10 The extent of the significant effects of the proposed Wind Farm on the character of the landscapes in the Hillslopes and Saddles LCT is illustrated by the zones of visibility on and around the site extending up to approximately 5 km in all directions, and as illustrated by Vps 7, 10, 11, 12, 13, 22 and 23. Within these zones, the 17-turbines would become a key characteristic of the landscape and would contrast with the existing character, although few existing key characteristics would be permanently (or long term temporarily) lost and the effects would be reversed at the end of the 25-year operational stage.

5.6.11 There is also a zone of visibility within the Plateau LCT extending up to 6 km to the northwest and west of the site, as illustrated by Vps 4 and 18. Within this zone, the 17-turbines would become a key characteristic of the landscape and would contrast with the existing character, although few existing key characteristics would be permanently (or long term temporarily) lost and the effects would be reversed at the end of the 25-year operational stage

5.6.12 The Teme Valley is largely outside the ZTV for the proposed Wind Farm (see ES Figure 5.3 and the 2014 SEI Figure 5.1A) but with some visibility along the west facing slopes along a 4 km section of the valley, around Vp 6. Within this zone, the 17-turbines would become a key characteristic of the landscape and would contrast with the existing character, although no existing key characteristics would be permanently (or long term temporarily) lost and the effects would be reversed at the end of the 25-year operational stage. This is less extensive than for the 23-turbine scheme where significant effects on landscape character were predicted for a 7km section of the Teme Valley. Furthermore, as a consequence of the removal of T7, T12 and T19 on the eastern side of the site, where there would be views of the turbines from the Teme Valley to the east, fewer turbines would be visible so the intensity of the effect on landscape character would also be less.

5.6.13 In contrast, the Ithon Valley to the west is almost entirely outside the ZTV for the proposed Wind Farm (see ES Figure 5.3 and the 2014 SEI Figure 5.1A).

5.6.14 Therefore, the proposed Wind Farm would have a significant effect on the character of the landscapes in parts of the Hillslopes and Saddles LCT (Beacon Hill unit), the Plateau LCT (Clun Forest unit) and the Wooded Hills and Farmlands LCT (Teme Valley Farmlands unit) within 5-6km of the proposed Wind Farm but not on the remainder of these LCTs, the Ithon Valley LCT or on the character of the landscapes in any of the other LCTs in the study area.

LANDMAP Aspect Areas

5.6.15 As predicted for the original 23-turbine scheme in Appendix SEI 9 (2013 SEI), there would be significant effects on the following LANDMAP Aspect Areas:

- Geological Landscape Aspect Area – RDNRGL152 (in which the proposed Wind Farm would be located) – significant effects where physical effects occur (see paragraph 3.3.3 and Table 3, Appendix SEI 9);
- Landscape Habitat Aspect Areas – no significant effects (see paragraph 3.3.4 and Table 4, Appendix SEI 9);

- Visual and Sensory Aspect Areas – MNTGMVS254 and RDNRVS110, 111, 114, 122 (in which proposed Wind Farm would be located), 128 and 130 - significant effects up to approximately 5km from the turbines (see paragraph 3.3.5 and Table 5, Appendix SEI 9);
- Historic Landscape Aspect Areas – RDNRHL121, 613, 806, 984 and 997 (in which proposed Wind Farm would be located) – localised significant effects on and around the wind farm site (see paragraph 3.3.6 and Table 6, Appendix SEI 9); and
- Cultural Landscape Aspect Area – RDNRCL007 (in which proposed Wind Farm would be located) – localised significant effects on and around the wind farm site (see paragraph 3.3.7 and Table 7, Appendix SEI 9).

5.6.16 However, with the reduction in turbine numbers (from 23 to 17), there would no longer be any significant effects on Visual and Sensory Aspect Area – MNTGMVS443 which is over 5km from the proposed Wind Farm and already characterised by the Llandinam (P&L) Wind Farm.

Landscape designations

National landscape designations - Shropshire Hills AONB, England

5.6.17 The effects on the special qualities of the AONB would be less extensive than predicted for the original 23-turbine scheme in Appendix SEI 1 (2013 SEI) due to the reduced scale of the proposed Wind Farm (in terms of turbine numbers and array width) in views from the AONB. In particular:

- The diversity and contrast of its landscape – no significant effects on the character of the farmed countryside, woodlands, rivers and valleys within the AONB or on the distinctive hills within the AONB (including the Stiperstones, the Long Mynd, the Stretton Hills, the Wrekin, the Clee Hills, Wenlock Edge, all of which are outside the 30 km study area, and the rolling hills of Clun Forest which are more than 10 km from the proposed Wind Farm);
- The important geology, wildlife and heritage aspects of the landscape – no significant effects on the geology, wildlife or heritage aspects of the landscapes within the AONB;
- Scenic quality and panoramic views and tranquillity – significant effects on elevated and panoramic views from locations in the AONB within approximately 10 km of the proposed Wind Farm, with rotor movement noticeable in good or better visibility, for example, Vp 3 (8.1 km), Vp 4 (6.7 km), Vp 18 (5.2 km) and Vp 19 (8.4 km) (see Figure 5.1B for viewpoint locations and zones of theoretical visibility within 10km of the proposed Wind Farm). Llandinam (P&L) Wind Farm is already visible from Vps 3, 18 and 19, but the P&L turbines are much smaller and more distant and do not have a significant effects on views from the AONB. The turbines would be discernible from elevated locations further afield within the AONB, for example from Vp 1 (29.9 km), Vp 2 (11.4 km), Vp 5 (10.6 km) and Vp 20 (16.7 km) but, in these locations, the proposed wind turbines would be small and distant features, and with rotor movement discernible only in very good or better visibility (see Table 5.2 above and Figures 5.5.1 – 5.5.23);
- Tranquillity – the proposed Wind Farm would not affect the peace and quiet or the dark skies within the AONB and is unlikely to affect visitor pressure within the AONB. Rotor movement would be discernible in elevated views (as described above) and could affect the perception of tranquillity in the closer views; and
- Culture and opportunities for enjoyment – no significant effects on the cultural settings of Telford, Ironbridge, Church Stretton, Ludlow, Craven Arms and Much Wenlock (all of which are outside the study area) and no significant effects on the ability of the public to access the public rights of way network, open access land or outdoor activities within the AONB.

5.6.18 Therefore, in relation to the defined special qualities of the AONB, there would be significant effects on some elevated and panoramic views from locations in the AONB within approximately 10 km of the proposed Wind Farm (which is less extensive than the 12 km predicted for the original 23-turbine scheme) and on the perception of tranquillity when rotor movement is discernible in the closer views but not on the other special qualities of the AONB.

5.6.19 In addition, there would be a significant effect on the character of the landscapes in the AONB within parts of the Plateau LCT (Clun Forest unit) and the Wooded Hills and Farmlands LCT (Teme Valley Farmlands unit) within 6 km of the proposed Wind Farm. This zone extends approximately 3 km into the AONB and covers less than 12 km2 which equates to less than 1.5 % of the AONB.

5.6.20 Consequently, the proposed Wind Farm is unlikely to compromise the ability of the AONB to fulfil its statutory purpose or achieve the four nationally adopted AONB objectives.

Historic Landscapes

Landscapes, Parks and Gardens of Historic Interest

5.6.21 All the Parks and Gardens of Historic Interest (in Wales) and the Registered Historic Parks and Gardens (in England) within the study area are located more than 10 km from the proposed Wind Farm, are almost all outside any zones of theoretical visibility and there would not be any views of the proposed wind turbines from these locations. Therefore, the proposed Wind Farm would not have any effects on landscape character or on the visual amenity of receptors within these historic parks and gardens.

Effects on Visual Amenity

Settlements

5.6.22 The effects on the visual amenity of residents in settlements in the study area would remain as described for the previous 23-turbine scheme in ES paragraphs 5.6.94 – 5.6.115 and summarised in ES Table 5.11. Consequently, there would be a significant effect on the visual amenity of residents in Felindre but not on residents in the other settlements in the study area (including Welshpool, Llandrindod Wells, Llanbadarn Fynydd, Llanbister, Beguildy and Dutlas).

Main Roads

5.6.23 The effects on the visual amenity of road users on the primary road routes in the study area (A483, A470, A44 and A458) would remain as described for the previous 23-turbine scheme in ES paragraphs 5.6.116 - 5.6.126. Consequently, there would not be any significant effects on the visual amenity of road users on these routes.

Railway Lines

5.6.24 The effects on the visual amenity of passengers on the two railway lines in the study area (Shrewsbury/Aberystwyth rail line and Shrewsbury/South Wales rail line) would remain as described for the previous 23-turbine scheme in ES paragraphs 5.6.127 – 5.6.132. Consequently, there would not be any significant effects on the visual amenity of passengers on these routes.

Long Distance Footpaths

5.6.25 The effects on the visual amenity of walkers on the long distance recreational routes in the study area remain largely as described in ES paragraphs 5.6.133 – 5.6.151 and summarised in ES Table 5.12, but with fewer turbines visible, as follows:

- Glyndŵr's Way – there would be significant effects on the visual amenity of walkers on a 12km section from Beacon Hill to Llanbadarn Fynydd although the number of turbines and the array width visible from this section would be reduced - between Beacon Hill and Felindre (up to 17 turbine) and between Felindre and Llanbadarn Fynydd (up to 17 turbines). Also, with the removal of T20, T21 and T22, the designated route now skirts around the turbines rather than through the site;
- Offa's Dyke Path, Shropshire Way, Jack Mytton Way, Severn Way and Wye Valley Walk – are all more than 10km from the proposed Wind Farm and there would not be any significant effects on the visual amenity of walkers on these long distance footpaths; and
- Kerry Ridgeway – this follows a ridgeline that defines the northerly edge of the zone of theoretical visibility to the north of the site. There would be intermittent views of the proposed Wind Farm from about 5km of the 9km section of the route that runs from Cider House on the B4355 south of Dolfor eastwards to the Ceri Forest and, as illustrated by Vps 3 and 10, at distances of between 4.9 – 8.1 km from the proposed wind turbines, there would be a significant change in the view (see the viewpoint analysis in Table 5.2 above). Consequently, there would be a significant effect on the visual amenity of walkers on this 9km section of the Kerry Ridgeway. However, in comparison with the 23-turbine scheme, the number of turbines and the array width visible from this section would be reduced.

5.6.26 Therefore, the proposed Wind Farm would have a significant effect on the visual amenity of residents in Felindre and walkers on a 12km section of Glyndŵr's Way and a 9km section of the Kerry Ridgeway but not on the visual amenity of residents in other settlements, road users on the primary road routes, passengers on the two railway lines, or walkers on the Offa's Dyke Path, Shropshire Way, Jack Mytton Way, Severn Way and Wye Valley Walk.

5.7 Assessment of Cumulative Effects

5.7.1 This section considers the additional cumulative effects of the proposed Wind Farm on landscape and visual amenity in the context of:

- The Section 36 Applications relating to Llandinam Repowering and Llaithddu wind farms in SSA C west (Scenario 2);
- The Section 36 Applications relating to Llandinam Repowering and Llaithddu wind farms in SSA C west and the Section 36 Application for Llanbadarn Fynydd wind farm in SSA C east (Scenario 3); and
- The Section 36 Applications relating to Llandinam Repowering and Llaithddu wind farms in SSA C west and the Section 36 Application for Llanbadarn Fynydd wind farm and the proposed (appealed) Neuadd Goch and (in planning) Bryngydfa wind farms in SSA C east (Scenario 4).

Viewpoint Analysis

5.7.2 The viewpoint analyses for Scenarios 2, 3 and 4 are provided in Table 5.2 below. This has assumed that all the other wind farms in each scenario have been permitted and built and has considered the additional effects of the proposed Wind Farm on these views.

5.7.3 In general terms, the additional cumulative effects of the proposed Wind Farm in the context of the appealed Llandinam Repowering and Llaithddu wind farms in SSA C west (Scenario 2) would be similar to the additional cumulative effects of the proposed Wind Farm in the context of the operational Llandinam P&L wind farm (Scenario 1). This is because these three wind farms are all over 8km west of the proposed Wind Farm and in a different direction from most locations, such that the proposed Wind Farm would always appear as a new feature in a different sector.

5.7.4 The same affect occurs where viewpoints are between the proposed Wind Farm and the proposed Llanbadarn Fynydd wind farm (in Scenario 3) or the proposed Neuadd Goch wind farm (in Scenario 4). From other locations further afield, the proposed Wind Farm would be in the same sector of the view as these two wind farms and so the additional cumulative effects of the proposed Wind Farm would be less than Scenario 1 as assessed in section 5.6 above.

5.7.5 As the proposed Bryngydfa Wind Farm is located to the immediate north and south of the proposed Wind Farm, the proposed wind turbines would always be seen in the context of the proposed Bryngydfa wind turbines in Scenario 4. From most locations, the proposed wind turbines would fill the gap between the two Bryngydfa turbine clusters and so the additional cumulative visual effect of the proposed Wind Farm would be less than Scenario 1 from most locations.

Table 5.3: Viewpoint Analysis – Scenarios 2, 3 and 4

VP no	Viewpoint	Visual Receptors		Scenario 2		Scenario 3		Scenario 4	
		Type	Sensitivity	Magnitude	Visual effect	Magnitude	Visual effect	Magnitude	Visual effect
1	Shropshire Way, Long Mynd (AONB)	AONB visitors	High	Slight	Moderate (not significant)	Slight	Moderate (not significant)	Slight/ negligible	Moderate/ minor+ (not significant)
2	Two Crosses (AONB)	Minor road users in AONB	High/ medium	Moderate/ slight	Moderate (not significant)	Moderate/ slight	Moderate (not significant)	Moderate/ slight	Moderate (not significant)
3	Kerry Ridgeway, Ceri Forest (AONB)	Walkers on Kerry Ridgeway	High	Moderate	Major/ moderate (significant)	Moderate	Major/ moderate (significant)	Moderate/ slight	Moderate+ (not significant)
4	Bettws-y-Crwyn (AONB)	Minor road users in AONB	High/ medium	Substantial /moderate	Major/ moderate (significant)	Substantial /moderate	Major/ moderate (significant)	Moderate	Moderate+ (not significant)
5	Offa's Dyke Path, Llanfair Hill (AONB)	Walkers on Offa's Dyke	High	Slight	Moderate (not significant)	Slight	Moderate (not significant)	Slight	Moderate (not significant)
6	Felindre	Walkers on Glyndŵr's Way	High	Substantial /moderate	Major/ moderate+ (significant)	Substantial/ moderate	Major/ moderate+ (significant)	Substantial/ moderate	Major/ moderate+ (significant)
7	Beacon Hill	Walkers on Glyndŵr's Way	High	Substantial /moderate	Major/ moderate+ (significant)	Substantial/ moderate	Major/ moderate+ (significant)	Moderate	Major/ moderate (significant)
8	A488 near Pant Farm	Road users	Medium	Slight/ negligible	Moderate/ minor (not significant)	Slight/ negligible	Moderate/ minor (not significant)	Negligible	Minor (not significant)
9	Llandrindod Wells	Residents	High	None	No additional effect	None	No additional effect	None	No additional effect
10	Kerry Ridgeway, Two Tumps	Walkers on Kerry Ridgeway	High	Moderate/ slight	Moderate+ (not significant)	Moderate/ slight	Moderate+ (not significant)	Slight	Moderate (not significant)
11	Minor Road north of Llanbadarn Fynydd	Residents	High	Substantial /moderate	Major/ moderate+ (significant)	Moderate	Major/ moderate (significant)	Moderate	Major/ moderate (significant)

VP no	Viewpoint	Visual Receptors		Scenario 2		Scenario 3		Scenario 4	
		Type	Sensitivity	Magnitude	Visual effect	Magnitude	Visual effect	Magnitude	Visual effect
12	Fron Top	Residents, Walkers on Glyndŵr's Way	High	Substantial	Major (significant)	Substantial	Major (significant)	Substantial	Major (significant)
13	Glyndŵr's Way near Bryn Mawr Cottage	Walkers on Glyndŵr's Way	High	Substantial	Major (significant)	Substantial	Major (significant)	Substantial/ moderate	Major/ moderate+ (significant)
14	A483 Llanbister Bridge	Road users	Medium	None	No additional effect	None	No additional effect	None	No additional effect
15	North of Llaethdy	Residents	High	Moderate/ slight	Moderate+ (not significant)	Slight	Moderate (not significant)	Slight	Moderate (not significant)
16	Carn Gafallt	Walkers	Medium/ high	Slight	Moderate/ minor+ (not significant)	Slight	Moderate/ minor+ (not significant)	Slight	Moderate/ minor+ (not significant)
17	Aberystwyth Mountain Road	Road users	Medium/ high	Negligible	Minor+ (not significant)	Negligible	Minor+ (not significant)	Negligible	Minor+ (not significant)
18	Nantypyllau (AONB) (SEI Vp 1)	Road users in AONB	High/ medium	Substantial /moderate	Major/ moderate (significant)	Substantial/ moderate	Major/ moderate (significant)	Moderate	Moderate+ (not significant)
19	Rhos Fiddle Nature Reserve (AONB) (SEI Vp 2)	AONB and NR visitors	High	Moderate	Major/ moderate (significant)	Moderate	Major/ moderate (significant)	Moderate/ slight	Moderate+ (not significant)
20	Shropshire Way, Colebatch Hill (AONB) (SEI Vp 3)	Walkers in AONB	High	Slight/ negligible	Moderate/ minor+ (not significant)	Slight/ negligible	Moderate/ minor+ (not significant)	Slight/ negligible	Moderate/ minor+ (not significant)
21	Hopesay Common (AONB) (SEI Vp 4)	Walkers in AONB	High	Slight	Moderate (not significant)	Slight	Moderate (not significant)	Slight/ negligible	Moderate/ minor+ (not significant)

VP no	Viewpoint	Visual Receptors		Scenario 2		Scenario 3		Scenario 4	
		Type	Sensitivity	Magnitude	Visual effect	Magnitude	Visual effect	Magnitude	Visual effect
22	Glyndŵr's Way between T21 and T22 (now deleted) (SEI Vp B)	Walkers on Glyndŵr's Way	High	Substantial	Major (significant)	Substantial/ moderate	Major/ moderate+ (significant)	Moderate	Major/ moderate (significant)
23	Junction of Glyndŵr's Way and PROW in Valley of Gwenlas Brook (SEI Vp C)	Walkers on Glyndŵr's Way	High	Substantial /moderate	Major/ moderate+ (significant)	Substantial/ moderate	Major/ moderate+ (significant)	Moderate	Major/ moderate (significant)

Cumulative Effects on Landscape Resources

Strategic Landscape Character Types

Plateau LCT

5.7.6 The Llandinam Repowering wind farm and some of the northern Llaithddu wind turbines would be located in the Plateau LCT which is already characterised by the Llandinam P&L wind farm. The proposed Wind Farm would not affect the character of the Plateau LCT and there would not be a significant cumulative effect on the landscape character of the Plateau LCT as a consequence of the addition of the proposed development (in Scenarios 2, 3 or 4).

Hillslopes and Saddles LCT

5.7.7 The southern Llaithddu, Llanbadarn Fynydd and Bryngydfa wind turbines would be located in the Hillslopes and Saddles LCT in which the proposed Wind Farm would also be located. Each wind farm would have a localised effect on the character of the Hillslopes and Saddles LCT up to approximately 5km from each wind farm and the addition of the proposed Wind Farm would result in a significant additional cumulative effect on the character of this LCT (in Scenarios 2, 3 and 4) such that the Hillslopes and Saddles LCT would become a "landscape unit with wind turbines", with the areas on and around each wind farm becoming "wind farm landscapes".

Plateau LCT – Clun Forest Unit

5.7.8 Although the Llandinam Repowering and Llaithddu wind turbines in SSA C west would be visible from the Plateau LCT in the Shropshire Hills AONB (Clun Forest Unit), they would be distant features, visible only in very good or better visibility (see Vps 4, 18 and 19) and so the additional cumulative effect of the proposed development on the character of the Plateau LCT in the AONB in the context of these wind farms (Scenario 2) would be similar to Scenario 1.

5.7.9 Llanbadarn Fynydd (Scenario 3) and Neuadd Goch (Scenario 4) are closer to the Plateau LCT in the Shropshire Hills AONB but would be seen amongst and within the array width of the SSA C west wind farms so, again, the additional cumulative effect of the proposed development on the character of the Plateau LCT in the AONB in the context of these four wind farms (Scenarios 3 and 4) would be similar to Scenario 1.

5.7.10 The Bryngydfa wind farm would be visible as two clusters in views from the Plateau LCT in the Shropshire Hills AONB (Clun Forest Unit). The addition of the proposed development would fill the gap between the two Bryngydfa turbine clusters and create the impression of one large wind farm which would be nearly double the number of turbines and a wider array width when viewed from the Plateau LCT (see Vps 4, 18 and 19) such that the additional cumulative effect of the proposed Wind Farm in conjunction with Bryngydfa wind farm on the character of the Plateau LCT in the AONB in the context of the other four wind farms (Scenario 4) would be greater than Scenario 1. However, due to the screening effects of the terrain and vegetation within the AONB, this increase in effects on landscape character would be contained to the same part of the Plateau LCT as in Scenario 1, i.e. the degree of change to landscape character would be higher but the area of landscape affected would be the same.

LANDMAP Aspect Areas

5.7.11 The additional cumulative effects on *LANDMAP* Aspect Areas arising from the original 23-turbine scheme in the context of the Llandinam Repowering and Llaithddu wind farms (Scenario 2) and the Llandinam Repowering, Llaithddu and Llanbadarn Fynydd wind farms (Scenario 3) were comprehensively assessed in Appendix SEI 8 (2013 SEI). Since then, Llandinam Repowering has reduced from 39 to 34 wind turbines, Llaithddu has reduced from 29 to 27 turbines and the proposed development has reduced from 23 to 17 turbines. However, this is only a 14 % reduction in the total number of wind turbines in Scenario 2 and a 12 % reduction in the total number of wind turbines in Scenario 3. In addition, Neuadd Goch (9-turbines) and Bryngydfa (12-turbines) wind farms (which were not in

planning when the assessment in Appendix SEI 8 was undertaken) are located within the *LANDMAP* Aspect Areas which were assessed in the 2013 SEI and considered to be significantly affected by the previously proposed 23-turbine scheme both individually and in the context of one or more of the other proposed wind turbines.

5.7.12 On this basis, the *LANDMAP* Aspect Areas likely to be significantly affected by the addition of the proposed Wind Farm to Scenarios 2, 3 and 4 would be those Aspect Areas as predicted to be significantly affected in Scenario 1 as per the assessment in Appendix SEI 8 (2013 SEI).

Landscape designations

National landscape designations - Shropshire Hills AONB, England

5.7.13 The additional cumulative effects of the proposed Wind Farm in the context of Scenarios 2, 3 and 4 on the special qualities of the AONB would be as follows:

- The diversity and contrast of its landscape – as with Scenario 1, there would be no significant additional cumulative effects on the character of the farmed countryside, woodlands, rivers and valleys within the AONB or on the distinctive hills within the AONB (including the Stiperstones, the Long Mynd, the Stretton Hills, the Wrekin, the Clee Hills, Wenlock Edge, all of which are outside the 30 km study area, and the rolling hills of Clun Forest which are more than 10 km from the proposed Wind Farm);
- The important geology, wildlife and heritage aspects of the landscape – as with Scenario 1, there would be no significant additional cumulative effects on the geology, wildlife or heritage aspects of the landscapes within the AONB;
- Scenic quality and panoramic views and tranquillity – as illustrated by the cumulative viewpoint analysis in Table 5.3 above, if Scenarios 2, 3 or 4 were to occur, then the panoramic views from locations in the AONB within approximately 10 km of the proposed Wind Farm would become progressively characterised by wind turbines such that, by Scenario 4, the addition of the proposed development would have only a slight additional effect on the scenic quality of these views. Consequently, the addition of the proposed development would have a significant additional cumulative effect only in the closer views for Scenarios 2 and 3, i.e. Vp 3 (8.1 km), Vp 4 (6.7 km), Vp 18 (5.2 km) and Vp 19 (8.4 km) and no significant additional effect on views for Scenario 4;
- Tranquillity – as with Scenario 1, the proposed Wind Farm would not affect the peace and quiet or the dark skies within the AONB and is unlikely to affect visitor pressure within the AONB. Rotor movement would be discernible in elevated views (as described above) and could affect the perception of tranquillity in the closer views; and
- Culture and opportunities for enjoyment – as with Scenario 1, no significant additional cumulative effects on the cultural settings of Telford, Ironbridge, Church Stretton, Ludlow, Craven Arms and Much Wenlock (all of which are outside the study area) and no significant effects on the ability of the public to access the public rights of way network, open access land or outdoor activities within the AONB.

5.7.14 Therefore, in relation to the defined special qualities of the AONB, there would be significant additional cumulative effects on some elevated and panoramic views from locations in the AONB within approximately 10 km of the proposed Wind Farm (for Scenarios 2 and 3) and on the perception of tranquillity when rotor movement is discernible in the closer views but not on the other special qualities of the AONB.

5.7.15 In addition, as with Scenario 1, there would be a significant additional cumulative effect on the character of the landscapes in the AONB within parts of the Plateau LCT (Clun Forest unit) and the Wooded Hills and Farmlands LCT (Teme Valley Farmlands unit) within 6 km of the proposed Wind Farm (Scenarios 2, 3 and 4). This zone extends approximately 3 km into the AONB and covers less than 12 km2 which equates to less than 1.5 % of the AONB.

5.7.16 Consequently, the addition of the proposed Wind Farm (to Scenarios 2, 3 and 4) is unlikely to compromise the ability of the AONB to fulfil its statutory purpose or achieve the four nationally adopted AONB objectives.

Effects on Visual Amenity

Settlements

5.7.17 The Llandinam Repowering, Llaithddu and Llanbadarn Fynydd wind farms would not be visible from Felindre, so the additional cumulative effects of the proposed development on the visual amenity of residents in Felindre arising from Scenarios 2 and 3 would be as predicted for Scenario 1. As illustrated by Vp 6, six of the Bryngydfa wind turbines would be visible alongside the proposed development in Scenario 4 but the significant change in the view would arise primarily from the presence of the proposed development and so the additional cumulative effects of the proposed development in this view would also remain as predicted for Scenario 1.

Main Roads

5.7.18 There would be the occasional views of one or more of the wind farms in Scenarios 2, 3 and 4 from the primary road routes in the study area (A483, A470, A44 and A458). However, the proposed Wind Farm is at a distance from these routes and, as for Scenario 1, there would not be any significant additional cumulative effects on the visual amenity of road users on these primary road routes as a result of the addition of the proposed Wind Farm to these scenarios.

Railway Lines

5.7.19 The Shrewsbury/Aberystwyth rail line in the far north of the study area and the Shrewsbury/South Wales rail line wind farms in Scenarios 2, 3 and 4. There would be few views of these wind farms from these routes and there would not be any significant additional cumulative effects on the visual amenity of passengers on these routes.

Long Distance Footpaths

5.7.20 The additional cumulative effects on the visual amenity of walkers on the long distance recreational routes in the study area would be as follows:

- Glyndŵr's Way – there would be intermittent views of the wind farms in Scenarios 2, 3 and 4 from various locations along this route as it crosses the landscape Beacon Hill to just south of the operational Llandinam (P&L) wind farm and there would be significant additional cumulative effects on the visual amenity of walkers on the 12km section from Beacon Hill to Llanbadarn Fynydd that loops around the site for Scenarios 2, 3 and 4 as a result of the proposed development;
- Offa's Dyke Path, Shropshire Way, Jack Mytton Way, Severn Way and Wye Valley Walk – these are all more than 10km from the proposed Wind Farm and there would not be any significant additional cumulative effects on the visual amenity of walkers on these long distance footpaths; and
- Kerry Ridgeway – there would be intermittent views of the wind farms in Scenarios 2, 3 and 4 from about 5km of the 9km section of the route that runs from Cider House on the B4355 south of Dolfor eastwards to the Ceri Forest. As illustrated by Vp 10 (4.9 km north of the proposed wind turbines), where the proposed wind turbines would be clearly visible and in a separate sector of the view, there would be a significant additional change in the view from this route and this would occur in the first 4km of the route from Cider House travelling eastwards. However, as illustrated by Vp 3 (8.1 km and northeast of the proposed wind turbines), where the proposed wind turbines would be seen within the cluster of other wind farms, the additional effect of the proposed Wind Farm would not be significant.

5.7.21 Therefore, in Scenarios 2, 3 and 4, the proposed Wind Farm would result in significant additional cumulative effects on the visual amenity of walkers on a 12km section of Glyndŵr's Way and a short section of the Kerry Ridgeway but not on the visual amenity of residents in settlements, road users on the primary road routes, passengers on the two railway lines, or walkers on the Offa's Dyke Path, Shropshire Way, Jack Mytton Way, Severn Way and Wye Valley Walk.

5.8 Assessment of Effects at Decommissioning Stage

5.8.1 The activities during the decommissioning stage for the proposed Wind Farm would be similar to those for the previously proposed 23-turbine wind farm but with slightly reduced ground disturbance arising from fewer turbines, crane hardstandings and tracks, and so would also have a minimal effect on the landscape and visual amenity of the locality, as described in ES paragraphs 5.8.1 – 5.8.2.

5.9 Summary and Conclusion

5.9.1 In summary, the proposed Wind Farm would result in some significant effects, both individually and cumulatively, in the context of the operational and other proposed Wind Farms, as follows:

Scenario 1 – in the context of the operational Llandinam (P&L) wind farm

5.9.2 There would be significant additional cumulative effects on:

- Landscape character - of the landscapes in parts of the Hillslopes and Saddles LCT (Beacon Hill unit), the Plateau LCT (Clun Forest unit) and the Wooded Hills and Farmlands LCT (Teme Valley Farmlands unit) within 5-6km of the proposed Wind Farm;
- *LANDMAP* Aspect Areas – localised effects on one Geological Landscape Aspect Area (RDNRGL152), seven Visual and Sensory Aspect Areas (MNTGMVS254 and RDNRVS110, 111, 114, 122, 128 and 130), five Historic Landscape Aspect Areas (RDNRHL121, 613, 806, 984 and 997) and one Cultural Landscape Aspect Area (RDNRCL007);
- Landscape designations - some elevated and panoramic views from within the Shropshire Hills AONB up to 10 km from the proposed Wind Farm, on the perception of tranquillity where rotor movement is discernible in the closer views and on the character of the landscapes within parts of the Plateau LCT (Clun Forest unit) and the Wooded Hills and Farmlands LCT (Teme Valley Farmlands unit) within 6 km of the proposed Wind Farm, a zone which would extend approximately 3 km into the AONB and would cover approximately 12 km^2 which equates to less than 1.5 % of the AONB. However, the proposed Wind Farm is unlikely to compromise the ability of the AONB to fulfil its statutory purpose or achieve the four nationally adopted AONB objectives;
- Visual amenity – of residents in Felindre, walkers on a 12km section of Glyndŵr's Way from Beacon Hill to Llanbadarn Fynydd and walkers on a 9km section of the Kerry Ridgeway from the B4355 south of Dolfor eastwards to the Ceri Forest;

5.9.3 However, these effects are less than predicted for the previously proposed 23-turbine scheme where significant effects on the landscapes in the Narrow Valleys LCT (Aran/Ithon unit) to the west of the site and in the Visual and Sensory Aspect Area – MNTGMVS443 were also predicted. Also, the effects on views and tranquillity in the AONB extended to 12km from the proposed Wind Farm and the effects on the character of the landscapes in the AONB covered a zone of approximately 30 km2 which equates to 3.5 % of the AONB.

5.9.4 In addition, at most locations the proposed Wind Farm would result in an increase in the distance of the turbines from receptor locations, a reduction in the number of turbines visible and, in some locations, a quite substantial reduction in array widths which would be noticeable from most viewpoints and would result in a reduction in the visual effects and effects on visual amenity at all these locations.

Scenario 2 – in the context of the appealed Llandinam Repowering and Llaithddu Wind Farms

5.9.5 Due to the distance between the proposed Wind Farm and these SSA C west wind farms, there would be few significant combined cumulative effects on landscape character, LANDMAP Aspect Areas, the AONB or the visual amenity of receptors and the additional cumulative effects of the proposed Wind Farm would be similar to Scenario 1.

Scenario 3 – in the context of the appealed Llandinam Repowering, Llaithddu and Llanbadarn Fynydd Wind farms

5.9.6 The Llanbadarn Fynydd wind farm would be located in SSA C east approximately 2km northwest of the proposed Wind Farm and there would be significant additional cumulative effects on:

- Landscape character - of the landscapes in parts of the Hillslopes and Saddles LCT (Beacon Hill unit) and the Plateau LCT (Clun Forest unit) within 5-6km of the proposed Wind Farm, although these LCTs would already be characterised to various extents by the Llanbadarn Fynydd wind farm;
- LANDMAP Aspect Areas – localised effects on one Geological Landscape Aspect Area (RDNRGL152), seven Visual and Sensory Aspect Areas (MNTGMVS254 and RDNRVS110, 111, 114, 122, 128 and 130), five Historic Landscape Aspect Areas (RDNRHL121, 613, 806, 984 and 997) and one Cultural Landscape Aspect Area (RDNRCL007) although these Aspect Areas would already be characterised to various extents by the Llanbadarn Fynydd wind farm;
- Landscape designations – similar to Scenario 1 with significant additional effects on some elevated and panoramic views from within the Shropshire Hills AONB up to 10 km from the proposed Wind Farm, on the perception of tranquillity where rotor movement is discernible in the closer views and on the character of the landscapes within parts of the Plateau LCT (Clun Forest unit) within 6 km of the proposed Wind Farm, a zone which would extend approximately 3 km into the AONB and would cover approximately 12 km2 which equates to less than 1.5 % of the AONB. However, the addition of the proposed Wind Farm is unlikely to compromise the ability of the AONB to fulfil its statutory purpose or achieve the four nationally adopted AONB objectives;
- Visual amenity – of walkers on a 12km section of Glyndŵr's Way from Beacon Hill to Llanbadarn Fynydd and walkers on a 4km section of the Kerry Ridgeway from the B4355 south of Dolfor eastwards to the Ceri Forest;

5.9.7 These additional cumulative effects are slightly less than for Scenario 1 due to the prior presence of Llanbadarn Fynydd in the landscape and in views.

Scenario 4 – in the context of the appealed Llandinam Repowering, Llaithddu and Llanbadarn Fynydd Wind farms and the proposed (in planning) Neuadd Goch and Bryngydfa Wind Farms

5.9.8 The Neuadd Goch and Bryngydfa wind farms would also be located in SSA C east Neuadd Goch approximately 3.5km north-northwest of the proposed Wind Farm and the Bryngydfa turbines to the immediate north and south of the proposed Wind Farm. There would be significant additional cumulative effects on:

- Landscape character - of the landscapes in parts of the Hillslopes and Saddles LCT (Beacon Hill unit) and the Plateau LCT (Clun Forest unit) within 5-6km of the proposed Wind Farm although these LCTs would already be characterised to various extents by the Llanbadarn Fynydd, Neuadd Goch and Bryngydfa wind farms;
- LANDMAP Aspect Areas – localised effects on one Geological Landscape Aspect Area (RDNRGL152), seven Visual and Sensory Aspect Areas (MNTGMVS254 and RDNRVS110, 111, 114, 122, 128 and 130), five Historic Landscape Aspect Areas (RDNRHL121, 613, 806, 984 and 997) and one Cultural Landscape Aspect Area (RDNRCL007) although these Aspect Areas would already be characterised to

various extents by the Llanbadarn Fynydd, Neuadd Goch and Bryngydfa wind farms;

- Visual amenity – of walkers on a 12km section of Glyndŵr's Way from Beacon Hill to Llanbadarn Fynydd and walkers on a 4km section of the Kerry Ridgeway from the B4355 south of Dolfor eastwards to the Ceri Forest;

5.9.9 Due to the presence of the other five wind farms in this scenario, the additional cumulative effects arising as a result of the proposed Wind Farm on panoramic views, tranquillity and the character of the landscapes in the Shropshire Hills AONB would be slight and not significant.

5.9.10 These additional cumulative effects are slightly less than for Scenario 1 due to the prior presence of Llanbadarn Fynydd in the landscape and in views.

5.10 References, Glossary and Abbreviations

Countryside Council for Wales (June 2010) LANDMAP Information Guidance Note 3

Herefordshire County Council (2004, updated 2009) "Landscape Character Assessment - Supplementary Planning Guidance 2004 – Updated 2009"

Herefordshire County Council (2007) Herefordshire Unitary Development Plan 2007

Landscape Institute/Institute of Environmental Management and Assessment (2013) Guidelines for Landscape and Visual Impact Assessment, 3rd Edition (GLVIA 3)

Montgomeryshire District Council (1992) The Montgomeryshire Landscape Assessment

Powys County Council (2010) Powys Unitary Development Plan 2010

Renewable Energy Systems (2013) Garreg Lwyd Hill Wind Farm 2013 Supplementary Environmental Information (2013 SEI) Volume I: Main Document; Volume II: Technical Appendices; Volume III: Figures

Scottish Natural Heritage (2006) Visual Representation of Wind Farms: Good Practice Guidance

Scottish Natural Heritage (March 2012) Assessing the Cumulative Impact of Onshore Wind Energy Developments

Shropshire County Council (2006) The Shropshire Landscape Typology

Shropshire Hills AONB Partnership (2009) Shropshire Hills Area of Outstanding Natural Beauty Management Plan 2009 – 2014, on behalf of Shropshire Council and Telford & Wrekin Council, with observations by Natural England

Shropshire Hills AONB Partnership (2014) Shropshire Hills AONB Management Plan 2014 – 2019, on behalf of Shropshire Council and Telford & Wrekin Council

South Shropshire District Council (2004) South Shropshire Local Development Plan 2004 - 2011

Glossary and Abbreviations

See Appendix 5.2

6. BAT ASSESSMENT

6.1 Introduction

6.1.1 This document has been prepared by BSG Ecology. It provides updated survey results from April-July 2014 and a reassessment of the potential effects on bats of the proposed wind farm.

6.1.2 It updates and supersedes all previous information provided concerning bats in the Ecology chapter of the original ES, as well as the previous SEI relating to bats; and updates the assessment for the proposed wind farm. A summary of the methods and results of the 2006 and 2009 surveys are included in sections 6.3 and 6.4, as background contextual information to inform the assessment.

6.1.3 The assessment provides baseline information, evaluates the bat resource, identifies potential impacts on bats, assesses the significance of those impacts, describes mitigation measures to avoid, reduce, remedy or compensate for those impacts, and assesses the significance of the residual effects based on the magnitude of the impact and the sensitivity of the receptor. The SEI also provides a cumulative assessment of in-combination effects taking into account other existing and proposed wind farms within 10km of the proposed wind farm and discusses ongoing management and monitoring measures. These assessments are considered for the construction, operation and decommissioning phases of the project.

6.1.4 The site area (area within the red line boundary) is shown in Figure 4.1 and is situated in the north of the old county of Radnorshire in mid-Powys. It lies mainly on the upland plateau between the River Ithon at Llanbadarn Fynydd and the River Teme at Felindre. The site covers an area of approximately 440 Ha (4.4km2). The plateau is between 484 metres above sea level (asl) at Ty'n-y-ddol Hill and 300 metres asl on the steeper slopes below. It is bordered by agriculturally improved pasture, with coniferous and broad leaved woodlands in the valleys below and common land to the south with heath and unimproved acid grassland.

6.1.5 Agriculturally improved pasture covers the majority of the site, with some small areas of wetter land on the uplands, and less improved pasture land and woodland on the steeper slopes. The fields are mainly bounded by fences, with some hedges, shrubs or trees along some boundaries. Cattle and sheep grazed most of the site at the time of the surveys.

6.1.6 The proposed wind farm originally included 23 wind turbines but was reduced to 17 in June 2014 after Turbines T20, T21, T22, T7, T12 and T19 were removed from the scheme. The scheme will also include micro-siting of turbines up to 75 m, associated transformers, crane hardstandings, public car park, temporary and permanent anemometer mast, access tracks, watercourse crossings, underground cabling, a substation compound with control buildings and transformers; borrow pits, and temporary construction compounds (See ES 2008, Chapter 4 for details). Electrical cabling will be required to connect the project to the electricity grid.

6.2 Relevant Legislation and Policy

6.2.1 There are a number of national, regional and local policies that relate to nature conservation, ecology, and specifically to bats. Reference to these provides an indication of the likely requirements and expectations of statutory authorities in relation to planning applications within a given area. A brief outline of the relevant planning policy and guidance that relates to nature conservation and ecology is provided below. All relevant policies are further considered in Chapter 2 of the 2014 SEI.

6.2.2 The following legislation relates to bats:

- The Conservation (Natural Habitats, &c.) Regulations 2010 (as amended);
- The Wildlife and Countryside Act 1981 (as amended);
- The Countryside and Rights of Way (CRoW) Act 2000;
- The Natural Environment and Rural Communities Act 2006.

6.2.3 Particular attention has been paid to the planning policy and strategy documents listed below:

- Planning Policy Wales - Technical Advice Note 5: Nature Conservation and Planning (September 2009);
- Powys Local Development Plan: Preferred Strategy (March 2012);
- Powys Unitary Development Plan (UDP) 2001 – 2016 (Adopted 1st March 2010);
- Powys UDP – Supplementary Planning Guidance – Interim Development Control Guidance (IDCG): Biodiversity Conservation and Enhancement in Development Proposals (April 2009);
- Powys UDP – Supplementary Planning Guidance – Second Draft Interim Development Control Guidance: Wind farm Development in Powys (2008);
- UK Post-2010 Biodiversity Framework (JNCC; July 2012);
- Environment Strategy for Wales (Welsh Government; 2006); and
- Our Partnership with Nature: A Local Biodiversity Action Plan for Powys (Powys County Council; October 2002).

