LLANBRYNMAIR WIND FARM

Supplementary Environmental Information

August 2013

Volume I – Main Document

power for good

PREFACE

This Supplementary Environmental Information (SEI) has been prepared in support of a planning application for a proposed wind farm at Llanbrynmair, Powys.

This SEI supersedes the original Environmental Statement and the five subsequent SEI packages submitted as supporting information between 2010 and 2012. This SEI collates all relevant information from the aforementioned documents whilst incorporating additional information subsequently requested by statutory consultees.

The SEI is contained within three separate volumes:

Volume I Main Text
Volume II Supporting Appendices: Technical material to support Volume I
Volume III Supporting Figures: To accompany the text in Volume I

The SEI has been prepared by Arup in collaboration with the following specialist consultants:

Landscape Architect Land Use Consultants 37 Otago Street Glasgow G12 8JJ	**Ecology and Peat** Ecology Matters Bronhaul, Pentrbach, Talybont Ceredigion SY24 5EH	**Ornithology** Ecology Consulting Swallow Ridge Barn Old Cassop Durham DH6 4QB	**Cultural Heritage** Headland Archaeology 13 Jane Street Edinburgh EH6 5HE
Hydrology & Hydrogeology Fluid Environmental Consulting 108/15 Great Junction St. Edinburgh EH6 5LD	**Hydrology & Hydrogeology** SKM Enviros ONESIXTY 160 Dundee Street Edinburgh EH11 1DQ	**Acoustic** Hayes McKenzie Partnership Unit 3 Oakridge Office Park Whaddon Salisbury Wiltshire SP5 3HT	**Transport** Aecom 5th Floor 2 City Walk Leeds
Legal Squire Sanders 2 Park Lane Leeds LS3 1ES	**Planning** David Stewart Associates Selgars House Uffculme Cullompton Devon EX15 3DA		

Copies of the full SEI may be viewed during normal opening hours at the following locations:

Powys County Council Severn Road Welshpool Powys SY21 7AS Tel: 01938 551000	**Powys County Council** The Gwalia Llandrindod Wells Powys LD1 5LG Tel: 01597 826000		

Electronic copies of the SEI are available on CD-ROM for £5.

Hard copies of Volume I, II, and III are available from RES at a charge of £200 per combined copy.

Copies of the non-technical summary are available free of charge.

The SEI can also be viewed on the RES web page:

www.llanbrynmairwind farm.co.uk

Requests for documents should be made in writing, including payment if purchase of the full SEI is required.

RES has an environmental management system which actively encourages the reduction of paper consumption and recycling where possible.

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1 INTRODUCTION

1.1 Glossary

CADW – The historic environment service of the Welsh Government;

CPAT – Clwyd Powys Archaeological Trust;

DECC – Department of Energy and Climate Change;

EIA – Environmental Impact Assessment;

ES – Environmental Statement;

Ha – Hectare;

kWh – kilowatt hour;

MOD – Ministry of Defence;

MW – Megawatt;

NATS – National Air Traffic Services;

NRW – Natural Resources Wales (previously Countryside Council for Wales [CCW], Environmental Agency Wales [EAW] and Forestry Commission Wales [FCW]);

PCC – Powys County Council;

RSPB – Royal Society for the Protection of Birds

SEI – Supplementary Environmental Information;

TWh – Terawatt hour;

WG – Welsh Government.

1.2 The Application

1.2.1 RES UK & Ireland Ltd, hereafter referred to as RES, applied to the Department of Energy and Climate Change (DECC) under Section 36 of the Electricity Act 1989 for consent to construct and operate a wind farm development (hereafter, 'the Proposal') on land between the villages of Llanerfyl and Llanbrynmair, north west of Newtown, Powys in April 2009.

1.2.2 To support the application five rounds of Supplementary Environmental Information (SEI) have been submitted between 2010 and 2012.

1.2.3 The planning application for this wind farm is currently under consideration by DECC and the statutory consultees and is due to be appraised at the Mid-Wales (Powys) Conjoined Public Inquiry.

1.2.4 This SEI supersedes the original Environmental Statement and the five subsequent SEI packages submitted as supporting information between 2010 and 2012. This SEI collates all relevant information from the aforementioned documents whilst incorporating additional information subsequently requested by statutory consultees.

1.2.5 The Proposal has undergone considerable changes since the original submission, not least the reduction in the number of turbines from 43 to 30. In order to update and consolidate these changes RES have combined all relevant information into this single overarching SEI package for submission to the Mid-Wales (Powys) Conjoined Wind farms Public Inquiry.

1.2.6 This SEI package is an update of the original Environmental Statement incorporating the information provided within the supplementary SEI packages. This aims to avoid submitting multiple report packages with outdated and potentially conflicting information.

1.2.7 The changes to the Proposal have culminated in a design that has comprehensively considered environmental aspects and one that would deliver environmental gains.

1.3 The Proposal

1.3.1 The current Proposal comprises a wind farm of 30 wind turbines, with an installed capacity between 60MW and 90MW, on land between the villages of Llanerfyl and Llanbrynmair, north-west of Newtown, Powys. The site is centred on GB National Grid Reference E294500, N306500; OS Grid Reference SH 945 065. The site development area covers approximately 1,700 hectares, and consists of small to medium sized fields primarily used for grazing of sheep and cattle. The site location is identified in Figure 1.1.

1.3.2 The proposal includes the erection of 30 three-bladed, horizontal axis wind turbines, each up to 126.5m maximum height to tip and associated infrastructure including, on-site tracks, underground cabling and crane hardstandings, a communications mast (25m high), a permanent (80m high) free standing lattice wind monitoring mast, borrow pits, water crossings, electrical transformers, electrical connection works, a substation and control building, for a period of 25 years.

1.3.3 Each wind turbine will have three blades and a tapered tubular tower. The overall height to blade tip will not exceed 126.5m. Based on nominal 2.0MW capacity turbines the wind farm would produce sufficient electrical energy to satisfy the average requirements of approximately 37,000 homes, equivalent to 63% of the annual consumption of all the houses in Powys (2011 UK census data), see Appendix 1.1.

1.3.4 RES request that if planning consent is granted, a period of at least eight years to implement the consent is permitted, to allow off-site works to be completed prior to commencement of the Proposal construction. Such works include the reinforcement of the transmission grid system as recognised in paragraph 2.13 of Annex C of TAN8. The eight years to implement consent will allow for further commitments to be made to ensure grid reinforcement is constructed in a timely manner.

1.3.5 Various alternative designs have been considered throughout the development of the Proposal: alternative sites through the preferred site analysis, alternative designs through multiple iterations of infrastructure layout and alternative access routes through assessment of preferred route options; each further refining the design to minimise environmental effects.