6.2.4 The following Powys County Council Unitary Development Plan (Approved 1st March 2010) policies have also been considered:

- Policy ENV3 – Safeguarding Biodiversity and Natural Habitats;
- Policy ENV4 – Internationally Important Sites;
- Policy ENV5 – Nationally Important Sites;
- Policy ENV6 – Sites of Regional and Local Importance; and
- Policy ENV7 – Protected Species.

6.2.5 The following Powys County Council Local Development Plan – Preferred Strategy (March 2012) policy has also been considered:

- Policy LDP SP3 – Natural, Historic Environment and Landscape.

6.3 Approach and Methods

Consultation

6.3.1 In July 2009, Powys County Council (PCC) responded with regard to baseline information on bats presented in the 2008 ES. They concluded by stating that insufficient information was provided to assess impacts on bats within the application site and that they have particular concerns about noctule Nyctalus noctula bats. RES undertook further bat surveys in 2009 to obtain this extra information and to determine the extent of use of the site by noctule bats.

6.3.2 Survey methods were agreed in advance with the PCC Ecologist and were designed to address PCC's concerns and to further determine the extent of the use of the site by noctule bats. The results of these surveys were submitted by RES as SEI in 2010.

6.3.3 Comments were received from the Countryside Council for Wales (CCW) and PCC in response to the 2010 SEI, requesting more information on noctule bat activity at the site. Further information from the 2006 and 2009 surveys were provided by RES in an updated assessment for noctule bats included as SEI in 2013.

6.3.4 In September 2013, Natural Resources Wales (NRW were previously known as CCW) responded to the 2013 SEI and welcomed the further data on noctule bats that had been presented. However, they expressed concern that the bat data was now over three years old and potentially out of date, and that new best practice guidance had been produced for surveying bats at onshore wind farm developments (referring to Hundt, 2012) since the surveys had been carried out.

6.3.5 The Refusal Notice for the proposed wind farm was received in September 2013 and Reason 4 stated that "Insufficient information has been submitted to demonstrate that the proposed development would not have an unacceptable impact on bats".

6.3.6 Further correspondence has been undertaken with NRW since receipt of the Refusal Notice via email and two telephone meetings have taken place. The scope of surveys in 2014 has been discussed and agreed verbally with Caroline Moscrop and John Messenger of NRW. The preliminary results of bat surveys carried out between April and June 2014 have been provided to NRW and discussions concerning the removal of NRW's objection (with regard to bats) and agreement concerning conditions governing post-construction monitoring for bats are ongoing at the time of the submission of this SEI. At the time of writing two more months of survey in August and September 2014 have yet to be undertaken and the results of these surveys will be provided to NRW and PCC upon completion.

Methods of Evaluation and Impact Assessment

Ecological Impact Assessment Methods

6.3.7 This assessment has been undertaken based on the Guidelines for EcIA in the United Kingdom developed by the CIEEM (IEEM, 2006), which is generally recognised as current best practice. The purpose of the guidelines is to provide decision makers with clear, well-reasoned and concise information about the likely significant ecological effects associated with a project. The guidelines include advice on best practice in four key areas of EcIA:

- Identifying and evaluating ecological features;
- Characterising and quantifying impacts and assessing their significance;
- Minimising adverse effects and maximising benefits through the scheme design process; and
- Identifying legal and policy implications and their consequences for decision-making.

Valuing Ecological Resources and Features

6.3.8 The IEEM guidelines for EcIA (IEEM, 2006) recognise that evaluation is a complex process and that a number of factors need to be considered in attributing value to ecological receptors. These include:

- Designated sites and features;
- Biodiversity value;
- Potential value;
- Secondary or supporting value; and
- Legally protected sites and species.

6.3.9 The guidelines state that assigning value is a matter of professional judgement which should be guided by the importance and relevance of each of the factors listed above so as to allow each ecological resource or receptor to be valued having regard to a Geographic Frame of Reference (set out below).

6.3.10 With regard to assessments of biodiversity value, there are various characteristics that can be used to identify ecological resources or features that are likely to be important in terms of biodiversity, and these include:

- Rare or uncommon species in the local, national or international context;
- Endemic or locally distinct sub-populations of a species;
- Species on the edge of their distribution;
- Notably large populations of animals or concentration of animals considered uncommon or threatened in a wider context;
- Species-rich assemblages of bats;
- Ecosystems and their component parts, which provide the habitats required by the above species, populations and/or assemblages;

6.3.11 In order to evaluate the importance of ecological features identified in the desk study and field surveys, all ecological resources or features to be assessed are assigned a value in relation to their geographical context. The following hierarchy is used:

- International importance (e.g. Special Areas of Conservation that are designated for their bat interest);
- National importance (e.g. Sites of Special Scientific Interest that are wholly or partly designated for their bat interest);
- Regional importance (e.g. EA regional biodiversity indicators, important features in NE Natural Areas);
- County importance (e.g. Local Nature Reserves or Sites of Importance for Nature Conservation that are wholly or partly designated for their bat interest);
- Importance within the Vice-County – Powys is a large unitary authority and in this context Radnorshire (the vice-county) is a suitable context that has here been referred to as a Borough. (e.g. a lake that provides good foraging habitat for a number of common bat species)
- Local (Community/Ward) importance (e.g. occasional presence of a bat species that is thought to be uncommon).
- Important within the site and immediate environs e.g. a small population of a common species of bat (i.e. within the zone of influence only);
- Negligible importance would usually be applied to areas such as built development or areas of intensive agricultural land.

6.3.12 The evaluation has been carried out to assess the importance of the site for different species of bats and the predicted zone of influence of the proposals. In this respect only those species that have potential to be affected by the proposed operations have been considered.

6.3.13 It should be noted that it is usual to consider habitats and species together when ascribing a value to a feature using this geographic context. However, there are circumstances where an ecologist may feel it necessary to assign a value to a particularly valuable species. In assigning value to species it is necessary to consider the species distribution and status including a consideration of trends based on available historical records.

Predicting and Characterising Ecological Impacts

6.3.14 Impacts on bats are characterised, where appropriate, in terms of what is important about the structure of the ecosystem that is supporting a bat species; and in terms of impact on the integrity of a feature (such as a roost, foraging area or commuting route). Reference is made where appropriate and relevant to: beneficial or adverse effects; extent; magnitude; duration; reversibility; timing and frequency; and cumulative effects. These can be quantitative or qualitative, direct or indirect.

Determining the Ecological Significance of Impacts

6.3.15 IEEM Guidance indicates that an ecologically significant impact on bats would be an impact (adverse or beneficial) on the conservation status of bat species within a given geographical area (IEEM, 2006). This constitutes the guiding principle in determining whether an impact is significant and if so at what level.

6.3.16 A beneficial or adverse effect is determined to be significant or not, in ecological terms, in relation to the integrity of the defined site or ecosystem(s) and/or the conservation status of bats within a given geographical area, which relates to the level at which it has been valued. If an effect is found not to be significant at the highest geographical level at which the resource or feature has been valued, it may be significant at a lower geographical level.

6.3.17 The value of any feature that will be significantly affected at a given geographical level is then used to determine the implications, in terms of legislation, policy and/or development control. IEEM (2006) states:

"If an ecological resource or feature is likely to experience a significant impact, the consequences in terms of development control, policy guidance and legislation will depend on the level at which it is valued. Significant impacts on features of ecological importance should be mitigated (or compensated for) in accordance with guidance derived from policies applied at the scale relevant to the value of the feature or resource. Any significant impacts remaining after mitigation (the residual impacts), together with an assessment of the likelihood of success in the mitigation, are the factors to be considered against legislation, policy and development control in determining the application".

Confidence in Predictions

6.3.18 Following an assessment of the significance of any residual impacts a judgement is made in relation to each resource or receptor, about the degree of confidence in the impact assessment.

6.3.19 A measure of certainty is also applied to the likely success or otherwise of measures to mitigate adverse ecological effects. In addition the available degree of detail, at this stage in the development of the scheme, about a particular mitigation measure, can also affect certainty.

6.3.20 In this assessment, confidence in prediction is expressed by reference to a scale of probablility with High being equivalent to a certainty or near-certainty of an outcome occuring through Medium and Low to Very Low, when the probability of an outcome not occuring would be certain or near-certain.

Mitigation and Assessment of Residual Impacts

6.3.21 The residual impacts are those significant impacts that remain after implementation of mitigation and compensation measures. These impacts and an assessment of the likely success of any mitigation measures will be considered against legislation and planning policy in making a planning decision.Further Guidance on Assessing Bat Sensitivity to Wind Turbines

6.3.22 In the guidance produced by Natural England (NE) on bats and onshore wind turbines (2012), each UK bat species has been assessed to try and determine their risk of collision with wind turbines. The level of risk for each species is classified as high, medium or low based on mortality data from monitoring studies at wind farms as well as what is known of their the species' habitat preferences, echolocation characteristics, weight, wing-shape, flight speed and height, hunting techniques, flight behaviour, and use of the landscape. Table 6.1 assigns species of bats a category of likely level of risk of death through interaction with operational wind turbines.

6.3.23 In addition, the guidance assesses the potential threat (high, medium or low) posed to species from mortality caused by collision with wind turbines. This assessment is based on current UK population estimates for each species in combination with the collision risk assessment for each species.

6.3.24 Table 6.2 lists the likely level of risk of bat populations to wind-farm related adverse effects which are based on current population estimates published by the JNCC/Tracking Mammals Partnership (Battersby [Ed]., 2005). Both tables have been adapted from Natural England (2012).

Table 6.1: The likelihood of bat species being killed by wind turbines

High-risk	Medium-risk	Low-risk
Noctule	Common pipistrelle	*Myotis*[1] species
Leisler's bat	Soprano pipistrelle	Long-eared bats
Nathusius' pipistrelle	Serotine	Horseshoe bats
	Barbastelle	

Table 6.2: Threat to UK bat populations from wind turbines

High-risk	Medium-risk	Low-risk
Noctule	Serotine	Common pipistrelle
Leisler's bat	Barbastelle	Soprano pipistrelle
Nathusius' pipistrelle		*Myotis* species
		Long-eared bats
		Horseshoe bats

Limitations to Surveys

6.3.25 No significant limitations have been identified to the 2006 and 2009 bat surveys.

6.3.26 For the 2014 surveys BCT guidance (2012) recommends that surveys are carried out in temperatures of greater than 10°C. During the walked transect surveys, the temperature dropped below 10°C during all surveys in April and May, two surveys in June and one survey in July. All of these surveys were commenced in temperatures of greater than 10°C, except one in April and one in May that were both between 9°C and 10°C. During the same May survey, the arrival of a fog bank caused the early cancellation of the Vantage Point survey due to lack of visibility. This is not considered to be a constraint in the sense that the surveys were typical and representative of the weather conditions at site in 2014. All of the site is upland (more than 300m above sea level) and exposed, and often several degrees cooler than surrounding, lower-lying areas.

6.3.27 During the automated surveys, one detector (T14A, located at habitat features adjacent to T14 – see 6.4.58) deployed in June recorded no data, and a detector from July had to be redeployed after it failed (T15 and T15A). This data has not been collected yet and it is not included in the assessment. This amounts to a loss of five night's data in comparison to a total of 293 nights of data that was successfully collected and analysed. In the context of overall effort, and the results of survey work, this is highly unlikely to have affected the conclusions drawn in this assessment.

6.3.28 The surveys presented here cover the period April – July 2014. Bat surveys on the site will continue in August and September 2014 to complete a full season of survey in accordance with the 2012 BCT guidance. The results of the last two months of survey will be provided to the Planning Appeal for the proposed wind farm upon completion of the surveys.

6.3.29 Although data from August and September 2014 are not included here, this is not considered to be a significant information gap that is likely to materially affect the conclusions of this assessment. Nevertheless the assessment will be reviewed once the data from August and September has been added to the results. The assessment is based on survey data that has been collected during three calendar years (2006, 2009 and 2014) and therefore the baseline surveys provide a robust data set on which to carry out the assessment.

[1] Refers to any bat species of the genus *Myotis*.

Methods of 2006 Surveys

6.3.30 A summary of the methods of the 2006 bat surveys, undertaken by Ecology Matters, is provided below as taken from the original ES (produced in 2008).

6.3.31 The following survey method was developed by Ecology Matters to assess proposed windfarm sites for bat usage, and was employed at the site.

- Daylight inspection: The site was surveyed in daylight to assess the suitability of the habitat for bats in terms of feeding areas and flight lines, to identify a survey transect route and position for a static detector, and to identify any potential roost sites within or close to the site.
- Activity Survey: A transect route was devised that sampled the different habitat types, probable bat habitats within the site and probable flight lines onto the site, but was also safe to walk in the dark. Details of the transect route are given in Appendix 6.1 of the 2008 ES. The site was surveyed on three occasions over the main period of bat activity (May to end of August) and once during the autumn when bats are moving to mating and hibernation sites.

6.3.32 Each survey started at least one hour after sunset in order to allow time for bats to reach the site from their roosts. A surveyor walked the transect route for approximately two hours mapping any bat passes. The surveyor carried a frequency division Bat Box Duet detector recording to an mp3 player which recorded all bat sounds during the survey period. The sound files were later analysed using computer software (BatSound) to determine the bat species. A static detector (Anabat) was also left in situ during the period of each survey.

Methods of 2009 Surveys

6.3.33 A summary of the methods of the 2009 bat surveys is provided below, as taken from the SEI 2010.

6.3.34 After agreeing the survey methods with the PCC Ecologist, the following surveys were undertaken:

- Transect surveys on three occasions (once in July, August and October) across the site with a dusk survey starting at sunset and a dawn survey (July and August) starting at least an hour before sunrise;
- Anabat recording detectors were left overnight on the three visits and set to record between approximately half an hour before sunset and half an hour after sunrise on each survey night. They were positioned either at the location of a proposed turbine or where it was hoped to obtain information on movement of bats across the site;
- On the third visit Anabat detectors were left recording for 4 nights, although on the second night there was heavy drizzle which resulted in three of the Anabats recording rain and no bats, the fourth detector was in a more sheltered position and was unaffected by the weather.

Methods of 2014 Surveys

6.3.35 The bat survey methods were derived with reference to guidance documents produced by NE (2012) and BCT (Hundt, 2012).

6.3.36 The determination of the baseline conditions present at the site was undertaken through a combination of desk study and field surveys.

6.3.37 A desk study was carried out to collate existing records from the site and the surrounding area, and to inform the necessary field surveys. Additional information was also obtained from the baseline surveys carried out for the proposed Llanbadarn Ffynydd wind farm site that is located west of and adjacent to the site.

6.3.38 Field surveys to inform the assessment for the proposed wind farm comprise the following elements:

- Site appraisal survey;
- Walked transect survey including Vantage Point (VP) surveys for noctule bats;
- Automated bat detector survey; and
- Roost survey.

Desk Study

6.3.39 The Biological Information Service for Powys was approached for records of low and medium-risk species of bats within 5km of the site, and statutory designated sites (designated for bats) and high-risk bats within 10km. The data were requested on 16 July 2014.

6.3.40 Additional information was also obtained from the baseline surveys carried out for other wind farm sites (proposed or consented) within 10km of the site.

6.3.41 Information obtained during the course of a desk study is dependent upon people and organisations having made and submitted records for the area of interest. As such, a lack of records for a particular protected species does not necessarily mean that they do not occur in the study area. Likewise, the presence of records for protected species does not necessarily mean that these species still occur within the area of interest, only that conditions were once suitable. This is particularly true with older records.

Site Appraisal Survey

6.3.42 The guidance for methods of baseline pre-construction survey described within the BCT Guidelines (2012) is based upon identifying the likely level of risk to bats associated with a particular site. For the site this involved assessing the quality of the habitats for bats during an initial site appraisal and also taking account of the likely on-site assemblage of bats based on the results of previous surveys, desk study and the known habitat preferences of UK bats. Three main elements determine habitat quality for most bats: the presence of potential roosting habitat and foraging habitat, and the extent to which the habitats present in the site are connected to those in the surrounding landscape. The BCT guidance is the same as NE guidance in terms of its assessment of the level of risk associated with bat populations and uses the same classifications of high, medium and low risk for both species and survey sites.

6.3.43 A site appraisal was carried out by Matt Hobbs of BSG Ecology on 15 April 2014 and confirmed the site risk-level for bats as being low/medium, based on previous survey results (from 2006 and 2009) that confirmed the exposed, upland setting and the limited diversity and scale of the foraging and roosting habitats present for bats to exploit; but also took into account the apparently regular presence of a high risk species (noctule). More details are provided under separate sections covering each survey method below.

6.3.44 For a site that is assessed as 'low risk' surveys would normally be carried out during three months (in spring, summer and autumn), e.g. May, July and September. For a site assesed as being of medium risk, monthly surveys would normally be carried out during the main active period, April – September/October. It was decided to take a robust approach by opting for undertaking monthly surveys. It was decided not to collect data in October 2014 for two reasons: previous experience of surveying in October in upland habitats indicates that bat activity declines significantly as the weather deteriorates during this month; and it is not essential to do so under the 2012 BCT guidance (survey until September is acceptable). For automated surveys, given the large number of survey locations described below and the uniformity of the landscape (see 6.3.57) surveys of each location would be undertaken every other month, rather than monthly.

6.3.45 The site appraisal also informed the level of further survey that should be undertaken through identifying:

- The precise routes that will be used for the walked and driven transect surveys (see below) taking into account access/terrain issues; and
- The locations where automated bat detectors would be deployed (see below).

Selection of Survey Areas

6.3.46 The site was initially divided into three clusters of turbines that could each be covered by a single evening transect walk, where it was safe to access land on foot and at night. Each cluster (including a 200m buffer zone around the turbines as recommended in the BCT guidance) was defined as an individual Survey Area (SA) and the site was split into three SAs, with SA1 the most southerly, SA2 occupying the central section, and SA3 the most northerly. After the change to the scheme layout in June, the transect routes were changed to reflect this for the July surveys. The transect routes were designed to sample a representative proportion of each habitat present within the survey area, based on areas that were accessible and safe to walk at night.

6.3.47 Figure 6.1 shows the boundaries of the three SAs, the grouped locations of automated detectors (see below), and the locations of VPs for noctule during the April-June surveys and Figure 6.2 shows the changes in SAs for the July surveys.

Walked Transect Survey including Vantage Point (VP) Survey for Noctule Bats

6.3.48 VP surveys can be useful to assess the number of early emerging bats present on a site, the approximate direction to a roost (sometimes actual roost locations), commuting routes and type of activity.

6.3.49 Surveys started fifteen minutes before sunset and for the first hour of the survey (while there is still light to see) the two surveyors carried out a VP watch for noctule bats. Two VPs were selected within SA1 and SA3 with one location in SA2 (the locations of which are illustrated in Figure 6.1) so that as much of each SA could be viewed from the locations as possible. At SA2, the single VP enabled good views in all directions and allowed surveyors to watch 'back to back'.The surveyors watched for noctule bats and recorded their movements (principally flight height and direction) as well as counting the number of bats seen.

6.3.50 In July, the VP locations for noctules were moved for two reasons: the SA boundaries and transect routes were changed to allow for the reduction in the number of turbines; and noctules had only been twice recorded during VPs in April-June and, following a review of the data, the locations were adjusted to be closer to areas where noctule activity was regularly recorded by automated detectors.

6.3.51 At each of the SAs (three in April – June and two in July; see 6.4.48), monthly transects (and VPs) were undertaken between April and July 2014[2]. The walked element of the surveys involved walking a predetermined transect route through the site following completion of the VP surveys and recording all bat echolocation calls using bat detectors, (details of bat detectors used for VP and transect surveys are included in Appendix 6.1), as well as noting any bat activity heard or seen on standardised recording forms.

6.3.52 Two surveyors walked each transect route. Surveys were carried out only when weather conditions were suitable for bats to be active, avoiding temperatures below 10°C (when possible; see 6.4.27) heavy rain and high wind speeds. Each transect took 2-3 hours to complete. The timing of the surveys covered the bat emergence period and the period of most intense foraging activity when invertebrate prey is most abundant (Altringham, 2003).

[2] Surveys are ongoing until September 2014.

6.3.53 The direction and start point of each transect route was altered for each survey to ensure that different parts of the site were surveyed at different times of the night. This approach was adopted to remove any bias that could be introduced into the survey data if each transect was walked in the same direction. This bias could result in any given point on the transect route being visited at approximately the same interval after sunset.

Automated Bat Detector Survey

6.3.54 Wildlife Acoustics SM2BAT and SM2BAT+ bat detectors were used to record bat activity (bat echolocation calls) at fixed points throughout the site. The number of locations that were surveyed depended on the number and quality of habitat features in proximity to proposed turbine locations. The BCT guidance suggests that where turbines are within 100m plus the rotor swept radius of medium or higher quality habitat features for bats, such as woodland, watercourses, or hedgerows then pairs of automated detectors should be deployed simultaneously for five nights at both locations (the turbine and adjacent habitat feature) in each recording period. This approach allows a direct comparison to be made between the level of bat activity at open turbine locations and adjacent habitat features.

Survey location groupings

6.3.55 Nine of the original 23 proposed turbine locations are within 100m (plus the rotor swept radius) of such features, with eight close to woodland or stands of mature trees (T6, T8, T11, T13, T14, T15, T19, T21), one close to a pond (T6) and two close to watercourses (T8 and T23). At these locations, pairs of detectors were deployed every other month (either April and June or May and July).

6.3.56 The other 14 original turbine locations (T1, T2, T3, T4, T5, T7, T9, T10, T12, T16, T17, T18, T20, and T22) are in open areas away from defined habitat features and at these locations detectors were deployed every other month as described above.

6.3.57 These groups of detector locations were split into three groups to enable comparison between the relative activity recorded at each, and particularly between those at habitat features (Group 1) and those at open turbine locations (Groups 2 and 3):

- Group 1 – nine detector locations at adjacent habitat features paired with turbines - (T6A[3], T8A, T11A, T13A, T14A, T15A, T19A, T21A, and T23A);
- Group 2 – nine detector locations at turbine locations within 100m (plus the rotor swept area of habitat features (T6, T8, T11, T13, T14, T15, T19, T21, and T23);
- Group 3 – 14 detectors at turbine locations in open areas (T1, T2, T3, T4, T5, T7, T9, T10, T12, T16, T17, T18, T20, and T22).

6.3.58 In summary, there were 32 locations where detectors were deployed every other month during April-June. In July, this number reduced to 24.

6.3.59 The detectors were left in situ for 5 nights at each survey point, and set to record from half an hour before sunset to half an hour after sunrise, the period during which bats are usually active away from their roost. The duration of recording per night varied throughout the survey period according to day/night length.

Roost Survey

6.3.60 The BCT guidance recommends that a daytime inspection of structures and trees suitable for roosting bats be carried out within 200 m of the developable area (turbine envelope) and that further surveys should be carried out if evidence of 'significant' roosts of medium and/or high-risk species is found within this survey area. The guidance also suggests that further survey should be carried out if the desk-study identifies roosts that could be affected by the development.

[3] A stands for 'adjacent habitat feature'

Initial Assessment

6.3.61 An initial assessment of potential roosting habitat within 200 m of the developable area was carried out by Matt Hobbs during the site appraisal survey on 15 April 2014. This included inspecting trees and buildings within 200 m of turbines. The survey was undertaken from ground level using binoculars (where necessary) and features suitable for roosting bats, such as split limbs, cracks, hanging bark and/or cavities were recorded onto standardised field survey sheets where present.

Detailed Inspection Survey

6.3.62 Following this initial assessment, two buildings in the centre of the site (a derelict cottage and a number of stone walls being used as a sheep pen) (National Grid Reference SO 09500 78494) were identified as having potential to support roosting bats and were inspected on 15 July 2014 by Matt Hobbs and Rachel Taylor.

6.3.63 The inspection of the structures involved a search of all external elevations (the structures consisted of derelict walls) for evidence of bats such as droppings, feeding remains, staining and scratch marks. The survey was undertaken from ground level using an endoscope and torch to inspect cracks / crevices and cavities in the walls of the derelict buildings. Most crevices could be inspected in this way with some out of reach in the higher parts of some walls. Close focussing binoculars and high-powered torches (1 million candlepower) were used to visually search higher elevations. Any roosting opportunities were recorded onto standardised field survey sheets.

6.3.64 Bats may use a number of roosting opportunities within walls, for example, cracks and crevices within stonework where they are difficult to see. The absence of evidence (such as droppings) does not necessarily mean that roosting bats are not present as bats may not be roosting in the accessible or visible parts of a wall, and they do not always leave visible signs (particularly if the roosts have been recently established, support small numbers of bats or are temporary in nature). The absence of roosting bats in a structure can be very difficult to prove for this reason. As a result an assessment of the buildings' potential to accommodate roosting bats was also made in the absence of any clear evidence of bats being present.

Materials and Data Analysis

6.3.65 Full details of the equipment used for surveys and the data analysis methods are provided in Appendix 6.1.

6.4 Baseline Conditions

Desk Study Results

Records from Biological Information Service for Powys

6.4.1 No statutory protected nature conservation sites designated wholly or partly for their bat interest are located within 10km of the site.

6.4.2 Two bat detector records of noctule were received from within 5 km of the site (the closest approximately 2.7 km from the site). Of the 66 records of high-risk species returned from within 5 km and 10 km of the site boundary, three records of Nathusius' pipistrelle Pipistrellus nathusii and 63 records of noctule were returned. Two bat detector records of the former species were recorded on the same evening in September 2013 from Newtown, approximately 9.5 km from the site, with another record from a similar location in July 2013. Of the noctule records, 60 records refer to bats seen in flight or heard with bat detectors. Most of these records are apparently from bat surveys carried out in 2013 on the southern side of Newtown, approximately 9-10 km from the site and there is only one record of noctule from within 5 km of the site, from the A483 to the north-east of Llaithddu in June 2003, approximately 3.8 km to the north west of the site. There are three old records from a roost near Dolau (approximately 8.8 km south of the site) in 1984/5 that may have held around 25 noctules (from an anecdotal report) at one time and from which a single lactating female bat was caught in July 1985.

6.4.3 A total of 30 records of medium or low-risk bat species and three records of unidentified bats were returned from the search area within 5 km of the site boundary, with none of these from within the site. Records for each species are summarised below:

- Common pipistrelle *Pipistrellus pipistrellus* – four bat detector records and three roost records were returned. The roost records included a record of an apparent colony of 20+ bats from Felindre (approximately 2.6 km east-north-east of the site) in 1991;
- Soprano pipistrelle Pipistrellus Pygmaeus – three bat detector records were returned;
- Unidentified pipistrelle *Pipistrellus sp.* – four roost records were received from three locations in Llanbadarn Ffynydd, Felindre and Llyn Dwr (approximately 5 km north-west of the site);
- Brown long-eared bat Plecotus auritus – nine roost records from five locations were returned. The closest records were received from two locations in Felindre in 1986;
- Natterer's bat *Myotis nattereri* – two roost records (droppings and single bat emerging) from Llanbadarn Ffynydd in 2009 and 2011;
- Unidentified bats – four roost records were returned which include a record of 137 bats (presumably pipistrelles) emerging from a residential property in Llanbadarn Ffynyd in July 1997.

Records from other wind farms within 10km

6.4.4 In addition to these records, bats were recorded from baseline surveys for a number of wind farm sites that are either consented, in planning or at Public Inquiry stage. The species recorded at each site are summarised below:

- Llandinam Repowering (ca. 9 km north-west of the site) – surveys carried out in 2007/2008. Bats recorded included noctule, common pipistrelle, soprano pipistrelle and Myotis bats;
- Llaithddu (ca. 9 km west of the site) – surveys carried out in 2006 and 2013. Bats recorded included noctule, common pipistrelle, soprano pipistrelle, brown long-eared bat and Myotis sp.;
- Llanbadarn-Fynydd (ca. 1 km to the west of the site) – surveys carried out in 2006 and 2012. Bats recorded included noctule, common pipistrelle, soprano pipistrelle, brown long-eared bat and Myotis sp.;
- Neuadd-Goch Bank (ca. 2 km to north-west of site) – surveys carried out in 2010. Bats recorded included noctule, common pipistrelle, soprano pipistrelle, brown long-eared bat and Myotis sp.;
- Bryngydfa (adjacent to the site) – surveys carried out in 2010. Bats recorded included noctule, common pipistrelle, soprano pipistrelle, brown long-eared bat and Myotis sp.; and
- Hirddywel (ca. 9km west of the site) - surveys carried out in 2008 - 2009. Bats recorded included noctule, common pipistrelle, soprano pipistrelle, and Myotis sp.

Results of 2006 Surveys

6.4.5 A summary of the results of the 2006 bat surveys is provided below as taken from the original ES (produced in 2008). Full results of the bat surveys are provided in Appendix 6.1 of the original ES.

6.4.6 Surveys were carried out on the nights of 8 June, 15 July, 24 August, 8 September and 7 November 2006. In addition, a small area added after the boundary was amended was surveyed on 27th June 2007.

6.4.7 Several bat species were detected using the site: common and soprano pipistrelles, noctule, Myotis sp. and brown long-eared bat.

6.4.8 The most frequently detected bats were common pipistrelles and noctule bats. Noctules were particularly noticeable in the northern half of the site; feeding along woodland edges and across open sheep and cattle grazed farmland. Pipistrelle bats were also found to favour woodland edges and hedgelines.

Results of the 2009 Surveys

6.4.9 A summary of the results of the 2009 bat surveys is provided below as taken from the 2010 SEI. Full details are provided in the 2010 SEI.

6.4.10 Surveys were carried out on the nights of 30 July, 29 August, and 1 October 2009.

6.4.11 Several bat species were detected using the site: common and soprano pipistrelle, noctule, and Myotis sp. bats.

6.4.12 The most frequently detected bats were common and soprano pipistrelles. Noctule bats were recorded regularly with the majority of the noctules detected during the surveys either commuting over the northern half of the wind farm site or feeding next to Trefoel Brook. They were also detected next to the woodland at Garreg Lwyd Hill and on the east side of Ty'n y Ddol Hill. Noctule activity during each survey is summarised below:

30 July

6.4.13 A noctule was seen flying over the north part of the site from the south east to the North West at 21:49 hours. It was estimated to be flying at a height of Garreg Lwyd Hill Wind Farm approximately 10 m above the ground and was feeding whilst commuting across the site, maintaining the same direction of flight the whole time it was seen. An Anabat recording detector (A1) located near this position picked up a noctule flying over at 21:37 and 21:48 hours.

6.4.14 One noctule was heard (but not seen) close to the west end of Trefoel Brook at 22:02 hours and one was seen feeding low (approximately 2-3 m height) over rough grassland close to Trefoel Brook at SO 13268007 at 22:11 hours. The Anabat (A5) located fairly close to this bat did not record any noctule activity. The Anabat microphone was pointing in an easterly direction and it is possible the bat had not flown near this detector.

29 August

6.4.15 Noctules were again detected flying over the north part of the site in a north westerly direction at a height of approximately 10 m and two were also seen feeding along the far west end of Trefoel Brook, flying low over the grassland at a height of approximately 2 m. A noctule was also detected on the edge of the woodland at Garreg Lwyd Hill but was not seen. No noctules were seen or heard during the dawn survey.

6.4.16 The Anabat located close to the north edge of the woodland (the approximate location of turbine T11) recorded 14 passes in total by noctules. There were 9 passes over the evening period and 5 over the dawn period.

1 October

6.4.17 Two noctules were recorded flying over the north part of the site, in a north west direction and one was heard feeding on the east edge of Ty'n y Ddol Hill during the transect survey.

6.4.18 Noctules were only recorded on four occasions by the Anabat detectors. Anabat A6 located on the north edge of the woodland at Garreg Lwyd Hill recorded a noctule flying past at 19:34 hours on 1 October and at 19:11 hours on 2 October. Anabat A8 located on Ty'n y Ddol Hill also recorded a noctule at 19:24 hours on 4 October. No noctules were recorded over the dawn period but one was recorded at 00:07 hours by A5 located close to Trefoel Brook.

Results of 2014 Surveys

Walked Transect Survey including Vantage Point Survey for Noctule Bats

6.4.19 Details of transect and VP surveys are included in Table 1 in Appendix 6.1, with maps showing walked transect routes for each SA as well as the number of passes and species recorded during each transect survey included in Figures 6.3-6.7.

6.4.20 In total 348 bat passes (B) of at least four species of bats were recorded during walked transect surveys in 2014. Table 6.3 summarises the relative activity level (Bat passes per hour (B/h); for the definition of B and B/h used in this analysis see 'Materials and Data Analysis' in Appendix 6.1) recorded during walked transects (not including VP survey) for all species. Full details of the number of passes and species recorded during each transect survey are included in Table 2 in Appendix 6.1.

Table 6.3: Number of passes recorded (B) and relative activity (B/h) for each species during all walked transects

Species	B	B/h
Common pipistrelle	123	3.8
Soprano pipistrelle	118	3.6
Myotis sp.	42	1.2
Common/soprano pipistrelle	32	0.9
Noctule	24	0.7
Common/ Nathusius' pipistrelle	7	0.2
Nyctalus sp. / serotine	2	<0.1
Total	**348**	**10.5**

Summary of Activity

6.4.21 During VP surveys in April-June just two passes of noctule were recorded, from the VP location in SA2 on May 28. After the VP locations were changed in July, one noctule was recorded flying across the pond to the west of Garreg Lwyd Hill on July 15.

6.4.22 Across the survey season, common pipistrelle was the most frequently encountered species on walked transects with 3.8 B/h and 35 % of all passes recorded as this species (B = 123). Soprano pipistrelle was the second most numerous with 3.7 B/h. When passes from unidentified pipistrelles are added to the total, 80 % of all the recorded passes were identified as bats from the Pipistrellus genus[4,5]. Activity levels of 1.3 B/h and 0.7 B/h were recorded for Myotis sp. and noctule respectively with two passes that were unidentified but categorised as either Nyctalus sp. (either noctule or Leisler's bat Nyctalus leislerii) or serotine Eptesicus serotinus.

6.4.23 Bat activity levels varied between transects, with a mean of 10.8 B/h (range; 1.8-52.6 B/h). Fluctuations between surveys are within normal limits, being influenced by factors such as short-term variations in weather conditions and prey availability and seasonal variations. During April, an average of 5.4 B/h was recorded, which then rose to a peak in May of 27.1 B/h and declined in June (6.6 B/h) and July (4.3 B/h). A dramatic peak in activity occurred during the May transect in SA1 when an activity rate of 52.6 B/h (B = 163) was recorded. The next two highest activity rates were also recorded in May, of 10.5 B/h during surveys in both SA1 and SA3.

[4] See Appendix 6.1 for identification parameters used for the *Pipistrellus* genus.
[5] It is likely that all records labelled as either common or Nathusius' pipistrelle refer to common pipistrelle due to the relative rarity of Nathusius' pipistrelle and this species was not confirmed as present during any bat surveys on the site.

High Risk Species

6.4.24 Noctule was the only high risk species recorded during walked transects, with 25 passes recorded during eight of the 11 transect surveys (see Table 2 in Appendix 6.1) and a further three passes recorded from VP surveys in SA2. Noctules were recorded in all of the SAs and in all months. There was not a clear pattern to the records and generally the activity levels recorded were low with clusters of passes where a single bat was probably recorded more than once (although this was not usually confirmed visually). Most bats were heard but not seen during surveys and it was not possible to gain a clear indication of their flight-lines across the site from either VP or transect surveys.

6.4.25 Of this total, ten passes were recorded in SA1 during three surveys as follows:

- April 15 - six passes (presumably from the same bat – that was not seen) from the south-west corner of SA1 during 21:01-21:02;
- May 15 – two passes (presumably from the same bat – that was not seen) from 200 m east of T2 at 22:26 and one pass from ca. 130 m east of T6 at 22:45; and
- 3 June – one pass (not seen) from ca. 60 m south of 23:36.

6.4.26 Four passes were recorded in SA2 during three surveys as follows:

- April 24 – single passes were recorded from the stream corridor ca. 70 m to the north-east of T11 at 21:33 with another from the strip of plantation woodland ca. 300 m south of T15 at 22:27;
- May 28 – Two passes (presumably one bat) were recorded twice in one minute (21:27 – eight minutes after sunset) but the bat was not seen due to foggy conditions during the VP survey. The VP survey was aborted after 25 minutes due to the poor visibility. Two passes were also recorded between 21:54 and 21:55 from a bat that apparently flew between the plantation woodland at Garreg Lwyd Hill and the pond to the south-west of the woodland;
- July 15 – a single noctule flew north at around 30 m above ground level over the pond during the VP survey at 21:53, 24 minutes after sunset.

6.4.27 Seven passes were recorded in SA3 during two surveys as follows:

- April 29 – a single pass was recorded from ca. 260 m east of T20 at 21:27; and
- June 18 – six passes were recorded from a single bat seen flying along the stream corridor ca. 200 m north-west of T21 during 22:51-22:54.

Medium Risk Species

6.4.28 All pipistrelle species are classified as medium-risk to collision/barotrauma and low risk to population level effects. During walked transects both species were recorded in all the survey areas; with generally low-moderate levels of activity recorded for both of these species. Common pipistrelle was recorded during 10 (of 11) transect surveys and soprano pipistrelle during eight. Activity of both species peaked in May with 8.6 B/h recorded for common pipistrelle and 10.3 B/h for soprano pipistrelle. There was a marked decline in activity for both species in June (1.9 and 2.9 B/h respectively) and July (1.2 and 1.8 B/h respectively), despite settled warm weather throughout much of June and July. However, this trend is slightly skewed by the single transect in May with very high pipistrelle activity. Most pipistrelles were recorded in sheltered areas (likely to provide concentrations of insects), e.g. along stream corridors, along hedgerows, on the edge of woodland and copses, by the farm buildings in the centre of the site and next to water bodies.

Low risk species

6.4.29 Myotis bats are classified as low-risk. During walked transects, a fairly low level of activity was recorded (1.3 B/h: B = 42) with most passes recorded from SA1 (B = 37) in all months with a peak of 21 passes in May and 11 in June. Low numbers of passes were recorded from all other surveys. Myotis bats were largely recorded in similar areas to pipistrelle bats (See Figures 6.3-6.5).

Automated Bat Detector Survey

6.4.30 Automated bat detectors were operating for a total of 293 nights, equating to 1939 hours of survey time during April-July 2014. Table 3 in Appendix 6.1 gives details of fixed point bat detector deployment dates and locations with the latter, as well as the extent of the SAs, proposed turbine locations and automated detector locations illustrated in Figure 6.1 for April-June and Figure 6.2 for July. Table 6.4 gives details of the number of passes and relative activity recorded during automated detector surveys.

6.4.31 A total of 18110 passes from at least six species of bats were recorded. Figure 6.8 illustrates the proportion of activity recorded for different species at each automated survey location, with relative activity at each automated survey location of noctule, common pipistrelle, soprano pipistrelle and Myotis sp. illustrated for the whole survey period as well as spring (April-May) and summer (June-July) in Figures 6.9-6.18. Data for bats not identified to species-level (e.g. common/soprano pipistrelle) or for which there were insufficient data (e.g. Plecotus sp. and lesser horseshoe bat Rhinolophus hipposideros) have not been illustrated.

Table 6.4: Total number of passes recorded (B) and relative activity (B/h) for all bat species during automated surveys

Species	B	B/h
Common pipistrelle	7855	4.1
Soprano pipistrelle	6485	3.4
Noctule	2230	1.2
Myotis sp.	706	0.4
Common/soprano pipistrelle	729	0.4
Nyctalus sp. / serotine	56	<0.1
Common/ Nathusius' pipistrelle	36	<0.1
Myotis sp. / long-eared bat sp.	9	<0.1
Nyctalus sp.	2	<0.1
Long-eared bat sp.	1	<0.1
Lesser horseshoe bat	1	<0.1
Total	**18110**	**9.4**

Summary of Activity

6.4.32 Across the survey season, the highest activity rate was recorded from common pipistrelle, at an average of 4.1 B/h (B = 7855) followed by soprano pipistrelle (3.4 B/h) with 83.4% of all the recorded passes identified as bats from the Pipistrellus genus. The third most frequently recorded species was noctule with 1.2 B/h (B = 2215) with 0.4 B/h recorded for Myotis sp. Only one pass was recorded for long-eared bat Plecotus sp.[6] and also for lesser horseshoe bat.

[6] All *Plecotus* sp. records are assumed to be brown long-eared bat *Plecotus auritus* (see Appendix 6.1 for full details).

6.4.33 The data presented in Table 6.5 indicate that overall bat activity dropped from Spring (April and May; 11.5 B/h) to Summer (June and July; 5.9 B/h) April (4.3 B/h) but that the pattern of activity was not the same for all species of bats. These differences are described under the individual species' accounts below.

Table 6.5: Total number of passes recorded (B) and relative activity (B/h) for all bat species by survey month

	Spring (April/May)		Summer (June/July)	
Species	**Total**	**B/h**	**Total**	**B/h**
Common pipistrelle	6079	5.1	1776	2.4
Soprano pipistrelle	5717	4.8	768	1.0
Noctule	918	0.8	1312	1.8
Common / Soprano pipistrelle	544	0.5	185	0
Myotis sp.	475	0.4	231	0.3
Nyctalus sp. / serotine	41	<0.1	15	<0.1
Common / Nathusius' pipistrelle	3	<0.1	33	<0.1
Myotis sp. / long-eared bat sp.	0	0	9	<0.1
Noctule / Leisler's bat	2	<0.1	0	0
Lesser horseshoe bat	1	<0.1	0	0
Long eared bat sp.	1	<0.1	0	0
Grand Total	**13781**	**11.5**	**4329**	**5.9**

6.4.34 Bat activity was generally higher at habitat features within 150m of turbines (Group 1; 25.6 B/h) than at turbines within 150 m of those features (Group 2; 2.9 B/h) and higher than at turbine locations in open habitats (Group 3; 1.3 B/h) – see Table 6.6 below.