1.3.6 The grid connection is not covered by the Section 36 application; its assessment within this SEI is restricted to a high-level Grid Route Assessment as provided in Appendix 4.4. The purpose of the assessment was to identify a number of environmentally and technically feasible broad route corridors which could be taken by grid infrastructure in order to link the proposed wind farm to a National Grid hub. The content and findings of these studies are still current and will remain as such until more detailed information about the Mid Wales Connections Project is made publicly available to RES UK and Ireland Ltd. and other developers by SP Energy Networks (Scottish Power Energy Networks). The release of additional information is scheduled for September 2013 at which time more detailed grid connection routeing study may be required.

1.4 The Applicants

1.4.1 RES is a British company and one of the world's leading independent renewable energy project developers with operations across Europe, North America and Asia-Pacific. RES has developed and/or built more than 7.5GW of wind energy capacity worldwide. In the UK alone, RES currently has more than 1,000MW of wind energy either constructed, under construction or consented. The RES Group is active in a range of renewable energy technologies, including large-scale biomass, solar, wave and tidal and on-site renewable installations. With more than 30 years' experience in the wind industry, RES has gained a high level of expertise in the technical, environmental and financial disciplines essential for the development of a successful wind farm.

1.4.2 In 2013, RES was awarded its second Queen's Award for Enterprise, this time in the category of International Trade.

1.4.3 RES' award winning eco-friendly headquarters and education centre in Kings Langley, Hertfordshire, is a showcase for renewable energy generation including solar power, energy crops and a wind turbine next to the M25. More than 4,500 people visited us in the last year to learn about renewable energy and sustainable building design. RES also operates a number of regional offices in key markets worldwide.

1.5 Environmental Impact Assessment (EIA)

1.5.1 An Environmental Statement (ES) was submitted to the Department for Energy and Climate Change (DECC) in April 2009, prepared in accordance with the Electricity Work (Environmental Impact Assessment) (England & Wales) Regulations 2000, which implement Council Directive No. 85/337/EEC on the assessment of the effects of certain public and private projects on the environment (the EIA Directive), as amended by Council Directive No. 97/11/EC (EC, 1997) and Article 3 of Directive 2003/35/EC.

1.5.2 The legal requirements are supported by guidance on best practice including the publication 'Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment – A Good Practice Guide' (DETR, 1995).

1.5.3 The Environmental Impact Assessment (EIA) process follows guidelines to predict and evaluate a proposal's effect on the environment in a systematic and transparent manner. An effect may be beneficial (i.e. positive) as well as adverse (negative).

1.5.4 Information about the environmental effects of a project is collected, both by the applicant and independent consultants, and is submitted within an ES and any Supplementary Environmental Information (SEI) required with a planning application. This will inform decision makers and interested parties of the proposed development details and potential significant effects resulting from the project.

1.5.5 This SEI package, and the original ES, for Llanbrynmair wind farm have been prepared in accordance with the Regulations. It describes the wind farm development, the nature of the site and its surroundings, the likely significant effects of the development and measures proposed to mitigate any potential adverse effects. This SEI comprises a Non-Technical Summary (NTS), the full text SEI (Volume I), supporting appendices (Volume II) and supporting Figures (Volume III).

1.5.6 The Full SEI (Volume I) comprises the following chapters:

- Chapter 1 Introduction;
- Chapter 2 Renewable Energy and Planning Policy;
- Chapter 3 Description of Project;
- Chapter 4 Landscape and Visual Amenity;
- Chapter 5 Ecological Assessment;
- Chapter 6 Ornithogial Assessment;
- Chapter 7 Cultural Heritage;
- Chapter 8 Geology, Hydrology and Hydrogeology;
- Chapter 9 Acoustic Assessment;
- Chapter 10 Transportation and Access;
- Chapter 11 Other Issues;
- Chapter 12 Socio-Economic Assessment); and
- Chapter 13 Mitigation Summary.

1.6 The Original Environmental Statement

1.6.1 The original ES, the basis for this SEI, followed these key stages:

- Stage 1 – Screening:

  The proposed Llanbrynmair wind farm falls under Schedule 2 of the EIA Regulations, a development for which EIA is required if there are likely to be significant environmental effects. RES considered the nature of the Llanbrynmair wind farm and considered that an Environmental Statement should be submitted in support of the planning application.

- Stage 2 – Scoping:

  Consultation with relevant statutory consultees and other stakeholders was undertaken at an early stage to obtain their initial views and input into the scope of the EIA. A formal scoping opinion was sought from Powys County Council (PCC) and the Department for Trade and Industry (DTI) in early 2006.

- Stage 3 – Baseline Studies:

  Identification of existing environmental features and conditions through desk studies, reviewing existing data and field studies as required.

- Stage 4 – Assessment of Effects:

  Assessment and prediction of potential effects on the environment; quantification of effects where possible including:

  - *Assessment of Significance of Effects* - local, regional, national and international scales of potential effects assessed;
  - *Mitigation* – identification of measures to reduce these likely significant environmental effects, these should not solely be applied after the prediction and assessment of significance of effects, but should also be an integral part of the whole design and assessment process; and
  - *Residual Effects* - identification of residual effects which cannot be avoided through mitigation.

- Stage 5 – Environmental Reporting: preparation of the ES and any subsequent SEI.

1.6.2 A formal scoping opinion was not received from PCC, but was received from DTI; the statutory consultees that would normally be consulted by the LPA in the formation of such a scoping opinion were contacted directly by RES. A list of organisations contacted during the scoping and consultation process is provided in Appendix 1.3. Each assessment carried out in the preparation of the ES, and transposed into this SEI, takes account of the matters raised by these consultees.

1.6.3 There are many issues which are common to all wind farms, and their environmental effects are now well known from information gained from existing wind farms in the UK. The relative importance of these environmental effects is, however, site specific and can be weighted according to comments received from statutory consultees, the concerns of the general public, and the results of the different environmental impact assessments carried out. The key potentially significant effects are identified and assessed in Chapters 4-12 of this SEI.

1.6.4 Specialist consultants have been commissioned to assess landscape and visual, ecology, ornithology, cultural heritage, hydrology and transport effects, and RES Group's own experienced teams have assessed the acoustic, electromagnetic, aviation and socio-economic effects.

1.6.5 Once environmental effects have been predicted, the next step is to assess their relative significance to allow a focus on those key effects during the decision making process. It is therefore important to clarify the definition of significance in the process of EIA.

1.7 Scheme History

1.7.1 The original ES was supported by five rounds of SEI; both ES and the supporting SEI packages have been superseded by this SEI. However, the process by which the Proposal has evolved is detailed in Table 1.1.

1.7.2 Table 1.1 provides a summary of the SEI packages that supported the original ES, the topics for which new or updated information has been provided, and where in this SEI (i.e. Chapter or Appendix) that information has been incorporated and can be found.

Table 1.1 SEI Packages – Topics updated and their respective locations as superseded within this SEI

SEI Package	Year Published	Topics Updated	Where the information can be found in this document
SEI 1	2010	Landscape & Visual	Chapter 4: Landscape and Visual Amenity
		Ecology	Chapter 5: Ecological Assessment
		Assessment of the Significance of the Impact of Development on the Historic Landscape (ASIDOHL)	Chapter 4: Landscape and Visual Amenity
		Cultural Heritage	Chapter 7: Cultural Heritage Assessment
		Ornithology	Chapter 6: Ornithological Assessment
		Habitats Regulation Assessment (HRA)	Appendix 6.2
SEI 2	2011	Planning Policy Review	Chapter 2: Renewable Energy & Planning Policy
		Access Route Surveys	Chapter 10: Transportation and Access
		Grid Route Assessment	Appendix 4.4
		Habitat Management Plan	Appendix 6.2
		Peat Management Plan	Appendix 8.9
		Ecology	Chapter 5: Ecological Assessment
		Ornithology	Chapter 6: Ornithological Assessment
		Peat	Chapters 5 & 8: Ecological Assessment
		Hydrology	Chapter 8: Hydrology and Hydrogeology Assessment
		Cultural Heritage of the main site	Chapter 7: Cultural Heritage Assessment
		Landscape	Chapter 4: Landscape and Visual Amenity
		Noise	Chapter 9: Acoustic Assessment
SEI 3	2012	Design Development	Chapter 3: Description of the Project
		Hydrology	Chapter 8: Hydrology and Hydrogeology Assessment
		Landscape and Visual	Chapter 4: Landscape and Visual Amenity
		Ecology and Nature Conservation	Chapter 5: Ecological Assessment
		Ornithology	Chapter 6: Ornithological Assessment

SEI Package	Year Published	Topics Updated	Where the information can be found in this document
		Socioeconomic	Chapter 12: Socio-economic Assessment
		Acoustic	Chapter 9: Acoustic Assessment
SEI 4	2012	Transport and Access	Chapter 10: Transportation and Access
		Non-Avian Ecology	Chapter 5: Ecological Assessment
		Cultural Heritage	Chapter 7: Cultural Heritage Assessment
		Landscape and Visual	Chapter 4: Landscape and Visual Amenity
SEI 5	2012	Site Boundary Drawing	Drawings 1A to 1-3E

1.8 Consultation

1.8.1 Consultation with statutory and non-statutory consultees and other interested parties began in 2005 to identify and screen potential wind farm sites (see Chapter 3 – Description of the Project for further details). Such consultation offered instrumental advice and input into the detailed site design and mitigation options and therefore enabled development of a wind farm with minimal effect on the environment. Specific details of the consultation process are presented throughout the SEI in the relevant assessment chapters.

1.8.2 Copies of the Scoping responses are presented within Appendix 1.4.

1.8.3 Consultation has continued since the submission of the application in April 2009. This process aimed to ensure that any environmental information submitted post-planning submission is conducted in a manner that satisfies all relevant consultees; and to ensure that all formal consultation responses are properly addressed.

1.8.4 From 1 April 2013, the principal consultee on hydrological and hydrogeological issues, Natural Resources Wales (NRW) took over the functions formally carried out by the Countryside Council for Wales (CCW) and Forestry Commission Wales, along with the devolved functions of Environment Agency Wales and some functions that are currently carried out within the Welsh Government.

1.8.5 Table 1.2 identifies the key issues raised by statutory and non-statutory bodies during the post-planning submission consultation, and identifies where these issues have been addressed within the SEI.

Table 1.2 Statutory and Non-Statutory Responses to Llanbrynmair ES and subsequent SEI packages

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
Natural Resources Wales	2012	Wind farm Design Development	NRW raised the following concerns regarding the wind farm design: - Landscape and visual concerns relating to the number of turbines proposed; - Effects on peat close to Afon Garn due to location of access tracks; - Effects on an area of flush and raised bogs within the Esgair y Ffordd commercial forestry due to the location of infrastructure between (and including) Turbines R7	Chapter 4 Chapter 8 Chapter 8

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
			and R8; - Effects on visual receptors (including Glyndwr's Way and recreational routes) due to the proposed location of the electrical substations; - Potential effects that the underground connections between the turbines and central substation may have on ecological receptors.	Chapter 4 Chapter 5 & Chapter 8
Natural Resources Wales	July 2012	Wind farm Design Development	NRW raised the following issues regarding the revised substation design: - Landscape and visual effects of the welfare compounds; - ecological effects of underground cabling, especially on peat and breeding birds; - confirmation of the revised substation footprint; - consideration of the grid connection; - landscape and visual effects of the revised substation, including consideration of Glyndwr's Way; - ecological effects of the revised substation, including consideration of curlew and the proposed HMP.	Chapter 4 Chapter 5 and Chapter 8 Chapter 3 Chapter 4 Appendix 4.4 Chapter 5 and Chapter 6
Natural Resources Wales	2010	Landscape and Visual	Request to consider the effect of the Proposal with the proposed Carnedd Wen Wind farm. To include: - Review of cumulative assessment of LVIA; - Assessment of additional impacts of the Proposal with Carnedd Wen and all other proposed schemes upon agreed viewpoints; - Additional photography and assessment of 3 new viewpoints; - Assessment of compatibility of the Proposal design with Carnedd Wen using agreed viewpoints; and - ZTV analysis.	Chapter 4
Natural Resources Wales Powys County Council	Feb 2011	Landscape and Visual	NRW and PCC requested the following additional information: - A detailed assessment of the effects of the Proposal on landscape character to include use of LANDMAP data to level 3; - Assessment of the potential effects on landscape character and visual	Chapter 4

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
			amenity of the proposed modifications to the minor road between Llanerfyl and the site entrance to the proposed wind farm; - Recommended mitigation measures to ensure that effects of modifications to the minor road are minimised; - Wireframes from viewpoints located at nearby villages, the A470 corridor and the Caersws area indicating any potential reduction in visual effects resulting from the removal of turbines R29 & R30. The wireframes to show any potential reduction in effect resulting from the removal of other turbines removed as part of the redesign process; - A residential amenity survey to identify the potential effects upon residential properties within 1km of the nearest turbine to the proposed development.	
Powys County Council	2012	Landscape and Visual	PCC raised concerns regarding visual effects from the proposal to villages along the A470 corridor, Carno and the Caersws Basin. They requested that turbines 1, 2, 3 and 28 be relocated or removed. PCC also requested further detail regarding mitigation of effects of the minor road access works as they would have a direct effect on hedgerows and woodland features identified as important by NRW.	Chapter 4
Natural Resources Wales	2012	Landscape and Visual	NRW raised the following concerns: Not enough detailed design information provided in SEI Package 2 to address the effects of the minor road on the character of the road including effects on bridges. CCW recommended more detailed landscape and visual assessment based on the final engineering design; Not enough information to fully assess the effect of the proposed sub-stations on the landscape and visual receptors. NRW requested additional photomontages and that alternative locations should be considered.	Chapter 4
Natural Resources Wales	2012	Landscape and Visual	Both raised concerns regarding the level of detail provided in SEI 2 regarding the engineering design of the proposed highway improvement	Chapter 4