Table 6.6: Total number of passes recorded (B) and relative activity (B/h) for all bat species by detector location Group

	Group 1		Group 2		Group 3	
Species	**B**	**B/h**	**B**	**B/h**	**B**	**B/h**
Common pipistrelle	7068	11.7	527	0.9	198	0.3
Soprano pipistrelle	6152	10.2	196	0.3	111	0.2
Noctule	1072	1.8	742	1.3	364	0.5
Common / Soprano Pipistrelle	649	1.1	44	0.1	27	0
Myotis sp.	391	0.6	90	0.2	216	0.3
Nyctalus sp. / serotine	0	0	19	<0.1	8	<0.1
Common / Nathusius' Pipistrelle	34	0.1	2	<0.1	0	0
Myotis sp. / long-eared bat sp.	7	<0.1	2	<0.1	0	0
Noctule / Leisler's bat	2	<0.1	0	0	0	0
Lesser horseshoe bat	1	<0.1	0	0	0	0
Long eared bat sp.	1	<0.1	0	0	0	0
Total	**15377**	**25.6**	**1627**	**2.9**	**927**	**1.3**

High risk species

6.4.35 In general activity levels for noctule were low-moderate[7] across the site. The species was recorded in all months, in all survey areas and at all but three of the survey locations (T9A, T15, and T20).

6.4.36 In contrast to the activity patterns for pipistrelle bats, which declined after May, noctule activity steadily increased during April – July to a peak of 2.5 B/h in July, a month during which noctule was the most frequently recorded bat species.

6.4.37 Recorded noctule activity was higher at habitat features adjacent to turbines (Group 1; 1.8 B/h) than at adjacent turbine locations (Group 2; 1.3 B/h) and at turbine locations away from habitat features (Group 3; 0.5 B/h) but this difference was much less marked than for pipistrelle bats with noctules recorded at all but two of the turbine locations and at fairly consistent levels of activity across the site.

6.4.38 The highest levels of activity (>1 B/h) were mainly recorded in the central part of the site at T6A, T7, T8, T8A, T9, T11 and T11A in the area of the pond, the plantation woodland at Garreg Lwyd Hill, the Gil-Owen Brook and the pasture around T7 and T8. In addition, relatively high levels of activity were also recorded at T13A further east along the Gil-Owen Brook and also in the north-east of the site at T19. Activity levels at each of these locations are described below:

- T6A – an average of 2.3 B/h was recorded on the fence line near to the pond, in April (B = 95) and June (B = 117). Activity levels at T6 were not as high with 0.7 B/h recorded;
- T7 – an average of 2.7 B/h was recorded in an open area of grazed marshy grassland in May (B = 88). The detector was not re-deployed in July as this turbine location has been removed from the scheme;
- T8 – an average of 1.4 B/h was recorded at this open area of pasture close to a small stream, plantation woodland and marshy grassland, in May (B = 59) and July (B = 27);
- T8A – an average of 4.8 B/h was recorded on the edge of the plantation woodland on Garreg Lwyd Hill, in May (B = 163) and July (B = 138);
- T11 – an average of 3.3 B/h was recorded in an area of sloping pasture between the Trefoel Brook and plantation woodland on Garreg Lwyd Hill, in April (B = 187) and June (B = 43);
- T11A – an average of 2.6 B/h was recorded on the edge of the Gil-Owen Brook and close to a copse of mature broad-leaved woodland, in April (B = 128) and June (B = 50);
- T13A – an average of 4.5 B/h was recorded above the steep-sided edge of the Tyfoel Brook, in May (B = 1) and July (B = 281). An unusually sustained period of activity both early and late in the night was recorded at this location in July after very little activity was recorded at the same location in May; and
- T19 – an average of 3.4 B/h was recorded at this location close to a strip of pine trees, in April (B = 10) and June (B = 214).

6.4.39 It should be noted that T7 and T19, where two of the highest levels of activity were recorded, have been removed from the scheme.

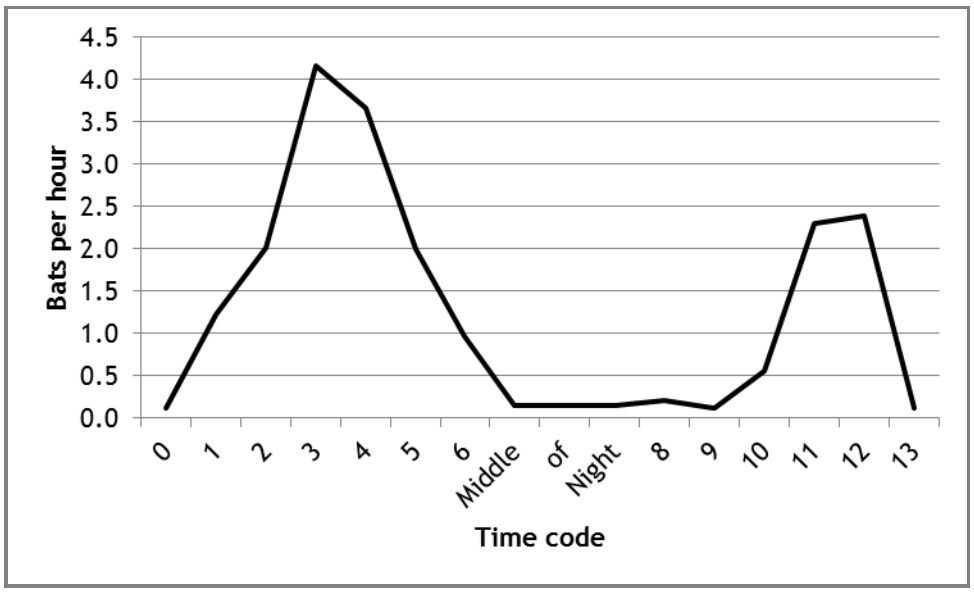
[7] Based on results from similar surveys carried out by BSG at many locations in Wales and the UK

6.4.40 Activity across the site during April-July peaked 40-60 minutes after sunset (Time Code[8] (TC) 3; 4.2 B/h) and 60-80 minutes after sunset (TC 4; 3.7 B/h) with activity then declining markedly during the middle period of the night between two hours after sunset and two hours before sunrise (TC 7; 0.1 B/h). A secondary peak in activity then occurred 60-40 minutes before sunrise (TC 11; 2.3 B/h) and 40-20 minutes before sunrise (TC 12; 2.4 B/h). This pattern is illustrated in Graph 6.1 (below).

6.4.41 A number of early noctule passes were recorded from several locations. Twelve passes were recorded at or before sunset with the earliest of these at 14 minutes before sunset with four calls recorded from T19A on 26 April between 20:15 and 20:16. The other eight passes were within two minutes of sunset and recorded at T19 and T19A (4 calls over two minutes - presumably the same bat) on 15 June and at T8A (4 calls in one minute – presumably the same bat) on 11 July. Calls from within 20 minutes of sunset have been recorded at T1, T2, T7, T8A, T10, T11A, T13A, T18A, T19, and T19A. Calls within 10 minutes of sunset were recorded for three consecutive nights in June at T19 and T19A and it is likely that this location was close to a roost at this time and potentially also in April when passes before sunset were recorded.

6.4.42 Late noctule passes have also been recorded regularly with 12 passes recorded between 11 and 19 minutes before sunrise. These passes were recorded from four locations: five passes from T8A on 16 and 17 May; one pass from T10 on 7 June; three passes from T19 on 13 and 15 June; and three passes from T23/T23A on 13 June. Activity between 40 and 20 minutes of sunrise has been recorded from 20 locations of the 33 that were surveyed and from most areas of the site.

Graph 6.1: Relative activity (B/h) patterns for noctule during automated surveys in relation to sunset and sunrise



Medium risk species

6.4.43 Overall activity for these two species was judged to be low-moderate[9]. Common and soprano pipistrelles were recorded at most automated survey locations and the pipistrelle species were the most frequently recorded bats overall. Common pipistrelle was recorded at all locations except T9A and T13 and soprano pipistrelle was not recorded at T3, T9A, T17 and T20. In general, pipistrelle activity around the site was localised with peaks of activity in small numbers of locations around the site with most areas recording low or very low levels of activity.

[8] The Time Code categories place bat calls in categories in relation to their proximity to sunset or sunrise. For a full explanation see Appendix 6.1: Materials and Data Analysis
[9] Based on results from similar surveys carried out by BSG Ecology at many locations in Wales and the wider UK

6.4.44 For common pipistrelle activity levels >3.0 B/h were recorded at six locations as follows:

- T6A – an average of 4.7 B/h was recorded in April (B = 3) and June (B = 321). Activity levels were much lower at T6 with 0.2 B/h recorded;
- T8A – an average of 56.3 B/h was recorded in May (B = 3313) and July (B = 218). Activity at this location was very high in May but was very low at the adjacent turbine location (0.8 B/h);
- T11A – an average of 19.4 B/h was recorded in April (B = 1109) and June (B = 238). Activity at the adjacent T11 was much lower (1.2 B/h);
- T15A – an average of 7.8 B/h (B = 269) was recorded in May along a strip of plantation woodland with no common pipistrelles recorded in July. Just five passes were recorded from the adjacent T15 in May;
- T21A – an average of 31.7 B/h (B = 1037) was recorded with no common pipistrelles recorded in July. Forty two passes were recorded from the adjacent T21 in May; and
- T23A – an average of 3 B/h was recorded in April (B = 1) and June (B = 199). A similar level of activity (2.3 B/h) was recorded from the adjacent T23.

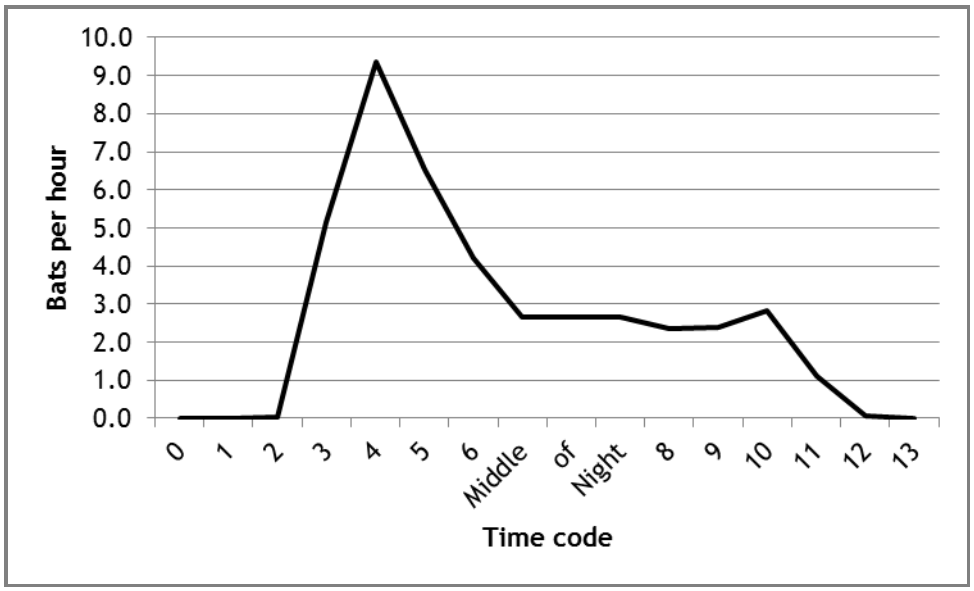
6.4.45 For soprano pipistrelle activity levels >3.0 B/h was recorded at four locations as follows:

- T8A - an average of 74.8 B/h was recorded in May (B = 4556) and July (B = 134). Activity at this location was very high in May but was very low at the adjacent turbine location (0.9 B/h);
- T11A – an average of 14 B/h was recorded in in April (B = 747) and June (B = 229). Activity at the adjacent T11 was much lower (1 B/h);
- T15A – an average of 3.1 B/h (B = 108) was recorded in May with no soprano pipistrelles recorded in July. Just seven passes were recorded from the adjacent T15 in May; and
- T21A – an average of 3.5 B/h (B = 115) in May was recorded with no soprano pipistrelles recorded in July. Just 13 passes were recorded from the adjacent T21 in May.

6.4.46 Common pipistrelle activity at habitat features (Group 1; 11.7 B/h) was much higher than at adjacent turbine locations (Group 2; 0.9 B/h) and at turbine locations away from habitat features (Group 3; 0.3 B/h). The pattern was similar for soprano pipistrelle: Group 1 (10.2 B/h); Group 2 (0.3 B/h); and Group 3 (0.2 B/h) (see Table 6.5).

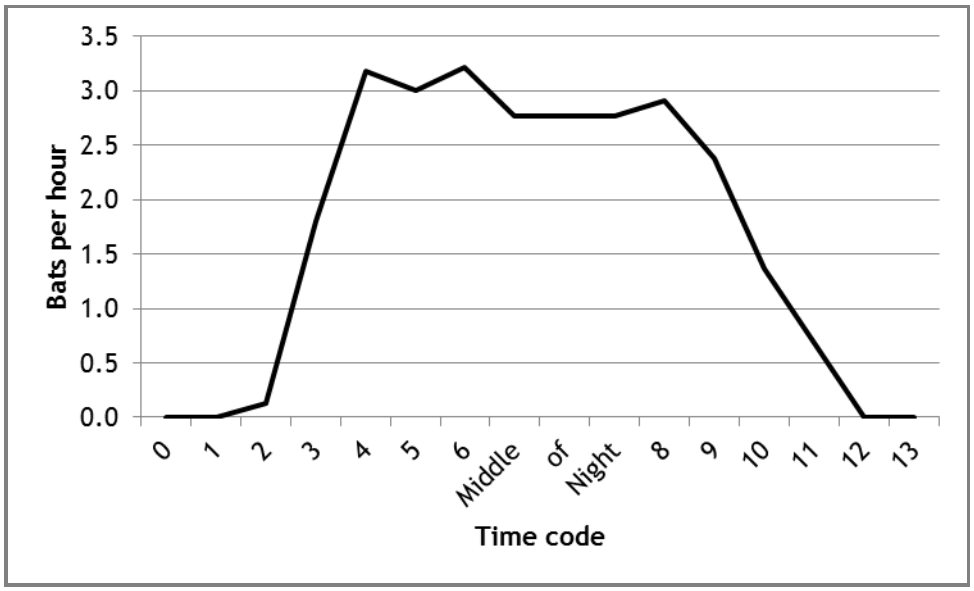
6.4.47 For common pipistrelle no particularly early or late passes were recorded with the earliest and latest passes recorded at 31 minutes after sunset and 36 minutes before sunrise respectively. The peak in activity was in the first two hours of the night and particularly between 60 and 80 minutes after sunset (TC4; 9.4 B/h) after which time activity remained fairly consistent during the middle period of the night (TC7; 2.7 B/h) until an hour before sunrise, after which activity levels dropped rapidly (see Graph 6.2).

Graph 6.2: Relative activity (B/h) patterns for common pipistrelle during automated surveys in relation to sunset and sunrise



6.4.48 For soprano pipistrelle, the pattern of activity was very similar to common pipistrelle with no particularly early or late passes recorded. The earliest and latest passes were recorded at 27 minutes after sunset and 44 minutes before sunrise respectively. Again, the peak in activity was in the first two hours of the night and particularly between 60 and 80 minutes after sunset (TC4; 3.2 B/h) after which time activity remained fairly consistent during the middle period of the night (TC7; 2.8 B/h) until an hour before sunrise, after which activity levels dropped rapidly (see Graph 6.3).

Graph 6.3: Relative activity (B/h) patterns for soprano pipistrelle during automated surveys in relation to sunset and sunrise



Low risk species

6.4.49 Low levels of Myotis sp. bat activity were recorded across the site (0.4 B/h) with activity at open turbine locations (Groups 2 and 3) generally low (0.2 B/h) in comparison with adjacent habitat features (Group 1; 0.7 B/h). The highest activity levels at Group 1 locations were recorded at T8A (2.3 B/h) and T23A (1.6 B/h) and the highest activity levels at turbine locations were recorded at T4 (0.6 B/h), T7 (0.4 B/h) and T23 (0.7 B/h). As for pipistrelle bats activity decreased from Spring (0.4 B/h) to Summer (0.3 B/h). Nocturnal peaks in activity for Myotis bats occurred 100-120 minutes after sunset (TC6; 0.5 B/h) with no activity recorded within an hour of sunset or sunrise.

6.4.50 Single passes were recorded of long-eared bat sp. and lesser horseshoe bat. The former was recorded at T11A on 17 April at 00:13 and the latter was recorded at T8A on 19 May at 00:34. Neither species is considered further in the assessment given that they are both considered to be of low risk to wind farm related impacts and that neither species was regularly recorded at the site in 2014 or has been recorded previously during surveys in 2006 and 2009.

Roost Survey

Initial assessment of trees/buildings

6.4.51 During the initial assessment, a single dead pine tree was found close to the Trefoel Brook with potential to support roosting bats. The tree was a single dead pine pole ca. 15 m in height with several woodpecker holes along the stem at various heights. Although it is possible that the stem of the tree may have been hollow in some areas it appeared that the holes were superficial and not leading to hollow cavities. The tree is shown in Image 1 in Appendix 6.1. The tree was assessed as being a likely Category 2 tree based on criteria given in the BCT guidance (Table 8.4 in Chapter 8: Roost Surveys).

6.4.52 Further survey was not recommended for this tree as the tree would not be affected by the proposed wind farm (it would not be felled) and there was no evidence of likely use by a significant bat roost of a medium or high risk species (as defined in the BCT guidance) given that it is considered to be of low potential to support roosting bats.

6.4.53 One building has potential to support roosting bats. Further survey was carried out on this building and the results of the survey are described below.

Inspection of Farm Buildings

6.4.54 There are two buildings either side of an access track just north of the Gil-Owen Brook in the centre of the site that were identified as having some potential for roosting bats during the initial assessment. To the north of the track there are a number of slate walls that enclose a sheep pen and to the south of the track there is a derelict slate cottage. Images of the buildings are included in Appendix 6.1.

6.4.55 Both structures are slate and are pointed with limestone mortar. The sheep pen is square with walls on each side. The walls are largely intact and of solid construction with no central cavities and are capped with concrete, but there are numerous cracks and crevices in the walls caused by missing slates and mortar that has fallen out. In general the cracks may be suitable for single or low numbers of bats to roost in, as they are not extensive. The majority of these cracks were inspected with an endoscope but no bats or evidence of bats was found in the cottage.

6.4.56 The derelict cottage offered similar opportunities to roosting bats as the sheep pen walls with numerous small cracks and crevices providing potential roost sites for small numbers of bats. Many of the crevices at head height or lower were inspected with an endoscope but it was not possible to inspect many crevices above this height due to difficult footing conditions preventing use of a ladder in most sections. The cottage also includes a chimney but it was not possible to inspect the inside of the chimney to see if any suitable features are present. No bats or evidence of bats was found in the walls of the cottage.

6.4.57 Overall, both structures are thought to be of low-moderate potential for roosting bats. They do not have significant cavities in the stonework that could support larger roosts of bats but may provide roosting habitat for single (or very low numbers of) bats. It is possible that bats may use the walls for hibernation but the cracks and crevices present do not appear to be deep enough to shelter bats throughout the winter.

6.4.58 A single dusk emergence survey of these buildings will be carried out in August 2014 to identify if there are bats roosting there. Given that the buildings will not be directly affected by the proposed wind farm the survey is necessary to identify if there is a significant roost of a medium or high-risk species that may be affected by the operation of the turbines.

Future Baseline Conditions

6.4.59 The site is unlikely to be attractive to commercial development and the only continuity that is likely is land management. Assuming that the construction of the scheme did not take place and the farming regime remains unchanged, the baseline is unlikely to change significantly in the foreseeable future. If the farming regime changed, then an increase in the extent of arable land, for example, and an associated loss of pasture land might have an adverse effect on noctule bats due to their apparent preferences for pasture habitat (Mackie & Racey, 2007).

6.5 Nature Conservation Value of the Identified Resources

Species Evaluations

6.5.1 It is difficult to to compare bat activity between 2006, 2009 and 2014, when the surveys were carried out. The reasons for this are because the surveys follow different methods, use different equipment (for automated surveys) and employ different levels of survey effort (again particularly for automated surveys). The key reason for this is changes in published guidance, with the BCT 2012 guidance requiring a higher level of survey. Some examples of key differences are included below:

- The site boundary and overall size changed and surveys were not always carried out in the same locations, e.g. transect routes and automated detector locations changed.
- In 2006 and 2009, the automated detectors were left out for short periods of time (often not a complete night period) and in 2014 detectors were always deployed for five complete nights;
- In 2006 and 2009 the automated survey locations were selected away from potential turbine locations to sample bat activity in areas where bat activity is likely to be high. In 2014, the locations for the bat detectors were chosen to quantify bat activity at turbine locations and near to them (following the methods described in the BCT guidance);
- In 2006 there were seven deployments (each for the duration of the transect survey) over three transect surveys. In 2009, between three and four Anabats were deployed for one night on two occasions and four nights on the last survey. In 2014, SM2BAT detectors were deployed for a total of 293 nights at 33 different locations.

6.5.2 Notwithstanding these differences, it is possible to say whether the species assemblage has remained the same and if particular species of bats, with the focus on noctule, as a high risk species, are occupying similar areas of the site. With regard to the first point, the species assemblage recorded using the site does not appear to have changed, with the exception of an additional species, lesser horseshoe bat (a single pass recorded) being recorded in 2014.

Noctule

6.5.3 Noctule bats are listed in Appendix II of the Bonn Convention; Appendix II of the Bern Convention; Annexes II and IV of the EC Habitats & Species Directive; Schedule 5 of the Wildlife and Countryside Act 1981; and as a priority or Section 42[10] species.

6.5.4 Noctule was recorded in all years that surveys were carried out within the site. In 2006, the species was recorded a number of times during transect and automated surveys, and particularly in the northern and central parts of the site. In 2009, noctule bats were recorded regularly with the majority of the noctules detected either commuting over the northern half of the wind farm site or feeding next to Trefoel Brook. They were also detected next to the woodland at Garreg Lwyd Hill and on the east side of Ty'n y Ddol Hill.

6.5.5 In 2014, increased survey effort and coverage demonstrated that noctule activity over the site was low to moderate (1.2 B/h) during automated surveys, and increased from Spring (0.8 B/h) to Summer (1.8 B/h). Due to the large detectable range (see Appendix 6.1) of the echolocation call of this species, it is considered that calls recorded simultaneously from turbines and adjacent locations are most likely to be from the same individual bat and that bats that commute over the site may be recorded from multiple locations. Both factors tend to inflate activity levels for this species in comparison to other species.

6.5.6 Although noctule is widespread across the site and has been recorded at fairly consistent levels from most areas, there is an apparent peak of activity in the central part of the site. This activity is apparently focussed on the area of the pond, the plantation woodland at Garreg Lwyd Hill, pasture areas adjacent to this and along the Gil-Owen Brook (particularly at T6A, T7, T8, and T11A). Although this part of the site does seem to be of relative importance to noctule bats, it is notable that in July relatively high levels of activity were recorded at two new locations, T13A (along the Tyfoel Brook) and also in the north-east corner of the site at T19, where relatively low levels of activity were recorded in May. It seems likely that noctule bats, being highly mobile and adapted to flying over open habitats, will exploit certain localised habitats within the site sporadically (and unpredictably) in response to seasonal prey distribution and potentially other factors rather than being static in their distribution across the site.

6.5.7 The timing of peaks of activity both early and late in the night indicates two possible scenarios:

- That the site is of importance for foraging for at least some of the noctule population that uses it, i.e. that they commute directly to the site to feed early in the evening and that they visit the site before dawn to feed before going to roost; and / or
- That a small proportion of the bats that use the site may (perhaps not regularly) roost relatively close to the site, based on sporadic early records of bats within 20 minutes of sunset. It is likely, as is suggested in the 2010 SEI, that noctule bats could be roosting in extensive areas of deciduous woodland to the east of the site, although it is also possible that roosts could be found in single isolated trees or in small copses or lines of trees, where there are suitable features to the north, east or south of the site (where there are less extensive areas of woodland habitat available).

6.5.8 The habitat present on site is suitable, although probably not optimal, for noctule, with Mackie & Racey, (2007) finding that noctule bats at Horner Woods (Devon) were found (in order of preference) to forage above woodland, then pasture, followed by other habitats, arable and finally moorland. Noctules are also known to preferentially feed over open water early in the evening. Noctules, like many bats, are opportunistic predators and will exploit a wide range of prey resources, although larger prey, such as beetle, is preferred (Jones, 2009).

[10] Species or habitats referred to within The Natural Environment and Rural Communities Act 2006 (NERC 2006) as of principal importance for the conservation of biodiversity in Wales which are listed on the Natural Resources Wales website. The government must take steps to "further the conservation" of these species/habitats under Section 42 of the NERC ACT 2006

6.5.9 Although radio-tracking studies of noctule are limited to one published study, this found that the mean maximum distance travelled from roosts was 6.3km (Mackie & Racey, 2007), which suggests that noctules recorded on the Garreg Lwyd site may fly considerable distances to their roosts if necessary. Noctules are also known to be fast and direct fliers and can cover large distances relatively quickly. As such early arrival on a site may not necessarily suggest that bats are roosting particularly close to a site.

6.5.10 The recorded activity suggests that although noctules use the site regularly they probably do so in small numbers as activity levels are not uniformly high across the site. The difference in activity between open turbine locations and habitat features is not as pronounced as with other species in this study (e.g. pipistrelles) and this is likely to reflect the typical behaviour of noctule in commuting and foraging at height rather than staying close to habitat features that most other species of bats associate with.

6.5.11 One of the conclusions of the 2010 SEI is that a few noctule bats (5-10) regularly cross over the site and at least two have been seen feeding on the site. This conclusion is based on very limited data and it is probably impossible to estimate absolute numbers of bats using the site at any one time with any level of accuracy. However, it is likely that the population using the site is not large based on the frequency of encounter during walked transect surveys combined with the far-carrying echolocation calls of noctule making this species readily detectable at distances of up to around 50 m (See Table 1: Appendix 6.1).

6.5.12 Noctule is a species of bat for which it is difficult to generate accurate population estimates due to its habit of roosting almost entirely in tree roosts, which are difficult to locate. It has been described as generally uncommon, although more numerous in wooded areas, with a Welsh population of around 4,750 which seems to be stable (Battersby, 2005). There is very little colony size data for noctule in the UK due to the difficulty in finding tree (rather than building) roosts of bats which may lead to low confidence in population estimates[11]. In recent years, there is evidence of an increasing population trend for noctule in the UK (although this is not thought to be significant due to the methods used) from National Bat Monitoring Programme (NBMP) data (BCT, 2012), with a 23 % population increase inferred from field (rather than roost) records during 1998-2011. Noctule is highly migratory in Europe with some migrations recorded of over 1,000km (Hutterer et al., 2005). However, it is currently not known to move out of the UK in winter and hibernating bats have been found in even very severe winters (Mackie & Racey, 2008).

6.5.13 Given that low-moderate noctule activity levels have been recorded on the site, of a bat that is generally easy to detect at distance, that noctule is widespread in Wales and was recorded at all proposed and consented wind farms for which bat survey was available within 10km, the site area is considered to be of Local importance for this species.

Common Pipistrelle

6.5.14 Common pipistrelle bats are listed in Appendix II of the Bonn Convention; Appendix II of the Bern Convention; Annexe IV of the EC Habitats & Species Directive; Schedule 5 of the Wildlife and Countryside Act 1981; and as a Priority Species under the Powys LBAP[12].

6.5.15 Nathusius' pipistrelle is not considered likely to be present and is not ascribed a value (see Section 6.4.22).

6.5.16 This is the most frequently recorded bat within the site with bats recorded in most areas of the site. High levels of activity were recorded from a small number of locations, all in the Spring (April and May) and activity declined markedly in Summer (June and July) from all automated detector locations, with low to moderate levels of activity recorded from locations on habitat features, such as coniferous plantation edge, stream valleys and low levels of activity over turbine locations.

[11] The author suggests that the majority of population estimates contained therein should be viewed with caution and are presented to provide comparative information on general population size for each species.
[12] Those for which Species Action Plans (SAP) are prepared under the Local Biodiversity Action Plans for Powys.

6.5.17 Common pipistrelle is the most abundant species of bat across the UK with a UK population of around 2,430,000 (Battersby, 2005; breakdowns by country are not available). The species is thought to have undergone declines of around 55 % since the 1960s although there is evidence of populations becoming stable or possibly increasing within the last ten years (Battersby, 2005). BCT field data indicates that populations may have increased by 65 % during 1998-2011 (BCT, 2012). There are no population figures for the combined Powys SAP for pipistrelle bats but mid-Wales are thought to have "particularly strong populations of pipistrelle bats"[13].

6.5.18 Given the abundance of the species in the UK, and the fairly typical activity levels recorded for this species within the site the population of this species within the site is considered to be of value at the level of the site.

Soprano Pipistrelle

6.5.19 Soprano pipistrelle bats are listed in Appendix II of the Bonn Convention; Appendix II of the Bern Convention; Annexe IV of the EC Habitats & Species Directive; Schedule 5 of the Wildlife and Countryside Act 1981; and as a Priority or Section 42 species.

6.5.20 This is the second most frequently recorded bat within the site with bats recorded in most areas of the site. High levels of activity were recorded from a small number of locations, all in the Spring (April and May) and activity declined markedly in Summer (June and July) from automated detector locations.

6.5.21 Soprano pipistrelle is the second most common species of bat in the UK with a UK population of around 1,300,000. Historic population trends do not exist for this species as it was not described until 1997 although recent work suggests the population is stable or increasing (Battersby, 2005) with an upward trend of 34 % during 1998-2011 from BCT data (BCT, 2012).

6.5.22 The site area is likely to be of importance at the level of the site for this species, due to the local abundance of this species within the general population context and the fairly typical activity levels recorded for this species within the site.

Myotis Bats

6.5.23 All Myotis species are listed in Appendix II of the Bonn Convention; Appendix II of the Bern Convention; Annexe IV of the EC Habitats & Species Directive; and Schedule 5 of the Wildlife and Countryside Act 1981. In addition Bechstein's bat Myotis bechsteinii is listed as a Priority Species under the UK Biodiversity Action Plan; Annexe II of the EC Habitats & Species Directive; and as 'Near threatened' under the IUCN Red List of Threatened Animals.

6.5.24 Low levels of Myotis bat activity were recorded within the site with localised areas of higher activity along habitat features.

6.5.25 It is difficult to generalise about the population status of Myotis bats. Table 6.7 (below) lists the UK population status and Welsh population size (from Battersby, 2005) for each Myotis species that could be found within the area of the site.

Table 6.7: Population status of Myotis bat species which may be found at the site

Common Name	Scientific Name	UK population status	Welsh population
Whiskered bat	*Myotis mystacinus*	Local	8,000
Brandt's bat	*Myotis brandtii*	Common in north and west, rare or absent elsewhere	22,500
Natterer's bat	*Myotis nattereri*	Fairly common throughout much of the UK	70,000
Daubenton's Bat	*Myotis daubentonii*	Common throughout much of the UK	95,000
Bechstein's bat	*Myotis bechsteinii*	Very rare	1,500

[13] http://www.powys.gov.uk/uploads/media/pipstrelle_bat_bi.pdf

6.5.26 It is likely that the most frequently recorded species was Natterer's bat, given that most calls fitted the parameters associated with this species and no other species were recorded from the desk study. It is considered unlikely that Bechstein's bat is present due to its rarity. It is assumed that no rare species occur on site and that the site is likely to be of importance at the level of the site for Myotis species of bats.

Sensitivity of the Valued Resources

6.5.27 BCT (Hundt, 2012) and NE (2012) guidance both identify species that are considered to be more susceptible to wind farm developments than others, through their categorisation of species as high, medium or low risk. As a result, noctule would be considered at most risk (both individuals and populations), followed by the two pipistrelles considered at risk of direct effects on individuals but not at risk at the population level. Myotis and long-eared bats are considered low risk in both respects.

6.5.28 These categories are not based on data collected in the UK and there is currently a paucity of robust evidence to show if and why impacts on UK bats occur from the operation of wind turbines. The impact assessment explores the current evidence base further and shows how UK impact assessments must largely rely on data from other European countries and generally adopt a precautionary approach to fill the evidence gap.

6.6 Impact Assessment

6.6.1 This section assesses the effects on bats that could result during the construction, operation and decommissioning phases of the development without mitigation in place.

Structure of the Impact Assessment

6.6.2 Direct and indirect effects on bats of the construction and operational and decommissioning phases of the proposed wind farm, based on the project description in Chapter 4 of the SEI 2014, are evaluated for each species of bat considered of medium or high risk – noctule, common pipistrelle and soprano pipistrelle. Myotis and long-eared bats are not considered further as they are considered low risk and unlikely to be effected.

6.6.3 Mitigation for identified adverse effects is then presented, below, along with proposals to enhance the value of the proposed wind farm for bats.

Proposed Site Layout

6.6.4 Following an analysis of ecological and other constraints, a final site layout minimising potential environmental impacts was produced as shown in the 2014 SEI (Figure 4.1) with the development of this layout described in Chapter 3 of the 2014 SEI.

6.6.5 The project has been designed so that land take is restricted to the minimum required for the construction and operation of the wind farm. This approach will minimise habitat losses and will help prevent the need for agricultural intensification to offset lost grazing land.

6.6.6 The track network has been designed so that where it is possible to upgrade existing tracks, rather than construct new tracks, and for new tracks to follow existing field boundaries, these opportunities have been taken.

6.6.7 The total permanent land take from new access tracks, turbine foundations, crane hardstandings, met-mast, substation, and welfare buildings would be approximately 11.5 ha; roughly equivalent to 2.6 % of the total site area.

Potential Effects on Bats

6.6.8 The most commonly documented direct impact is considered to be mortality through direct collision with turbine blades. Some studies have concluded that barotrauma[14] accounted for up to 60 % of documented fatalities (e.g. Baerwald, 2008); however, a recent study found that most cases of barotrauma had probably been misdiagnosed and that at most 6 % of bats found at wind farm sites may show signs of barotrauma. Traumatic injury (caused by direct collision) is by far the major cause of mortality (Rollins et al., 2012).

6.6.9 Other possible impacts include:

- Loss of foraging habitat (directly due to wind farm construction or indirectly because bats avoid the wind farm area); and
- Fragmentation of habitat (indirectly because wind farms form barriers to commuting or seasonal movements, and due to severance of foraging habitat).

6.6.10 BSG Ecology is not aware of any robust published studies concerning fatality monitoring for bats in the UK, although a Defra-funded study carried out by Exeter University is due to report in autumn 2014. In addition, data from studies in continental Europe may not be entirely comparable to patterns of fatality in the UK, given that the general abundance of bats and the diversity of species is greater in countries where detailed monitoring has been carried out (e.g. Spain, Germany, and France). Nonetheless, in the absence of such published information a precautionary approach has been taken and this assessment takes into account findings from elsewhere (as detailed below) with the assumption that impacts on bats, could occur and be in a manner described from studies in continental Europe.

Predicted Effects during Construction

6.6.11 There are limited potential effects on bats during the construction phase of the proposed wind farm. There is a potential for disturbance of active bats from construction works. However, most work would be undertaken during the day during the active period (6.00 am to 8.00 pm) so disturbance would be unlikely.

6.6.12 Although it could be argued that loss of habitat is a construction effect as well as an operational effect this effect will be dealt with under operational effects given that the full extent of habitat loss will be during this period of the development.

6.6.13 It is considered that the construction phase would not result in a significant impact on bats. This assessment is made with a high level of confidence.

Predicted Effects during Operation

Collision with Turbine Blades (and Barotrauma)

6.6.14 Studies from Europe, Australia and North America have identified a number of cases where fatalities have occurred as a result of collision/barotrauma. Results from European studies are discussed below.

[14] Mortality due to damage to bats' lungs caused by sudden change in air pressure close to the turbine blade

6.6.15 Noctule bats are considered to be at high risk of collision/barotrauma due to their 'hawking' feeding strategy. Hotker et al. (2006) reviewed studies from 13 wind farm sites in Germany where monitoring for bat fatalities had taken place. At these sites noctule bat was the species most affected with 120 deaths recorded at six of the wind farm sites studied. The same study reported that the second-most affected species was the common pipistrelle with 44 bat fatalities recorded at the same sites. Latest fatality figures from the Brandenburg Institute in Germany[15] have reported a total of 696 noctule fatalities across Europe. However, several other bat species have been killed in high numbers by wind turbines and include species that were recorded during surveys at this site: common pipistrelle (1054), soprano pipistrelle (154) and much lower totals for brown long-eared bat (3) and for four species of UK Myotis bats (16 in total). If it is assumed, for precautionary reasons, that bats are unlikely to be displaced by operating wind turbines and continue to commute in those areas where they have previously been recorded, mortality through collision/barotrauma is a possibility. Many recent studies have indicated that there are a number of reasons why bats may be attracted to wind turbines and subsequently killed as a result. Although many of these are currently unproven hypotheses, the list below includes the most plausible current explanations which have been adapted from a review by Jones et al. (2009):

- Attraction to tall tree-like objects. This may be due to bats looking for somewhere to roost or the 'tallest tree' hypothesis where males which establish and defend mating territories may attempt to mate with females around the tallest structure available;
- Prey concentration around 'warm' wind turbine nacelles may attract bats to forage close to the rotor swept zone;
- Increases in flight height and changes in aerial behaviour during migration periods; and
- Bats may investigate wind turbines as potential roost sites.

6.6.16 However a more recent review by Rydell et al. in two separate research papers (2010; 2010a) concluded that there is little evidence to support any of these hypotheses from studies in Europe, and that the most likely reason for bats to be attracted to turbines is high altitude feeding on migrating insects that accumulate at turbine towers. This hypothesis explains why there are such seasonal peaks in bat mortality (August-September and May-June) in Europe, and why high mortality generally occurs in weather conditions associated with large-scale migratory movements of insects. It has been previously documented that insects may gather around turbines in such numbers that dead insects on turbine blades may even impede their operation (Corten & Veldkamp, 2001).

Impacts on High Sensitivity Species – Noctule Bat

6.6.17 Noctule is listed as being of high risk to collision/barotrauma and the threat to the status of its UK populations posed by wind farms is thought to be high (NE, 2012; Hundt, 2012).

6.6.18 Noctule activity on the site was judged to be low-moderate in comparison with numerous other sites surveyed by BSG Ecology in Wales and the wider UK. During the walked transects, 25 passes by noctules were recorded during the 2014 survey programme, which is a relatively low level of activity. A further three passes of noctule were recorded during VP surveys. A higher level of activity was recorded during automated surveys and noctule was recorded from most areas of the site, with some areas where higher activity levels were recorded, mainly from central parts of the site. Although levels of activity were fairly consistent in 2014 it is not possible to say what numbers of noctules are using the site or what the status of any such population might be (e.g. breeding females, males) but it is thought that the numbers of bats present at any one time are likely to be fairly low, as would be expected from a widely distributed species that is usually found in low densities.

[15] Data from the central register of the State Fund Ornithological Station in State Office for Environment, Health and Consumer Protection of Brandenburg (2012)

6.6.19 There is some evidence that the site may be close to a roost or that some bats which use the site roost nearby, but the proximity of a roost does not affect the level of risk of individual bats being killed by collision / barotrauma unless it is known that high numbers of bats from an important and especially vulnerable roost (e.g. a large breeding or hibernation roost) are directly at risk from turbines.

6.6.20 If an effect occurs it would be adverse and is likely to be significant at no more than the Local level, given that it is unlikely that the entire local population of noctules (judged to be important at the Local level) is killed by the turbines. There is a medium-low level of confidence in this assessment due to the difficulty in predicting whether individual bats are likely to be struck by wind turbine blades, and of predicting the level of fatalities that are likely to occur.

Impacts on Medium Sensitivity Species – Common and Soprano Pipistrelle Bat

6.6.21 Both species are listed as being at medium risk to collision/barotrauma and the threat to the status of the UK populations of both species posed by wind farms is thought to be low (NE, 2012; Hundt, 2012).

6.6.22 Given that low-moderate levels of activity for pipistrelle species were recorded in comparison with numerous other sites surveyed by BSG Ecology in Wales and the wider UK, and the fact that regular pipistrelle fatalities have been recorded at wind farms in Europe, it is possible that collision/barotrauma impacts could occur for these two species of bats.

6.6.23 The locations of the turbines have been moved away from habitat features, where most pipistrelle activity has been recorded, in line with NE guidance (2012). This is likely to reduce potential effects on pipistrelle bats significantly given that pipistrelle bats generally fly less frequently over open landscapes than those with habitat features. This is shown clearly by the results of transect and automated surveys where the highest levels of activity have all been recorded at distinct habitat features.

6.6.24 The effect on common pipistrelle is not likely to be significant at any geographic level due to their general abundance and the low likelihood of fatalities occurring on a regular enough basis to have any effect on the local population status of the species. The effect on soprano pipistrelle is also not likely to be significant for the reasons given above for common pipistrelle. There is a medium level of confidence in this assessment due to the difficulty in predicting whether individual bats are likely to be struck by wind turbine blades, and of predicting the level of fatalities that are likely to occur.