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
Powys County Council			works and the assessment of effects and mitigation proposed. NRW recommended additional and more detailed landscape and visual assessment based on the final engineering design. This is to provide engineering certainty and allow the proposed highway improvements to be assessed by NRW.	
Powys County Council	Sept 2012	Landscape and Visual	PCC advise further information and clarification regarding the access route south from Llanerfyl (Capita Symonds advice).	Chapter 4
Natural Resources Wales	2010	Non-Avian Ecology	Recommendation made by NRW to consider altering the proposed site layout to avoid the most sensitive habitats and minimise infrastructure overlap with peat. Request by NRW for exact areas of each vegetation type impacted upon and peat depths.	Chapter 5 and Chapter 8
Natural Resources Wales	2011	Non-Avian Ecology	Agreed with NRW to undertake additional surveys for great crested newts and bats, to update information on the extent of bat activity on site.	Chapter 5 and additional SEI to follow on bats
Natural Resources Wales	2012	Non-Avian Ecology	NRW requested details of vegetation beneath the forestry for those turbines located within plantations.	Chapter 5 and Chapter 8
Natural Resources Wales	November 2010	Peat	NRW requested additional peat data and further hydrological assessment of the effect of the Proposal on peat resources, due to deficiencies in data, making the evaluation of effect and determination of mitigation difficult. Data requested included: - Additional peat depth data for the site to inform re-siting and demonstrate effects on peat have been avoided and minimised; - Peat depth data for all infrastructure positions; - Further hydrological assessment of the effect of infrastructure on habitats.	Chapter 5 and Chapter 8
Natural Resources Wales	June 2012	Peat	NRW requested further detail regarding: - The location and engineering detail of the excavation and foundation footprints relative to turbine 7 and 8 and the ridgeline;	Chapter 5 and Chapter 8

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
			- An assessment of the hydrological implications of the development on the Esgair y Ffordd fen and the associated raised bogs.	
RSPB	2010	Ornithology	Update assessment in light of RSPB publication on the effects of wind farms on upland bird species (Pearce-Higgins, *et al.*, 2009). Updated cumulative assessment of the ornithological effects of the Proposal in combination with other schemes in the area.	Chapter 6
DECC		Ornithology	DECC advised that an Appropriate Assessment for the project may be required for the project under the Habitats Regulations due to the potential effect on breeding birds from the Berwyn SPA.	Appendix 6.2
Natural Resources Wales RSPB	Nov 2010	Ornithology	NRW and RSPB have requested: Black grouse - Updated assessment of distance between breeding areas, collision risk and cumulative assessment with Carnedd Wen; Curlew – Further information on proposed diversion of public rights of way through main curlew area, cumulative assessment to consider all wind farms in SSA B with regard to curlew, management prescriptions and baseline data; Hen harrier – additional assessment detailing potential loss of foraging habitat and information on the benefits resulting from the habitat management plan.	Chapter 6
Natural Resources Wales	2012	Ornithology	NRW raised concerns on the effects the location of the wind farm substation would have on Curlew.	Chapter 6
RSPB	Sept 2012	Ornithology	RSPB remove their objection relating to ornithology.	
Powys County Council	2010	Cultural Heritage	PCC recommended an ASIDOHL assessment be undertaken to assess the effects on the historic landscape of the development area and its surroundings.	Chapter 7
Clwyd-Powys Archaeological Trust	2011	Cultural Heritage	Revision of infrastructure layout to assess any risk to cultural heritage and employ adequate mitigation methods.	Chapter 7
CADW	Aug 2012	Cultural Heritage	CADW endorse the report's conclusions and recommendations.	Chapter 7

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
Clwyd-Powys Archaeological Trust	Oct 2012	Cultural Heritage	CPAT endorse the report's conclusions and recommendations.	Chapter 7
Welsh Government	July 2012	Transport	WG require consideration of: - Pool Quay and Abermule layover areas; - movement during daylight; - timings through Newtown; - passing places.	Chapter 10
Welsh Government	Aug 2012	Transport	Acceptance of the Mid Wales Wind farms Transport Tool as a means of planning and programming wind turbine component movements.	Chapter 10
Powys County Council	Sept 2012	Transport	Further detail and clarification is required on: - timings of HGV movements; - clarity of visibility splays; - confirmation of land agreements; - Gosen Bridge widening; - identification of a positive drainage system; - confirmation of redline boundary at the junction of the C2031 and trunk road A458; - consideration of public rights of way; - construction details and alternative proposals for the Gosen to Sychtyn section.	Chapter 10
RenewableUK	Dec 2012	Transport	Approval in principle for Sections 1 to 5 of sTMP.	Chapter 10
Welsh Government	Feb 2013	Transport	Further detail required on: - visibility splays – details and land ownership; - maximum vehicle size and swept-path analysis; - scenario testing with regard to approach gradients.	Chapter 10
Welsh Government	Mar 2013	Transport	Further detail required on: - maximum vehicle size and swept-path analysis for the Llanerfyl junction; - cumulative traffic assessment;	Chapter 10

Statutory/Non-Statutory Body Response	Date Received	Topic Concerned	Issues	Location of Information
			- visibility splays – details and land ownership, re. topographic data.	
Welsh Government	Mar 2013	Transport	Advice provided for refining draft transport drawings for submission. Recommendations for modifications to proposed works at Llanerfyl junction. Recommendation to consult with Powys CC Highways Officers.	Chapter 10
Welsh Government	Mar 2013	Transport	Confirmation that the Welsh Government as highway authority for the Welsh trunk road network has no objection in principle to the use of the A470 and the junction with the Llanerfyl road at Talerddig for construction traffic associated with eth Llanbrynmair wind farm, subject to the implementation of appropriate improvement measures.	Chapter 10
MOD, CAA NATS	Sept 2012 Aug 2012	Other Issues	No objection response issued to DECC.	
Powys County Council	Sept 2012	Socio-Economic	PCC Countryside Services require consideration of public rights of way (PRoW) with regard to the traffic management plan, to be addressed by condition, and recommend no turbines are to be microsited closer to a PRoW without PCC consent.	Chapter 12

1.9 References

1.9.1 DETR, 1995. Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment – A Good Practice Guide. ODPM, London.

1.9.2 European Commission (EC), 1997. Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment. Available from:

http://europa.eu.int/comm/environment/eia/full-legal-text/9711_consolidated.pdf Viewed November 2008.

1.9.3 The Town and Country Planning (Environmental Impact Assessment (England and Wales) Regulations 1999 (SI 1999 No 293). UK Census data, 2001 taken from website: http://neighbourhood.statistics.gov.uk/. Viewed November 2008

2 RENEWABLE ENERGY AND PLANNING POLICY

2.1 Climate Change and the Need for Renewable Energy Development

2.1.1 Climate change is regarded by many as one of the most serious threats facing the world's environment, economy and society (from Climate Change - the UK Programme 2006)[1]. While there remain those who argue either that climate change is not happening to any significant extent, or who see it as no more than a natural stage in the cycle of the climatic system of the world, the consensus of scientific opinion is that there is a link between man's actions and a variety of climate-related issues such as rising sea and air temperatures, rising sea-levels, melting ice caps and changes in the pattern and severity of a range of meteorological conditions. In this context, the national policy imperatives that the UK Government has set are predicated on the prevailing scientific concerns and are not open to challenge in the context of an individual wind farm proposal. They are clearly set out in the White Paper of 2007[2] which identifies the threats from climate change and the responses to it. The UK Renewable Energy Strategy published in July 2009[3] reinforced this even more strongly, as do a raft of policy statements issued since the Coalition Government came to power in 2010, up to the publication of the Energy Bill late in 2012. National policy here is clear and unequivocal and falls to be applied, not questioned.

2.1.2 The Energy Challenge (July 2006)[4] set out the 'Statement of National Need for Renewable Energy' in its Annex D. The White Paper entitled 'Meeting the Energy Challenge' May 2007[3] is also relevant. Box 5.3.3 in the 2007 White Paper restated the 'Renewables Statement of Need' and included the important statement that:

> *"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 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 decisions makers in reaching their decisions."*

2.1.3 Later in this Chapter reference will be made to advice in the latest version of PPWales from October 2012 on precisely the same point as to the requirement to balance any harm which is identified against the wider benefits of securing renewable sources of electricity.

2.2 The UK Renewable Energy Strategy

2.2.1 The UK Renewable Energy Strategy (UKRES) was issued by the Department of Energy and Climate Change (DECC) in July 2009. The Strategy states that the UK needs to "radically increase our use of renewable electricity….". The document sets out the means by which the UK can meet the legally binding target of 15% of energy consumption from renewable sources by 2020. This will mean a 7-fold increase in the share of renewables in little more than a decade (page 8).

2.2.2 In the UKRES, a 'lead scenario' is presented which suggests that more than 30% of electricity should be generated from renewables by 2020, which would be up from approximately 5.5% in 2009. The majority of this is expected to come from wind power, both on and offshore. Clearly, the lead scenario represents a more challenging target than the 2003 White Paper target (20%), which most Development Plan 2020 renewable energy targets are designed to achieve.

2.2.3 In terms of financial support, the UKRES sets out a framework of long term, comprehensive and targeted financial support for renewables. The UKRES stated that the Renewables

Obligation was to be expanded and extended to ensure it can deliver approximately 30% renewable electricity by 2020 (UKRES, paragraph 3.4).

2.2.4 The UKRES makes the point that the Strategy is expected to deliver significant environmental benefits, in particular by contributing to global action against climate change. It recognises that there will also be some 'pressures' on local environments from new infrastructure provision. The document states that if the renewable energy targets and longer term carbon reduction targets are to be met, then "many communities will need to 'host' renewable energy projects such as wind farms…." (UKRES, paragraph 6.3).

2.2.5 The UKRES refers explicitly to economic and employment opportunities: these are highlighted and the aspiration is for the UK to be at the forefront of global competition in the low carbon economy. The Government estimates that the Strategy will deliver a range of benefits including:

- Putting the UK on a path towards **decarbonising** the production of energy in the UK, alongside nuclear and carbon capture and storage
- Contributing to the **security of energy supplies** in the UK through reducing demand for fossil fuels of around 10% and gas imports by between 20 – 30% against forecast use in 2020
- Bring outstanding **business opportunities** and enable the UK to restructure into a low carbon economy, providing around £100Bn of investment opportunities and contribute to the creation of up to 0.5m more jobs in the UK renewable energy sector

2.2.6 The strategy is expected to deliver significant environmental benefits, in particular by contributing to global action against climate change. It recognises that there will also be some pressures on the local environments and natural heritage from new infrastructure provision

2.2.7 With regard to the economic benefits of the proposed development, it is apparent from the UKRES that Government takes the view that addressing climate change presents "a huge opportunity" in terms of maximising economic opportunities (UKRES, para 1.8, p27). The Government notes that supplying the demands of a low carbon economy offers a significant potential contribution to the economic growth and job creation in the UK, "not only as part of our short term economic recovery but also through sustainable growth over the decades to come". Noting that up to half a million additional jobs might be generated in the UK renewables sector and its related supply chains, the Government states (UKRES, para 1.9) that "the current economic difficulties make this even more important…"

2.2.8 Sufficient progress needs to be made each year "to remain on track to achieve our 2020 target". Under the Renewable Energy Directive, the UK has Interim Targets to achieve the following shares for renewables in the energy mix, namely:

- 4.0% in 2011-12
- 5.4% in 2013-14
- 7.5% in 2015-16
- 10.2% in 2017-18
- 15% in 2020

2.2.9 The targets for the UK set out in EU Directives are now formally enshrined in law by the SI 243 – Promotion of the Use of Energy from Renewable Sources Regulations[5] which came into force on 14th March 2011, setting out not only the 15% overall energy use target but the steps along the way to 2020 to achieve that.

2.3 The Low Carbon Transition Plan (2009)[6]

2.3.1 Along with the UKRES, the UK Government published the UK Low Carbon Transition Plan, (LCTP) as a White Paper in July 2009. The plan seeks to deliver emission cuts of 18% on 2008 levels by 2020 (and over a third reduction on 1990 levels) (p4).

2.3.2 The White Paper seeks to ensure that the UK will get 40% of electricity from low carbon sources by 2020, with policies to produce approximately 30% of UK electricity from renewables by 2020 (in line with the UKRES), by substantially increasing the requirement for electricity suppliers to sell renewable electricity (p4).

2.3.3 It states that the UK Government has put in place the world's first legally binding target to cut emissions by 80% by 2050 and it has set five year "carbon budgets" to 2022 to 'keep the UK on track' (p6). The White Paper sets out how these budgets will be met for the first time.

2.3.4 In terms of carbon savings to 2020, in April 2009 the Government announced the first three budgets, covering the periods 2008 – 12, 2013 -17 and 2018 – 22. The Government has emphasised that the carbon budgets will be "stretching" (p36 and repeated on p38). The final budget period centred on 2020 requires a 34% cut on 1990 levels.