Disturbance or Loss of Foraging Habitat or Commuting Routes

6.6.25 There is no evidence that the site contains an important commuting route for bats and effects on commuting routes are characterised as for foraging areas.

6.6.26 With regard to habitat loss caused by installation of turbines and associated ancillary infrastructure, a very small area would be taken up by the turbine bases and access tracks (see SEI 2013, Chapter 3). Due to careful selection of the routes of access tracks and turbine locations the proposed wind farm ensures that effects on bats through habitat loss would not be significant. This assessment can be made with a high level of confidence.

Predicted Effects during Decommissioning

6.6.27 Given that decommissioning activity is unlikely to take place within the timeframe considered by this SEI it would be inappropriate to comment on this phase in much detail i.e. the ecology of the site has the potential to change considerably in the time period leading up to decommissioning.

6.6.28 The effects of the decommissioning phase are likely to be comparable with those considered during the construction phase, although of lesser magnitude, as decommissioning would take less time and be potentially less damaging due the presence of an existing track network. It would be possible to restrict vehicles and machinery to these tracks during much of the decommissioning phase.

6.6.29 Decommissioning works would be planned with care so as to minimise the potential for effects on bats.

6.6.30 There is some risk of disturbance of bats from decommissioning works. However, provided all work is undertaken during the day, disturbance would be kept to a minimum. It is considered that impacts on bats through the decommissioning of the proposed development would be negligible in the short term and not significant. This assessment is made with a high level of confidence.

6.7 Mitigation and Enhancement Measures

6.7.1 The following mitigation and enhancement measures would be implemented as part of the development to ensure that impacts resulting from construction, operation and decommissioning would be reduced as far as reasonably practicable. The measures have been developed in conjunction with the engineering design to maximise opportunities for mitigation and enhancement.

6.7.2 Best practice and associated guidance from statutory consultees would be secured through agreement of a Construction Method Statement and Construction Environmental Management Plan as well as agreement over the content of the Habitat Management Plan (HMP).

Constraints and Design Evolution

6.7.3 A constraint to the layout was identified as a result of guidance published in 2009 by NE. This was used to inform the final layout of the development to minimise its impact on bats.

6.7.4 Turbines will be located such that their turbine blade tips will be at least 50m from habitat features (specifically plantation edge and stream gullies) following published guidance from NE (2012). In some instances this will be carried out by micro-siting turbines which are shown to be close to 50m from habitat features.

Construction

6.7.5 Designated working areas, storage areas and access routes would be identified at the commencement of the construction phase. The proposed works would be phased so that access tracks are constructed first. Vehicular access would be restricted to designated routes throughout construction and operation as far as possible, thereby minimising potential disturbance of wildlife. Night working will not be carried out therefore minimising disturbance effects on bats. Tree felling has not been identified as necessary and there should be no impacts on bat roosts.

Operation

6.7.6 No further mitigation during the operational phase is considered necessary, given the design mitigation that has been adopted to reduce the potential effects on bat species discussed above. However, given the uncertainty as to whether bats will be killed by operational turbines and whether the deaths of individual bats would lead to population level effects, the recommendations for post-construction monitoring (see Section 1.10), specify that the following measure should be adopted:

6.7.7 “A procedure for agreeing and implementing remedial measures aimed at reducing or avoiding bat mortality if mortality is at a level considered to be detrimental to the maintenance of the local population”). Such measures may include, but not be limited to, turbine curtailment, and or land management changes”

6.7.8 This measure, for remedial mitigation based on fatality data, in combination with the other measures recommended for post-construction monitoring, should ensure that if an impact on noctule bat occurs, as a result of turbine operation, then remedial mitigation will be implemented to prevent impacts on noctules having a significant effect on the local population of this species.

6.7.9 In addition, and following further discussions with consultees, a HMP has been developed for the site. The detailed HMP is presented in Appendix 4 of the SEI 2013. This will cover the life of the development. Key points in the plan that will result in enhancements for bats include a number of management practices that will improve invertebrate density and diversity for foraging bats:

- Streamside planting of native hedgerow species will create commuting and foraging habitat for bats and fencing of stream corridors will allow vegetation to establish and provide a foraging resource for bats;
- Moving the fencing around the pond edge back from the edge will allow tall herb vegetation to develop and improve foraging opportunities for bats; and
- Bat boxes will be installed in mature woodland areas (off site) such as Cwm Wood, woodland on Coety Bank, Square Wood and Ddol Wood. Boxes will be Schwegler woodcrete boxes Type 2FN and Type 1FD. It is recommended to install five of each type of bat box in each woodland, the locations to be agreed with the onsite ecologist.

6.7.10 If the HMP and the enhancement measures provided therein for bats are taken into account it is likely that the small loss of habitat (see 6.7.7) will be balanced by the gain in new or improved foraging and commuting habitats. As a result the effect on bats will be neutral, or may lead to a beneficial long-term effect at the level of the site for all bat species, and particularly pipistrelles. There is a high level of confidence in this assessment.

Decommissioning

6.7.11 In order to ensure that none of the decommissioning effects on the site's bat interest are significant, similar mitigation measures will be implemented as for the construction phase of the development.

6.8 Residual Effects

Wind Farm Proposal

6.8.1 Adverse effects significant at the Local level may occur as a result of the operation of the proposed wind farm through the potential for a small number of noctule bats to be killed by collision with turbine blades (or possibly barotrauma). No further residual effects have been identified and no further mitigation measures are proposed.

6.9 Cumulative Effects

6.9.1 It is necessary to undertake a cumulative assessment in relation to bats due to their mobile nature and their ability to potentially exploit resources over a wide area. Given that the maximum foraging/commuting range known for noctule from one study is 6.3km (Mackie & Racey, 2007) a precautionary approach has been taken and it is assumed that the zone of influence of the development for noctule bats (the only high-risk species recorded) is 10km. In addition, the BCT guidance (2012) advises that a desk-study should include records of high-risk species within 10km, which coincides with this precautionary zone of influence.

6.9.2 The typical flying ranges of the bat species for which an impact assessment was carried out are summarised in Table 6.8.

Table 6.8: Typical Bat Ranging Distances, adapted from (Hundt, 2012)

Bat species	Flying range
Noctule	Migratory – can fly thousands of km when migrating in Europe. Only anecdotal evidence of migration in UK. Mean maximum distances to foraging grounds recorded as 6.3km (Mackie & Racey, 2007)
Common and soprano pipistrelle	Foraging areas up 3-4km from roosts.

6.9.3 The assessment includes all existing and proposed wind farms (for which planning applications have been submitted) within 10 km of the site boundary.

6.9.4 Of these projects, seven have been selected for the consideration of cumulative effects on bats. Table 6.9 lists the other developments that have been considered as well as the likely significant effect of each on bats. Of these developments the environmental statements (and other relevant documents) were reviewed, where available, to identify the likely significant effect of each development on bats.

Table 6.9: Cumulative effects on bats from other developments within 10km

Development	Status	Distance from Application Boundary (km)	No. of Turbines	Significance of Effects on Bats
Llandinam	Operational	ca. 9 km	103	No data available
Llandinam Repowering	Public Inquiry	ca. 9 km	42 (to replace 103above)	No significant effect
Llaithddu	Public Inquiry	ca. 9 km	27	No significant effect
Llanbadarn Fynydd	Public Inquiry	ca. 1 km	17	No significant effect
Neuadd Goch	Planning Application submitted	ca. 2 km	9	No significant effect
Bryngydfa	Planning Application submitted	Adjacent to site boundary	12	No significant effect
Hirddywel	Planning Application submitted	ca. 9 km	9	No significant effect

6.9.5 Information on the predicted ecological effects of these developments was available for six of the seven sites, and none were considered (by the author of the ES for each site) likely to have significant effects on bats. All of these sites are similar upland habitats that provide sub-optimal habitat for bats and were identified as low risk for bats. All of the sites in question recorded the same four species (noctule, common and soprano pipistrelle, Myotis bats) with some also recording brown long-eared bat. Most of the relevant assessments also acknowledge that the adjacent lowland areas are or are likely to be more suitable for bats.

6.9.6 As a consequence, for these developments, there is no or very limited potential for significant cumulative effects. There is a high level of confidence in this assessment.

6.10 Monitoring

6.10.1 There is no detailed, or prescriptive guidance currently available on monitoring effects on bats at UK wind farms, although there is an ongoing study by Exeter University (and funded by Defra) to determine whether British bat species are at risk from onshore wind turbines which has yet to report its results and conclusions.

6.10.2 Guidance from NE (2012) suggests that:

"Standardised surveying/monitoring pre-and post-installation should be required in most high risk situations and welcomed everywhere. Detailed monitoring is required on sites where impacts are predicted. Such methods could include installation of remote detectors at height to record activity, and corpse searching. Such data can make a valuable contribution to the evidence base and help set the risk in context".

6.10.3 The proposed wind farm has been identified as a low-moderate, rather than high, risk site, and a significant impact has not been predicted for any population of bat, although there is a possibility of individual bats being killed by turbines, particularly noctules. As such, there is not a clear justification for carrying out post-construction monitoring surveys for bats at the proposed wind farm. Nonetheless, RES has discussed the likely requirement for monitoring surveys for bats with NRW on several occasions and have agreed that it would be appropriate for similar monitoring specifications to be agreed for the proposed Garreg Lwyd wind farm as for three of the sites that will be determined as part of the Mid-Wales (Powys) Conjoined Wind Farms Public Inquiry, which closed in May 2014.

6.10.4 For Carnedd Wen, Llanbrynmair and Llanbadarn Fynydd, it has been agreed that monitoring will incorporate some prescriptions but that detailed specifications will be agreed post-consent and should be made the subject of a planning condition or planning agreement, which should be agreed in consultation with NRW. A Bat Protection Plan should be submitted and approved in writing to PCC prior to any development commencing and this plan should be implemented as approved and include but not be limited to details of:

- Pre-commencement surveys should be undertaken for bats, and mitigation measures detailed (if necessary) to ensure their protection throughout construction;
- A monitoring procedure to record bat activity and weather conditions;
- A monitoring procedure to record bat mortality at wind turbines;
- Annual reporting of the results of monitoring with recommendation of any remedial action that may reduce bat mortality;
- A procedure for agreeing and implementing remedial measures aimed at reducing or avoiding bat mortality (it is suggested that the following sentence is added here: “If mortality is at a level considered to be detrimental to the maintenance of the local population”). Such measures may include, but not be limited to, turbine curtailment, and or land management changes; and
- An agreed timeframe for monitoring, sufficient to determine the impact of the operation of the wind farm on bats and the efficacy of any remedial measures to be implemented. Where surveys are required, the methods and scope will be submitted and agreed in writing with PCC prior to being undertaken.

6.11 Conclusions and Statement of Significance

6.11.1 The assessment of the potential residual effects of the proposed wind farm on bats is summarised in Section 6.8.

6.11.2 The proposed wind farm does not involve significant land take and, with habitat management to increase insect diversity and densities, no significant effects on foraging habitats for bats are predicted from the development of the site and there should be a neutral or slightly beneficial net gain from the proposed habitat enhancement measures.

6.11.3 There is a risk of bat mortality from collisions with turbine blades (or barotrauma), particularly for noctule bats, although this is assessed to be unlikely to have a significant effect on the local population of this species. Despite this conclusion, due to the difficulty of predicting absolute mortality rates on a precautionary basis, RES has agreed to implement post-construction monitoring measures that will include a Bat Protection Plan designed to identify whether impacts are occurring (i.e. bats are being killed by turbines) and, if so, to implement effective remedial action to further minimise bat mortality during the operational phase of the development to avoid significant harm to local bat populations. This commitment to monitoring and remedial actions, if required, provides greater confidence in the assessment that there is unlikely to be a significant adverse effect on the local bat population.

6.11.4 As such it is concluded that the Proposed Wind Farm would comply with relevant statutory protections and planning policies in relation to bats. Overall, no significant impacts on bats are likely to occur as a result of the proposed wind farm that would be considered significant under the EIA Regulations.

6.12 Glossary

BCT – Bat Conservation Trust

CIEEM – Chartered Institute of Ecology and Environmental Management

CCW – Countryside Council for Wales

EcIA – Ecological Impact Assessment

ES – Environmental Statement

LBAP – Local Biodiversity Action Plan

NE – Natural England

NRW – Natural Resources Wales

PCC – Powys County Council

SAP – Species Action Plan

SEI - Supplementary Environmental Information

6.13 References

Altringham, J.D. (2003). British Bats. HarperCollins. London.

Baerwald, E. F., D'Amours, G. H. Klug, B. J. & Barclay, R. M. R. (2008). Barotrauma is a significant cause of bat fatalities at wind turbines. Current Biology 18(16): 695–696.

Battersby, J. (Ed) & Tracking Mammals Partnership. 2005. UK Mammals: Species Status and Population Trends. First Report by the Tracking Mammals Partnership. JNCC/Tracking Mammals Partnership, Peterborough.

Bat Conservation Trust (2012). The state of the UK's bats: National Bat Monitoring Programme Population Trends 2012. The Bat Conservation Trust.

Corten, G.P. & Veldkamp H., (2001). Aerodynamics: insects can halve wind-turbine power. Nature 412, 41-42.

Hotker, H. et al. (2006). Impacts on biodiversity of exploitation of renewable energy sources: the example of bats and birds. NABU Miachael-Otto-Institut.

Hundt, L. (2012). Bat Surveys: Good Practice Guidelines, 2nd Edition. Bat Conservation Trust.

Hutterer, R., Ivanova, T., Meyer-Cords, C. & L. Rodrigues (2005). Bat Migrations in Europe. A Review of Banding Data and Literature. Naturschutz und BiologischeViefalt 28. Federal Agency for Nature Conservation, Bonn.

Institute of Ecology and Environmental Management (2006). Guidelines for Ecological Impact Assessment in the United Kingdom (version 7 July 2006). http://www.ieem.org.uk/ecia/index.html

Jones, G. (1995). Flight performance, echolocation and foraging behaviour in noctule bats Nyctalus noctule. Journal of Zoology, 237 (2):303–312.

Jones, G., Cooper-Bohannon, R., Barlow, K. and Parsons, K. (2009). Determining the potential ecological impact of wind turbines on bat populations in Britain. Bristol University and Bat Conservation Trust. DEFRA.

Mackie, I. J. & Racey, P. A. (2007). Habitat use varies with reproductive state in noctule bats (Nyctalus noctula): Implications for conservation. Biological Conservation. 140: 70-77.

Mackie, I. J. & Racey, P. A. (2008). 'Noctule Nyctalus noctula' in Mammals of the British Isles: Handbook, 4th Edition (Harris, S., Yalden, D. W. Eds.). The Mammal Society.

Natural England (2012). Bats and Onshore Wind Turbines: Interim Guidance, second edition. Natural England Technical Information Note TIN051.

Rodrigues, L., L. Bach, Dubourg-Savage M.-J., Goodwin, J. & Harbusch, C. (2008). Guidelines for consideration of bats in wind farm projects. EUROBATS Publication Series No. 3 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany, 51 pp.

Rollins, K. E. Meyerholz, D. K. Johnson, G. D. Capparella A. P. & Loew ,S. S. 2012. A Forensic Investigation into the Etiology of Bat Mortality at a Wind Farm: Barotrauma or Traumatic Injury? Vet. Pathol.: 2012 49: 362.

Rydell, J., Bach, L., Dubourg-Savage, M., Green, M, Rodrigues, L., Hedenström, A. (2010). Bat Mortality at Wind turbines in Northwestern Europe. Acta Chiropterologica, 12: 261-274.

Rydell, J., Bach, L., Dubourg-Savage, M., Green, M, Rodrigues, L., Hedenström, A. (2010a). Mortality of bats at wind turbines links to nocturnal insect migration? Eur. J. Wildl. Res. DOI 10.1007/s10344-010-0444-3.

7. CULTURAL HERITAGE

7.1 Introduction

7.1.1 In April 2014, Simon Collcutt (Managing Director, Oxford Archaeological Associates Limited) was appointed by the Appellant as expert witness for the cultural heritage topic. Dr. Collcutt is the author of the present SEI chapter.

7.1.2 The objectives of this chapter are (a) to respond, by way of clarification and the provision of additional relevant information, to certain issues raised by PCC, first in the Officer's Report to Committee (September 2013) and second in PCC's Statement of Case (April 2014), and (b) to expand on certain matters referred to in the 2008 ES.

7.2 Assessment Methodology

7.2.1 Since the 2008 ES, there have been significant changes in case law, Planning decision precedents and professional guidelines pertaining to the cultural heritage topic, as directly issued in Wales and as relevant due to wider parallels within the UK Planning system.

7.2.2 It is also a fact that the present SEI calls for certain assessments on the part of the present author.

7.2.3 Accordingly, a full discussion of current assessment methodology and relevant changes in local and national policy since the submission of the ES is set out in SEI Appendix 7.1. The present author has nevertheless reviewed the original ES chapter and is satisfied that, save where alternative findings are set out in the present SEI, the ES conclusions are still acceptable in terms of the levels of development effect recognised.

7.3 Scheduled Monument – Castell y Blaidd

7.3.1 As appropriate under professional standards and in accordance with Powys UDP Policy SP3(B), the present author contacted Cadw in June 2014, noting that he wished to discuss the "*desirability of certain works to a Scheduled Monument […]. The monument in question is Castell y Blaidd (SO124797) (which I believe likely to be an Anglo-Norman fortification); I would like to discuss repair of major 'sheep scars', as well as public access and interpretation.*"

7.3.2 Will Davies (Regional Inspector of Ancient Monuments & Archaeology) readily agreed to a site meeting and discussion of the matters indicated. Mr. Davies and the present author clearly understood that Mr. Davies would be asked to comment upon the desirability of the works in question in their own right, not upon any repercussions for the Garreg Lwyd appeal. Both the Clwyd Powys Archaeological Trust (CPAT) and PCC were invited to send representatives but, due to timetabling difficulties, neither was able to attend.

7.3.3 After the meeting, and following discussion with the Appellants and the landowner, the present author sent a proposal to Mr. Davies:

As you know, the larger context here is the Garreg Lwyd Wind Farm appeal. I wish to explore how any effect (which I here leave unspecified) of the proposal upon the monument could be reduced or offset, an approach I believe to be a matter of professional standards, without implying that I find the current Planning proposal unacceptable in any way. I suggest the following package of measures, conditional upon the granting of a suitable Planning permission in due course.

(a) Repair of the Monument

(i) Archaeological-standard micro-topographical survey of earthworks and immediate hillside surroundings.

(ii) Plotting of all earthwork scarring on micro-topographic survey, together with photographic record of all scarring.

(iii) Repair of scarring to full professional standard (requiring temporary fencing to keep sheep out until scars sufficiently healed).

(iv) Consideration (including relevant consultation amongst interested parties) of whether steps might be taken to render the earthwork less vulnerable to sheep erosion in the future (for instance, might some low and small-scale shelter forms, as artificial scrapes/banks and/or bush planting, be created on a nearby slope that might attract the sheep away from using the ramparts in this way, whilst still leaving access open for (desirable) grazing).

(b) Interpretation of Monument

(i) Public access is desirable; given the likelihood that visitor numbers will be relatively low, no made path is needed (indeed, this is not desirable in this case); possible access instruction to the public to be included on interpretation boards.

(ii) Boards (2 copies) best placed north and south, on Glyndŵr's Way, at a sufficient distance not to mar views of the Monument's simple lines.

(iii) Information on interpretation boards to be acceptable to Cadw. In this context, the current lack of certain knowledge as to the age of the Monument (whether Iron Age, as stated in the Schedule, or Anglo-Norman, as seems more likely on the few available facts, taking into account the probability that construction of the Castell, whatever its age, was never completed) is problematical and will need to be explained to the public. The possibility of exploratory excavation at scarring sites, before repair, was considered but no location is apparent which shows sufficient potential to provide unequivocal answers to warrant further physical intervention. However, Cadw would look favourably upon a (professional standard) magnetic susceptibility (surface loop) and magnetometer survey of the interior and entrance area, which would certainly provide useful information (even if results are 'null') for future management and (possibly, bearing in mind the need to protect the Monument) for inclusion in the interpretation boards, as well as providing a possibility of finding something more diagnostic by means of non-intrusive methods.

You have explained your position to me. My question is therefore simple: assuming an appropriately detailed specification which would meet Cadw's requirements, is the suggested package of measures in respect of Castell y Blaidd desirable in its own right?

7.3.4 Mr. Davies replied:

I confirm that the actions you indicate are an accurate summary of the conservation measures required to bring Castell y Blaidd into a stable condition and that the interpretation proposals are in keeping with our discussions and would appear to be of a reasonable scale and approach for a rural site of this nature. To answer your question I would therefore agree that such a scheme of work would be desirable in the context of a standalone project.

The implementation of the proposed conservation and interpretation actions would of course require an application to Cadw for Scheduled Monument Consent. Without pre-judging such an application, proposals that take this approach are likely to be considered acceptable to us.

7.3.5 The original email exchanges are set out in full in SEI Appendix 7.2.

7.3.6 Background information on Castell y Blaidd is set out in SEI Appendix 7.3. Whilst the broad level of significance of the site is common ground (and the national importance of a Scheduled Monument is a statutory matter), the site is enigmatic, there being no compelling evidence at present as to its age (Iron Age or Medieval). The proposal upon which Cadw have commented as a "stand alone" option is, of course, submitted to the Inquiry as an offset package, involving repair, public access[16], interpretation and an improved information & management base; the opinion of PCC will be sought on this proposal and the Council will be invited to support this proposal in the Statement of Common Ground.

7.4 Other Archaeological Issues

Additional Interpretation

7.4.1 The ES contained the following statements relevant to interpretation:

7.6.15 - Mitigation options to improve access to, awareness of, and information about cultural heritage features in the vicinity of the Proposal and the historic landscape generally, through the use of information panels should be considered. Further information is provided in Chapter 12.

12.3.18 - Given the likelihood of local and visitor interest in the wind farm, RES are currently consulting with Powys Council and CCW regarding the potential of providing a visitor information board resource such as information boards and other interpretative material. Interpretation boards can usefully include information not only about the wind farm development itself, but about the surrounding area, cultural heritage, ecology, farming activities and the Country-Code. Such activity would require the agreement of the landowner and relevant bodies and interest groups.

7.4.2 The opinion of PCC will be sought on the proposal for cultural heritage input to interpretation boards and the Council will be invited to support this proposal in the Statement of Common Ground.

Additional Physical Enhancement

7.4.3 The ES states that the Cae-glas barrow cemetery is a Scheduled Monument group (RD104). In fact, only two barrows of this cluster appear to be Scheduled (CPAT HER Nos. 1962 and 4149); the other (possible) barrows (No.2154 being a probable barrow and Nos. 2155 and 4150 being less certain), although indeed standing in a relatively tight area, are unscheduled.

7.4.4 Nos. 2154 and 2155 currently carry mature trees that represent an on-going risk to the earthworks (on the precautionary principle, assuming them both to be archaeological), especially from actual tree-throw in this relatively exposed position. The Appellant has approached the landowner, who is willing to allow the trees growing actually on the mounds to be removed with care (to professional archaeological standards).

7.4.5 The opinion of PCC will be sought on the proposal for tree-clearance from these monuments and the Council will be invited to support this proposal in the Statement of Common Ground.

7.5 Reduction in Turbine Numbers to the West

7.5.1 As appropriate under professional standards and in accordance with PPWales (paragraph 12.8.12), the present author contacted CPAT in June 2014, noting that he was "*seeking opinions (even from those who have no objection) as to how the undoubted cultural heritage effects of the proposal could be reduced or compensated further*".

7.5.2 Mark Walters (CPAT) replied: "*Other than reducing the number of turbines I don't see what else can be done here*".

[16] The present author has confirmed with the landowner and Cadw that there is currently no lawful public access to this monument (despite recent statements to the contrary on behalf of Powys CC).

7.5.3 The present author had already considered the proposed turbine number and layout, and had arranged for an analytical wireline, showing both the Garreg Lwyd turbines and the proposed Bryngydfa turbines.

7.5.4 The following suggestion was therefore sent to Mr. Walters:

Following your email and our telephone conversation earlier today, I am writing to confirm certain ideas which have emerged. The Garreg Lwyd turbines will be located on improved grassland, whilst the (majority) of the close upstanding monuments lie on unimproved land, a setting which is appropriate and historically authentic. There therefore seems to be good reason to look to see how this conceptual 'division' might be reinforced. We can also note that Glyndŵr's Way tends to follow this same 'division', so that walkers can look one way (broadly westwards) to see a landscape of historic significance and another to see rather less interesting improved grassland. There is one point at which this pattern breaks down under the current Garreg Lwyd proposal, namely the fact that T20 (although still on a tongue of improved land) would be located immediately west (by some 130 m) of the Cwm Rhos Goch round barrow (PRN 1912).

I am interested in exploring how the cultural heritage effects of the proposal could be reduced or compensated further, an approach I believe to be a matter of professional standards, without in any way suggesting that I find the current proposal unacceptable. I note that you have already advised that (subject to your stated conditions) CPAT has no objection to the Garreg Lwyd proposal as it now stands. However, in this same spirit of exploring the possibility of improvement, would I be correct in thinking that you would see a cultural heritage advantage were T20 to be removed from the proposal, so as to leave the 'divide' noted above even clearer? If you are able to confirm, I will put the point to our clients; any advantage you and I perceive can only be on cultural heritage grounds and the overall likely effects of any such removal would need to be checked before a final decision could be reached on whether or not to revise the proposal.

I also attach wireframe material, showing the proposed Bryngydfa turbines (marked in red as 'B') as well as the GL ones (marked in blue as 'T'), along the 'green line of sight' from the southern barrow RD084 at Rhiw Porthnant towards the RD104 ones at Cae-glas […]. I believe this might be of help in your consideration of my question.

7.5.5 Mr. Walters replied:

I note with interest the clear distinction between the majority of archaeological sites lying in unimproved grassland while the wind farm is located wholly on improved grassland. Having viewed the layout plan and wireframe T20 is clearly out on its own beyond the tight cluster of other turbines and would visually encroach on the grouping of prehistoric funerary monuments which lie within a more authentic unimproved landscape setting. The logic of preserving this grouping of monuments in their more authentic setting seems perfectly valid and we would therefore support the proposal to remove T20 to enhance the setting of the prehistoric monuments overall, and Cwm Rhos Goch round barrow (PRN 1912) in particular.

7.5.6 The original email exchange is set out in full in SEI Appendix 7.3.

7.5.7 In addition to the matter of the 'division' between the improved and unimproved land and between the public viewing directions, the line of sight for the wireframe was specifically chosen to link all the upstanding barrows in the immediate vicinity (and in particular two Scheduled Monument groups), since intervisibility has often been cited as a likely criterion for the original prehistoric builders and would thus constitute a relevant parameter in the assessment of the contribution from setting to the heritage-significance of the monuments. The more specific benefit for the unscheduled but readily apparent Cwm Rhos Goch round barrow, were T20 to be removed from rather close proximity, was noted in the email exchange; the specific mitigation (protection by fencing) suggested in the ES will no longer be necessary.

7.5.8 The proposition that a reduction in cultural heritage impact would result, were the development to be reduced from the west, was then studied by the Appellant, taking all material considerations into account. It was finally decided that three turbines, T20-22, should be removed at the northwestern end of the Site, so as to render the proposed wind farm as compact as reasonably possible. The present author was able to confirm that this would widen yet further the visual 'buffer' along the barrow distribution axis and would set all turbines east of visitors on Glyndŵr's Way, reinforcing the heritage-relevant 'divide'. It is also noteworthy that the reduction in turbines would decrease the arc in which turbines would be visible from Castell y Blaidd (see above) by 64° (some 44%), as well as removing one of the three nearest proposed turbines to that Scheduled Monument. A formal version of the wireframe mentioned above is presented here in Fig.7.3 (with T20-22 coded in magenta but still shown) and Fig.7.4 (with T20-22 removed); the locations for the turbines (those proposed for both Garreg Lwyd and Bringydfa), together with the 'green line of sight', are shown in Fig.7.1.

7.5.9 The present assessor has reviewed all the heritage assets in the ES in the light of the proposed reduction in the scheme, from 23 to 17 turbines. The reduction will either cause no material effect (will be neutral) or will reduce an adverse effect, the most significant instances being those discussed in this SEI.

7.6 Listed Buildings

Blaen-nant-du

7.6.1 This Listed Building [17] (the Listing text for which is included in SEI Appendix 7.4) was mistakenly omitted from the CH chapter of the ES.

7.6.2 An assessment was therefore carried out by the present author. The farmhouse and attached ranges at Blaen-nant-du (NGR E310775 N281934) appeared to be outside the blade tip ZTV. Through a site visit, it was established that the only significant public viewpoint was on the road at the farmyard entrance. A wireframe visualisation was requested from the Building position, presented here as Fig.7.2, with the viewpoint location mapped in Fig.7.1.

7.6.3 It is here confirmed that there will be no visibility of turbines at Blaen-nant-du. The effect of the proposed wind farm will be Negligible.

Cwm yr Hob

7.6.4 These Listed Buildings (the Listing texts for which are included in SEI Appendix 7.4) were mistakenly omitted from the ES. The group comprises an "*old house & attached farm range*" to the north, together with a detached "*barn*" just to the southeast (note that this building is misplaced in the corresponding HER entry); both units are Listed at Grade II. Appendix 7.4 includes a set of recent photographs of the exterior elevations.

7.6.5 The List entry for the main farmhouse includes the following propositions:

Built c1700 as a timber-framed house with hearth-passage plan, set into a slope with a farm range below. It was improved c1825 when the house was encased in stone, with a lobby-entry plan, and an outshut was added to the rear. Later the farm range was also rebuilt in stone. […]

[…] said by RCAHM Wales to retain the original plan of hall and parlour, and to have retained timber-framing between main range and outshut, part of the original outside wall.

[17] This is the Listing title but there is an alternative location spelling of "*Blaen-nant-ddu*", which would be more in keeping with other local place names.

7.6.6 After initial inspection of the interior of the farmhouse, the present author sees no reason to question the historical and general layout details quoted above. However, it should be noted that, throughout the building, the exposed woodwork displays very common signs of repair and modification. There is a distinct impression that many timbers have been re-used in different locations from their original positions. Indeed, the proposition above that the (now interior) wall between main range and outshut is a survival of the original timber-framed outer wall seems open to question. The building would merit full survey to establish its detailed history.

7.6.7 The house and farm range (originally including cow shed and stable) are associated with the early C19 barn. The List entries state that, in addition to the interior features of interest, this group was protected because it is "*traditional*", and has "*strong vernacular character*" and "*strong regional character*". It is reasonable to conclude that the parameters of 'rarity' or 'architectural excellence/novelty' are not engaged; it is rather that the group is 'representative', even 'typical', of traditional farmsteads in the region.

7.6.8 The proper setting of the farmstead comprises the agricultural land on the hillsides around the buildings. This land contributes to the heritage-significance of the assets, especially since there is still a clearly visible linkage between the continuing use of some of the buildings and the active farm.

7.6.9 A public footpath passes northwards, from the road to Felindre and around the eastward 'snout' of highland, before crossing the stream and then rising to pass the farmstead on its immediate eastern side. The inward walker, from the south and especially in the other direction (from the east northeast), will be able to appreciate the farmstead without interference in most, longer views.

7.6.10 In the original 23-turbine layout, no turbine footing would have been visible from any point along the footpath. However, in closer views around the buildings, broadly to the west, several turbines would have been readily apparent, standing 'just over the horizon', with the blades of others also visible at times. The 'photowire' in Fig.7.6 should first be used to visualise how turbines would be clearly visible immediately south of the barn, between the barn and north of the house, that is, in open views immediately adjacent to the buildings. The actual viewpoint in Fig.7.6 (a point slightly higher and further east than the proper line of the public footpath, shown in Fig.7.5) was chosen to provide a 'worst case' scenario, more or less at closest approach; a walker passing the front of the house and farm range would probably not see turbine blades above the roof ridges. The nearest turbine (T3) is 0.79 km from the farmstead. In the terminology discussed in SEI Appendix 7.1, the present author judged that the intrusive effect of the development would be in the second or third pentile in (up to approximately 60% through) the range of "*material but less than substantial harm*".

7.6.11 In the context of the study by the Appellant of the possibility of removing turbines from the layout so as to render the proposed development as compact as reasonably possible (see above), the present author indicated that there was scope to reduce the heritage setting impact at Cwm yr Hob. Accordingly, and taking all material considerations into account, T7, T12 and T19, were removed. Turbines T7 and T12 are so labelled in Fig.7.6; the proposed reduction would remove them from this view. Whilst views 'around' the buildings to turbines will remain, a walker should be able to pass close to the farmstead and to appreciate the asset without interference. It is therefore concluded that, in the terminology discussed in SEI Appendix 7.1, the resultant effect (after taking turbine reduction into account) upon **Cwm yr Hob** of the proposed wind farm development will be no more than the first pentile in (up to approximately 20% through) the range of Major effects of "*material but less than substantial harm*".

7.6.12 It is very important (and legally material) to note that, at the time of Listing (2004):

(a) The house itself was no longer occupied or, indeed, in any beneficial agricultural use; and

(b) The various undesirable (intrusive, if structually unavoidable) elements on the attached range (corrugated metal roofing, blockwork, steelwork gable support) were already in place.

7.6.13 The barn is still in use as a feed store; the cow shed (having taken over the stable space) retains the original use. Since 1963, when a new house was built to the east, the landowner has managed to maintain the farmhouse (without grant support), with special attention to the critical matter of keeping the roof intact. Nevetheless, it has now been over 50 years since the house served its purpose and it cannot be realistically expected that it will last very much longer in a state capable of saving from ruin. This is a downhill-sited structure (cut into the slope) and thus ultimately vulnerable without appropriate treatment.

7.6.14 After discussion between the landowner, the Appellant and the present author, it was decided to investigate the possibility of making both the Listed Buildings safe through necessary repair and refurbishment and of bringing the house back into proper (associated) use. The landowner (the active multi-generational farming family) confirmed that, were the house in a fit state for domestic use, it could indeed be re-integrated as part of the agricultural holding, as originally intended. A specialist building architect/contractor (known to have collaborated with CPAT in similar projects in the vicinity) was therefore contacted and the buildings were inspected. The conclusion was that, although very significant works would be necessary, it was indeed still possible to bring the group back into proper use, with the retention of historic structural elements wherever possible (and replacement with suitable comparable materials where not). A basic listing of the necessary works is attached in SEI Appendix 7.4.

7.6.15 The present author has advised the Appellant that full Listed Building Consent (supported by detailed plans and specifications, to the satisfaction of Conservation Officers and Committee Members) will be needed in due course to bring these proposals to fruition. The proposals are conformable with national aspirations for asset enhancement, as expressed locally in Powys UDP Policy SP3. The opinion of Powys CC will be sought on the proposals for these Listed Buildings and the Council will be invited to support these proposals in the Statement of Common Ground.

7.6.16 The effect upon the Listed Buildings of the proposals (repair & refurbishment) will be very significantly positive, a package that should be weighed as substantial, that is, the equivalent of, but of the opposite valency to, "*substantial harm*" (cf. the unavoidable effect were this package not to be made available and the buildings to continue to deteriorate). It is concluded that the net effect of the proposed development on **Cwm yr Hob** (adverse setting effects as set against advantageous fabric effects) will be significantly positive. In the light of the requirements of the Planning (Listed Buildings & Conservation Areas) Act 1990, the decision-makers in the present appeal are respectfully invited to accord this desirable enhancement considerable weight.

"The Old Vicarage"

7.6.17 The only other Listed Building said, in the ES, to lie within 2.5 km of the Site was "*The Old Vicarage LBII, SO 135767*" (cf. ES Table 7.15). After due enquiry, it is reported here that no such Building exists (inclusion in the ES was an error, due to misplaced data referring to a Building of this name in Llangorse, Brecon).

7.7 Revised & New Assessment

Three Round Barrows at Rhiw Porthnant

7.7.1 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this Scheduled barrow group (RD084) would be "*Major/Moderate*". The removal of six turbines will cause a 48% reduction (to 17°) in the arc over which the proposed development will be visible, at a distance of 2.5 km (an increase of 25%) from the barrows; as already noted, the long line of sight linking barrows to the southeast would fall within a widened visual 'buffer'. In the present author's opinion, the distracting effect of the relatively distant turbines would not produce a significant effect and no "*material harm*"; in the terminology discussed in SEI Appendix 7.1, the effect upon the **Pothnant Barrows** should be categorised as Moderate.

Castell y Blaidd

7.7.2 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon the Scheduled Castell y Blaidd (RD102) would be "*Major*". The earthwork does not stand on the highest topographic point in the immediate area and it is not particulraly obvious what the design principles involved might have been, a point which may bolster the surmise that the monument is incomplete (cf. SEI APPENDIX 7.3). The main outward views from the monument are certainly to the west and south, since the land rises quite quickly in other directions. Nevertheless (and applying something of a 'precautionaty principle' in the weighting of the setting contribution to heritage-significance in this uncertain case), in the present author's opinion, the dominating effect of the relatively close turbines would indeed have produced a significant effect which, in the terminology discussed in SEI Appendix 7.1, should be categorised as the fourth pentile in (approximately 60-80% through) the range of "*material but less than substantial harm*".

7.7.3 It has been noted above that the arc of view to the turbines has now been reduced (by the removal of the nearby turbines T20-22) by 44%; the nearest turbine will still be at a distance of 0.55 km from the earthwork. This will reduce the dominating effect upon the monument, plausibly by at least one pentile.

7.7.4 It has also been noted above that a package (repair, access, interpretation and improvement of information & management base) is being offered by the Appellant, upon the advice of the present author and in the light of national aspirations for enhancement, as expressed locally in Powys UDP Policy SP3. The significantly positive effect of this package will be worth, by way of offset, the equivalent of some two pentiles of 'harm'.

7.7.5 It is therefore concluded that, in the terminology discussed in SEI Appendix 7.1, the resultant effect (after taking turbine reduction and offset package into account) upon **Castell y Blaidd** of the proposed wind farm development will be no more than the first pentile in (up to approximately 20% through) the range of Major effects of "*material but less than substantial harm*".

Coventry Round Barrow

7.7.6 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this Scheduled barrow (RD103) would be "*Major*". The removal of six turbines will cause a 17% reduction (to 140°) in the arc over which the proposed development will be visible, but still at a distance of only 0.31 km from the barrow; as already noted, the long line of sight linking barrows to the northwest and southeast would fall within a widened visual 'buffer'. In the present author's opinion, the distracting and somewhat dominating effect of the relatively close turbines will produce a significant effect upon the **Coventry Barrow** which, in the terminology discussed in SEI Appendix 7.1, should be categorised as the first pentile in (approximately 20% through) the range of Major effects of "*material but less than substantial harm*".

Cae-glas Barrow Cemetery

7.7.7 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this barrow group (including the Scheduled pair of RD104) would be "*Major*". The removal of six turbines will cause a 15% reduction (to 57°) in the arc over which the proposed development will be visible, but still at a distance of 0.81 km from the barrows; as already noted, the long line of sight linking barrows to the northwest would fall within a widened visual 'buffer' (there is no impediment to the southwest). The desirable tree-removal from two of the mounds should also be taken into account. In the present author's opinion, the distracting effect of the relatively close turbines will produce a significant effect upon the **Cae-glas Barrows** which, in the terminology discussed in SEI Appendix 7.1, should be categorised as the first pentile in (approximately 20% through) the range of Major effects of "*material but less than substantial harm*".

Warren Hill Round Barrow

7.7.8 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this Scheduled barrow (RD105) would be "*Major/Moderate*". The removal of six turbines will cause a 24% reduction (to 41°) in the arc over which the proposed development will be visible, still at a distance of 1.04 km from the barrow; as already noted, the long line of sight linking barrows to the northwest would fall within a widened visual 'buffer' (there is no impediment to the southwest). In the present author's opinion, the distracting effect on the **Warren Hill Barrow** of the turbines would not produce a significant effect and no "*material harm*"; in the terminology discussed in SEI Appendix 7.1, the effect on the **Warren Hill Barrow** should be categorised as Moderate.

Gors Lydan Round Barrows

7.7.9 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this Scheduled barrow pair (RD106) would be "*Major/Moderate*". The removal of six turbines will cause a 22% reduction (to 38°) in the arc over which the proposed development will be visible, at a distance of 2.3 km from the barrows. In the present author's opinion, the distracting effect of the relatively distant turbines would not produce a significant effect and no "*material harm*"; in the terminology discussed in SEI Appendix 7.1, the effect on the **Gors Lydan Barrows** should be categorised as Moderate.

Castell y Blaidd Mediaeval Settlement

7.7.10 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this earthwork group (RD155) would be "*Major/Moderate*". The removal of six turbines will cause a 34% reduction (to 78°) in the arc over which the proposed development will be visible; the nearest turbine will still be at a distance of 0.78 km from the earthworks. It should be noted that there is no compelling evidence that this deserted settlement was indeed of Medieval date; it is equally likely that this was a post-Medieval 'opportunistic' settlement (occupied without initial land rights), a rather more common category of survival (the CPAT HER categorises a "*Castell y Blaidd Hafod*" as "*modern*" as at least part of this group). It is also relevant that the observer on one of the local footpaths will nearly always be looking away from the proposed turbines when viewing these comparatively low earthworks; indeed, probably the best vantage point will be the top of Castell y Blaidd itself, once public access has been arranged as part of the present scheme. In the present author's opinion, the distracting effect of the turbines would not produce a significant effect and no "*material harm*"; in the terminology discussed in SEI Appendix 7.1, the effect on the **Castell y Blaidd Mediaeval Settlement** should be categorised as Moderate.

Ty'n-y-ddol Hill Round Barrow

7.7.11 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this Scheduled barrow (RD252) would be "*Major*". The removal of six turbines will cause a 14% reduction (to 136°) in the arc over which the proposed development will be visible, but still at a distance of only 0.37 km from the barrow; as already noted, the long line of sight linking barrows to the northwest (probably only as far as Coventry Barrow in this case) and southeast would fall within a widened visual 'buffer'. In the present author's opinion, the distracting and somewhat dominating effect of the relatively close turbines will produced a significant effect on the **Ty'n-y-ddol Barrow** which, in the terminology discussed in SEI Appendix 7.1, should be categorised as the first pentile in (approximately 20% through) the range of Major effects of "*material but less than substantial harm*".

Cwm Rhos Goch Barrow

7.7.12 The ES found that the likely effect of the proposed wind farm (23-turbine layout) upon this barrow (HER No.1912) would be "*Major*". The removal of six turbines will cause a 72% reduction (to 60°) in the arc over which the proposed development will be visible, at a distance of 0.48 km (more than 4 times the previous stand-off) from the barrow; as already noted, the long line of sight linking barrows to the northwest and southeast would fall within a widened visual 'buffer'. One may also note that this un-scheduled mound is relatively low and not readily recognisable from the public footpaths. In the present author's opinion, the distracting effect of the turbines would not produce a significant effect and no "*material harm*"; in the terminology discussed in SEI Appendix 7.1, the effect upon the **Cwm Rhos Goch Barrow** should be categorised as Moderate.

Positive 'Surplus' & Residual Effects

7.7.13 The repair & refurbishment proposals for the Listed Buildings at Cwm yr Hob will significantly outweigh the adverse effect upon setting through visibility of the eastern turbines (see above). This 'positive surplus' may properly be set against the remaining adverse effects upon archaeological earthworks, as described above in this section.

7.7.14 The present author still finds a number of Major effects to setting of "*material but less than substantial harm*". However, none of these will be any more than the first pentile in (up to approximately 20% through) the range of this category. The present author does not recommend that the 'positive surplus' should be taken to neutralise all remaining adverse effects. He nevertheless feels that the resudual "*material harm*" to cultural heritage assets from the proposed Garreg Lwyd wind farm is of only modest magnitude.

7.8 Cumulative Matters

7.8.1 Consideration of cumulative matters must necessarily begin with the observation that, in Wales, major wind energy projects should normally be concentrated within designated Strategic Search Areas (SSAs) (cf. TAN 8). Garreg Lwyd falls within SSA C (Newtown South).

7.8.2 The Appellant has stated (in the ES and the Statement of Case) that such a designation does indeed create a presumption in favour of wind energy development, justifying the fact that this will cause some landscape change (including change in the historic dimension), although clearly not an unqualified presumption (cf. TAN 8 paragraph 24).

7.8.3 TAN 8 itself did not use cultural heritage criteria (other than those of the "highest" importance) to help define SSAs. However, the TAN made provision for local revision:

2.10 Local planning authorities should take an active approach to developing local policy for SSAs in order to secure the best outcomes. Further advice is contained in Annex D. Some of the local issues, which could be addressed in this way are: […] Local historic and landscape considerations and micro-siting in relation to issues of local importance […].

7.8.4 Turning to Annex D (Potential Methodology for Local Planning Authorities with Strategic Search Areas (excerpts from Review of Final Report (Arup 2005)), one finds:

3.1 The following factors should typically be reviewed for the study in order to identify "technically feasible areas" for the development of onshore wind energy schemes, broadly in the order outlined below.

[…]

3.5 Digital data representing the locations of scheduled ancient monuments (SAM) should be used. SAMs are represented by point features in the available dataset from Cadw; consultation should therefore be undertaken with the local Archaeological trust if any archaeological features appear to present a particular constraint to any one site.

7.8.5 Powys CC has followed this advice. The first (2006) revision still did not use cultural heritage criteria. However, the 2008 (most recent) revision certainly did. In a third (5 out of 15) of the "*areas of exclusion*" from SSA C, the presence of "*features of historic interest*", sometimes including "*tumuli*", is cited as determinative. It is stated (p.34) that, in summary, the "*main differences between the SSA C revised refined boundary and the SSA C 2006 draft IDCG boundary* […]" include some land in Zone 12 and Zone 15, "[… which, in addition to a steepness criterion, has] *also been excluded to protect the setting of historic features within the area, see Table 8b.*". Thus, the Council's consultants could have 'revised out' the Garreg Lwyd site on Cultural Heritage (CH) grounds had this been felt necessary, without adding new criteria to their revision exercise; that the consultants did not do so indicates, at the very least, that the presence of "*features of historic interest*" at Garreg Lwyd was not considered to render this site unacceptable.

7.8.6 It is clear that policy has long recognised that it is unlikely that all 'adverse effects' can be avoided in the context of wind energy. Thus, EN-1, paragraph 5.8.12, encourages steps to "*minimise conflict*". The approach advocated in PPWales is similar:

12.8.12 […] *The Welsh Government accepts that the introduction of new, often very large structures for onshore wind needs careful consideration to avoid and where possible minimise their impact. However, the need for wind energy is a key part of meeting the Welsh Government's vision for future renewable electricity production as set out in the Energy Policy Statement (2010) and should be taken into account by decisions makers when determining such applications.*

7.8.7 The Appellant has certainly done everything reasonable to minimise effects upon cultural heritage assets. The present author is nevertheless at pains to point out that neither he nor (in his understanding) the original ES assessors have lowered the standard of actual effect assessment of individual assets in the light of any SSA presumption.

7.8.8 However, when one turns to the matter of cumulative impacts (between different wind energy proposals), it is impossible, for assessors as well as Planners and decision-makers, to ignore that fact that Welsh policy requires concentration. PPWales notes:

12.8.14 […] Within the SSAs, whilst cumulative impact can be a material consideration, it must be balanced against the need to meet the Welsh Government's aspirations for energy in Wales and the conclusions reached fully justified in any decisions taken. Developers will need to be sensitive to local circumstances, including siting in relation to local landform, proximity to dwellings and other planning considerations. The development of large wind farms or other large scale renewable and low carbon energy schemes will not generally be appropriate in internationally or nationally designated areas and sites […].

7.8.9 Before looking at other wind energy proposals in the vicinity, one may note the general historic dimension of the landscape. Characterisation of the Garreg Lwyd site as 'remote' or 'historically important' (as has been done by PCC) is not unacceptable in itself; however, these characteristics would equally apply to most of SSA C. The site sits within the Pen Ithon historic landscape aspect area (RDNRHL997) which is said to be of "*moderate value*", characterised as follows:

Predominantly enclosed 19th-century upland common around the headwaters of the river Ithon. Mostly large, straight-sided fields defined by either hedges or post-and-wire fences. Later prehistoric activity indicated by numerous flint scatters and dispersed burial mounds. Medieval and post-medieval settlement and land use represented by house platforms, pillow mounds and small stone quarries. Dispersed farms largely of 19th-century origin. Small areas of modern forestry and planted shelter belts.

7.8.10 This characterisation is rather crude and cannot be used to help differentiate between various wind energy schemes falling within this same, very extensive, historic landscape aspect area (although it will have a bearing upon differentiation from schemes which fall in higher priority aspect areas). It has already been noted above that the Garreg Lwyd site itself sits within a more 'historically bland' zone of improved grassland, unlike much of the land in the wider surroundings.

7.8.11 The proposed Garreg Lwyd Hill Wind Farm will not cumulate significantly in CH terms with the more distant projects broadly to the west (LLandinam, Llaithddu, Hirddywel). The Llandinam turbines are already visible across a wide swaithe of the horizon; repowering and granting of permission for the other two sites would not significantly increase the effect upon assets in proximity to Garreg Lwyd. In the present author's opinion, the distracting effect of the turbines at this considerable distance would not produce a significant effect and no "*material harm*"; in the terminology discussed in SEI Appendix 7.1, the effect on the '**western schemes**' should be categorised as no more than Moderate.

7.8.12 There are three '**eastern schemes**' (in addition to the proposed Garreg Lwyd Hill Wind Farm) of relevance: Bryngydfa, Neuadd Goch Bank and Llanbadarn Fynydd.

7.8.13 The Bryngydfa proposal involves two separate blocks of turbines, In the present assessor's opinion, this proposal alone would cause "material but less than substantial harm" to cultural heritage interests, approximately half way along the range of this category of effect. The main reasons why this is the case are exactly the same reasons as render cumulative assessment difficult, in that the Bryngydfa effects would clash with the objectives of the present design of the proposed Garreg Lwyd Hill Wind Farm in respect of CH issues. Thus:

(a) Some of the Bryngydfa turbines would occupy areas of rough pasture (which would run counter to the measures that have been taken to keep the proposed Garreg Lwyd Hill Wind Farm turbines well inside the much less heritage-sensitive 'improved grassland' zone);

(b) Many of the Bryngydfa turbines would stand higher in the landscape, producing significant 'massing' in this area (cf. the Bryngydfa turbines shown in Fig.7.4 in the view from the north, which could be mirrored in a reverse view from the vicinity of the Cae-glas barrows); and

(c) Seen from the vicinity of Rhiw Porthnant, the Bryngydfa turbines would produce a wide spread, especially in the critical long line of sight linking Scheduled and unscheduled barrows from northwest to southeast (which would run counter to the measures that have been taken to keep the proposed Garreg Lwyd Hill Wind Farm turbines well separated to the east; cf. the Bryngydfa turbines shown in Fig.7.4).

7.8.14 Whether or not all the compensatory measures suggested for the proposed Garreg Lwyd Hill Wind Farm would still make sense, it will be assumed here that they would be carried forward into the cumulative case. Were the Bryngydfa turbines already permitted, certain types of detriment would already have been allowed and the addition of the proposed Garreg Lwyd Hill Wind Farm would make little difference. Nevertheless, primarily because of the overall increase in geographical spread (the proposed Garreg Lwyd Hill Wind Farm filling the 'gap' between the two Bryngydfa blocks), the cumulative effect would be greater than for Bryngydfa alone, by at least one pentile.

7.8.15 The Neuadd Goch Bank scheme lies within Landmap historic landscape aspect areas, said to be of "*outstanding*" (Kerry Hills MNTGMHL124) and "*high*" (Kerry Ridgeway RDNRHL121) value. At its northwestern end, the scheme approaches quite close to the Scheduled Glog Barrows (MG121). Other Scheduled barrows lie within the proposal site itself (MG109, RD250 and RD251). This last, the Windy Hall Barrow, is the most northerly element in the long sight line to the southeast, noted repeatedly in the present chapter. In the present assessor's opinion, this proposal alone would cause "*material but less than substantial harm*" to cultural heritage interests, approximately half way along the range of this category of effect. Given the removal of western turbines, so as to widen the relevant visual 'buffer', addition of the proposed Garreg Lwyd Hill Wind Farm scheme would not produce a significant cumulative effect on the same set of assets. It is still necessary to take into account the effect upon assets closest to the proposed Garreg Lwyd Hill Wind Farm, although the cummulative effect would be no more than a pentile above that for Neuadd Goch Bank alone.

7.8.16 It is understood that, at the recent Mid-Wales Inquiry, with one exception, PCC have claimed no significant cultural heritage adverse effects from Llanbadarn Fynydd. The exception involves the farmstead at Blaen-nant-du (which lies outside the Garreg Lwyd Hill Wind Farm ZTV, as noted above). Nevertheless, were the Llanbadarn Fynydd scheme already in place, the addition of the proposed Garreg Lwyd Hill Wind Farm scheme would greatly increase the arc of view in which turbines would be visible from Castell y Blaidd to about 230°, albeit with a northerly 'gap'; against this should be set the positive package (repair, access, interpretation and improvement of information & management base) proposed above. The present author would suggest that an overall cumulative effect no more than one pentile higher than that for the proposed Garreg Lwyd Hill Wind Farm alone might result, still well within the "*material but less than substantial harm*" range.

7.8.17 There are various possible combinations of two schemes with the proposed Garreg Lwyd Hill Wind Farm, each pushing the cumulative effect a little higher on the "*material but less than substantial harm*" scale. Were all three 'eastern schemes' already permitted, the addition of the proposed Garreg Lwyd Hill Wind Farm would bring turbines into view around much of the periphery of a number of important monuments and would take the cumulative effect to the very top of this range; it would only be the compensatory measures (proposed solely in the context of the proposed Garreg Lwyd Hill Wind Farm scheme) that might prevent this cumulation from tipping into the "*substantial harm*" category.

7.8.18 Since consideration of cumulative effects implies a degree of 'competition' between proposed schemes, and in as much as the Planning situation at the time of an individual determination allows the point any relevance, it is the present assessor's opinion that the proposed Garreg Lwyd Hill Wind Farm scheme, as now proposed, is well conceived in CH terms and in this respect to be preferred ahead of the schemes for Bryngydfa and Neuadd Goch Bank.

7.9 Glossary and Abbreviations

CH – cultural heritage (interchangeable with 'historic environment')

CPAT – Clwyd Powys Archaeological Trust.

Cadw – an executive arm of the Welsh Government, responsible for historic environment matters.

HER – Historic Environment Record, databases held by various CH bodies (e.g. Cadw, CPAT, Royal Commission on the Ancient & Historical Monuments of Wales).

MG – HER code for the old county of Montgomeryshire.

RD – HER code for the old county of Radnorshire.

MNTGMHL - Montgomeryshire historic landscape aspect area (an area defined in the Landmap database).

RDNRHL – Radnorshire historic landscape aspect area (an area defined in the Landmap database).

SSA – Strategic Search Area, an area preferred by the Welsh Government for larger scale wind energy development, as explained in TAN8.

TAN – Technical Advice Note, one of a numbered set of Planning documents issued by the Welsh Government.

SAM – "Scheduled Ancient Monument", more properly called a 'Scheduled Monument', a historic site directly protected by law under the Ancient Monuments & Archaeological Area Act 1979; often an archaeological site but sometimes a (disused) building.

LB – Listed Building, a building or structure directly protected by law under the Planning (Listed Buildings & Conservation Areas) Act 1990; often but not always still in use.

PPW – Planning Policy Wales, the principal Welsh Planning guidance.

Pentiles - fifth parts (each about 20% of the whole) along a range (used here to give a qualitative scale of professional judgement of the degree of potential effects).

8. TRANSPORT AND ACCESS

8.1 Introduction

8.1.1 Transport and access was first dealt with in the 2008 ES (planning application P/2008/0785). The access design was changed following consultation with key consultees and resulted in a new access route application in August 2010 (P/2010/1028).

8.1.2 The development of the strategic Traffic Management Plan (sTMP) and ongoing conultation resulted in further access design changes which were included in a new access route application in July 2013 (P/2013/0733).

8.1.3 Further changes were made to the sTMP in late 2013 and early 2014 and the Newtown to Strategic Search Area C section of the strategic route was finally approved by WG in March 2014. The final design inlcuded a number of small changes to the design presented by RES in the July 2013 application. These changes (see Drawing 01589D2533-04 in Appendix 8.11) were included in a new planning application in July 2014 (P/2014/0735).

8.1.4 The July 2013 access route application and 2013 ES overrides the transport and access element of the 2008 ES and the July 2014 access route application should be considered anlongside the July 2013 ES.

8.1.5 This SEI is provided to present the findings of additional survey, assessment and design work that has been undertaken since July 2013, together with other information that has been prepared in relation to cumulative effects of the proposed Garreg Lwyd Hill Wind Farm together with other wind farms.

8.1.6 The works proposed in the 2013 Access Route ES consisted of highway upgrades between Ellesmere Port and the proposed Garreg Lwyd Hill Wind Farm to facilitate the deliveries of Abnormal Indivisible Loads (AILs). The proposed Garreg Lwyd Hill Wind Farm Access Route is the subject of a separate appeal with its own stand alone ES and SEI.

8.1.7 The wind farm proposal now includes the erection of 17 turbines and associated infrastructure rather than 23 as indicated in the July 2013 Access Route ES.

8.1.8 Traffic calculations for use of the proposed access route were assessed in Section 4.3.1 of the proposed Garreg Lwyd HillWind Farm Traffic Management Plan (2013) and provided in its Appendix 2. These traffic flows have been updated and are included in Appendix 8.5 of this SEI.

8.1.9 Section 3 Description of Development in the 2013 Access Route ES referred to the Strategic Route from Ellesmere Port to the proposed Garreg Lwyd Hill Wind Farm site. The Strategic Route Works from Ellesmere Port to Newtown as indicated in paragraph 3.2.2 of the 2013 ES remains unchanged. Figure 3.1 in the 2013 ES was identified as using the A489 Kerry Road and the Vastre, south of Newtown, to gain access to the A483 and, subsequently, access to the site. Two alternative options were also indicated – the Heol Treowen Option (in Figure 3.2) and the Mochdre Industrial Estate Option (in Figure 3.3).

8.1.10 The Strategic Route now proposed is the use of the Mochdre Industrial Estate as indicated in Figure 3.3 of the 2013 ES.

8.1.11 The site entrances require works and were previously indicated in paragraph 3.2.13 and Plan 01589D2430-03 of Appendix 2 of the 2013 ES. Plan 01589D2430-04 now replaces the Appendix 2 of the 2013 ES and is included in Appendix 8.6 of this SEI with associated correspondence.

8.2 Strategic Traffic Management Plan (sTMP) Section 6 Revision T

8.2.1 This document has been prepared by AECOM on behalf of RenewableUK Cymru and is a March 2014 update of an earlier version of sTMP6 which was included within Appendix 1 of Volume III of the July 2013 ES.

8.2.2 The document reflects the change in Strategic Route through and around Newtown to access the A483 to the proposed Garreg Lwyd Hill Wind Farm. The Strategic Route now passes through the Mochdre Industrial Estate in Newtown and subsequently accesses the A483 via a new Mochdre Link. This replaces the use of the A489 Kerry Road and the Vastre.

8.2.3 A full copy of the report can be found at Appendix 8.1 of this SEI.

8.3 Road Safety Audit (RSA) for Sections 2-5 of the Strategic Traffic Management Plan (sTMP) for Mid Wales Wind Farms (August 2013)

8.3.1 This document has been prepared by Gm Traffic Consultants Ltd on behalf of Vattenfall, FWL, RES and RWE. This report results from a Stage 1 road safety audit (RSA) carried out on the various off-site highway works to enable the transportation of Abnormal Indivisible Loads (AILs) from Ellesmere Port to Mid-Wales (Sections 2-5).

8.3.2 Gm Traffic Consultants Ltd carried out the Audit between 13th June 2013 and 3rd September 2013. The Audit consisted of a desktop study and a site visit, which was carried out between 15th June 2013 and 18th June 2013.

8.3.3 The RSA identified three issues that could occur as a result of the movement of AILs along the proposed route and offered recommendations on how to deal with these (Section 4). These issues related to overhanging branches, misuse of passing place lay-bys and forward visibility to back of traffic queues.

8.3.4 A full copy of the report can be found at Appendix 8.2.

8.4 Road Safety Audit (RSA) for Section 6 of the Strategic Traffic Management Plan (sTMP) for Mid Wales Wind Farms (May 2014)

8.4.1 This document has been prepared by Gm Traffic Consultants Ltd on behalf of Vattenfall, FWL, RES and RWE. This report results from a Stage 1 road safety audit (RSA) carried out on the various off-site highway works to enable the transportation of Abnormal Indivisible Loads (AILs) from Newtown to SSA C (Section 6).

8.4.2 Gm Traffic Consultants Ltd carried out the Audit between 3rd May 2014 and 28th May 2014. The Audit consisted of a desktop study and a site visit, which was carried out on Wednesday 4th December 2013.

8.4.3 The RSA identified four issues that could occur as a result of the movement of AILs along the proposed route and offered recommendations on how to deal with these (Section 4). These issues related to overhanging branches, misuse of passing place lay-bys and forward visibility to back of traffic queues and no details of a Road Restraints Risk Assessment Process (RRRAP) assessment.

8.4.4 A full copy of the RSA report can be found at Appendix 8.3.

8.5 Non-AIL Cumulative Transport Assessment on the Strategic Road Network (July 2014)

8.5.1 This document has been prepared by AECOM and details the process of appraising and modelling the impact on the strategic road network of non-AIL construction traffic for the proposed Mid Wales wind farm schemes. This has been done through the use of a Cumulative Impact Model and the Institute of Environmental Assessment (IEA) Guidelines for the Environmental Assessment of road traffic. The model has been produced with the purpose of modelling the impact of construction traffic on the trunk road and principal road network in Mid Wales during the construction periods of the proposed wind farms in the area.

8.5.2 This model was used in the recent Mid Wales (Powys) Conjoined Wind Farms Public Inquiry (Mid Wales Conjoined Inquiry) for five Section 36 wind farm proposals in Mid Wales. Non-Section 36 applications were also included within the assessment. The assessment model and its content are, therefore, suitable for use in relation to the proposed Garreg Lwyd Hill Wind Farm proposal.

8.5.3 The report concludes that:

Overall Cumulative Impact of Construction Traffic

- In terms of overall construction traffic it is evident that the daily cumulative impact of the wind farm proposals on the strategic road network does not exceed the 30% increase in overall traffic identified by IEA Guidelines as the screening threshold for assessment of potential significance.
- Whilst many of the road network links are classed as medium sensitivity receptors, the assessment of significance leads to values of no impact or neutral or slight in all cases.

Cumulative HGV Impact of Construction Traffic

- In terms of overall construction traffic it is evident that the daily cumulative impact of the wind farm proposals on the majority of the strategic road network does not exceed the 30% increase in overall traffic identified by IEA Guidelines as the screening threshold for assessment of potential significance.
- The A483 south of Newtown and Dolfor in the vicinity of the site is the one exception, requiring further consideration for 2016 during which the greatest traffic impact is realised. This is undertaken and the analysis concludes that the impact is satisfactory overall given the factors of the impact being limited to a short length of the A483, low base traffic flows, the temporary nature of the traffic flow increases and that this is a trunk road expected to cater for such traffic movements.

8.5.4 A full copy of the Non-AIL Cumulative Transport Assessment can be found at Appendix 8.4

8.6 Garreg Lwyd Hill Non-AIL Cumulative Transport Assessment on the Strategic Road Network (July 2014)

8.6.1 This technical note, produced by AECOM, assesses the impact of the proposed Garreg Lwyd Hill Wind Farm on the strategic road network and should be read in conjunction with the report produced by AECOM, Non-AIL Cumulative Transport Assessment found at Appendix 8.4. This note identifies the impact associated with the proposed Garreg Lwyd Hill Wind Farm on the strategic road network.

8.6.2 The document outlines the predicted traffic impact associated with the proposed Garreg Lwyd Hill Wind Farm in actual vehicle numbers and also in terms of a percentage increase in traffic in terms of the construction programme and as a yearly average.

8.6.3 The technical note concludes that:

- The construction traffic impact of proposed Garreg Lwyd Hill Wind Farm on the adjacent strategic road network is not discernible and has no significance in accordance with IEA Guidelines.
- The HGV construction traffic is not discernible and has no significance apart from the A483 and A44 in the vicinity of the site.
- In all cases, for both construction traffic overall and HGV construction traffic, the impact does not exceed the 30% increase in overall traffic identified by the IEA Guidelines as the screening threshold for assessment of potential significance.

8.6.4 A full copy of the Non-AIL Transport Assessment on the Strategic Road Network can be found at Appendix 8.5.

8.7 Site Entrances Drawings and Associated Correspondence (August 2013)

8.7.1 The site entrances require works and were previously indicated in paragraph 3.2.13 and Plan 01589D2430-03 of Appendix 2 of the 2013 ES.

8.7.2 Plan 01589D2430-04 now replaces the Appendix 2 2013 ES Plan. The Plan shows revised site entrance details for the proposed site access to Garreg Lwyd Hill Wind Farm. The arrangement has been changed to a 'T' junction off the C1057 for all traffic except AILs entering the site. The AILs would use the slip lane shown as grass permeable paving.

8.7.3 Associated correspondence took place between RES and PCC in August 2013 regarding the drawing replacement and the Council's acceptance of its content.

8.7.4 A copy of the replacement drawing and the associated correspondence can be found at Appendix 8.6.

8.8 Nant Oer Rail Bridge Note, Associated Drawings and Associated Correspondence (February 2014)

8.8.1 A technical note and associated drawings indicating dimensions of the delivery vehicle (drawing 1) and levels under the bridge (drawing 2) prepared by AECOM in February 2014 demonstrated the ability of a number of candidate turbines to satisfactorily pass under the Nant Oer Rail Bridge on the A489 Llanidloes Road in Newtown.

8.8.2 This was the subject of correspondence between AECOM and PCC's transport consultants, Vectos, in January and February 2014. This correspondence was submitted as Appendix MA2 of PCC's transport evidence for Session 4 of the MidWales Conjoined Inquiry on Cumulative Effects. This led the Council's appointed transport consultant to conclude in evidence that he was satisfied that SSA C sites are capable of being appropriately accessed from Ellesmere Port encompassing the route set out in the sTMP document.

8.8.3 A copy of the technical note, drawings and the associated correspondence of Appendix MA2 (as described above) can be found at Appendix 8.7.

8.9 Agreed Statement on the Delivery Process for Abnormal Indivisible Loads (AILs) (January 2014)

8.9.1 An Agreed Statement on the Delivery Process for AILs (January 2014) was prepared by Stuart Michael Associates on behalf of RenewableUK Cymru, RWE NPower Renewables, RES, Vattenfall and Celtpower in consultation with the Highways Agency AIL Division, Welsh Government (Transport), Welsh Police, West Mercia Police and PCC. This was presented to Session 4 of the Mid Wales Conjoined Inquiry.

8.9.2 This Agreed Statement was prepared in order to provide a clear understanding of how the deliveries of AILs to the proposed developments will be effectively managed and coordinated such that they are compliant with current planning policies, Road Vehicle Regulations and reflect best practice. Planning conditions can be imposed on the consented schemes to ensure that the appropriate controls are in place.

8.9.3 The Statement demonstrates that the management and delivery of AILs can be undertaken in an effective and coordinated manner. All aspects of the delivery process have been consulted upon. There is common agreement amongst the consultees that the principles and measures outlined in the Statement will achieve the objective of ensuring effective management and coordination of multiple AIL deliveries during the construction period. WG and PCC are keen that this delivery process becomes a 'model' for all future wind farm schemes in mid Wales.

8.9.4 Key components of the Statement are:

- The appointment of a Transport Coordinator to be responsible for managing and scheduling the deliveries of AILs to each development.
- Delivery slots will reflect the state of readiness of the developments and be ranked according to their status.
- Delivery slots will be able to be transferred from one developer to another to cater for construction programme changes
- All AILs deliveries associated with Mid Wales wind farms will be escorted by the Police.

- Welsh Police will set up an AIL Escort Unit specifically to deal with and provide the necessary resources for the escorts to the Mid Wales wind farm developments

8.9.5 A copy of the Agreed Statement can be found at Appendix 8.8.

8.10 Agreed Water Preferred Policy Assessment (February 2014)

8.10.1 An assessment of Ellesmere Port in relation to the Highway Agency's Water Preferred Policy has been undertaken and confirms its suitability. Policy requires abnormal loads to be delivered to the port nearest the destination site in order to minimise road mileage making sure the most appropriate roads are used.

8.10.2 Ellesmere Port is the nearest suitable UK port for access to SSA C and the site. It has excellent links to the M53. The strategic route then follows the A55/A483/A5/ A483/A489/Mochdre Industrial Estate/A483 route to site.

8.10.3 The route from Ellesmere Port follows the trunk road network as far as is reasonably practical. In general, the trunk road network has been designed to carry greater volumes of traffic and so is constructed to higher standards compared to the county road network.

8.10.4 A copy of the Water Preferred Policy Assessment can be found at Appendix 8.9.

9. ACOUSTIC ASSESSMENT

9.1 Introduction

9.1.1 This Chapter contains an assessment of the acoustic impact of the proposed Garreg Lwyd Hill Wind Farm. The Chapter assesses wind farm operational noise and construction noise upon the most acoustically sensitive residential properties.

Statement of Authority

9.1.2 This assessment has been undertaken by RES, with at least one in-house Member of the Institute of Acoustics involved in its production. RES has undertaken acoustic impact assessments in every single one of its UK wind farm development applications since 2000. RES has also carried out noise assessments and reported to several local planning authorities on wind energy projects including taking measurements on newly constructed wind farms to ensure compliance with planning conditions.

9.1.3 Additionally, RES has been project co-ordinator for several Joule[18] projects, leading European research into wind turbine noise, were involved in producing the guideline 'The Assessment and Rating of Noise from Wind Farms' [1] for the DTI in 1996, acted as peer reviewer for the 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' [2], and contributed to the RenewableUK work on Amplitude Modulation [3]. Publications include:

- 'An Investigation of Blade Swish from Wind Turbines', P Dunbabin, Proceedings of the 1996 International Congress on Noise Control Engineering (Internoise '96), 30 July – 2 August 1996, Book 1, pp 463 – 469;
- 'An Automated System for Wind Turbine Tonal Assessment', R Ruffle, Proceedings of the 1996 International Congress on Noise Control Engineering (Internoise '96), 30 July – 2 August 1996, Book 6, pp 2997 – 3002;
- 'Wind Turbine Measurements for Noise Source Identification', ETSU W/13/003914/00.REP, 1999, Dr P Dunbabin, RES et al;
- 'A Critical Appraisal of Wind Farm Noise Propagation', ETSU W/13/00385/REP, 2000 Dr J Bass, RES;
- 'Aerodynamic Noise Reduction for Variable Speed Turbines', ETSU/W/45/00504/REP, 2000, Dr P Dunbabin, RES;
- 'Fundamental research in amplitude modulation - a project by RenewableUK', Fourth International Meeting on Wind Turbine Noise, Rome, April 2011;
- 'Investigation of the 'Den Brook' Amplitude Modulation methodology for wind turbine noise', J Bass, Acoustics Bulletin Vol 36 No 6 November/December 2011; and
- 'How does noise influence the design of a wind farm?', M Cassidy, Fifth International Conference on Wind Turbine Noise, Denver, 2013.

9.1.4 Additional information, including background noise survey photos and charts are provided in the Technical Appendices.

Wind Turbine Noise

9.1.5 Noise levels from turbines are generally low and, under most operating conditions, it is likely that turbine noise would be completely masked by wind generated background noise such as the sound of wind blowing through trees and around buildings.

[18] DGXII European Commission funded projects in the field of Research and Technological Development in non-nuclear energy

9.1.6 As described by the Planning Policy Wales Technical Advice Note 8 [4]:

"There are two quite distinct types of noise source within a wind turbine - the mechanical noise produced by the gearbox, generator and other parts of the drive train and the aerodynamic noise produced by the passage of the blades through the air. There has been a significant reduction in mechanical noise since the early 1990's so the latest generation of wind turbines are much quieter than those first installed in Wales".

Construction Noise

9.1.7 The sources of construction noise, which are temporary, will vary both in location and duration as the different elements of the wind farm are constructed and will arise primarily through the operation of large items of plant.

9.1.8 Noise will also arise due to the temporary increase in construction traffic near the site. This level also depends on the different elements of the wind farm being constructed.

9.2 Scope of Assessment

9.2.1 Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. The effect of noise, both in the construction and operational phase, is therefore a material consideration in the determination of planning applications.

Operational Noise

9.2.2 The main focus of the acoustic impact assessment of operational noise from the wind farm presented here is based on the two most relevant types of noise emission for modern wind turbines: broadband and tonal noise, both of which are types of 'audible noise'. Implicitly incorporated within this assessment is the normal character of the noise associated with wind turbines (commonly referred to as 'swish') and consideration of a range of noise frequencies, including low frequencies.

Low Frequency Noise

9.2.3 The frequency range of 'audible noise' is generally taken to be 20 Hz to 20,000 Hz, with the greatest sensitivity to sound typically in the central 500 Hz to 4,000 Hz region. The range from 10 Hz to 200 Hz is generally used to describe 'low frequency noise', and noise with frequencies below 20 Hz used to describe 'infrasound' [5], although there is sometimes a lack of consistency regarding the definition of these terms in both common usage and the literature.

9.2.4 Low frequency noise is always present, even in an ambient 'quiet' background [5]. It is generated by natural sources, including the sea, earthquakes, the rumble of thunder and wind. It is additionally an emission from many artificial sources found in modern life, such as household appliances (e.g. washing machines, dishwashers) and all forms of transport.

9.2.5 Noise emitted from wind turbines covers a broad spectrum from low to high frequencies. In relation to human perception of the broadband noise produced by wind turbines, the dominant frequency range is not the low frequency or infrasonic ranges [6]. The reason for this is that the perception threshold for hearing in these ranges is much higher than for speech frequencies of between 250 Hz and 4000 Hz. As a result of this decreased sensitivity, wind turbine noise at the lowest frequencies of the range described as 'low frequency noise' would be below the average hearing threshold.

9.2.6 A comprehensive literature review of 'Low Frequency Noise and Infrasound Associated with Wind Turbine Generator Systems', undertaken for the Ontario Ministry for the Environment in 2010, indicated that low frequency noise from wind turbines crosses the threshold boundary, and thus would be considered to become audible, above frequencies of around 40-50 Hz [6]. The degree of audibility depends upon the wind conditions, the degree of masking from background noise sources and the distance from the wind turbines [6].

9.2.7 Although audible under some conditions, a paper; 'Infrasound and low frequency noise from wind turbines: exposure and health effects' [7], published by the authors of a literature review on the subject prepared for the Swedish Environmental Protection Agency in 2011 [8], concludes that the level of low frequency noise produced by wind turbines does not exceed levels from other common sources, such as road traffic noise [7].

9.2.8 In response to an article published in the national press in 2004, alleging that low frequency noise from wind turbines may give rise to adverse health effects, the Department of Trade and Industry (DTI) commissioned the Hayes McKenzie Partnership to perform an independent study to investigate these claims [9]. The Government released the following advice based on the report's findings [10]:

"The report concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines."

9.2.9 This is re-iterated in the review undertaken for the Ontario Ministry for the Environment, which concludes that publications by medical professionals indicate that; at typical setback distances, the noise levels produced by wind turbines, including noise at low and infrasound frequencies, do not represent a direct health risk.

9.2.10 The Oregon Health Authority's Public Health Division conducted a strategic Health Impact Assessment in response to a convergence of questions about potential health impacts from wind energy facilities in Oregon. The report, titled 'Strategic Health Impact Assessment on Wind Energy Development in Oregon [11]' states that:

"Some field studies have found that in some locations near wind turbine facilities, low frequency noise (frequencies between 10 and 200 Hz) may be near or at levels that can be heard by humans. However, there is insufficient evidence to determine if low frequency noise from wind turbines is associated with increased annoyance, disturbance or other health effects".

9.2.11 Whilst low frequency content of the noise from wind farms shall be considered through the use of octave band specific noise emission and propagation modelling within the assessment presented here, it is considered that specific and targeted assessment on low frequency content of noise emissions from the proposed wind farm is unjustified.

Infrasound

9.2.12 In relation to infrasound in general, frequencies below 20 Hz may be audible, although tonality is lost below 16 - 18 Hz, thus losing a key element of perception [5]. In relation to modern, upwind turbines; there is strong evidence that the levels of infrasound produced will be well below the average threshold of human hearing [6]. The aforementioned DTI report extended this conclusion to more sensitive members of the population [9]:

"Even assuming the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion".

9.2.13 As such [7]:

"infrasound from wind turbines is not audible at close range and even less so at distances where residents are living".

9.2.14 In February 2005, the BWEA [12] published background information on low frequency noise from wind farms [13]. The conclusion states that:

"It has been repeatedly shown, by measurements of wind turbine noise undertaken in the UK, Denmark, Germany and the USA over the past decade, and accepted by experienced noise professionals, that the levels of infrasonic noise and vibration radiated from modern upwind configuration wind turbines are at a very low level; so low that they lie below the threshold of perception, even for those people who are particularly sensitive to such noise, and even on an actual wind turbine site".

9.2.15 The BWEA report goes on to quote Dr Geoff Leventhall, author of the DEFRA report on 'Low Frequency Noise and its Effects', as saying:

"I can state, quite categorically, that there is no significant infrasound from current designs of wind turbines".

9.2.16 With regard to health effects, the DTI report quotes the document 'Community Noise', prepared for the World Health Organisation (WHO), which states that [9]:

"there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects".

9.2.17 The DTI report goes on to conclude that:

"infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour".

9.2.18 Furthermore, researchers at Keele University explain that:

"The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect the low frequency sound. There is no scientific evidence to suggest that infrasound has an impact on human health." [14]

9.2.19 In January 2013 the Environment Protection Authority, South Australia, presented their findings of a study into the level of infrasound within typical environments with a particular focus on comparing wind farm environments to urban and rural environments away from wind farms [15]. The report states:

"This study concludes that the level of infrasound at houses near the wind turbines assessed is no greater than that experienced in other urban and rural environments, and is also significantly below the human perception threshold. Also, that the contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment."

9.2.20 Therefore, in accordance with literature, it is not considered appropriate or relevant to undertake specific assessment in relation to infrasound for the proposed wind farm.

Sleep Disturbance

9.2.21 ETSU-R-97 states that different limits should be applied during daytime and night-time periods. The daytime limits are intended to preserve outdoor amenity, while the night-time limits are intended to prevent sleep disturbance. The night-time criterion is derived from the 35 dB(A) sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB(A) for attenuation through an open window (which is conservative) and a correction of 2 dB(A) to allow for the use of LA90, rather than LAeq.

9.2.22 A report entitled 'Sleep Disturbance and Wind Turbine Noise' by Dr Christopher Hanning reviewed the potential consequences of wind turbine noise and its effect on sleep and health, and made recommendations on setback distances [16]. The report was created on behalf of 'Stop Swinford Wind Farm Action Group' (SSWFAG).

9.2.23 Dr Hanning states that:

"There can be no doubt, that groups of industrial wind turbines ("wind farms") generate sufficient noise to disturb the sleep and impair the health of those living nearby."

9.2.24 Dr Hanning's paper fails to acknowledge the link between noise level and sleep disturbance. This link is acknowledged in the most recent advice published by the World Health Organisation Night Noise Guidelines for Europe [17]. This report recommends acceptable levels of night time noise below which no appreciable adverse effects on sleep can reasonably be identified and levels above which sleep effects may be expected. The levels identified in these guidelines indicate an outdoor annualised free field noise level of 40 dB(A). Such averaging would allow short term levels in excess of this. In comparison to the likely noise limits to be imposed upon the wind farm, based upon ETSU-R-97 recommendations, this 40 dB(A) annualised limit is much more lenient. There will be significant portions of time that the noise levels shown in this report, due to wind direction, wind speed or conservatism in modelling, are not realised.

9.2.25 In another article published by Dr Hanning and Professor Alun Evans, in the British Medical Journal [18] it states:

"A large body of evidence now exists to suggest that wind turbines disturb sleep and impair health at distances and external noise levels that are permitted in most jurisdictions, including the United Kingdom."

9.2.26 Research evidence supports the conclusion that noise from any source will result in measurable effects on sleep when it reaches a certain level. Such effects may comprise changes in sleep state without those exposed actually awakening, or they may comprise complete awakenings. Either of these responses may or may not have a consequential long term effect on wellbeing depending on the subjects concerned and the extent of the effects being considered.

9.2.27 There is no reason why wind turbine noise should be any different to other forms of noise, in that there will be a certain level at which wind turbine noise would impact on the sleep of those exposed to it. As with other forms of noise, some variability in response across the exposed population would be expected, with some people being more noise sensitive and others more noise tolerant.

9.2.28 In a report by the Chief Medical Officer of Health of Ontario [19], in response to public health concerns about wind turbine noise, the review concluded that:

"...while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects..."

9.2.29 A report published the Massachusetts Department of Environmental Protection concludes that [20]:

"Evidence regarding wind turbine noise and human health is limited. There is limited evidence of an association between wind turbine noise and both annoyance and sleep disruption, depending on the sound pressure level at the location of concern".

9.2.30 Since ETSU-R-97 accounts for sleep disturbance when setting night time noise limits it is therefore concluded that protection from sleep disturbance is considered within this acoustic impact for the proposed wind farm.

Vibration

9.2.31 Structure borne noise, originating in vibration, is also low frequency, as is neighbour noise heard through a wall, since walls generally block higher frequencies more than lower frequencies.

9.2.32 A report by Snow gives details of low frequency noise and vibration measurements made at a wind farm [21]. Measurements were made both on the wind farm site, and at distances of up to 1 km. It was found that the vibration levels at 100 m from the nearest turbine itself were a factor of 10 lower than those recommended for human exposure in the most critical buildings (i.e. laboratories for precision measurements), and lower again than the limits specified for residential premises [22]. Noise and vibration levels were found to comply with recommended residential criteria, even on the wind turbine site itself, and the acoustic signal was below the generally assumed frequency range of audible noise i.e. below 20 Hz. In addition, it was found that there was no clear relationship between vibration levels and wind speed, and that some vibrations appeared to come from other sources, as they were found even when the turbines were switched off.

9.2.33 More recently, in 2004/2005, researchers at Keele University investigated the effects of the extremely low levels of vibration resulting from wind farms on the operation of the seismic array at Eskdalemuir, one of the most sensitive installations in the world [14]. The results of this study have frequently been misinterpreted and, to clarify the position, the authors have explained that:

"The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect."

9.2.34 They go on to say:

"Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise - they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health."