2.3.5 The UK's carbon budget is stated as being equivalent to a 34% cut in greenhouse gas emissions by 2020 (p39). This figure is based on a comparison of average annual emissions over the budget period against UK emissions in 1990.

2.3.6 In terms of the planning system, at page 67 of the White Paper, Government takes the clear position that "the planning system will need to play a central role in supporting the deployment of renewable energy". The White Paper highlights that delivering large increases in renewable electricity will be 'critical' in decarbonising the power sector.

2.4 The Coalition Government

2.4.1 The Coalition Government in 'Our Programme for Government' stated with regard to energy and climate change:

> *"The Government believes that climate change is one of the gravest threats we face, and that urgent action at home and abroad is required. We need to use a wide range of levers to cut carbon emissions, decarbonise the economy and support the creation of new green jobs and technologies…..we will seek to increase the target for energy from renewable sources, subject to the advice of the Climate Change Committee".*

2.5 National Renewable Energy Action Plan for the UK

2.5.1 The UK Government also published the 'National Renewable Energy Action Plan for the United Kingdom'[8] in July 2010. It states (page 4) that:

> *"The UK needs to radically increase its use of renewable energy. The UK has been blessed with a wealth of energy resources. …As we look forward, we need to ensure that we also make the most of our renewable resources to provide a secure base for the UK's future energy needs".*

2.5.2 This Action Plan (page 4) also makes reference to the independent UK Committee on Climate Change (CCC) and that "it will review the renewables target and provide advice on increasing the level of ambition".

2.6 Committee on Climate Change

2.6.1 The CCC advised the Secretary of State for Energy on 9th September 20109 with regard to the renewable energy ambition for 2020 as follows:

> *"The envisaged contribution from renewable electricity (to account for around 30% of total generation by 2020, compared with 6.6% in 2009) is appropriate in the context of the need to substantially decarbonise the power sector by 2020, on the path to meeting the economy wide target to reduce 2050 emissions by 80% relative to 1990 levels. Investment now in a broad range of renewables technologies, but predominantly onshore and offshore wind, will directly contribute to required decarbonisation…it could also provide economic opportunities for UK based firms". (Emphasis added).*

2.6.2 The letter added (page 2) that meeting the 2020 renewable energy target would require a step change in the rate of progress and that:

> *"Our forward indicators for renewable electricity generation set out key actions that would deliver the 2020 target. A ramping-up in the pace of investment is required (around 1 GW of wind generation was added to the system in 2009, compared to over 3 GW required annually by the end of the decade)".*

2.6.3 Failure to address key risks would limit the scope for investment and would imply a reduced share of renewable electricity in 2020. Such risks would include the need to *"reduce the planning application period for new renewable projects and increase the planning approval rate".*

2.6.4 The 'Renewable Energy Review'[10] (published by the CCC on 9 May 2011) ("the RER") expressed 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 RER 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.

2.6.5 Consequently, onshore wind is a key element of the portfolio of low carbon generation technologies which the CCC says is required to ensure that the UK's renewable energy targets and climate change commitments are met. However, the RER recognises that further approvals will be required in order to deliver the renewable energy (and, in particular, the onshore wind) ambition which is advocated by the UKRES.

2.6.6 On the 19th May 2011 the UK Government issued a statement on the 4th Carbon Budget[11], which will cut greenhouse gas emissions by 50% by 2025.

2.6.7 A limit on the total amount of greenhouse gases to be emitted by the UK between 2023 and 2027 has been proposed to cut Britain's emissions by 50% from 1990 levels and highlighting the Government's commitment to being the greenest Government ever.

2.6.8 The proposal, set out by the then Energy and Climate Change Secretary Chris Huhne, was in line with advice from the independent CCC. It sets a fourth carbon budget of 1950 MtCO2e for the period that will span from 2023 to 2027, putting the UK on course to cut emissions by at least 80% by 2050.

2.7 National Policy Statement for Energy

2.7.1 The Overarching NPS for Energy (EN-1)[12] and the NPS for Renewable Energy Infrastructure (EN-3)[13] were approved by the UK Parliament in July 2011. They are material considerations in the consideration of this proposal and should be accorded significant weight. They apply specifically to Nationally Significant Infrastructure Projects, which in the case of onshore wind energy cover schemes for 50MW or more of installed capacity. Although the Llanbrynmair wind farm was submitted under Section 36 of the Electricity Act and not the Planning Act 2008, the intention is that the provisions of the NPSs will apply to all such projects as well. The primary aim of the NPSs is to provide a policy framework for decisions on nationally significant infrastructure projects in the energy field. Furthermore, *"The energy NPSs should speed up the transition to a low carbon economy and thus help to realise UK climate change commitments sooner than continuation under the current planning system"* (paragraph 1.7.2).

2.7.2 The clear urgency and necessity to increase the transition to a low carbon economy (through the installation of renewables technologies) is evident. To cite but one example, paragraph 2.2.8 of EN-1 states, *"To avoid the most dangerous impacts of climate change, the increase in average global temperatures must be kept to no more than 2°C, and that means global emissions must start falling as a matter of urgency. To drive the transition needed the Government has put in place the world's first ever legally binding framework to cut emissions by at least 80% by 2050, that will deliver emission reductions through a system of five year carbon budgets that will set a trajectory to 2050".* At paragraph 3.3.7, EN-1 states, *"In the UK at least 22 GW of existing electricity generating capacity will need to be*

replaced in the coming years, particularly to 2020. This is as a result of tightening environmental regulation and ageing power stations". Also, "an increase in renewable electricity is essential to enable the UK to meet its commitments under the EU Renewable Energy Directive" (paragraph 3.3.11). The need for a major growth in the installation of renewable energy generation is a given under the NPS.

2.7.3 It is also stated in NPS EN-3 that *"onshore wind farms are the most established large-scale source of renewable energy in the UK. Onshore wind farms will continue to play an important role in meeting renewable energy targets"* (paragraph 2.7.1). In terms of the issue of the "temporary" nature of a wind farm, the Government recognises this as a feature of a wind farm, where the consent expires after a set period of time, normally 25 years. It goes on to state that this temporary nature will be an important consideration for the IPC (now the Secretary of State DECC) (para 2.7.17) and hence therefore decision-makers on applications and appeals.

2.7.4 EN-3 also makes some helpful comments about issues that have been raised many times before in applications and appeals such as the need for flexibility in turbine dimensions to reflect availability of machines when development is to take place (2.7.19). It also addresses the possible need for micrositing in what it regards as typical ranges of 30-50m for elements of the infrastructure (2.7.24). The NPS also states that sequential testing of sites should not be carried out, and that in the context of the setting of cultural heritage assets, significant weight should be given to the fact that onshore wind turbines are time-limited and non-permanent in the context of such effects. At 2.7.63-2.7.72, the Government advises on shadow flicker that, following further research it had commissioned, it has concluded that it is unlikely that shadow flicker will occur outside 10 rotor diameters from the turbine. It is also stated in NPS EN-3 that *"onshore wind farms are the most established large-scale source of renewable energy in the UK. Onshore wind farms will continue to play an important role in meeting renewable energy targets"* (paragraph 2.7.1). In terms of the issue of the "temporary" nature of a wind farm, the Government recognises this as a feature of a wind farm, where the consent expires after a set period of time, normally 25 years. It goes on to state that this temporary nature will be an important consideration for the IPC (now the Secretary of State)(para 2.7.17) and hence therefore decision-makers on applications and appeals.