9.2.35 The Ministry of Defence's approach to safeguarding the Eskdalemuir seismic array is to allocate a budget in terms of the cumulative level of seismic vibration from wind turbines. This restricts the number of wind farms that can be located within a certain distance of the Eskdalemuir seismic array without adversely impacting upon its operation. In 2013 AWE provided an interim technical report to the Eskdalemuir Working Group detailing the findings of an 'Initial study of seismic ground vibration data from mega-watt class wind turbines' [23]. The study found that the levels of vibration produced by wind turbines were being over-estimated. Xi Engineering were appointed as consultants to verify the findings of the study and their report 'Initial Study of ground vibration data recorded near Craig Wind farm. Phase 0 report – estimate of potential head room in the Eskdalemuir Budget' [24] concludes that:

"the current budget over estimates the seismic vibration produced by wind turbines."

9.2.36 Consequently:

"there is a likelihood of significant prospective head room that would allow the building of wind farms without breaching the 0.336 nm threshold."

9.2.37 A scientific advisory panel comprising independent experts in acoustics, audiology, medicine and public health conducted a comprehensive review of the available literature on the issue of perceived health effects of wind turbines, titled 'Wind Turbine Sound and Health Effects - An Expert Panel Review', and prepared a report for the American and Canadian Wind Energy Associations in December 2009 [25]. The authors explain that:

"Vibration of the body by sound at one of its resonant frequencies occurs only at very high sound levels and is not a factor in the perception of wind turbine noise".

9.2.38 The authors further state that:

"Airborne sound can cause detectable body vibration, but this occurs only at very high levels — usually above sound pressure levels of 100 dB. There is no scientific evidence to suggest that modern wind turbines cause perceptible vibration in homes or that there is an associated health risk".

9.2.39 Therefore, in accordance with literature, it is not considered appropriate or relevant to undertake specific assessment in relation to vibration caused by the operation of the proposed wind farm.

Aerodynamic Modulation

9.2.40 The noise normally associated with wind turbines and commonly referred to as 'swish' is the modulation of aerodynamic noise produced at blade passing frequency (the frequency at which a blade passes a fixed point). This noise character is acknowledged by, and accounted for, in the recommendations of ETSU-R-97 [1]. However the aforementioned DTI report researching low frequency noise and/or infrasound emitted by wind turbines noted that a related phenomenon known as 'Aerodynamic Modulation' (AM) - alternatively referred to as 'Amplitude Modulation', was, in some isolated circumstances, occurring in ways not anticipated by ETSU-R-97 [10]. Such AM above and beyond that considered by ETSU-R-97 is often referred to as Excess, or Other, AM.

9.2.41 On the 16th December 2013, the wind industry trade association RenewableUK published detailed new scientific research [26] into the identification, occurrence and prevention of 'Other Amplitude Modulation' (OAM). This work is an important study and represents a significant step forward in the industry's understanding of the acoustic characteristics associated with OAM, its causes and mitigations. This research was carried out by a group of independent experts, including academics from the Universities of Salford and Southampton, and the National Aerospace Laboratory of the Netherlands, Hoare Lea Acoustics, Robert Davies Associates and DTU Riso in Denmark. The findings of this research, conducted over a three-year period, identify a range of possible solutions for mitigating the occurrence of OAM and for minimizing existing issues on those few sites where it is found to occur.

9.2.42 A methodology for measuring amplitude-modulated wind turbine noise was defined and listening tests undertaken to determine the subjective response to noise with a modulating character as part of the package of work funded by RenewableUK. These pieces of work formed the basis for a template planning condition for the assessment and control of wind turbine amplitude modulation noise. The template planning condition takes the form of a penalty scheme with the magnitude of the penalty dependent upon the level of amplitude modulation. However, as the occurrence of OAM at any given site and the frequency of the occurrence at sites where it is acknowledged to exist is low, it is considered that a specific noise condition relating to OAM is not required on the basis of planning necessity.

9.2.43 Therefore it is not considered appropriate or relevant to undertake specific assessment in relation to AM above and beyond that considered by ETSU-R-97 that may be potentially produced by the operation of the proposed wind farm development.

Wind Turbine Syndrome

9.2.44 The condition proposed by paediatrician Dr Nina Pierpont in her report 'Wind Turbine Syndrome: A Report on a Natural Experiment' cites a range of physical sensations and effects as being caused by living near a wind farm [27]. This study is based on a series of interviews comprising a study group of 10 families. It is a self-published report with none of the research being published in any peer reviewed medical journal.

9.2.45 In a NHS response to the Pierpont report, a report titled 'Are wind farms a health risk?' states that there is no conclusive evidence that wind turbines have an effect on health or are causing the set of symptoms described as 'wind turbine syndrome' [28]. It was noted that the group study by Pierpont was not sufficient to grant the claims stated.

9.2.46 The aforementioned report 'Wind Turbine Sound and Health Effects - An Expert Panel Review' [25], prepared by a scientific advisory panel for the American and Canadian Wind Energy Associations, concludes that Wind Turbine Syndrome is:

"not a recognized medical diagnosis, is essentially reflective of symptoms associated with noise annoyance and is an unnecessary and confusing addition to the vocabulary on noise".

9.2.47 The report went on to say:

"There are no unique symptoms or combinations of symptoms that would lead to a specific pattern of this hypothesized disorder."

9.2.48 An independent review of the state of knowledge about the alleged health condition was carried out [29]. This report includes three expert opinions provided by: Richard J.Q. McNally - Reader in Epidemiology at the Institute of Health and Society Newcastle University; Geoff Leventhall – an independent consultant specialising in low frequency noise, infrasound and vibration; and Mark E. Lutman - Professor of Audiology at the University of Southampton. Their critique of Pierpont's study concludes that the reported symptoms are the effects mediated by stress and anxiety when exposed to an adverse element in their environment. There is no evidence that they are patho-physiological effects of wind turbine noise.

9.2.49 A paper by Pedersen explores data from three cross-sectional studies comprising A-weighted sound pressure levels of wind turbine noise, and subjectively measured responses from 1,755 people, to find the relationships between sound levels and aspects of health and well-being [30]. It was concluded that there is no consistent association between wind turbine noise exposure and the symptoms associated with Wind Turbine Syndrome.

9.2.50 A study conducted by Simon Chapman, Professor of Public Health at Sydney University, provides evidence that noise and health complaints about wind turbines are psychogenic [31]. The authors conclude that:

"In view of scientific consensus that the evidence for wind turbine noise and infrasound causing health problems is poor, the reported spatio-temporal variations in complaints are consistent with psychogenic hypotheses that health problems arising are communicated diseases with nocebo effects likely to play an important role in the aetiology of complaints".

9.2.51 Therefore, in accordance with literature, it is not considered appropriate or relevant to undertake specific assessment in relation to Wind Turbine Syndrome potentially caused by the operation of the proposed wind farm.

Construction Noise

9.2.52 The acoustic impact assessment of construction noise from the wind farm presented here is based on RES's experience of constructing wind farms and calculated for the operation of the primary large items of construction equipment. Additionally, consideration is given to the increased noise levels due to increased traffic flows during the construction phase to and from the site.

9.2.53 Whilst noise will also arise during decommissioning of the wind farm (through turbine deconstruction and breaking of the exposed part of the concrete bases) this is not discussed separately as noise levels resulting from it are expected to be lower than those from the construction activity.

9.3 Legislative Framework & Guidance

Operational Noise

9.3.1 Within Wales, noise is defined within the planning context by PP Wales [32] which states that:

"Noise can affect people's health and well-being and have a direct impact on wildlife and local amenity. Noise levels provide an indicator of local environmental quality. The objective of a policy for noise is to minimise emissions and reduce ambient noise levels to an acceptable standard."

9.3.2 PPWales references Technical Advice Note 11: Noise [33] which:

"…provides advice on how the planning system can be used to minimise the adverse impact of noise without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business."

9.3.3 Technical Advice Note 11: Noise refers to detailed guidance on noise from wind turbines as being contained in Technical Advice Note 8: Planning for Renewable Energy [4].

9.3.4 In relation to noise from wind farms Technical Advice Note 8: Planning for Renewable Energy states:

"The report 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97), describes a framework for the measurement of wind farm noise and gives indicative noise levels calculated to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or planning authorities. The report presents the findings of a cross-interest Noise Working Group and makes a series of recommendations that can be regarded as relevant guidance on good practice."

9.3.5 It is therefore considered that the use of ETSU-R-97, as a criterion for assessment of wind farm noise, fulfils the requirements of Technical Advice Note 11: Noise and Planning Policy Wales.

9.3.6 The methodology described in ETSU-R-97 was developed by a working group comprised of a cross section of interested persons including, amongst others, environmental health officers, wind farm operators and independent acoustic experts.

9.3.7 The guidance makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that arise through the development of renewable energy resources. The principle of balancing development needs against protection of amenity may be considered common to any type of noise control guidance.

9.3.8 The basic aim of ETSU-R-97, in arriving at the recommendations contained within the report, is the intention to provide:

"Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities."

9.3.9 ETSU-R-97 provides a robust basis for assessing the noise impact of a wind farm and has been applied at the vast majority of wind farms currently operating in the UK and is proposed as adequate for use in this assessment. Based on the advice of planning policy, as outlined above, a wind farm which can operate within noise limits derived according to ETSU-R-97 is considered to be acceptable.

9.3.10 An article published in the Institute of Acoustics Bulletin (IoA Bulletin) Vol. 34 No. 2, March/April 2009 [34], recommends a methodology for addressing issues not made explicit by, or outside the scope of, ETSU-R-97, such as in relation to wind shear or noise propagation modelling. Whilst this article does not represent formal legislation or guidance it was authored by a group of independent acousticians experienced in wind farm noise issues who have undertaken work on behalf of wind farm developers, local planning authorities and third parties and as such is a good indicator of best practice techniques. The assessment presented herein adopts the recommendations made within this article.

9.3.11 A Good Practice Guide (IoA GPG) to the application of ETSU-R-97 for the assessment and rating of wind turbine noise [2], issued by the Institute of Acoustics in May 2013 and endorsed by the Department of Energy and Climate Change (DECC), Northern Ireland Executive, Scottish Executive and the Welsh Assembly Government, provides guidance on all aspects of the use of ETSU-R-97 and reaffirms the recommendations of the Acoustics Bulletin article with regard to propagation modelling and wind shear. The assessment presented herein adopts the recommendations of the Good Practice Guide.

Construction Noise

9.3.12 In Wales, advice on construction noise assessment is referred to in the 'Technical Advice Note 11: Noise' which states [33]:

"Detailed guidance on assessing noise from construction sites can be found in BS 5228, parts 1-4. In particular, Part 1: 1984, 'Code of practice for basic information and procedures for noise control" describes a method for predicting noise from construction sites as well as giving general advice'.

9.3.13 Since the 1984 version has been superseded by BS 5228-1:2009 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise' [35], this has been identified as being suitable for the purpose of giving guidance on appropriate methods for minimising noise from construction activities, and is adopted herein.

9.3.14 The legislation Control of Pollution Act 1974 provides information on the need for ensuring that the best practicable means are employed to minimise noise [36].

9.4 Methodology

Operational Noise

9.4.1 To ensure adequate assessment of the potential impacts of the operational noise from the proposed wind farm the following steps have been taken, in accordance with relevant guidance detailed above:

- The baseline noise conditions at each of the nearest residential properties to the wind farm are established by way of representative background noise surveys;
- The noise levels incident at the nearest residential properties due to the combined operation of all the wind turbines, for the proposed wind farm, using a sound propagation model, are estimated giving due regard to: the locations of the wind turbines; the locations of the nearest, or most noise sensitive residential properties; the intervening terrain; and the likely noise emission characteristics of the wind turbines;
- With due regard to relevant guidance or regulations the acoustic assessment criteria is derived; and
- The evaluation of the acoustic impact is undertaken by comparing the predicted noise levels with the assessment criteria.

Establishing Baseline Conditions

9.4.2 Similar to other assessments of noise impacts (most notably BS 4142, 'The Method for Rating Industrial Noise affecting Mixed Residential and Industrial Areas' which ETSU-R-97 identifies as forming the basis of its recommendations), the ETSU-R-97 methodology requires the comparison of predicted noise levels due to turbine emissions (which vary with hub height wind speed) with noise limits based upon the noise levels existing under those same conditions (i.e. the baseline conditions).

9.4.3 Since background noise levels depend upon wind speed, as indeed do wind turbine noise emissions, it is important when making reference measurements to put them in that context. Thus, the assessment of background noise levels at potentially sensitive residential properties requires the measurement of not only noise levels, but concurrent wind conditions, covering a representative range of wind speeds. These wind measurements are made at the wind turbine site rather than at the residential properties, since it is this wind speed that will subsequently govern the wind farm's noise generation. Often the residential properties themselves will be sheltered from the wind and will consequently have relatively low background noise.

9.4.4 To establish the baseline conditions, sound level meters and associated apparatus are set-up to record the required acoustic information at a selection of the most noise sensitive residential properties geographically spread around the proposed wind farm site and which are likely to be representative of other residential properties in the locale.

9.4.5 Wind speed and direction are recorded as 10 min averages for the same period as for the noise measurements, and are synchronised with the acoustic data to allow correlations to be established. The wind speed that is adopted for use is the same wind speed as that which drives the turbine noise levels.

9.4.6 The adoption of this wind speed was presented as appropriate within the article published in the IoA Bulletin and the subsequent IoA GPG.

9.4.7 Prior to establishing the baseline conditions the acoustic data is filtered as follows:

- For each background noise measurement location, the measured noise data is divided into two sets, as specified by ETSU-R-97 and shown in Table 1:

Table 1: Definition of Time of Day Periods

Time of Day	Definition
Quiet waking hours	18:00 - 23:00 every day 13:00 - 18:00 Saturday 07:00 - 18:00 Sunday
Night-time hours	23:00 - 07:00 every day

- Rainfall affected data is systematically removed from the acoustic data set. To facilitate this, a rain gauge is deployed at site to record 10 min rainfall data and identify potentially affected noise data.
- Periods of measured background noise data thought to be affected by extraneous noise sources, i.e. non-typical, and are generally identified by means of inference are removed from the acoustic data set. Whilst some 'extraneous' data may actually be real, in practice it tends to bias any trend lines upwards, so its removal is adopted as a conservative measure.
- In practice this means close inspection of the measured background noise data and comparison with concurrent data measured at nearby locations. Such analysis considers directional and temporal variation in the background noise for all survey locations.

Calculating Standardised Wind Speed

9.4.8 In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data with wind speed data referenced to 10 m height. In contrast to this, acoustic emission measurements on wind turbines are undertaken following an international standard which specifies that the turbine noise emission should be reported as a function of a 'standardised' wind speed at 10 m height. In practice this translates as extrapolation of wind speed at hub height down to 10 m height using a specified, and fixed, relationship.

9.4.9 However, whilst there are good reasons for this approach, for example it allows developers to compare noise emission data from different makes and models of wind turbine, it does create potential problems. If for example, the wind shear on a site where the turbines are to be deployed differs from the assumed values/model, the result is that, for a given 'standardised' wind speed at 10 m height, the hub height wind speed may be different. The consequence is that the turbine generates a different amount of power, and emits a different level of sound power, than might be expected from the standardised wind speed alone.

9.4.10 Two options are available in order to reconcile potential anomalies:

- The turbine sound power levels can be re-calculated taking due consideration of site-specific wind shear; or
- The noise limits can be derived with reference to the same wind speed as the turbine noise levels.

9.4.11 This assessment has been undertaken using the second option which was presented as appropriate both by a group of independent acoustic consultants who have undertaken work on behalf of wind farm developers, local planning authorities and third parties in the IoA Bulletin and in the subsequent IoA GPG. The methodology outlined below is therefore applied to those wind speeds measured on-site concurrently with the background noise survey:

- Where hub height wind speed has not been directly measured this may be calculated by extrapolating the wind speed measured at the uppermost anemometer to the hub height by use of the measured wind shear exponent. The wind shear exponent is a commonly used, empirically based, engineering description of the rate of change of wind speed with height and may vary according to atmospheric conditions and be affected by interactions between ground features and the wind flow.
- It therefore follows that the hub height wind speed for each 10-minute period may be calculated from the wind speed measured at the uppermost anemometer, and the calculated wind shear exponent.
- The reporting of wind turbine noise emissions are carried out according to the international standard IEC 61400-11, 'Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques' [37]. This standard specifies that the sound power level for the turbine is reported as a function of the 'standardised' wind speed at 10 m height. It should be noted that this standardised wind speed is not the wind speed that would be expected to be measured at 10 m height for any specific hub height wind speed, rather better considered as a proxy for the hub height wind speed (the primary driver of noise emission from the turbine).
- The 'standardised' wind speed is calculated by extrapolating the hub height wind speed to 10 m height.
- The standardised 10 m wind speed is correlated with the measured background noise survey data.

Modelling Noise Propagation

9.4.12 Whilst there are several sound propagation models available, the ISO 9613 Part 2 model has been used [38], this being identified as most appropriate for use in such rural sites [39]. The specific interpretation of the ISO 9613 Part 2 propagation methodology recommended in the aforementioned IoA Bulletin and the subsequent IoA GPG has been employed.

9.4.13 To make noise predictions it is assumed that:

- The turbines are identical;
- The turbines radiate noise at the power specified in this report;
- Each turbine can be modelled as a point source at hub-height;
- Each residential property is assigned a reference height to simulate the presence of an observer.

9.4.14 The sound propagation model takes account of attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 °C and
70 % respectively, as recommended in the IoA Bulletin and IoA GPG. Ground effects are also taken into account by the propagation model with a ground factor of 0.5 and a receiver height of 4 m used as recommended in the IoA Bulletin and IoA GPG.

9.4.15 The barrier attenuations predicted by ISO 9613 Part 2 have been shown to be significantly greater than those measured in practice under downwind conditions [39]. Therefore, barrier attenuation according to the ISO 9613 Part 2 method has been discounted. In lieu of this, where there is no direct line of sight between the residential property in question and any part of the wind turbine, 2 dB attenuation has been assumed as recommended in the IoA Bulletin and the IoA GPG.

9.4.16 Additionally, verification studies have also shown that ISO 9613 Part 2 tends to slightly underestimate noise levels at nearby dwellings in certain exceptional cases, notably in a valley type environment where the ground drops off between source and receiver. In these instances an addition of 3 dB(A) has been applied to the resulting overall A-weighting noise level as recommended by the IoA GPG.

9.4.17 To generate the ground cross sections between each turbine and each dwelling necessary for reliable propagation modelling, ground contours at 5 m intervals for the area of interest have been generated from 50 m grid resolution digital terrain data.

9.4.18 The predicted noise levels are calculated as LAeq noise levels and changed to the LA90 descriptor (to allow comparisons to be made) by subtraction of -2 dB, as specified by ETSU-R-97.

9.4.19 It has been shown by measurement based verification studies that the ISO 9613 Part 2 model tends to slightly overestimate noise levels at nearby dwellings [39]. Examples of additional conservatism modelled are:

- Downwind propagation is modeled in all directions. In reality, noise propagation biases towards downwind locations, therefore predicted values are overestimated for upwind and crosswind of the proposed wind turbines;
- Although, in reality, the ground is predominantly porous (acoustically absorptive) it has been modelled as 'mixed', i.e. a combination of hard and porous, corresponding to a ground absorption coefficient of 0.5 as recommended by the IoA Bulletin and IoA GPG;
- Receiver heights are modeled at 4 m above local ground level, which equates roughly to first floor window level, as recommended by the IoA Bulletin and IoA GPG. This results in a predicted noise level anything up to 2 dB(A) higher than at the typical human ear height of 1.2-1.8 m;
- Trees and other non-terrain shielding effects have not been considered;
- An additional allowance for measurement uncertainty has been added to the warranted sound power levels for the presented turbine.

Significance Criteria

9.4.20 Noise is measured in decibels (dB) which is a measure of the sound pressure level, i.e. the magnitude of the pressure variations in the air. Measurements of environmental noise are usually made in dB(A) which includes a correction for the sensitivity of the human ear.

9.4.21 In accordance with the recommendations of ETSU-R-97, the acceptance of the proposed wind farm is established by comparing the noise levels produced by the combined operation of the wind turbines with appropriate noise limits at nearby residential properties.

9.4.22 Whilst ETSU-R-97 presents a comprehensive and detailed assessment methodology for wind farm noise, it also states a simplified methodology:

"if the noise is limited to an LA90,10min of 35dB(A) up to wind speeds of 10 m/s at 10 m height, then these conditions alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary".

9.4.23 In the detailed methodology, ETSU-R-97 states that different limits should be applied during daytime and night-time periods. The daytime limits are intended to preserve outdoor amenity, while the night-time limits are intended to prevent sleep disturbance. The general principle is that the noise limits should be based on existing background noise levels, except for very low background noise levels, in which case a fixed limit may be applied. The suggested limits are given below, where LB is the background LA90,10min and is a function of wind speed. During daytime periods and at low background noise levels, a permissible noise level of 35–40 dB(A) should be used. The exact value is dependent upon a number of factors: the number of nearby dwellings, the effect of the noise limits on energy produced, and the duration and level of exposure.

Table 2: Permissible Noise Level Criteria

Time of Day	Permissible Noise Level
Daytime periods	• 35-40 dB(A) for L_B less than 30-35 dB(A) • L_B + 5 dB, for L_B greater than 30-35 dB(A)
Night-time hours	43 dB(A) for L_B less than 38 dB(A) L_B + 5 dB, for L_B greater than 38 dB(A)

9.4.24 Note that a higher noise level is permissible during night-time hours than during daytime periods, as it is assumed that residents would be indoors. The night-time criterion is derived from sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB for attenuation through an open window.

9.4.25 The wind speeds at which the acoustic impact are considered are less than or equal to 12 m/s at a height of 10 m and are likely to be the acoustically critical wind speeds. Above these wind speeds, as stated in ETSU-R-97, reliable measurements of background and turbine noise are difficult to make. However, if a wind farm meets the noise criteria at wind speeds lower than that presented, it is highly unlikely that it will cause any greater loss of amenity at higher wind speeds due to increasing background noise levels masking wind farm generated noise.

9.4.26 It is important to note that, since reactions to noise are subjective, it is not possible to guarantee that a given development will not result in any adverse comment with regard to noise as the response to any given noise will vary from person to person. Consequently, standards and guidance that relate to environmental noise are typically presented in terms of criteria that would be expected to be considered acceptable by the majority of the population.

Method for Construction Noise Assessment

9.4.27 To ensure adequate assessment of the potential impacts of the construction noise from the proposed wind farm the following steps have been taken:

- Baseline noise criteria are established from the appropriate guidance BS 5228-1:2009;
- Noise predictions are made at the most critically sensitive residential properties due to on-site construction activities. These are calculated using the BS 5228-1:2009 standard;
- Predictions are made at the same residential properties due to construction traffic and are calculated using the BS 5228-1:2009 standard;
- The combined effect of on-site construction activities with construction traffic is compared with the target level specified by BS 5228-1:2009.

9.5 Baseline Conditions

Operational Noise

9.5.1 The proposed Garreg Lwyd Hill Wind Farm is located approximately 2 km south-west of Felindre. The surrounding area is predominantly rural in nature with an A-class road running to the west of the site. The general noise character is typical of a rural environment with noise from farm machinery, sheep, cattle, and birds, with the occasional overhead aircraft.

9.5.2 Background noise measurements were undertaken at six residential property locations by RES and a further two locations by a third party in accordance with ETSU-R-97 as detailed in Table 3.

Table 3: Background Noise Survey Details

Survey	House Name	Measurement Period			Instrument Type
		Start	End	Duration	
RES 1	Hopes Castle Farm	30/06/2006	24/07/2006	24 days	Rion NL 31
RES 1	Killowent	30/06/2006	24/07/2006	24 days	Rion NL 31
RES 1	Lower Green	30/06/2006	24/07/2006	24 days	Rion NL 31
RES 2	Bryn-mawr Cottage	27/04/2009	30/05/2009	33 days	Rion NL 31
RES 2	Cwm-mawr Stud	27/04/2009	30/05/2009	33 days	Rion NL 31
RES 2	Gatehouse Farm	27/04/2009	30/05/2009	33 days	Rion NL 31
Nuon	Blaen-nant-du 2	23/06/2006	14/07/2006	21 days	Rion NL 31
Nuon	Gwenlas	23/06/2006	14/07/2006	21 days	Rion NL 31

9.5.3 The background noise monitoring equipment was housed in weather-proof enclosures, and powered by lead-acid batteries. The microphones are placed at a height of approximately 1.2 – 1.5 m above ground, and equipped with all-weather wind shields which also provide an element of water resistance.

9.5.4 The wind shields used are designed to reduce the effects of wind-generated noise at the microphone and accord with the recommendations of the IoA GPG in that they are the appropriate size and, in combination with the microphone, are certified by the manufacturer as meeting Type 1 / Class 1 precision standards.

9.5.5 Noise levels are monitored continuously, and summary statistics stored every 10 minutes in the internal memory of each meter. The relevant statistic measured is the $LA_{90,10min}$ (The A-weighted sound pressure level exceeded for 90 % of the 10 minute interval).

9.5.6 The sound level meters were placed away from reflecting walls and vegetation. Photos of the equipment, in situ, may be seen in Technical Appendix 9.1. The apparatus were calibrated before and after the survey period and no significant drift was detected. All instrumentation had been subject to laboratory calibration traceable to national standards within the previous 24 months, as recommended in the IoA GPG.

9.5.7 Technical Appendix 9.2 Charts 1-3 show the measured wind rose at the proposed Garreg Lwyd Hill Wind Farm over the first RES, second RES and Nuon background noise survey periods respectively, as measured by the meteorological mast located on-site.

9.5.8 For illustrative purposes, Technical Appendix 9.2 Chart 4 shows the measured wind rose over an extended period 23/03/06 – 05/03/13 from the meteorological mast located on the proposed wind farm site. As previously discussed, the noise prediction model employed is likely to overestimate the real noise immission levels for locations not downwind of the turbines. Technical Appendix 9.2 Chart 4 therefore may aid the reader as to the likelihood of over-estimation due to this factor.

9.5.9 The noise data has been cross-referenced with rainfall data measured at the on-site met mast using a rain gauge. Any noise data identified as having been affected by rainfall has been removed from the analysis as shown in Technical Appendix 9.2 Charts 5 to 20.

9.5.10 Short-term periods of increased noise levels considered to be atypical, along with periods of increased noise levels identified as being due to the dawn chorus, typically between 4 am and 6 am, have been removed from the dataset. The excluded data is shown in Technical Appendix 9.2 Charts 5 to 20.

9.5.11 Technical Appendix 9.2 Charts 5-12 show $L_{A90,10min}$ correlated against wind speed during quiet waking hours at each survey location. In each case, a 'best fit' line has been fitted to the data and the noise limits added.

9.5.12 Technical Appendix 9.2 Charts 13-20 show $L_{A90,10min}$ correlated against the wind speed for night-time periods at each survey location. In each case, a 'best fit' line has been fitted to the data and the noise limits added. Table 4 and Table 5 details the $L_{A90,10min}$ background noise levels calculated from the derived 'best fit' lines, as described above:

Table 4: Quiet Waking Hours Background Noise Levels, dB(A)

House Name	Quiet Waking Hours Background Noise Levels at Indicated Locations Standardised 10 m Wind Speed (ms^{-1})

	1	2	3	4	5	6	7	8	9	10	11	12
Hopes Castle Farm	26.5	26.5	27.0	28.7	31.2	34.3	37.8	41.4	44.9	48.0	48.0	48.0
Killowent	28.5	28.5	28.7	29.6	31.0	32.8	34.9	37.3	39.8	42.3	42.3	42.3
Lower Green	27.9	27.9	28.1	29.0	30.6	32.7	35.2	37.9	40.7	43.5	43.5	43.5
Bryn-mawr Cottage	26.5	26.8	28.1	30.0	32.6	35.5	38.6	41.7	44.6	47.3	49.4	49.4
Cwm-mawr Stud	28.1	28.1	28.2	28.9	30.0	31.7	33.8	36.2	39.0	42.1	45.5	45.5
Gatehouse Farm	22.0	23.4	25.5	28.3	31.6	35.3	39.2	43.2	47.1	50.9	54.3	54.3
Blaen-nant-du 2	24.5	25.1	26.2	27.7	29.6	31.9	34.4	37.2	40.2	43.4	43.4	43.4
Gwenlas	29.3	29.3	29.6	30.3	31.4	33.0	34.9	37.4	40.5	44.0	44.0	44.0

Table 5: Night-time Background Noise Levels, dB(A)

House Name	Night Time Background Noise Levels at Indicated Locations Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Hopes Castle Farm	20.7	20.7	21.1	22.5	24.8	27.9	31.5	35.6	35.6	35.6	35.6	35.6
Killowent	24.4	24.4	24.4	24.5	25.6	27.8	31.1	35.6	35.6	35.6	35.6	35.6
Lower Green	20.7	20.7	21.0	22.7	25.2	28.2	31.2	33.6	33.6	33.6	33.6	33.6
Bryn-mawr Cottage	18.2	18.2	19.4	22.1	25.9	30.3	35.0	39.6	43.6	46.9	46.9	46.9
Cwm-mawr Stud	23.7	23.7	24.1	25.1	26.6	28.6	31.0	33.9	37.2	40.9	40.9	40.9
Gatehouse Farm	18.5	19.6	21.7	24.7	28.3	32.4	36.6	40.8	44.8	48.2	48.2	48.2
Blaen-nant-du 2	20.8	20.8	20.8	22.0	23.9	26.2	28.5	30.5	30.5	30.5	30.5	30.5
Gwenlas	26.1	26.1	26.1	26.1	26.4	27.3	28.8	31.2	31.2	31.2	31.2	31.2

Construction Noise

9.5.13 For the on-site construction noise assessment, Annex E of BS 5228-1:2009 provides guidance on setting environmental noise targets. Several methods of assessing the significance of noise levels are presented in Annex E and the most applicable to the construction of the proposed wind farm development is the ABC method. The ABC method sets threshold noise levels for specific periods based on the ambient noise levels.

9.6 Potential Impacts

Potential Operational Impacts

Noise Propagation Modelling

9.6.1 The locations of the proposed Garreg Lwyd Hill wind turbines are provided in Table 6 and shown in Figure 9.1.

Table 6: Location of Proposed Turbines

Turbine	OSGB Co-ordinates		Elevation (m)
	X (m)	Y (m)	
T1	314077	278776	449
T2	313719	278813	451
T3	314596	279042	464
T4	314257	279082	480
T5	313880	279128	461
T6	313543	279204	433
T8	313815	279489	431
T9	313282	279451	440
T10	314082	279723	432
T11	313539	279694	413
T13	313773	280096	401
T14	313379	280045	408
T15	313035	279770	444
T16	313191	280351	443
T17	313490	280494	446
T18	313845	280628	436
T23	312826	280256	439

9.6.2 The locations of the nearest residential properties to the turbines have been determined by inspection of relevant maps and through site visits. More residential properties may have been identified but have not been considered critical to this acoustic assessment or may be adequately represented by another residential property. The locations considered are listed in Table 7 and are also shown in Figure 9.1. Elevations, given in metres above mean sea level, have been determined from digital terrain data.

9.6.3 The distances from each residential property to the nearest turbine are given in Table 7. It can be seen that the minimum house-to-turbine separation to a proposed Garreg Lwyd Hill Wind Farm turbine is 814 m.

Table 7: Location of Residential Properties and Distances to Nearest Proposed Turbine

House Name	OSGB Co-ordinates		Elevation (m)	Distance (m)	Nearest Turbine
	X (m)	Y (m)			
Blaen-nant-du	310772	281936	425	2654	T23
Blaen-nant-du 2	310535	281877	432	2806	T23
Bryn-mawr Cottage	312712	281598	423	1336	T16
Bwlch-gwyn	314530	276779	432	2048	T1
Cork Cottage	314124	282351	346	1745	T18
Cwm yr Hob	315104	279678	337	814	T3
Cwm-gwyn Hall	313667	282633	332	2013	T18
Cwm-mawr	310786	279885	336	2073	T23
Cwm-mawr Stud	310692	279592	318	2235	T23
Ddol	311201	279689	326	1721	T23
Ddol - Holiday Home	311344	279818	351	1545	T23
Garn	310215	281777	435	3022	T23
Gatehouse Farm	315162	280038	410	1125	T10
Great House Barn	314944	281823	322	1624	T18
Green Hollow	316167	279704	403	1705	T3
Gwenlas	311435	280395	338	1398	T23
Hendy	314897	282374	304	2038	T18
Higher Fiddlers Green	311658	281737	401	1886	T23
Hopes Castle Farm	313288	281753	445	1255	T18
Killowent	315017	280583	310	1173	T18
Little House Farm	314734	281967	337	1607	T18
Llanrhys	315899	278546	355	1394	T3
Lower Fiddlers Green	311761	281614	388	1726	T23
Lower Green	312910	278434	393	893	T2
Lower House Farm	315527	278940	319	937	T3
Lower House Holt	315460	279110	323	867	T3
Maes-gwyn	315029	277734	386	1378	T3
New House	315556	278508	338	1099	T3
Pink House	315655	278530	326	1176	T3
Rhuvid	314814	281316	359	1188	T18
Scrubs Farm	316152	280018	318	1837	T3
Sign	312131	279161	421	1090	T15
Tansomalia	316061	280298	293	1930	T3
Tynybryniau	312296	278537	380	1344	T9
Upper Cae-glas	313496	276907	374	1919	T2
Upper Green	312768	278726	391	889	T9
Upper Ty-llidiart	314475	282226	356	1718	T18
Waen	312205	282244	386	2083	T23
Wood Cottage	315841	280678	335	1997	T18

9.6.4 Although not finalised, the candidate turbine type for the proposed Garreg Lwyd Hill Wind Farm is the Vestas V90 1.8 MW. This report uses the acoustic data from the manufacturer's general specification from this machine for all analysis [40]. The manufacturer has identified these values as warranted and comparison with the results of an independent test report suggests that some margin has already been incorporated. However, should the levels be tested it may be that the level of uncertainty in the test

measurement would also need to be accounted for. Accordingly, as a conservative measure within the assessment presented here, a further 1 dB has been added to the warranted turbine noise levels to allow for this given that a typical uncertainty of 0.9 dB can be expected according to IEC 61400-11 [37]. Details assumed in this analysis are as follows:

- A hub height of 80 m;
- A rotor diameter of 90 m;
- Sound power levels, LWA, for standardised 10 m height wind speeds (v10) as shown in Table 8;
- Octave band sound power level data as shown in Table 9;
- Tonal emission characteristics such that no clearly audible tones are present at any wind speed.

Table 8: Sound Power Levels for the Vestas V90 1.8 MW Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	A-Weighted Sound Power Level, dB(A)	
	Warranted noise levels	+1 dB uncertainty
3	92.6	93.6
4	95.6	96.6
5	99.8	100.8
6	102.8	103.8
7	103.7	104.7
8	104.0	105.0
9	104.0	105.0
10	104.0	105.0
11	104.0	105.0
12	104.0	105.0

Table 9: Octave Band Sound Power Level Data for the Vestas V90 1.8 MW Wind Turbine

Octave Band (Hz)	A-Weighted Sound Power Level at 10m standardised wind speeds, dB(A)				
	6 ms^{-1}	7 ms^{-1}	8 ms^{-1}	9 ms^{-1}	10 ms^{-1}
63	85.8	87.2	87.1	86.5	86.8
125	90.3	91.8	91.7	91.1	91.5
250	93.6	94.5	94.2	93.4	93.8
500	96.0	96.8	96.7	95.8	96.2
1000	98.7	99.3	99.5	98.8	99.3
2000	97.1	97.8	98.5	98.0	98.5
4000	95.1	96.3	97.0	99.3	97.5
8000	86.2	89.6	90.3	91.5	92.8
OVERALL	103.8	104.7	105.0	105.0	105.0

Predictions of Noise Levels at Residential Properties

9.6.5 Table 10 shows the predicted noise immission levels at the nearest residential properties at each wind speed considered, calculated from the operation of the proposed wind farm. The property with the maximum predicted noise immission level, 37.6 dB(A) and highlighted in bold, is Upper Green. Shading in the table indicates residential properties with predicted noise levels greater than 35 dB(A).

9.6.6 Figure 9.1 shows an isobel (i.e. noise contour) plot for the site at a 10 m height wind speed of 8 ms-1. Such plots are useful for evaluating the noise 'footprint' of a given development.

Table 10: Predicted Noise Levels At Nearby Residential Properties, dB(A)

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Blaen-nant-du	15.1	15.1	15.1	18.1	22.3	25.3	26.3	26.2	25.5	25.9	25.9	25.9
Blaen-nant-du 2	14.4	14.4	14.4	17.4	21.6	24.6	25.6	25.5	24.7	25.1	25.1	25.1
Bryn-mawr Cottage	22.5	22.5	22.5	25.5	29.7	32.7	33.6	33.6	32.8	33.2	33.2	33.2
Bwlch-gwyn	15.5	15.5	15.5	18.5	22.7	25.7	26.7	26.6	25.8	26.2	26.2	26.2
Cork Cottage	16.8	16.8	16.8	19.8	24.0	27.0	28.0	27.9	27.1	27.5	27.5	27.5
Cwm yr Hob	25.6	25.6	25.6	28.6	32.8	35.8	36.7	36.7	35.9	36.3	36.3	36.3
Cwm-gwyn Hall	15.7	15.7	15.7	18.7	22.9	25.9	26.8	26.7	26.0	26.4	26.4	26.4
Cwm-mawr	17.2	17.2	17.2	20.2	24.4	27.4	28.4	28.3	27.5	27.9	27.9	27.9
Cwm-mawr Stud	16.5	16.5	16.5	19.5	23.7	26.7	27.7	27.6	26.8	27.2	27.2	27.2
Ddol	18.6	18.6	18.6	21.6	25.8	28.8	29.7	29.6	28.9	29.3	29.3	29.3
Ddol - Holiday Home	19.9	19.9	19.9	22.9	27.1	30.1	31.0	31.0	30.2	30.6	30.6	30.6
Garn	15.6	15.6	15.6	18.6	22.8	25.8	26.9	26.8	26.0	26.4	26.4	26.4
Gatehouse Farm	26.2	26.2	26.2	29.2	33.4	36.4	37.3	37.2	36.5	36.9	36.9	36.9
Great House Barn	17.8	17.8	17.8	20.8	25.0	28.0	28.9	28.8	28.1	28.5	28.5	28.5
Green Hollow	22.1	22.1	22.1	25.1	29.3	32.3	33.3	33.2	32.4	32.8	32.8	32.8
Gwenlas	18.6	18.6	18.6	21.6	25.8	28.8	29.7	29.6	28.8	29.3	29.3	29.3
Hendy	15.2	15.2	15.2	18.2	22.4	25.4	26.4	26.3	25.5	25.9	25.9	25.9
Higher Fiddlers Green	19.1	19.1	19.1	22.1	26.3	29.3	30.2	30.1	29.4	29.8	29.8	29.8
Hopes Castle Farm	23.2	23.2	23.2	26.2	30.4	33.4	34.3	34.2	33.5	33.9	33.9	33.9
Killowent	23.4	23.4	23.4	26.4	30.6	33.6	34.5	34.5	33.7	34.2	34.2	34.2
Little House Farm	17.4	17.4	17.4	20.4	24.6	27.6	28.5	28.4	27.6	28.1	28.1	28.1
Llanrhys	22.0	22.0	22.0	25.0	29.2	32.2	33.1	33.0	32.3	32.7	32.7	32.7
Lower Fiddlers Green	18.8	18.8	18.8	21.8	26.0	29.0	29.9	29.8	29.1	29.5	29.5	29.5
Lower Green	26.4	26.4	26.4	29.4	33.6	36.6	37.4	37.4	36.7	37.1	37.1	37.1
Lower House Farm	22.7	22.7	22.7	25.7	29.9	32.9	33.8	33.8	33.0	33.4	33.4	33.4
Lower House Holt	23.1	23.1	23.1	26.1	30.3	33.3	34.1	34.1	33.4	33.8	33.8	33.8
Maes-gwyn	20.4	20.4	20.4	23.4	27.6	30.6	31.5	31.4	30.7	31.1	31.1	31.1
New House	22.6	22.6	22.6	25.6	29.8	32.8	33.6	33.6	32.9	33.3	33.3	33.3
Pink House	20.7	20.7	20.7	23.7	27.9	30.9	31.8	31.8	31.0	31.4	31.4	31.4
Rhuvid	21.1	21.1	21.1	24.1	28.3	31.3	32.2	32.1	31.4	31.8	31.8	31.8
Scrubs Farm	20.2	20.2	20.2	23.2	27.4	30.4	31.4	31.3	30.6	31.0	31.0	31.0
Sign	24.4	24.4	24.4	27.4	31.6	34.6	35.5	35.5	34.7	35.2	35.2	35.2
Tansomalia	18.8	18.8	18.8	21.8	26.0	29.0	29.9	29.9	29.1	29.5	29.5	29.5
Tynybryniau	23.1	23.1	23.1	26.1	30.3	33.3	34.2	34.1	33.4	33.8	33.8	33.8
Upper Cae-glas	16.7	16.7	16.7	19.7	23.9	26.9	27.9	27.8	27.0	27.4	27.4	27.4
Upper Green	26.6	26.6	26.6	29.6	33.8	36.8	**37.6**	**37.6**	36.9	37.3	37.3	37.3
Upper Ty-Ilidiart	16.8	16.8	16.8	19.8	24.0	27.0	27.9	27.8	27.1	27.5	27.5	27.5
Waen	15.8	15.8	15.8	18.8	23.0	26.0	27.0	26.9	26.1	26.5	26.5	26.5
Wood Cottage	21.2	21.2	21.2	24.2	28.4	31.4	32.3	32.2	31.5	31.9	31.9	31.9

9.6.7 Noise levels at 34 of the 39 nearest residential properties are below 35 dB(A) level, indicating that the noise immission levels would be regarded as acceptable and the residents amenity as receiving 'sufficient protection' without further assessment requiring to be undertaken.

9.6.8 There are five properties that have predicted noise levels greater than this simplified noise criteria as indicated in Table 10. Therefore the 'full' acoustic assessment need only be considered at these. However, as background noise surveys were carried out at Blaen-nant-du 2, Bryn-mawr Cottage Cwm-mawr Stud, Gwenlas, Hopes Castle Farm, Killowent and Lower Green, as agreed with the local authority, these properties have also been considered in the full acoustic assessment so as to provide a more comprehensive description of the acoustic impact of the proposed wind farm.

Acoustic Acceptance Criteria

9.6.9 As stated previously, during daytime periods and at low background noise levels, a permissible noise level of 35-40 dB(A) should be used with the exact value dependent upon a number of factors: the number of noise affected residential properties; the potential impact on the power output of the wind farm and the likely duration and level of exposure. Through consideration of these factors RES have adopted a 37.5 dB(A) level, with justification provided in the following paragraph and the permissible noise level criteria shown in Table 11.

9.6.10 Justification for the daytime lower limit, considering each of the factors recommended by ETSU-R-97 and the guidance provided by the IoA GPG, is as follows:

- **Number of noise affected residential properties**: Five residential properties, two of which would be downwind of the proposed wind farm in the predominant wind direction, are predicted to experience noise levels of greater than 35 dB(A). This is a relatively small number given the scale of the project, which would generate significant social, economic and environmental benefits, suggesting a limit towards the upper end of the range would be appropriate;
- **Potential impact on the power output of the wind farm**: The rated power of the proposed wind farm would be 30.6 MW should the turbine type considered in the acoustic assessment be installed, an intermediate size compared to other wind farm developments in Wales, suggesting that a lower limit in the middle of the range would be appropriate. Restricting the lower limit to 35 dB(A) could limit the number and size of turbines installed or result in noise management being required, thereby impacting the amount of energy produced;
- **The likely duration and level of exposure**: The amount of time that noise levels of greater than 35 dB(A) are predicted is limited to periods of sufficiently high wind speed. Noise levels will also be reduced when properties are not located downwind of the proposed wind farm. As mentioned above, two of the five residential properties with predicted noise levels of greater than 35 dB(A) are downwind in the predominant wind direction. It would therefore be suggested that a daytime lower limit in the middle of the range is applied.

Table 11: Permissible Noise Level Criteria in Vicinity of Proposed Garreg Lwyd Hill Wind Farm

Time of Day	Permissible Noise Level
Daytime periods	• 37.5 dB(A) for L_B less than 32.5 dB(A) • L_B + 5 dB, for L_B greater than 32.5 dB(A)
Night-time hours	43 dB(A) for L_B less than 38 dB(A) L_B + 5 dB, for L_B greater than 38 dB(A)

9.6.11 Note that a higher noise level is permissible during night-time hours than during daytime periods, as it is assumed that residents would be indoors.

Calculation of Acceptable Noise Limits from Baseline Conditions

9.6.12 The 'best-fit' lines of Technical Appendix 9.2 Charts 5-20 have been used to calculate the acceptable noise limits at the background noise measurement locations.

9.6.13 Table 12 shows the daytime noise limits and Table 13 the night time noise limits.

Table 12: Daytime Noise Limits, dB(A)

House Name	Daytime Noise Limits at Indicated Locations Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Hopes Castle Farm	37.5	37.5	37.5	37.5	37.5	39.3	42.8	46.4	49.9	53.0	53.0	53.0
Killowent	37.5	37.5	37.5	37.5	37.5	37.8	39.9	42.3	44.8	47.3	47.3	47.3
Lower Green	37.5	37.5	37.5	37.5	37.5	37.7	40.2	42.9	45.7	48.5	48.5	48.5
Bryn-mawr Cottage	37.5	37.5	37.5	37.5	37.6	40.5	43.6	46.7	49.6	52.3	54.4	54.4
Cwm-mawr Stud	37.5	37.5	37.5	37.5	37.5	37.5	38.8	41.2	44.0	47.1	50.5	50.5
Gatehouse Farm	37.5	37.5	37.5	37.5	37.5	40.3	44.2	48.2	52.1	55.9	59.3	59.3
Blaen-nant-du 2	37.5	37.5	37.5	37.5	37.5	37.5	39.4	42.2	45.2	48.4	48.4	48.4
Gwenlas	37.5	37.5	37.5	37.5	37.5	38.0	39.9	42.4	45.5	49.0	49.0	49.0

Table 13: Night-time Noise Limits, dB(A)

House Name	Night Time Noise Limits at Indicated Locations Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Hopes Castle Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Killowent	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Lower Green	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Bryn-mawr Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.6	48.6	51.9	51.9	51.9
Cwm-mawr Stud	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.9	45.9	45.9
Gatehouse Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.8	49.8	53.2	53.2	53.2
Blaen-nant-du 2	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Gwenlas	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

9.6.14 The recommendations of ETSU-R-97 state that where there are groups of properties that are likely to have a similar background noise environment, it is appropriate to use data from one representative location as the basis for assessment at the other properties. The survey results inferred to be representative for each property is shown in Table 14. The specific choice of noise survey chosen has been made considering the distance to the nearest survey location and the likelihood of experiencing a broadly similar exposure as the survey.

Table 14: Representative Background Noise Survey Locations

House Name	Representative Background Noise Survey
Blaen-nant-du	Blaen-nant-du 2
Blaen-nant-du 2	Blaen-nant-du 2
Bryn-mawr Cottage	Bryn-mawr Cottage
Bwlch-gwyn	Blaen-nant-du 2
Cork Cottage	Killowent
Cwm yr Hob	Killowent
Cwm-gwyn Hall	Killowent
Cwm-mawr	Cwm-mawr Stud
Cwm-mawr Stud	Cwm-mawr Stud
Ddol	Cwm-mawr Stud
Ddol - Holiday Home	Cwm-mawr Stud
Garn	Blaen-nant-du 2
Gatehouse Farm	Gatehouse Farm
Great House Barn	Killowent
Green Hollow	Gatehouse Farm
Gwenlas	Gwenlas
Hendy	Killowent
Higher Fiddlers Green	Blaen-nant-du 2
Hopes Castle Farm	Hopes Castle Farm

House Name	Representative Background Noise Survey
Killowent	Killowent
Little House Farm	Killowent
Llanrhys	Killowent
Lower Fiddlers Green	Blaen-nant-du 2
Lower Green	Lower Green
Lower House Farm	Killowent
Lower House Holt	Killowent
Maes-gwyn	Lower Green
New House	Killowent
Pink House	Killowent
Rhuvid	Killowent
Scrubs Farm	Killowent
Sign	Blaen-nant-du 2
Tansomalia	Killowent
Tynybryniau	Lower Green
Upper Cae-glas	Lower Green
Upper Green	Lower Green
Upper Ty-llidiart	Killowent
Waen	Blaen-nant-du 2
Wood Cottage	Killowent

9.6.15 As recommended in ETSU-R-97, the absolute lower noise limits may be increased up to 45 dB(A) if the occupant has a financial involvement in the wind farm. However, whilst some of the nearby properties may qualify for such an increase, these limits have not been adopted in the presented results.

Acoustic Assessment

9.6.16 Table 15 shows a comparison of the predicted noise levels with the recommended daytime noise limits for each residential property where the full assessment procedure is being applied. The predicted noise levels at 1 ms-1 and 2 ms-1 have been assumed as equal to 3 ms-1, though this is a conservative measure as noise levels at these wind speeds would typically be less. The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit. A negative value indicates that the predicted noise level is within the limit.

9.6.17 Table 16 shows a comparison with the recommended night-time noise limits.

9.6.18 Noise levels at all locations are within both the daytime and night-time noise limits, at all wind speeds considered. The minimum margin of predicted noise levels below derived noise limits, for all wind speeds considered, during daytime periods, is -0.9 dB(A). Similarly the minimum margin during night time periods, for all wind speeds considered, is -5.4 dB(A). These are highlighted in Table 15 and Table 16, Chart 21, Technical Appendix 9.2, shows the predicted noise levels and noise limits at the property where the minimum margin occurs; Upper Green.

Table 15: Comparison of Predicted Noise Levels and Daytime Noise Limits, dB(A)

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Blaen-nant-du 2	14.4	37.5	-23.1	14.4	37.5	-23.1	14.4	37.5	-23.1	17.4	37.5	-20.1
Bryn-mawr Cottage	22.5	37.5	-15.0	22.5	37.5	-15.0	22.5	37.5	-15.0	25.5	37.5	-12.0
Cwm yr Hob	25.6	37.5	-11.9	25.6	37.5	-11.9	25.6	37.5	-11.9	28.6	37.5	-8.9
Cwm-mawr Stud	16.5	37.5	-21.0	16.5	37.5	-21.0	16.5	37.5	-21.0	19.5	37.5	-18.0
Gatehouse Farm	26.2	37.5	-11.3	26.2	37.5	-11.3	26.2	37.5	-11.3	29.2	37.5	-8.3
Gwenlas	18.6	37.5	-18.9	18.6	37.5	-18.9	18.6	37.5	-18.9	21.6	37.5	-15.9
Hopes Castle Farm	23.2	37.5	-14.3	23.2	37.5	-14.3	23.2	37.5	-14.3	26.2	37.5	-11.3
Killowent	23.4	37.5	-14.1	23.4	37.5	-14.1	23.4	37.5	-14.1	26.4	37.5	-11.1
Lower Fiddlers Green	18.8	37.5	-18.7	18.8	37.5	-18.7	18.8	37.5	-18.7	21.8	37.5	-15.7
Lower Green	26.4	37.5	-11.1	26.4	37.5	-11.1	26.4	37.5	-11.1	29.4	37.5	-8.1
Sign	24.4	37.5	-13.1	24.4	37.5	-13.1	24.4	37.5	-13.1	27.4	37.5	-10.1
Upper Green	26.6	37.5	-10.9	26.6	37.5	-10.9	26.6	37.5	-10.9	29.6	37.5	-7.9

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Blaen-nant-du 2	21.6	37.5	-15.9	24.6	37.5	-12.9	25.6	39.4	-13.8	25.5	42.2	-16.7
Bryn-mawr Cottage	29.7	37.6	-7.9	32.7	40.5	-7.8	33.6	43.6	-10.0	33.6	46.7	-13.1
Cwm yr Hob	32.8	37.5	-4.7	35.8	37.8	-2.0	36.7	39.9	-3.2	36.7	42.3	-5.6
Cwm-mawr Stud	23.7	37.5	-13.8	26.7	37.5	-10.8	27.7	38.8	-11.1	27.6	41.2	-13.6
Gatehouse Farm	33.4	37.5	-4.1	36.4	40.3	-3.9	37.3	44.2	-6.9	37.2	48.2	-11.0
Gwenlas	25.8	37.5	-11.7	28.8	38.0	-9.2	29.7	39.9	-10.2	29.6	42.4	-12.8
Hopes Castle Farm	30.4	37.5	-7.1	33.4	39.3	-5.9	34.3	42.8	-8.5	34.2	46.4	-12.2
Killowent	30.6	37.5	-6.9	33.6	37.8	-4.2	34.5	39.9	-5.4	34.5	42.3	-7.8
Lower Fiddlers Green	26.0	37.5	-11.5	29.0	37.5	-8.5	29.9	39.4	-9.5	29.8	42.2	-12.4
Lower Green	33.6	37.5	-3.9	36.6	37.7	-1.1	37.4	40.2	-2.8	37.4	42.9	-5.5
Sign	31.6	37.5	-5.9	34.6	37.5	-2.9	35.5	39.4	-3.9	35.5	42.2	-6.7
Upper Green	33.8	37.5	-3.7	36.8	37.7	-0.9	37.6	40.2	-2.6	37.6	42.9	-5.3

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Blaen-nant-du 2	24.7	45.2	-20.5	25.1	48.4	-23.3	25.1	48.4	-23.3	25.1	48.4	-23.3
Bryn-mawr Cottage	32.8	49.6	-16.8	33.2	52.3	-19.1	33.2	54.4	-21.2	33.2	54.4	-21.2
Cwm yr Hob	35.9	44.8	-8.9	36.3	47.3	-11.0	36.3	47.3	-11.0	36.3	47.3	-11.0
Cwm-mawr Stud	26.8	44.0	-17.2	27.2	47.1	-19.9	27.2	50.5	-23.3	27.2	50.5	-23.3
Gatehouse Farm	36.5	52.1	-15.6	36.9	55.9	-19.0	36.9	59.3	-22.4	36.9	59.3	-22.4
Gwenlas	28.8	45.5	-16.7	29.3	49.0	-19.7	29.3	49.0	-19.7	29.3	49.0	-19.7
Hopes Castle Farm	33.5	49.9	-16.4	33.9	53.0	-19.1	33.9	53.0	-19.1	33.9	53.0	-19.1
Killowent	33.7	44.8	-11.1	34.2	47.3	-13.1	34.2	47.3	-13.1	34.2	47.3	-13.1
Lower Fiddlers Green	29.1	45.2	-16.1	29.5	48.4	-18.9	29.5	48.4	-18.9	29.5	48.4	-18.9
Lower Green	36.7	45.7	-9.0	37.1	48.5	-11.4	37.1	48.5	-11.4	37.1	48.5	-11.4
Sign	34.7	45.2	-10.5	35.2	48.4	-13.2	35.2	48.4	-13.2	35.2	48.4	-13.2
Upper Green	36.9	45.7	-8.8	37.3	48.5	-11.2	37.3	48.5	-11.2	37.3	48.5	-11.2

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit
The shaded value denotes the minimum daytime ΔL value

Table 16: Comparison of Predicted Noise Levels and Night Time Noise Limits, dB(A)

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Blaen-nant-du 2	14.4	43.0	-28.6	14.4	43.0	-28.6	14.4	43.0	-28.6	17.4	43.0	-25.6
Bryn-mawr Cottage	22.5	43.0	-20.5	22.5	43.0	-20.5	22.5	43.0	-20.5	25.5	43.0	-17.5
Cwm yr Hob	25.6	43.0	-17.4	25.6	43.0	-17.4	25.6	43.0	-17.4	28.6	43.0	-14.4
Cwm-mawr Stud	16.5	43.0	-26.5	16.5	43.0	-26.5	16.5	43.0	-26.5	19.5	43.0	-23.5
Gatehouse Farm	26.2	43.0	-16.8	26.2	43.0	-16.8	26.2	43.0	-16.8	29.2	43.0	-13.8
Gwenlas	18.6	43.0	-24.4	18.6	43.0	-24.4	18.6	43.0	-24.4	21.6	43.0	-21.4
Hopes Castle Farm	23.2	43.0	-19.8	23.2	43.0	-19.8	23.2	43.0	-19.8	26.2	43.0	-16.8
Killowent	23.4	43.0	-19.6	23.4	43.0	-19.6	23.4	43.0	-19.6	26.4	43.0	-16.6
Lower Fiddlers Green	18.8	43.0	-24.2	18.8	43.0	-24.2	18.8	43.0	-24.2	21.8	43.0	-21.2
Lower Green	26.4	43.0	-16.6	26.4	43.0	-16.6	26.4	43.0	-16.6	29.4	43.0	-13.6
Sign	24.4	43.0	-18.6	24.4	43.0	-18.6	24.4	43.0	-18.6	27.4	43.0	-15.6
Upper Green	26.6	43.0	-16.4	26.6	43.0	-16.4	26.6	43.0	-16.4	29.6	43.0	-13.4

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Blaen-nant-du 2	21.6	43.0	-21.4	24.6	43.0	-18.4	25.6	43.0	-17.4	25.5	43.0	-17.5
Bryn-mawr Cottage	29.7	43.0	-13.3	32.7	43.0	-10.3	33.6	43.0	-9.4	33.6	44.6	-11.0
Cwm yr Hob	32.8	43.0	-10.2	35.8	43.0	-7.2	36.7	43.0	-6.3	36.7	43.0	-6.3
Cwm-mawr Stud	23.7	43.0	-19.3	26.7	43.0	-16.3	27.7	43.0	-15.3	27.6	43.0	-15.4
Gatehouse Farm	33.4	43.0	-9.6	36.4	43.0	-6.6	37.3	43.0	-5.7	37.2	45.8	-8.6
Gwenlas	25.8	43.0	-17.2	28.8	43.0	-14.2	29.7	43.0	-13.3	29.6	43.0	-13.4
Hopes Castle Farm	30.4	43.0	-12.6	33.4	43.0	-9.6	34.3	43.0	-8.7	34.2	43.0	-8.8
Killowent	30.6	43.0	-12.4	33.6	43.0	-9.4	34.5	43.0	-8.5	34.5	43.0	-8.5
Lower Fiddlers Green	26.0	43.0	-17.0	29.0	43.0	-14.0	29.9	43.0	-13.1	29.8	43.0	-13.2
Lower Green	33.6	43.0	-9.4	36.6	43.0	-6.4	37.4	43.0	-5.6	37.4	43.0	-5.6
Sign	31.6	43.0	-11.4	34.6	43.0	-8.4	35.5	43.0	-7.5	35.5	43.0	-7.5
Upper Green	33.8	43.0	-9.2	36.8	43.0	-6.2	37.6	43.0	-5.4	37.6	43.0	-5.4

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Blaen-nant-du 2	24.7	43.0	-18.3	25.1	43.0	-17.9	25.1	43.0	-17.9	25.1	43.0	-17.9
Bryn-mawr Cottage	32.8	48.6	-15.8	33.2	51.9	-18.7	33.2	51.9	-18.7	33.2	51.9	-18.7
Cwm yr Hob	35.9	43.0	-7.1	36.3	43.0	-6.7	36.3	43.0	-6.7	36.3	43.0	-6.7
Cwm-mawr Stud	26.8	43.0	-16.2	27.2	45.9	-18.7	27.2	45.9	-18.7	27.2	45.9	-18.7
Gatehouse Farm	36.5	49.8	-13.3	36.9	53.2	-16.3	36.9	53.2	-16.3	36.9	53.2	-16.3
Gwenlas	28.8	43.0	-14.2	29.3	43.0	-13.7	29.3	43.0	-13.7	29.3	43.0	-13.7
Hopes Castle Farm	33.5	43.0	-9.5	33.9	43.0	-9.1	33.9	43.0	-9.1	33.9	43.0	-9.1
Killowent	33.7	43.0	-9.3	34.2	43.0	-8.8	34.2	43.0	-8.8	34.2	43.0	-8.8
Lower Fiddlers Green	29.1	43.0	-13.9	29.5	43.0	-13.5	29.5	43.0	-13.5	29.5	43.0	-13.5
Lower Green	36.7	43.0	-6.3	37.1	43.0	-5.9	37.1	43.0	-5.9	37.1	43.0	-5.9
Sign	34.7	43.0	-8.3	35.2	43.0	-7.8	35.2	43.0	-7.8	35.2	43.0	-7.8
Upper Green	36.9	43.0	-6.1	37.3	43.0	-5.7	37.3	43.0	-5.7	37.3	43.0	-5.7

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit
The shaded value denotes the minimum night-time ΔL value

Potential Construction Impacts

Construction Noise Assessment

9.6.19 Primary activities for which noise arises during the construction period include the construction of turbine foundations; turbine erection; the excavation of trenches for cables; and the construction of associated hard-standings, access tracks and construction compounds. Noise from vehicles on local roads and access tracks will also arise due to the delivery of turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

9.6.20 It should be noted that the exact methodology and timing of construction activities cannot be predicted at this time, this assessment is therefore based on assumptions representing a worst-case approach.

Construction Noise Predictions

9.6.21 The plant assumed for each construction activity is shown in Table 17. The number of items indicates how many of each plant are required for the specified activity, and the duration of activity is a percentage of a given 12 hour day period needed for that plant to operate. Overall sound power levels are based upon the data in Annex C of BS 5228-1:2009.

Table 17: Construction Phases and Sound Power Levels

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
Construct temporary site compounds	Tracked excavator	113	2	100	119
	Dump truck	113	2	100	
	Tipper lorry	107	2	50	
	Vibratory roller	102	1	75	
	Lorry	108	1	75	
Construct site tracks	Tracked excavator	113	3	100	120
	Dump truck	113	2	75	
	Tipper lorry	107	4	50	
	Dozer	109	1	100	
	Vibratory roller	102	1	75	
Construct Sub-Station	Tracked excavator	113	1	100	115
	Concrete mixer truck	108	2	50	
	Lorry	108	1	50	
	Telescopic Handler	99	1	100	
	Concrete pump	106	1	50	
Construct crane hard-standings	Tracked excavator	113	3	100	121
	Dump truck	113	2	100	
	Tipper lorry	107	4	50	
	Dozer	109	1	100	
	Vibratory roller	102	1	50	
Construct turbine foundations	Tracked excavator	113	2	75	119
	Dump truck	113	2	75	
	Concrete mixer truck	108	4	50	
	Mobile telescopic crane	110	1	50	
	Concrete pump	106	2	50	
	Compressor	103	3	50	
	Poker vibrator	106	3	50	
Excavate and lay site cables	Tracked excavator	113	2	100	117
	Tractor with hydraulic winch (towing equipment)	108	1	75	
	Tractor (towing trailer)	107	1	75	
	Vibratory plate	108	1	50	

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
Erect turbines	Mobile telescopic crane	110	2	75	119
	Lorry	108	1	75	
	Diesel generator	102	1	100	
	Torque guns	111	4	100	
Reinstate crane bases	Tracked excavator	113	2	75	116
	Dump truck	113	1	75	
Water Crossings	Tracked excavator	113	1	50	113
	Mobile telescopic crane	110	1	50	
	Vibratory plate	108	1	50	
	Lorry	108	1	50	
Borrow Pits	Tracked excavator	113	2	75	126
	Wheeled loader	108	1	75	
	Tracked semi-mobile crusher	124	1	75	
	Excavator mounted rock breaker	121	2	75	

9.6.22 Predictions of construction noise levels have been carried out using the methods prescribed in Annex F of BS 5228-1:200919 with adoption of the worst case scenario where all major construction activities take place at the nearest possible location to each assessed residential property. The locations of the construction activities are taken from the infrastructure drawing. The results of these predictions, made at five representative critical residential properties to the proposed wind farm, are shown in Table 18.

9.6.23 In all cases average noise levels over the construction period will be lower as the worst case is presented for when the activities are closest to the residential property.

Table 18: Construction Noise Predictions

Activity	Predicted Sound Pressure Level (dB L_{Aeq})				
	Blaen-nant-du	Cwm yr Hob	Gwenlas	Lower Fiddlers Green	Upper Green
Construct temporary site compound	54.7	42.8	45.6	49.3	46.1
Construct public car park	45.2	34.8	46.0	61.2	37.2
Construct site tracks	57.6	50.3	52.9	73.6	52.8
Construct sub-station	31.4	37.7	36.2	34.7	40.2
Construct crane hard-standings	39.1	50.6	45.3	43.3	49.8
Construct turbine foundations	37.9	49.5	44.2	42.1	48.6
Excavate and lay site cables	35.6	47.1	41.8	39.8	46.3
Erect turbines	37.0	48.6	43.3	41.2	47.7
Reinstate crane bases	34.9	46.4	41.1	39.1	45.6
Water crossings	39.1	40.6	44.3	47.4	39.7
Borrow pits	57.6	50.5	54.5	62.9	52.9

[19] A 50% mixed ground attenuation has been used throughout to conservatively account for the arable nature of ground conditions at Garreg Lwyd Hill Wind Farm

Construction Traffic

9.6.24 Due to the provision of construction material and wind farm components, vehicle movements either into or away from the site shall increase levels of traffic flow on public roads in the area. Traffic regularly accessing the site is shown in Chapter 8: Transport and Access and is assumed to be characterised by the sound power levels of Dump Trucks and Concrete Mixers as a worst case. It is estimated that a total of 180 vehicle movements per day would be required during the most intense period of construction activity although this would only be the case for a maximum of 17 days during foundation pouring.

9.6.25 Construction traffic noise has been quantified using the method described in BS 5228:2009 Part 1. Using the distances from residential properties to the centre of the relevant carriageway where site traffic will be, the noise levels predicted are presented in Table 19. According to the assumptions made the maximum sound pressure level due to traffic flows during the most intensive period of activity will be 55.4 dB LAeq.

Table 19: Traffic Noise Predictions

Activity	Predicted Sound Pressure Level (dB L_{Aeq})				
	Blaen-nant-du	Cwm yr Hob	Gwenlas	Lower Fiddlers Green	Upper Green
Dump truck	49.2	43.6	44.7	53.9	44.6
Concrete mixer truck	45.6	39.9	41.0	50.2	41.0
Total	50.8	45.1	46.3	55.4	46.2

General Construction Noise in Conjunction with Traffic Noise

9.6.26 Worst case construction noise levels may arise when the following simultaneous activities occur: construction of nearest access track or water crossing; construction of substation; construction of nearest crane hard-standing; construction of nearest turbine foundation; and the extraction of material from the nearest borrow pit. Therefore cumulative predictions of these construction activities and the additional noise contribution from construction traffic have been calculated and are shown in Table 20.

9.6.27 It should be noted that the predictions exclude the screening effects of local topography therefore actual levels of noise experienced at nearby residential properties could be lower.

Table 20: Predicted Noise Due to Combined Traffic Noise and Turbine Construction

Activity	Predicted Sound Pressure Level (dB L_{Aeq})				
	Blaen-nant-du	Cwm yr Hob	Gwenlas	Lower Fiddlers Green	Upper Green
Construction Plant Noise	60.6	56.3	57.3	73.9	57.5
Traffic Noise	50.8	45.1	46.3	55.4	46.2
Combined Noise	61.1	56.7	57.7	74.0	57.8

Assessment of Construction Noise

9.6.28 In accordance with the ABC method of Annex E of BS 5228-1:2009, due to the relatively low levels of ambient noise at the proposed Garreg Lwyd Hill Wind Farm site a Category A assessment of the ABC method is used for acceptable limits. This category sets minimum LAeq criteria of: 65 dB(A) during weekdays (0700-1900) and Saturdays (0700-1300); below 55 dB(A) at evenings and weekends; and below 45 dB(A) for night-time (2300-0700). Table 20 shows that predicted noise levels from the combined effect of increased traffic flows and activities associated with peak construction of the wind farm are below the 65 dB(A) daytime target level specified by BS 5228-1:2009 at four of the five assessed

residential properties. Peak construction noise levels are predicted to exceed the 55 dB(A) target level for evenings and weekends at all five of the assessed properties although, of the times when this criterion applies, construction is only scheduled to take place on Mondays to Fridays 0600-0700 and 1900-2000 and Saturdays 0600-0700 and 1300-2000 with the exception of turbine erection and commissioning or periods of emergency work. An assessment against the night-time target level has not been undertaken as construction work is not scheduled to take place during the night. The predictions made represent the worst case combination of most intensive traffic activity with simultaneous construction activity at the nearest possible location to each residential property.

9.6.29 Levels of construction noise greater than the 65 dB(A) daytime target level are predicted at Lower Fiddlers Green due to the construction of site tracks. Such noise levels will only occur over a limited time period when the track closest to the residential property is being constructed. Noise levels are predicted to drop below 65 dB(A) once the construction activity is greater than 180 m away, which is expected to occur after four days based on typical rates of construction.

9.7 Mitigation

Operational Noise

9.7.1 One of the key turbine layout design constraint considerations was the minimisation of potential noise impacts at the nearest residential receptors. As such the turbine layout was initially designed to ensure that there is an adequate separation distance between any of the proposed turbines and the nearest residential property.

9.7.2 Due to consideration in the design of the wind farm, no mitigation measures are required for the operation of the proposed turbines as the proposed development complies with noise criteria.

9.7.3 It is worth noting that the operation of many modern turbines may be altered by changing the pitch of the wind turbine blades resulting in a trade-off between power production and noise reduction. Therefore in the unlikely event that noise levels at nearby residential properties need to be readdressed once they become operational, there is a mechanism for enacting this.

9.7.4 Before procurement of a turbine, RES standard practice would be to seek to obtain a warranty from the manufacturer that the turbines will not incur a tonal penalty at the nearest residential properties, based upon the ETSU-R-97 guideline definition.

9.7.5 If planning permission is granted for the proposed wind farm, the decision letter would likely contain noise conditions which would provide a degree of protection to nearby residents in the unlikely event that noise from the wind farm gives rise to complaint.

Construction Noise

9.7.6 For all activities, measures will be taken to reduce noise levels with due regard to practicality and cost as per the concept of ‘best practicable means’ as defined in Section 72 of the Control of Pollution Act 1974.

9.7.7 BS 5228-1:2009 states that the ‘attitude of the contractor’ is important in minimising the likelihood of complaints and therefore consultation with the local authority should occur and steps should be taken to inform residents of intended activity. Non-acoustic factors, which influence the overall level of complaints such as mud on roads and dust generation, will also be controlled.

9.7.8 Furthermore, the following noise mitigation options will be implemented where appropriate:

- Consideration will be given to noise emissions when selecting plant and equipment to be used on site;
- All equipment should be maintained in good working order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable;
- Stationary noise sources will be sited as far away as reasonably possible from residential properties and where necessary and appropriate, acoustic barriers will be used to screen them; and
- The movement of vehicles to and from the site will be controlled and employees will be instructed to ensure compliance with the noise control measures adopted.

9.7.9 Site operations will be limited to 0600-2000 Monday to Saturday except during turbine erection and commissioning or during periods of emergency work. Should it be considered necessary to reduce noise levels from the conservative predicted levels to adhere to the 55 dB(A) target level for Mondays to Fridays 0600-0700 and 1900-2000 and Saturdays 0600-0700 and 1300-2000, the following mitigation measures would be considered:

- Reduce the number of construction activities occurring simultaneously;
- Restrict the distance of construction activity from nearby properties during these times; &
- Reduce construction traffic as appropriate.

9.7.10 The temporary increase of construction noise above the 65 dB(A) daytime target level at Lower Fiddlers Green could be mitigated through the use of acoustic barriers if required.

9.7.11 There are many strategies to reduce construction noise by the limitation of activities that would result in predicted noise levels being lower than the specified target. Any such measures should be considered adequate and the mitigation adopted should not be limited to the measures proposed.

9.8 Residual Effects

Operational

9.8.1 The acoustic assessment concludes that predicted noise levels at the nearest residential properties do not exceed either night time or quiet day time limits under all considered conditions. This should not be interpreted to mean that wind farm operational noise will be inaudible (or masked by background noise) under all conditions, but that the levels of noise are acceptable in accordance with relevant legislation and guidance.

Construction

9.8.2 There is predicted to be a temporary increase above the 65 dB(A) criteria noise level at Lower Fiddlers Green when the site tracks nearest this property are being constructed although this could be mitigated through the use of acoustic barriers if required. There may be an increase above the 55 dB(A) criteria level for Mondays to Fridays 0600-0700 and 1900-2000 and Saturdays 0600-0700 and 1300-2000 at all five of the assessed properties although this can be mitigated by restricting the activities that are allowed to take place as necessary. At all other times predicted noise levels from the worst case combination of increased traffic and site construction noise will not exceed relevant criteria and therefore no significant impacts are expected.

9.9 Cumulative Effects

Cumulative Operational Noise Assessment

9.9.1 An assessment of the cumulative acoustic impact of the proposed Garreg Lwyd Hill Wind Farm alongside the proposed Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms has been undertaken in accordance with the guidance on wind farm noise assessment; ETSU-R-97 and the IoA GPG. ETSU-R-97 states:

"It is clearly unreasonable to suggest that, because a wind farm has been constructed in the vicinity in the past which resulted in increased noise levels at some properties, the residents of those properties are now able to tolerate higher noise levels still. The existing wind farm should not be considered as part of the prevailing background noise."

9.9.2 The locations of the proposed Garreg Lwyd Hill, Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind turbines are shown in Figure 9.2.

9.9.3 The nearest residential properties to the turbines considered in this assessment are those detailed in Table 7.

9.9.4 Considering the proposed Garreg Lwyd Hill, Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms the distances from each house to the nearest turbine are given in Table 21.

Table 21: Distances from Residential Properties to Nearest Cumulative Turbine

House Name	Distance (m)	Nearest Turbine
Blaen-nant-du	673	L17
Blaen-nant-du 2	551	L2
Bryn-mawr Cottage	798	B1
Bwlch-gwyn	1313	B8
Cork Cottage	1143	B5
Cwm yr Hob	662	B11
Cwm-gwyn Hall	1502	B5
Cwm-mawr	838	L16
Cwm-mawr Stud	1104	L12
Ddol	1148	L16
Ddol - Holiday Home	1112	L16
Garn	428	L2
Gatehouse Farm	1023	B11
Great House Barn	1010	B5
Green Hollow	1439	B11
Gwenlas	812	L16
Hendy	1389	B5
Higher Fiddlers Green	870	L17
Hopes Castle Farm	760	B6
Killowent	1074	B5
Little House Farm	962	B5
Llanrhys	1077	B7
Lower Fiddlers Green	907	L17
Lower Green	893	T2
Lower House Farm	654	B11
Lower House Holt	580	B11
Maes-gwyn	720	B7
New House	732	B7
Pink House	833	B7
Rhuvid	680	B5
Scrubs Farm	1594	B11
Sign	1090	T15
Tansomalia	1713	B11

House Name	Distance (m)	Nearest Turbine
Tynybryniau	1344	T9
Upper Cae-glas	1276	B8
Upper Green	889	T9
Upper Ty-llidiart	1071	B5
Waen	1244	N9
Wood Cottage	1779	B5

Turbines prefixed "T" are the proposed Garreg Lwyd Hill turbines, those prefixed "B" are the proposed Bryngydfa turbines, those prefixed "L" are the proposed Llanbadarn Fynydd turbines and those prefixed "N" are the proposed Neuadd-goch Bank turbines

Cumulative Assessment Methodology

9.9.5 ETSU-R-97 recommends that the derived noise limits applicable at nearby residential properties shall relate to the cumulative effects of noise from all wind turbines that may affect a particular location.

9.9.6 The methodology is therefore to:

- Predict noise immission levels at the nearest residential properties due to the proposed Garreg Lwyd Hill, Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms;
- Complete a cumulative noise assessment by combining predicted noise levels due to the cumulative wind farms; and
- Compare these cumulative predictions to the ETSU-R-97 derived noise limits.

9.9.7 The methodology outlined above is in accordance with the appropriate guidance on cumulative wind farm noise assessment as described in ETSU-R-97 and the IoA GPG.

Predictions of Noise Levels at Residential Properties

Bryngydfa

9.9.8 The candidate turbine assessed in the noise chapter of the Bryngydfa Wind Farm Environmental Statement is the Vestas V90 2MW machine operating in Mode 2. Warranted acoustic data for this turbine is taken from the Bryngydfa Wind Farm Environmental Statement [41] where an uncertainty of 2 dB has been included. Details assumed in this analysis are as follows:

- A hub height of 80 m;
- A rotor diameter of 90 m;
- Assumed sound power levels, LWA, for standardised 10 m height wind speeds (v10) as shown in Table 22; and
- Octave band data sound power level data as shown in Table 23.

Table 22: Sound Power Levels for the Vestas V90 2MW Mode 2 Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	A-Weighted Sound Power Level, dB(A)	
	Warranted noise levels	+2 dB uncertainty
4	93.2	95.2
5	98.0	100.0
6	100.0	102.0
7	100.4	102.4
8	100.9	102.9
9	100.9	102.9
10	100.8	102.8
11	100.8	102.8
12	100.8	102.8

Table 23: Octave Band Sound Power Level Data for the Vestas V90 2MW Mode 2 Wind Turbine

Octave Band (Hz)	A-Weighted Sound Power Level, dB(A)
	8 ms^{-1}
63	86.8
125	92.1
250	94.8
500	95.8
1000	96.6
2000	96.3
4000	91.7
8000	78.2
OVERALL	102.9

Llanbadarn Fynydd

9.9.9 The noise limits in the suggested planning conditions for the proposed Llanbadarn Fynydd Wind Farm [42] are used to calculate the worst case noise levels.

9.9.10 The assumed noise levels for Llanbadarn Fynydd Wind Farm are derived as follows:

- Predictions are made using appropriate turbine noise data;
- Comparison is made between the predictions and the limits from the suggested noise conditions in order to identify the controlling property; and
- The predictions are scaled by the minimum margin between the predictions and the noise limits from the planning conditions at the controlling property. This yields predicted noise levels for the proposed Llanbadarn Fynydd Wind Farm which do not exceed the noise conditions at any property and are equal to the noise conditions at the controlling property and wind speed.

9.9.11 Note this method is referred to as the 'Controlling Property' method in the IoA GPG.

9.9.12 The candidate turbine assessed in the noise chapter of the Llanbadarn Fynydd Wind Farm Environmental Statement is the Vestas V90 3MW machine operating in Mode 3. Warranted acoustic data for this turbine is taken from the Llanbadarn Fynydd Wind Farm Supplementary Environmental Information [43]. Details assumed in this analysis are as follows:

- A hub height of 80 m;
- A rotor diameter of 90 m;
- Assumed sound power levels, LWA, for standardised 10 m height wind speeds (v10) as shown in Table 24; and
- Octave band data sound power level data as shown in Table 25.

Table 24: Sound Power Levels for the Vestas V90 3MW Mode 3 Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	A-Weighted Sound Power Level (dB(A) re 1 pW)
4	97.9
5	100.9
6	102.6
7	102.8
8	102.9
9	103.3
10	103.6
11	104.2
12	105.3

Table 25: Octave Band Sound Power Level Data for the Vestas V90 3MW Mode 3 Wind Turbine

Octave Band (Hz)	A-Weighted Sound Power Level at 10m standardised wind speeds, dB(A)						
	4 ms^{-1}	5 ms^{-1}	6 ms^{-1}	7 ms^{-1}	8 ms^{-1}	9 ms^{-1}	10 ms^{-1}
63	76.6	82.0	83.9	86	86.2	86.6	86.9
125	84.6	86.1	88.2	89.3	89.4	89.8	90.1
250	89.3	91.1	92.5	93.3	93.6	93.8	93.8
500	91.7	93.4	94.8	94.8	95.0	95.5	95.9
1000	92.3	96.2	98.3	98.1	98.0	98.3	98.6
2000	91.1	94.8	96.3	96.2	96.4	96.7	97.1
4000	86.8	90.0	91.1	92.7	92.8	93.4	93.9
8000	75.2	77.6	78.6	81	81.6	82.3	82.7
OVERALL	97.9	100.9	102.6	102.8	102.9	103.3	103.6

Neuadd-goch Bank

9.9.13 The candidate turbine assessed in the noise chapter of the Neuadd-goch Bank Wind Farm Environmental Statement is the Repower MM92 2050kW machine. Warranted acoustic data for this turbine is taken from the Neuadd-goch Bank Wind Farm Environmental Statement 0. Details assumed in this analysis are as follows:

- A hub height of 80 m;
- A rotor diameter of 92 m;
- Assumed sound power levels, LWA, for standardised 10 m height wind speeds (v10) as shown in Table 26; and
- Octave band data sound power level data as shown in Table 27.

Table 26: Sound Power Levels for the Repower MM92 2050kW Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	A-Weighted Sound Power Level, dB(A)
4	96.0
5	101.4
6	103.3
7	104.2
8	104.2
9	104.2
10	104.2
11	104.2
12	104.2

Table 27: Octave Band Sound Power Level Data for the Repower MM92 2050kW Wind Turbine

Octave Band (Hz)	A-Weighted Sound Power Level, dB(A)
	8 ms^{-1}
63	85.6
125	92.7
250	97.6
500	99.2
1000	98.8
2000	93.1
4000	84.6
8000	74.2
OVERALL	104.2

9.9.14 Table 28 shows the predicted cumulative noise immission levels at the nearest residential properties due to the operation of the proposed Garreg Lwyd Hill, Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms. Shading indicates residential properties with predicted noise levels greater than 35 dB(A). Residential properties in italics are locations

where the proposed Garreg Lwyd Hill Wind Farm does not contribute significantly to the cumulative noise level i.e. where the predicted noise level due to Garreg Lwyd Hill is greater than 10 dB(A) below the predicted noise level from another wind farm. These properties are therefore not considered further. The maximum predicted noise level at the remaining properties is highlighted in bold.