2.8 The 'UK Renewable Energy Roadmap' 2011[14]

2.8.1 The Department of Energy and Climate Change (DECC) issued the 'UK Renewable Energy Roadmap' in July 2011, alongside the Government's Electricity Market Reform White Paper.

2.8.2 The introduction explains that the goal is to ensure that 15% of UK energy demand is met from renewable sources by 2020. At paragraph 1.3, it explains that the ambition extends beyond 2020 and there is reference to the recent advice from the Committee on Climate Change 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.

2.8.3 The Roadmap sets out an analysis of recent trends in renewables deployment and the pipeline of projects that could come forward before 2020. It addresses the barriers to be overcome and sets out a targeted programme of action which the Government is taking in order to increase renewables deployment (paragraph 1.8).

2.8.4 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.

2.8.5 DECC's modelling is based upon work conducted by AEA Technology and involved stakeholder engagement, which considered build rates, technology costs and policy implications for the deployment of each technology. It concludes that 15% of projected UK energy can be delivered by 2020 (234TWh), from a mixture of electricity generation, heat installations and over 5% of transport fuels from renewables. Paragraph 2.17 states that the UK's total energy consumption from renewable energy was 3.3% in 2010 and that:

> *"there will need to be more than a fourfold increase in our renewable energy consumption by 2020 if 15% of our energy needs are to be met from renewable*

sources. Consumption of renewable energy will need to rise by 17% per annum to meet that goal" (page 20).

2.8.6 AEA Technology forecast 29GW of renewable electricity capacity in operation by 2020 (paragraph 2.20).

2.8.7 Various uncertainties in deployment by 2020 are highlighted, such as the cost of technologies (especially for marine technologies, page 19), the level of renewable energy deployment and future demand. Although the pipeline of new capacity is considered to be healthy (paragraph 2.20), the analysis indicates that: *"we cannot be certain that all the projects in the pipeline will be consented or commissioned, or that they will progress quickly enough to contribute".*

2.8.8 At page 23, there is a cross reference to the Overarching NPS for Energy (EN-1) which states that *"there is an urgent need for new large scale renewable energy projects to come forward to ensure that we meet the 2020 target and wider decarbonisation ambitions".*

2.8.9 Onshore wind is recognised as the biggest single contributor to the pipeline (paragraph 2.22), with over 11GW of capacity in planning, consented or under construction. The offshore wind pipeline is "expected to grow". The conclusions from the analysis state that there is still an urgent need for new projects to come forward (page 26).

Onshore Wind

2.8.10 The Roadmap focuses on the 8 technologies that have the greatest potential to help the UK meet the 2020 target in a cost effective and sustainable way, or offer great potential for the decades that follow.

2.8.11 In terms of onshore wind: the 'central range' for the deployment of onshore wind indicates that this technology could contribute up to 13GW by 2020. This level of capacity would equate to an annual growth rate of some 13%.

2.8.12 Challenges to deployment include minimising investment risk, reform of the planning system, overcoming radar interference from wind farms and ensuring cost effective grid investment and connection. The reform of the planning system is to include advice to local authorities to identify opportunities for the deployment of renewables using analysis from regional studies.

2.8.13 The majority of the capacity is expected to come from large scale projects over 5MW.

2.8.14 The existing planning pipeline is referred to at paragraph 3.11 and it is stated that it could potentially deliver 8.9GW. At paragraph 3.13, however, the Roadmap makes it clear that there is still a need to tackle challenges to deployment and that new proposals will also be required to come forward to meet the 2020 ambition, as well as longer term decarbonisation objectives.

2.8.15 The Roadmap is a relatively recent and comprehensive expression of Government policy on renewable energy and the strategy for its deployment. It should be accorded significant weight. It is intrinsically linked to the EMR White Paper.

2.9 The Carbon Plan (2011)[15]

2.9.1 The Coalition Government issued the Carbon Plan 'Delivering our Low Carbon Future' 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.

2.9.2 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 in storage (CCS)".*

2.9.3 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 todays electricity capacity to deal with peak demand"* (paragraph 44).

2.9.4 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.

2.9.5 The Government sets out its commitment to a revised fiscal mechanism for stimulating renewable investment and states that the introduction of Feed in Tariffs with Contracts for Difference from 2014 will provide "stable financial incentives for investment in all forms of low carbon generation".

2.10 The Electricity Market Reform (EMR) White Paper[16]

2.10.1 The Government set out its intention to reform the electricity market in the EMR White Paper (July 2011). In May 2012 the Government published a draft Energy Bill. Scrutiny since then by Parliament has resulted in the refinement of EMR proposals and the publication of the Energy Bill in November 2012.

2.10.2 In the White Paper onshore wind is described as a "mature technology" (paragraph 2.3.25), in which the market can be prepared to invest with some certainty.

2.10.3 The White Paper states that "The policy proposals …….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 (paragraph 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.

2.10.4 Chapter 1 of the White Paper describes the "vision" which is to be achieved by 2030 (see 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".* (my emphasis).
>
> *"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 form part of the "generation mix" in accordance with a range of advancing and currently infant renewable technologies.*

2.10.5 The White Paper is an expression of Government policy and illustrates the direction of travel intended by Government with priorities including decarbonisation of electricity generation and greater energy security. The document should be afforded significant weight.

2.11 The Renewables Obligation and the Consultation on Banding Review[17]

2.11.1 The framework of the Renewables Obligation (RO) has created significant demand for renewable generation and the market has reacted by bringing forward proposals for new

renewable plant. A large proportion of these proposed new developments are for onshore wind-powered generation in the UK.

2.11.2 Electricity supply businesses are subject to the RO, which requires them to source a specific and annually increasing percentage of the electricity that they supply from renewable sources. If they do not achieve the required percentage financial penalties are applied.