Table 28: Cumulative Predicted Noise Levels at Nearby Residential Properties, dB(A)

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Blaen-nant-du	*35.8*	*35.8*	*35.8*	*35.8*	*38.8*	*40.6*	*40.9*	*41.0*	*41.3*	*41.5*	*42.0*	*43.0*
Blaen-nant-du 2	*37.7*	*37.7*	*37.7*	*37.7*	*40.6*	*42.4*	*42.6*	*42.7*	*43.0*	*43.3*	*43.8*	*44.9*
Bryn-mawr Cottage	30.9	30.9	30.9	31.5	35.6	37.8	38.4	38.6	38.5	38.6	38.7	39.0
Bwlch-gwyn	22.6	22.6	22.6	23.4	27.8	30.1	30.7	31.0	30.8	30.9	30.9	31.0
Cork Cottage	24.5	24.5	24.5	25.1	29.6	31.8	32.5	32.7	32.5	32.6	32.7	32.8
Cwm yr Hob	29.1	29.1	29.1	30.7	35.1	37.7	38.4	38.6	38.1	38.3	38.4	38.4
Cwm-gwyn Hall	24.2	24.2	24.2	24.8	29.2	31.4	32.1	32.3	32.1	32.2	32.3	32.5
Cwm-mawr	33.2	33.2	33.2	33.3	36.1	38.0	38.3	38.4	38.7	38.9	39.4	**40.4**
Cwm-mawr Stud	31.9	31.9	31.9	32.0	34.8	36.7	37.0	37.2	37.4	37.6	38.1	39.1
Ddol	30.6	30.6	30.6	30.9	33.9	35.9	36.3	36.5	36.6	36.8	37.2	38.1
Ddol - Holiday Home	31.5	31.5	31.5	31.8	34.8	36.8	37.3	37.4	37.4	37.7	38.1	39.0
Garn	*40.1*	*40.1*	*40.1*	*40.1*	*42.9*	*44.7*	*45.0*	*45.0*	*45.4*	*45.6*	*46.2*	*47.3*
Gatehouse Farm	30.2	30.2	30.2	31.6	36.0	38.6	39.3	39.5	39.0	39.3	39.3	39.3
Great House Barn	24.4	24.4	24.4	25.3	29.7	32.1	32.7	32.9	32.7	32.8	32.8	32.9
Green Hollow	26.6	26.6	26.6	27.9	32.3	34.8	35.6	35.7	35.3	35.5	35.5	35.6
Gwenlas	32.3	32.3	32.3	32.5	35.5	37.4	37.8	37.9	38.1	38.4	38.8	39.7
Hendy	22.7	22.7	22.7	23.4	27.9	30.1	30.8	31.0	30.8	30.9	31.0	31.1
Higher Fiddlers Green	31.5	31.5	31.5	31.7	35.2	37.2	37.7	37.8	37.9	38.1	38.4	39.1
Hopes Castle Farm	30.8	30.8	30.8	31.5	35.8	38.0	38.7	38.9	38.7	38.8	38.9	39.1
Killowent	27.0	27.0	27.0	28.6	33.0	35.6	36.3	36.5	36.0	36.2	36.2	36.3
Little House Farm	23.9	23.9	23.9	24.8	29.2	31.6	32.3	32.5	32.2	32.3	32.4	32.5
Llanrhys	28.1	28.1	28.1	29.1	33.6	36.0	36.6	36.9	36.6	36.7	36.7	36.7
Lower Fiddlers Green	31.3	31.3	31.3	31.5	35.0	37.0	37.5	37.7	37.7	37.9	38.2	38.9
Lower Green	29.8	29.8	29.8	31.4	35.6	38.3	39.0	39.1	38.7	38.9	39.0	39.1
Lower House Farm	28.7	28.7	28.7	29.7	34.2	36.6	37.2	37.5	37.2	37.3	37.3	37.3
Lower House Holt	29.9	29.9	29.9	30.8	35.3	37.7	38.2	38.5	38.3	38.4	38.4	38.4
Maes-gwyn	27.4	27.4	27.4	28.2	32.7	35.1	35.7	35.9	35.7	35.8	35.8	35.8
New House	29.3	29.3	29.3	30.2	34.7	37.1	37.6	37.9	37.7	37.8	37.8	37.8
Pink House	28.2	28.2	28.2	28.9	33.5	35.8	36.4	36.7	36.5	36.5	36.5	36.6
Rhuvid	27.4	27.4	27.4	28.3	32.7	35.1	35.8	36.0	35.7	35.8	35.9	35.9
Scrubs Farm	24.9	24.9	24.9	26.2	30.6	33.1	33.8	34.0	33.6	33.8	33.8	33.9
Sign	29.0	29.0	29.0	30.3	34.1	36.7	37.4	37.5	37.1	37.4	37.5	37.8
Tansomalia	23.8	23.8	23.8	25.0	29.4	31.9	32.6	32.8	32.4	32.6	32.6	32.6
Tynybryniau	27.4	27.4	27.4	28.8	32.7	35.3	36.0	36.1	35.7	36.0	36.1	36.3
Upper Cae-glas	24.1	24.1	24.1	24.9	29.2	31.5	32.1	32.4	32.2	32.3	32.3	32.5
Upper Green	29.7	29.7	29.7	31.4	35.6	38.3	39.0	39.1	38.6	38.9	39.0	39.0
Upper Ty-Ilidiart	24.0	24.0	24.0	24.8	29.2	31.5	32.2	32.4	32.2	32.3	32.4	32.5
Waen	28.9	28.9	28.9	29.1	33.3	35.3	36.0	36.1	36.1	36.2	36.4	36.8
Wood Cottage	24.4	24.4	24.4	26.1	30.5	33.1	33.9	34.0	33.5	33.7	33.8	33.8

9.9.15 Noise levels at 11 of the 39 nearest residential properties are below 35 dB(A) level, indicating that the noise immission levels would be regarded as acceptable and the residents amenity as receiving 'sufficient protection' without further assessment requiring to be undertaken.

9.9.16 There are 28 properties with predicted noise levels greater than the simplified noise criteria as indicated in Table 28. Therefore the 'full' acoustic assessment has been considered at these, albeit excluding the three properties where the proposed Garreg Lwyd Hill Wind Farm does not contribute significantly to the cumulative predicted noise level.

Derived Acoustic Acceptance Criteria

9.9.17 Due to the greater generation capacity, and therefore increased planning merit, of the cumulative development and in accordance with the guidance of ETSU-R-97 and the IoA GPG, a 40 dB(A) daytime lower limit has been adopted. Justification for this limit is as follows:

- Number of noise affected residential properties: 28 residential properties are predicted to experience cumulative noise levels of greater than 35 dB(A), a relatively small number given the scale of the cumulative development which would generate significant social, economic and environmental benefits, suggesting a limit at the upper end of the range would be appropriate;
- Potential impact on the power output of the wind farm: The rated power of the cumulative development would be 124 MW should the turbine types considered in the acoustic assessment be installed, large in comparison with other wind farm developments in Wales, suggesting that a lower limit at the upper end of the range would be appropriate. Restricting the lower limit to 35 dB(A) could limit the number and size of turbines installed or result in noise management being required, thereby impacting the amount of energy produced;
- The likely duration and level of exposure: The amount of time that cumulative noise levels of greater than 35 dB(A) are predicted is limited to periods of sufficiently high wind speed. Furthermore, the noise levels experienced will be less in practice as it has been assumed that properties can be downwind of all wind farms simultaneously which will not be the case in reality. It would therefore be suggested that a daytime lower limit at the upper end of the range is applied.

9.9.18 As detailed in paragraph 9.6.14, the background noise survey results, i.e. derived ETSU-R-97 limits, inferred to be representative for each property are shown in Table 14.

9.9.19 As recommended in ETSU-R-97, the absolute lower noise limits may be increased up to 45 dB(A) if the occupant has a financial involvement in the wind farm. However, whilst some of the nearby residential properties may qualify for such an increase, these limits have not been adopted in the presented results.

9.9.20 The derived noise limits for daytime and night-time periods, for each residential property, can be found in Table 29 and Table 30.

Acoustic Assessment

9.9.21 Table 29 shows a comparison of the cumulative predicted noise levels for the proposed Garreg Lwyd Hill, Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms with the recommended daytime noise limits for the nearby residential properties. The predicted noise levels and derived noise limits at 1 ms-1 and 2 ms-1 have been assumed as equal to 3 ms-1, though this is a conservative measure. The term ΔL is used to denote the difference between the predicted cumulative noise level and the recommended limit. A negative value indicates that the predicted noise level is within the limit.

Table 30 shows a comparison with the recommended night-time noise limits.

9.9.22 Noise levels at all residential properties are within both the daytime and night-time noise limits at all wind speeds considered. The minimum margin of predicted noise levels below derived noise limits during daytime periods is –1.2 dB(A). Similarly the minimum margin during night time periods is –3.3 dB(A). The minimum margins are highlighted in the relevant tables.

9.9.23 At the residential properties where background noise surveys were carried out, excluding Blaen-nant-du 2 where the proposed Garreg Lwyd Hill Wind Farm does not contribute significantly to the cumulative noise level, the predicted noise levels due to all cumulative wind farms, and noise limits, are shown graphically in Charts 22-28 in Technical
Appendix 9.2.

9.9.24 At the residential property with the smallest margin between the cumulative predicted noise levels and noise limits, Upper Green, the predicted noise levels due to each wind farm, along with the noise limits, are shown graphically in Technical Appendix 9.2 Chart 29.

9.9.25 Figure 9.2 shows a cumulative noise contour plot for the proposed Garreg Lwyd Hill, Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms calculated using the ISO 9613 Part 2 propagation model. The plot is provided to illustrate the cumulative noise 'footprint' and should be considered indicative only. Where properties are located such that they cannot be downwind of all turbines simultaneously the predictions made using a downwind propagation model such as ISO 9613-2 are conservative given that reductions in noise would be expected when a property is cross-wind and upwind of a noise source respectively.

Table 29: Comparison of Cumulative Predicted Noise Levels and Daytime Noise Limits, dB(A)

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Bryn-mawr Cottage	30.9	40.0	-9.1	30.9	40.0	-9.1	30.9	40.0	-9.1	31.5	40.0	-8.5
Cwm yr Hob	29.1	40.0	-10.9	29.1	40.0	-10.9	29.1	40.0	-10.9	30.7	40.0	-9.3
Cwm-mawr	33.2	40.0	-6.8	33.2	40.0	-6.8	33.2	40.0	-6.8	33.3	40.0	-6.7
Cwm-mawr Stud	31.9	40.0	-8.1	31.9	40.0	-8.1	31.9	40.0	-8.1	32.0	40.0	-8.0
Ddol	30.6	40.0	-9.4	30.6	40.0	-9.4	30.6	40.0	-9.4	30.9	40.0	-9.1
Ddol - Holiday Home	31.5	40.0	-8.5	31.5	40.0	-8.5	31.5	40.0	-8.5	31.8	40.0	-8.2
Gatehouse Farm	30.2	40.0	-9.8	30.2	40.0	-9.8	30.2	40.0	-9.8	31.6	40.0	-8.4
Green Hollow	26.6	40.0	-13.4	26.6	40.0	-13.4	26.6	40.0	-13.4	27.9	40.0	-12.1
Gwenlas	32.3	40.0	-7.7	32.3	40.0	-7.7	32.3	40.0	-7.7	32.5	40.0	-7.5
Higher Fiddlers Green	31.5	40.0	-8.5	31.5	40.0	-8.5	31.5	40.0	-8.5	31.7	40.0	-8.3
Hopes Castle Farm	30.8	40.0	-9.2	30.8	40.0	-9.2	30.8	40.0	-9.2	31.5	40.0	-8.5
Killowent	27.0	40.0	-13.0	27.0	40.0	-13.0	27.0	40.0	-13.0	28.6	40.0	-11.4
Llanrhys	28.1	40.0	-11.9	28.1	40.0	-11.9	28.1	40.0	-11.9	29.1	40.0	-10.9
Lower Fiddlers Green	31.3	40.0	-8.7	31.3	40.0	-8.7	31.3	40.0	-8.7	31.5	40.0	-8.5
Lower Green	29.8	40.0	-10.2	29.8	40.0	-10.2	29.8	40.0	-10.2	31.4	40.0	-8.6
Lower House Farm	28.7	40.0	-11.3	28.7	40.0	-11.3	28.7	40.0	-11.3	29.7	40.0	-10.3
Lower House Holt	29.9	40.0	-10.1	29.9	40.0	-10.1	29.9	40.0	-10.1	30.8	40.0	-9.2
Maes-gwyn	27.4	40.0	-12.6	27.4	40.0	-12.6	27.4	40.0	-12.6	28.2	40.0	-11.8
New House	29.3	40.0	-10.7	29.3	40.0	-10.7	29.3	40.0	-10.7	30.2	40.0	-9.8
Pink House	28.2	40.0	-11.8	28.2	40.0	-11.8	28.2	40.0	-11.8	28.9	40.0	-11.1
Rhuvid	27.4	40.0	-12.6	27.4	40.0	-12.6	27.4	40.0	-12.6	28.3	40.0	-11.7
Sign	29.0	40.0	-11.0	29.0	40.0	-11.0	29.0	40.0	-11.0	30.3	40.0	-9.7
Tynybryniau	27.4	40.0	-12.6	27.4	40.0	-12.6	27.4	40.0	-12.6	28.8	40.0	-11.2
Upper Green	29.7	40.0	-10.3	29.7	40.0	-10.3	29.7	40.0	-10.3	31.4	40.0	-8.6
Waen	28.9	40.0	-11.1	28.9	40.0	-11.1	28.9	40.0	-11.1	29.1	40.0	-10.9

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Bryn-mawr Cottage	35.6	40.0	-4.4	37.8	40.5	-2.7	38.4	43.6	-5.2	38.6	46.7	-8.1
Cwm yr Hob	35.1	40.0	-4.9	37.7	40.0	-2.3	38.4	40.0	-1.6	38.6	42.3	-3.7
Cwm-mawr	36.1	40.0	-3.9	38.0	40.0	-2.0	38.3	40.0	-1.7	38.4	41.2	-2.8
Cwm-mawr Stud	34.8	40.0	-5.2	36.7	40.0	-3.3	37.0	40.0	-3.0	37.2	41.2	-4.0
Ddol	33.9	40.0	-6.1	35.9	40.0	-4.1	36.3	40.0	-3.7	36.5	41.2	-4.7
Ddol - Holiday Home	34.8	40.0	-5.2	36.8	40.0	-3.2	37.3	40.0	-2.7	37.4	41.2	-3.8
Gatehouse Farm	36.0	40.0	-4.0	38.6	40.3	-1.7	39.3	44.2	-4.9	39.5	48.2	-8.7
Green Hollow	32.3	40.0	-7.7	34.8	40.3	-5.5	35.6	44.2	-8.6	35.7	48.2	-12.5
Gwenlas	35.5	40.0	-4.5	37.4	40.0	-2.6	37.8	40.0	-2.2	37.9	42.4	-4.5
Higher Fiddlers Green	35.2	40.0	-4.8	37.2	40.0	-2.8	37.7	40.0	-2.3	37.8	42.2	-4.4
Hopes Castle Farm	35.8	40.0	-4.2	38.0	40.0	-2.0	38.7	42.8	-4.1	38.9	46.4	-7.5
Killowent	33.0	40.0	-7.0	35.6	40.0	-4.4	36.3	40.0	-3.7	36.5	42.3	-5.8
Llanrhys	33.6	40.0	-6.4	36.0	40.0	-4.0	36.6	40.0	-3.4	36.9	42.3	-5.4
Lower Fiddlers Green	35.0	40.0	-5.0	37.0	40.0	-3.0	37.5	40.0	-2.5	37.7	42.2	-4.5
Lower Green	35.6	40.0	-4.4	38.3	40.0	-1.7	39.0	40.2	-1.2	39.1	42.9	-3.8
Lower House Farm	34.2	40.0	-5.8	36.6	40.0	-3.4	37.2	40.0	-2.8	37.5	42.3	-4.8
Lower House Holt	35.3	40.0	-4.7	37.7	40.0	-2.3	38.2	40.0	-1.8	38.5	42.3	-3.8
Maes-gwyn	32.7	40.0	-7.3	35.1	40.0	-4.9	35.7	40.2	-4.5	35.9	42.9	-7.0
New House	34.7	40.0	-5.3	37.1	40.0	-2.9	37.6	40.0	-2.4	37.9	42.3	-4.4
Pink House	33.5	40.0	-6.5	35.8	40.0	-4.2	36.4	40.0	-3.6	36.7	42.3	-5.6
Rhuvid	32.7	40.0	-7.3	35.1	40.0	-4.9	35.8	40.0	-4.2	36.0	42.3	-6.3
Sign	34.1	40.0	-5.9	36.7	40.0	-3.3	37.4	40.0	-2.6	37.5	42.2	-4.7
Tynybryniau	32.7	40.0	-7.3	35.3	40.0	-4.7	36.0	40.2	-4.2	36.1	42.9	-6.8
Upper Green	35.6	40.0	-4.4	38.3	40.0	-1.7	39.0	40.2	-1.2	39.1	42.9	-3.8
Waen	33.3	40.0	-6.7	35.3	40.0	-4.7	36.0	40.0	-4.0	36.1	42.2	-6.1

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Bryn-mawr Cottage	38.5	49.6	-11.1	38.6	52.3	-13.7	38.7	54.4	-15.7	39.0	54.4	-15.4
Cwm yr Hob	38.1	44.8	-6.7	38.3	47.3	-9.0	38.4	47.3	-8.9	38.4	47.3	-8.9
Cwm-mawr	38.7	44.0	-5.3	38.9	47.1	-8.2	39.4	50.5	-11.1	40.4	50.5	-10.1
Cwm-mawr Stud	37.4	44.0	-6.6	37.6	47.1	-9.5	38.1	50.5	-12.4	39.1	50.5	-11.4
Ddol	36.6	44.0	-7.4	36.8	47.1	-10.3	37.2	50.5	-13.3	38.1	50.5	-12.4
Ddol - Holiday Home	37.4	44.0	-6.6	37.7	47.1	-9.4	38.1	50.5	-12.4	39.0	50.5	-11.5
Gatehouse Farm	39.0	52.1	-13.1	39.3	55.9	-16.6	39.3	59.3	-20.0	39.3	59.3	-20.0
Green Hollow	35.3	52.1	-16.8	35.5	55.9	-20.4	35.5	59.3	-23.8	35.6	59.3	-23.7
Gwenlas	38.1	45.5	-7.4	38.4	49.0	-10.6	38.8	49.0	-10.2	39.7	49.0	-9.3
Higher Fiddlers Green	37.9	45.2	-7.3	38.1	48.4	-10.3	38.4	48.4	-10.0	39.1	48.4	-9.3
Hopes Castle Farm	38.7	49.9	-11.2	38.8	53.0	-14.2	38.9	53.0	-14.1	39.1	53.0	-13.9
Killowent	36.0	44.8	-8.8	36.2	47.3	-11.1	36.2	47.3	-11.1	36.3	47.3	-11.0
Llanrhys	36.6	44.8	-8.2	36.7	47.3	-10.6	36.7	47.3	-10.6	36.7	47.3	-10.6
Lower Fiddlers Green	37.7	45.2	-7.5	37.9	48.4	-10.5	38.2	48.4	-10.2	38.9	48.4	-9.5
Lower Green	38.7	45.7	-7.0	38.9	48.5	-9.6	39.0	48.5	-9.5	39.1	48.5	-9.4
Lower House Farm	37.2	44.8	-7.6	37.3	47.3	-10.0	37.3	47.3	-10.0	37.3	47.3	-10.0
Lower House Holt	38.3	44.8	-6.5	38.4	47.3	-8.9	38.4	47.3	-8.9	38.4	47.3	-8.9
Maes-gwyn	35.7	45.7	-10.0	35.8	48.5	-12.7	35.8	48.5	-12.7	35.8	48.5	-12.7
New House	37.7	44.8	-7.1	37.8	47.3	-9.5	37.8	47.3	-9.5	37.8	47.3	-9.5
Pink House	36.5	44.8	-8.3	36.5	47.3	-10.8	36.5	47.3	-10.8	36.6	47.3	-10.7
Rhuvid	35.7	44.8	-9.1	35.8	47.3	-11.5	35.9	47.3	-11.4	35.9	47.3	-11.4
Sign	37.1	45.2	-8.1	37.4	48.4	-11.0	37.5	48.4	-10.9	37.8	48.4	-10.6
Tynybryniau	35.7	45.7	-10.0	36.0	48.5	-12.5	36.1	48.5	-12.4	36.3	48.5	-12.2
Upper Green	38.6	45.7	-7.1	38.9	48.5	-9.6	39.0	48.5	-9.5	39.0	48.5	-9.5
Waen	36.1	45.2	-9.1	36.2	48.4	-12.2	36.4	48.4	-12.0	36.8	48.4	-11.6

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit
The shaded value denotes the minimum daytime ΔL value

Table 30: Comparison of Cumulative Predicted Noise Levels and Night Time Noise Limits, dB(A)

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Bryn-mawr Cottage	30.9	43.0	-12.1	30.9	43.0	-12.1	30.9	43.0	-12.1	31.5	43.0	-11.5
Cwm yr Hob	29.1	43.0	-13.9	29.1	43.0	-13.9	29.1	43.0	-13.9	30.7	43.0	-12.3
Cwm-mawr	33.2	43.0	-9.8	33.2	43.0	-9.8	33.2	43.0	-9.8	33.3	43.0	-9.7
Cwm-mawr Stud	31.9	43.0	-11.1	31.9	43.0	-11.1	31.9	43.0	-11.1	32.0	43.0	-11.0
Ddol	30.6	43.0	-12.4	30.6	43.0	-12.4	30.6	43.0	-12.4	30.9	43.0	-12.1
Ddol - Holiday Home	31.5	43.0	-11.5	31.5	43.0	-11.5	31.5	43.0	-11.5	31.8	43.0	-11.2
Gatehouse Farm	30.2	43.0	-12.8	30.2	43.0	-12.8	30.2	43.0	-12.8	31.6	43.0	-11.4
Green Hollow	26.6	43.0	-16.4	26.6	43.0	-16.4	26.6	43.0	-16.4	27.9	43.0	-15.1
Gwenlas	32.3	43.0	-10.7	32.3	43.0	-10.7	32.3	43.0	-10.7	32.5	43.0	-10.5
Higher Fiddlers Green	31.5	43.0	-11.5	31.5	43.0	-11.5	31.5	43.0	-11.5	31.7	43.0	-11.3
Hopes Castle Farm	30.8	43.0	-12.2	30.8	43.0	-12.2	30.8	43.0	-12.2	31.5	43.0	-11.5
Killowent	27.0	43.0	-16.0	27.0	43.0	-16.0	27.0	43.0	-16.0	28.6	43.0	-14.4
Llanrhys	28.1	43.0	-14.9	28.1	43.0	-14.9	28.1	43.0	-14.9	29.1	43.0	-13.9
Lower Fiddlers Green	31.3	43.0	-11.7	31.3	43.0	-11.7	31.3	43.0	-11.7	31.5	43.0	-11.5
Lower Green	29.8	43.0	-13.2	29.8	43.0	-13.2	29.8	43.0	-13.2	31.4	43.0	-11.6
Lower House Farm	28.7	43.0	-14.3	28.7	43.0	-14.3	28.7	43.0	-14.3	29.7	43.0	-13.3
Lower House Holt	29.9	43.0	-13.1	29.9	43.0	-13.1	29.9	43.0	-13.1	30.8	43.0	-12.2
Maes-gwyn	27.4	43.0	-15.6	27.4	43.0	-15.6	27.4	43.0	-15.6	28.2	43.0	-14.8
New House	29.3	43.0	-13.7	29.3	43.0	-13.7	29.3	43.0	-13.7	30.2	43.0	-12.8
Pink House	28.2	43.0	-14.8	28.2	43.0	-14.8	28.2	43.0	-14.8	28.9	43.0	-14.1
Rhuvid	27.4	43.0	-15.6	27.4	43.0	-15.6	27.4	43.0	-15.6	28.3	43.0	-14.7
Sign	29.0	43.0	-14.0	29.0	43.0	-14.0	29.0	43.0	-14.0	30.3	43.0	-12.7
Tynybryniau	27.4	43.0	-15.6	27.4	43.0	-15.6	27.4	43.0	-15.6	28.8	43.0	-14.2
Upper Green	29.7	43.0	-13.3	29.7	43.0	-13.3	29.7	43.0	-13.3	31.4	43.0	-11.6
Waen	28.9	43.0	-14.1	28.9	43.0	-14.1	28.9	43.0	-14.1	29.1	43.0	-13.9

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Bryn-mawr Cottage	35.6	43.0	-7.4	37.8	43.0	-5.2	38.4	43.0	-4.6	38.6	44.6	-6.0
Cwm yr Hob	35.1	43.0	-7.9	37.7	43.0	-5.3	38.4	43.0	-4.6	38.6	43.0	-4.4
Cwm-mawr	36.1	43.0	-6.9	38.0	43.0	-5.0	38.3	43.0	-4.7	38.4	43.0	-4.6
Cwm-mawr Stud	34.8	43.0	-8.2	36.7	43.0	-6.3	37.0	43.0	-6.0	37.2	43.0	-5.8
Ddol	33.9	43.0	-9.1	35.9	43.0	-7.1	36.3	43.0	-6.7	36.5	43.0	-6.5
Ddol - Holiday Home	34.8	43.0	-8.2	36.8	43.0	-6.2	37.3	43.0	-5.7	37.4	43.0	-5.6
Gatehouse Farm	36.0	43.0	-7.0	38.6	43.0	-4.4	39.3	43.0	-3.7	39.5	45.8	-6.3
Green Hollow	32.3	43.0	-10.7	34.8	43.0	-8.2	35.6	43.0	-7.4	35.7	45.8	-10.1
Gwenlas	35.5	43.0	-7.5	37.4	43.0	-5.6	37.8	43.0	-5.2	37.9	43.0	-5.1
Higher Fiddlers Green	35.2	43.0	-7.8	37.2	43.0	-5.8	37.7	43.0	-5.3	37.8	43.0	-5.2
Hopes Castle Farm	35.8	43.0	-7.2	38.0	43.0	-5.0	38.7	43.0	-4.3	38.9	43.0	-4.1
Killowent	33.0	43.0	-10.0	35.6	43.0	-7.4	36.3	43.0	-6.7	36.5	43.0	-6.5
Llanrhys	33.6	43.0	-9.4	36.0	43.0	-7.0	36.6	43.0	-6.4	36.9	43.0	-6.1
Lower Fiddlers Green	35.0	43.0	-8.0	37.0	43.0	-6.0	37.5	43.0	-5.5	37.7	43.0	-5.3
Lower Green	35.6	43.0	-7.4	38.3	43.0	-4.7	39.0	43.0	-4.0	39.1	43.0	-3.9
Lower House Farm	34.2	43.0	-8.8	36.6	43.0	-6.4	37.2	43.0	-5.8	37.5	43.0	-5.5
Lower House Holt	35.3	43.0	-7.7	37.7	43.0	-5.3	38.2	43.0	-4.8	38.5	43.0	-4.5
Maes-gwyn	32.7	43.0	-10.3	35.1	43.0	-7.9	35.7	43.0	-7.3	35.9	43.0	-7.1
New House	34.7	43.0	-8.3	37.1	43.0	-5.9	37.6	43.0	-5.4	37.9	43.0	-5.1
Pink House	33.5	43.0	-9.5	35.8	43.0	-7.2	36.4	43.0	-6.6	36.7	43.0	-6.3
Rhuvid	32.7	43.0	-10.3	35.1	43.0	-7.9	35.8	43.0	-7.2	36.0	43.0	-7.0
Sign	34.1	43.0	-8.9	36.7	43.0	-6.3	37.4	43.0	-5.6	37.5	43.0	-5.5
Tynybryniau	32.7	43.0	-10.3	35.3	43.0	-7.7	36.0	43.0	-7.0	36.1	43.0	-6.9
Upper Green	35.6	43.0	-7.4	38.3	43.0	-4.7	39.0	43.0	-4.0	39.1	43.0	-3.9
Waen	33.3	43.0	-9.7	35.3	43.0	-7.7	36.0	43.0	-7.0	36.1	43.0	-6.9

House Name	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
Bryn-mawr Cottage	38.5	48.6	-10.1	38.6	51.9	-13.3	38.7	51.9	-13.2	39.0	51.9	-12.9
Cwm yr Hob	38.1	43.0	-4.9	38.3	43.0	-4.7	38.4	43.0	-4.6	38.4	43.0	-4.6
Cwm-mawr	38.7	43.0	-4.3	38.9	45.9	-7.0	39.4	45.9	-6.5	40.4	45.9	-5.5
Cwm-mawr Stud	37.4	43.0	-5.6	37.6	45.9	-8.3	38.1	45.9	-7.8	39.1	45.9	-6.8
Ddol	36.6	43.0	-6.4	36.8	45.9	-9.1	37.2	45.9	-8.7	38.1	45.9	-7.8
Ddol - Holiday Home	37.4	43.0	-5.6	37.7	45.9	-8.2	38.1	45.9	-7.8	39.0	45.9	-6.9
Gatehouse Farm	39.0	49.8	-10.8	39.3	53.2	-13.9	39.3	53.2	-13.9	39.3	53.2	-13.9
Green Hollow	35.3	49.8	-14.5	35.5	53.2	-17.7	35.5	53.2	-17.7	35.6	53.2	-17.6
Gwenlas	38.1	43.0	-4.9	38.4	43.0	-4.6	38.8	43.0	-4.2	39.7	43.0	-3.3
Higher Fiddlers Green	37.9	43.0	-5.1	38.1	43.0	-4.9	38.4	43.0	-4.6	39.1	43.0	-3.9
Hopes Castle Farm	38.7	43.0	-4.3	38.8	43.0	-4.2	38.9	43.0	-4.1	39.1	43.0	-3.9
Killowent	36.0	43.0	-7.0	36.2	43.0	-6.8	36.2	43.0	-6.8	36.3	43.0	-6.7
Llanrhys	36.6	43.0	-6.4	36.7	43.0	-6.3	36.7	43.0	-6.3	36.7	43.0	-6.3
Lower Fiddlers Green	37.7	43.0	-5.3	37.9	43.0	-5.1	38.2	43.0	-4.8	38.9	43.0	-4.1
Lower Green	38.7	43.0	-4.3	38.9	43.0	-4.1	39.0	43.0	-4.0	39.1	43.0	-3.9
Lower House Farm	37.2	43.0	-5.8	37.3	43.0	-5.7	37.3	43.0	-5.7	37.3	43.0	-5.7
Lower House Holt	38.3	43.0	-4.7	38.4	43.0	-4.6	38.4	43.0	-4.6	38.4	43.0	-4.6
Maes-gwyn	35.7	43.0	-7.3	35.8	43.0	-7.2	35.8	43.0	-7.2	35.8	43.0	-7.2
New House	37.7	43.0	-5.3	37.8	43.0	-5.2	37.8	43.0	-5.2	37.8	43.0	-5.2
Pink House	36.5	43.0	-6.5	36.5	43.0	-6.5	36.5	43.0	-6.5	36.6	43.0	-6.4
Rhuvid	35.7	43.0	-7.3	35.8	43.0	-7.2	35.9	43.0	-7.1	35.9	43.0	-7.1
Sign	37.1	43.0	-5.9	37.4	43.0	-5.6	37.5	43.0	-5.5	37.8	43.0	-5.2
Tynybryniau	35.7	43.0	-7.3	36.0	43.0	-7.0	36.1	43.0	-6.9	36.3	43.0	-6.7
Upper Green	38.6	43.0	-4.4	38.9	43.0	-4.1	39.0	43.0	-4.0	39.0	43.0	-4.0
Waen	36.1	43.0	-6.9	36.2	43.0	-6.8	36.4	43.0	-6.6	36.8	43.0	-6.2

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit
The shaded value denotes the minimum night-time ΔL value

Cumulative Construction Noise Assessment

9.9.26 Any noise for the construction of the cumulative wind farms is not likely to be ongoing at the same time. However if this does turn out to be the case, suitable measures would be implemented where necessary to mitigate any potential construction noise impact.

9.10 Summary

9.10.1 The acoustic impact due to the operation of the proposed Garreg Lwyd Hill Wind Farm on nearby residential properties has been assessed in accordance with the guidance on wind farm noise as issued in the DTI publication "The Assessment and Rating of Noise from Wind Farms", otherwise known as ETSU-R-97, and Institute of Acoustics Good Practice Guide (IoA GPG), as recommended for use by relevant planning policy.

9.10.2 To establish baseline conditions, background noise surveys were carried out at eight nearby properties and the measured background noise levels used to determine appropriate noise limits, as specified by ETSU-R-97 and the IoA GPG.

9.10.3 Operational noise levels were predicted using a noise propagation model, the proposed wind farm layout, terrain data and turbine emission data. The predicted noise levels are within derived appropriate noise limits at all considered wind speeds. The proposed Garreg Lwyd Hill Wind Farm therefore complies with the relevant guidance on wind farm noise and the impact on the amenity of all nearby residential properties would be regarded as acceptable.

9.10.4 A construction noise assessment, carried out in accordance with BS 5228-1:2009 "Noise control on construction and open sites Part 1 - Noise", indicates that the noise levels predicted to be experienced at the nearest residential properties may exceed construction noise criteria for short periods of time although appropriate mitigation measures have been identified.

9.10.5 A cumulative operational noise assessment was completed for the potential impact of the proposed Garreg Lwyd Hill Wind Farm alongside the proposed Bryngydfa, Llanbadarn Fynydd and Neuadd-goch Bank wind farms. The predicted cumulative noise levels are within derived appropriate noise limits at all considered wind speeds, as such, the impact on the amenity of nearby residential properties would be regarded as acceptable.

9.10.6 Table 31 summarises the potential impact of the proposed Garreg Lwyd Hill Wind Farm along with the mitigation proposed where required and the residual impact.

Table 31: Summary of Potential Impacts of the Proposed Wind Farm, Mitigation and Residual Impacts

Potential Significant Impact	Mitigation Proposed	Means of Implementation	Outcome/ Residual Impact
Operational			
Potential for significant impact due to operational noise at nearby residential properties	Not required due to absence of identified significant impact	Not applicable	No significant impacts identified
Construction			
Potential for significant impact due to construction noise at nearby residential properties	Action may be required to reduce noise levels at nearby properties due to the construction of site tracks	Acoustic barriers can be deployed during the construction of site tracks if necessary	No significant impacts expected should appropriate mitigation measures be implemented
	Action may be required to reduce construction noise levels at nearby properties for work scheduled to take place on Mondays to Fridays 0600-0700 and 1900-2000 and Saturdays 0600-0700 and 1300-2000	Reduce number of activities occurring simultaneously, restrict distance to nearby residential properties or reduce construction traffic as required	

9.11 Glossary

A-weighting

A frequency-response function defined in International standard IEC 61672:2003 providing a good correlation with the sensitivity of the human ear.

Broadband Noise

Noise which covers a wide range of frequencies (see Frequency).

Decibel dB(A)

The decibel (dB) is a logarithmic unit used in acoustics to quantify sound levels relative to a 0 dB reference (e.g. a sound pressure level of 2*10-5 Pa). The 'A' signifies A-weighting.

Equivalent Continuous Sound Level (L_{eq})

The equivalent continuous sound level is a notional steady noise level, which over a given time would provide the same energy as the intermittent noise. Noise standards often specify the length of time over which noise should be measured.

Frequency

Refers to how quickly the air vibrates, or how close the sound waves are to each other and is measured in cycles per second, or Hertz (Hz). The lowest frequency audible to humans is 20 Hz and the highest is 20,000 Hz. The human ear is most sensitive to the 1 kHz, 2 kHz and 4 kHz octave bands and much less sensitive at lower audible frequencies.

Frequency Spectrum

Description of the sound pressure level of a source as a function of frequency.

Percentile Sound Level (L_{90})

Sound pressure level exceeded for 90% of the time for any given time interval. For example, L(A)90,10min means the A-weighted level that is exceeded for 90% of a ten minute interval. This indicates the noise levels during quieter periods, or the background noise level. It represents the lower estimate of the prevailing noise level and is useful for excluding such effects as aircraft or dogs barking on background noise levels.

Noise Emission

The noise energy emitted by a source (e.g. a wind turbine).

Noise Immission

The sound pressure level detected at a given location (e.g. nearest dwelling).

Octave Band

Range of frequencies between one frequency ($f_0*2^{-1/2}$) and a second frequency ($f_0*2^{+1/2}$). The quoted centre frequency of the octave band is f_0.

Sound Power Level

Sound power level is the acoustic power radiated from a sound source and is independent of the surroundings. It is a logarithmic measure in comparison to a reference level (10^{-12} watts).

Sound Pressure Level

A logarithmic measure of the effective sound pressure of a sound relative to a reference value which is for minimum audible field conditions ($20*10^{-6}$Pa).

Third Octave Band

The range of frequencies between one frequency ($f_0*2^{-1/6}$) and a second frequency equal to ($f_0*2^{+1/6}$). The quoted centre frequency of the third octave band is f_0.

Tonal Noise

A noise that contains a noticeable or discrete, continuous note and includes noises such as hums, hisses, screeches.

9.12 References

[1] "The Assessment and Rating of Noise from Wind Farms", The Working Group on Noise from Wind Turbines, ETSU Report for the DTI, ETSU-R-97

[2] "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise", Institute of Acoustics, May 2013

[3] "Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects", RenewableUK, 2013

[4] "Planning for Renewable Energy", Technical Advice Note 8, Welsh Assembly Government, 2005

[5] "A Review of Published Research on Low Frequency Noise and Its Effects", Leventhall, Report for DEFRA, 2003

[6] "Low Frequency Noise and Infrasound Associated with Wind Turbine Generator Systems, a Literature Review", Ontario Ministry of the Environment, OSS078696, December 2010

[7] "Infrasound and low frequency noise from wind turbines: exposure and health effects", Bolin et al, Environmental Research Letters Volume 6, September 2011

[8] "A literature review of infra and low frequency noise from wind turbines: exposure and health effects", prepared for Swedish Environmental Protection Agency, November 2011

[9] "The Measurement of Low Frequency Noise at Three UK Wind Farms", Hayes, Contract Number W/45/00656/00/00, URN 06/1412, 2006, www.berr.gov.uk/files/file31270.pdf

[10] "Advice on findings of the Hayes McKenzie report on noise arising from Wind Farms", DTI, URN 06/2162, November 2006, www.berr.gov.uk/files/file35592.pdf

[11] "Strategic Health Impact Assessment on Wind Energy Development in Oregon", Sujata Joshi et al, Prepared By: Public Health Division Oregon Health Authority, March 2013, www.healthimpactproject.org

[12] BWEA is now known as RenewableUK, a group representing the concerns of companies in the Renewable Energy Industry

[13] "Low Frequency Noise and Wind Turbines", The British Wind Energy Association, 2005, www.bwea.com/ref/lowfrequencynoise.html & Technical Annex www.bwea.com/pdf/lfn-annex.pdf

[14] "Wind farm noise", Syles, & Toon, printed in the Scotsman newspaper as a rebuttal of claims made by the Renewable Energy Foundation, August 2005

[15] "Infrasound Levels Near Windfarms and in Other Environments" Environment Protection Authority & Resonate Acoustics, January 2013, www.epa.sa.gov.au

[16] "Sleep Disturbance and Wind Turbine Noise", Hanning, on behalf of Stop Swinford Wind Farm Action Group (SSWFAG), June 2009

[17] "Night Noise Guidelines for Europe", World Health Organisation, 2009

[18] "Wind Turbine Noise", Hanning et al, British Medical Journal, March 2012

[19] "The Potential Health Impact of Wind Turbines", Chief Medical Officer of Health (CMOH) Report, May 2010

[20] "Wind Turbine Health Impact Study: Report of Independent Expert Panel", Jeffrey M. Ellenbogen et al, Prepared for: Massachusetts Department of Environmental Protection Massachusetts Department of Public Health, January 2012

[21] "Low Frequency Noise & Vibration Measurements at a Modern Wind farm", Snow, ETSU W/13/00392/REP, 1997

[22] "Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)", British Standards Institution, BS 6472, 1992

[23] "Initial study of seismic ground vibration data from mega-watt class wind turbines – Interim Technical Report", AWE, June 2013

[24] "Initial Study of ground vibration data recorded near Craig Wind farm. Phase 0 report – estimate of potential head room in the Eskdalemuir Budget", B. Marmo et al, July 2013

[25] "Wind Turbine Sound and Health Effects - An Expert Panel Review" W.D. Colby et al, 2009

[26] "Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects", RenewableUK, 2013, www.renewableuk.com

[27] "Wind Turbine Syndrome - A Report on a Natural Experiment", Pierpont, K-Selected Books, 2009

[28] "Are wind farms a health risk?", NHS, 2009, www.nhs.uk

[29] "Wind Turbine Syndrome (WTS) - An independent review of the state of knowledge about the alleged health condition", RenewableUK, 2010, www.bwea.com

[30] "Health aspects associated with wind turbine noise—results from three field studies" Pedersen, Noise Control Engineering Journal, Volume 59, Issue 1, 2011

[31] "Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, communicated disease hypothesis", Chapman et al, University of Sydney, 2013

[32] "Planning Policy Wales", Edition 6, Welsh Assembly Government, February 2014

[33] "Planning Policy Wales Technical Advice Note 11: Noise", Welsh Assembly Government, October 1997

[34] "Prediction and Assessment of Wind Turbine Noise", Bowdler et al, Acoustics Bulletin Vol 34 No 2 March/April 2009

[35] "Noise and vibration control on construction and open sites - Part 1: Noise", British Standards Institution, BS 5228-1:2009

[36] "Control of Pollution Act", Control of Pollution Act, published by Her Majesty's Stationary Office, 1974

[37] "Wind turbine generator systems – Part 11: Acoustic noise measurement techniques", IEC 61400-11:2003 (Amendment 1: 2006)

[38] "Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation", International Organisation for Standardisation, ISO 9613-2:1996

[39] "A Critical Appraisal of Wind Farm Noise Propagation", ETSU Report W/13/00385/REP, 2000

[40] "General Specification V90 – 1.8/2.0 MW GridStreamer", Vestas, Document ID: 0005-6279 V15, 2011-10-27

[41] "Bryngydfa Wind Farm Environmental Statement", March 2009, Planning Application Reference P/2009/0384

[42] "Statement of Common Ground on Noise and Health between Vattenfall and Powys County Council"

[43] "Llanbadarn Fynydd Wind Farm Supplementary Environmental Information", February 2013, Planning Application Reference RAD/2007/0542

[44] "Neuadd-goch Bank Wind Farm Environmental Statement", January 2012, Planning Application Reference P/2012/004