2.11.3 The UK Government issued a 'Consultation on Proposals for the levels of banded support under the Renewables Obligation for the period 2013-17 and the Renewables Obligation Order' on 20th October 2011. The consultation ended on 12th January 2012. The Executive Summary of the document states that the Coalition Government has made clear its commitment to increasing the deployment of renewable energy across the UK (page 8). The Government proposed to adjust the RO banding to deliver the deployment trajectory set out in the UK Renewable Energy Roadmap, reducing support for onshore wind by 10% to 0.9 ROCs/MWh) which reflected the technology maturity and cost competitiveness of onshore wind (this has now been brought in during 2012 in the formal changes to the bandings). Onshore wind is specifically addressed at page 29 et seq. in the consultation document and it states that the analysis informing the consultation has concluded that:

> *"onshore wind within the UK still has significant deployment potential. Utilising the best onshore wind sites, together with the repowering of existing sites with newer, more efficient turbines, could provide an increase from present levels to deliver up to 13GW of capacity by 2020"*

2.11.4 In terms of RO support the document states (paragraph 3.7) that:

> *"as one of the most cost effective and developed of all the renewable energy technologies, we recognise the continuing significance of onshore wind for achieving our renewable energy target"* (my emphasis)

2.11.5 Therefore, the EMR proposals confirmed that onshore wind remains an important technology for the delivery of the Government's national targets for renewable electricity generation. In terms of the RO mechanism, there is justification and need for the development that is related to Government policy, which is in addition to the achievement of targets, arises out of a distinct legal obligation that seeks to bring about an increase in the proportion of electricity to be supplied from renewable sources. These factors should properly be regarded as relevant and material considerations in the determination of this application.

2.12 The Energy Bill[18] and Annual Energy Statement 2012[19]

2.12.1 On 23 November 2012 DECC issued a Press Notice entitled 'Government Agreement on Energy Policy sends clear, durable signal to investors'[39]. It contained various statements by the Energy and Climate Change Secretary which included the following:

> *"This is a durable agreement across the Coalition against which companies can invest and support jobs and our economic recovery. The decisions we've reached are true to the Coalition agreement, they mean we can introduce the Energy Bill next week and have essential electricity market reforms up and running by 2014 as planned. They will allow us to meet our legally binding carbon reduction and renewable energy obligations and will bring on the investment required to keep the lights on and bills affordable for consumers"*

2.12.2 Following this, the Annual Energy Statement was delivered to Parliament by the Energy and Climate Secretary on 29 November 2012.

2.12.3 In the oral Statement, the Minister stated that:

> *"we are preparing a once in a generation transformation of the energy landscape to bring on massive private sector investment which will boost the economy, create jobs and power Britain to a prosperous low carbon future"*

2.12.4 The Annual Energy Statement states at section 1.1 that the Government's vision is for a thriving, global competitive, low carbon economy and that energy policy is guided by the following objectives:

'Energy security

Climate change: to lead the UK Government's efforts to prevent dangerous climate change, both through international action and through cutting our own greenhouse gas emissions

Support growth: deliver our policies in a way that maximises the benefits to the economy in terms of jobs, growth and investment, …. and seizing the opportunities presented by the rise of the global green economy.'

2.12.5 It adds that around a fifth of power stations operating in 2012 have to close over this decade and investment is needed if we are to maintain secure energy supplies that are critical to the economy and our way of life. It adds that this investment is also key to "getting our economy moving".

2.12.6 Section 2.5 of the Statement states the following:-

"To provide certainty to investors and ensure we are taking the least cost approach to the UK's binding 2050 carbon target, the Government will take a power amending the forthcoming Energy Bill during its passage, to set a decarbonisation range for the power sector in 2030 in secondary legislation. The power will not be exercised until the Committee on Climate Change has provided advice on the fifth carbon budget (which covers the corresponding period) and the budget is set".

2.12.7 In terms of EMR, section 2.8 states that the Energy Bill is intended to implement the key aspects of EMR, by introducing major reforms that will result in greater stability and certainty for investors in energy infrastructure. It adds that EMR reforms could help support 250,000 jobs in the energy sector.

2.12.8 The Statement addresses renewable energy at section 2.15 and states 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".

2.12.9 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.

2.12.10 Section 2.19 makes reference to planning policy and refers to the NPPF which it states:

"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".

2.12.11 The Statement adds importantly that with regard to Local Planning Authorities that "they are also expected to approve applications if the impacts are (or can be made) acceptable".

2.12.12 The 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 key component. The new fiscal support mechanism will implement EMR 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.

2.12.13 A further document issued as part of the suite of documentation on the topic of EMR is a document entitled 'Electricity Market Reform Policy Overview'[40]. It describes in some detail the new physical support mechanism, Contracts for Difference, as well as other aspects of wider energy policy.

2.12.14 Page 9 et seq. sets out the Government's overall energy objectives. It states at paragraph 12 that:

'Government's energy and climate change goals are to deliver secure energy on the way to assist sustainable low carbon future and drive ambitious action on climate

change at home and abroad. It is critical that we address both security of supply and climate change challenges, while maximising the benefits….nowhere in our energy policy are these challenges more evident than in the electricity sector".

2.12.15 Paragraph 17 states that the Government's view is that "we cannot rely on any single form of generation and instead we should pursue a portfolio approach, leading to a diverse mix that balances the risks and uncertainties of different technology options".

2.12.16 Paragraph 19 states "to meet our climate change goals, we need to transform the way that electricity is generated". The document sets out an 'illustrative pathway' to meeting the Government's goals and the key points in this pathway are as follows:

Between now and 2020

2.12.17 Given the legally binding EU target for 15% for the UK's energy to come from renewable sources by 2020, DECC expects that around 30% of electricity would need to come from renewable energy generation by the end of the decade.

2020 – 2030

2.12.18 From 2020, further cuts in emissions from the power sector will be necessary to maintain a cost effective path in meeting 2050 commitments.

2.12.19 Reducing emissions from the power sector becomes increasingly important to help decarbonise other sectors. If we do not make progress in relation to electricity over the next two decades, work towards our 2050 target in the 2030s and 2040s may become more difficult.

2.12.20 There is a clear opportunity for large scale new low carbon capacity in the next two decades, created by the combination of the existing plant closures and an increase in demand.

2.12.21 The Government will take a power in the Energy Bill to set a decarbonisation target for the power sector for 2030.

2030 – 2050

2.12.22 By 2050 heating, transport and industry will become increasingly electrified, the amount of electricity that we need to generate is very likely to increase.

2.12.23 Recent DECC analysis shows that electricity demands is likely to increase by between 30% and 100% by 2050.

2.12.24 In order to meet legally binding 2050 carbon emission reduction targets Government expects that power will be generated largely from renewables, nuclear and fossil fuel stations fitted with CCS technology.

2.12.25 Even in 2050 unabated gas could still have an important role to play, albeit operating much less than it does today.

2.12.26 Paragraph 20 of the document states that to meet these challenges there is an investment challenge. It adds that the Government's view *"is that the current market arrangements will not deliver this investment, therefore EMR provides the tools needed to meet the challenge".*

2.12.27 It is clear from the published Energy Statement and the oral statement to Parliament, and the Policy Overview, that the Government remains committed to the growth of renewable energy and to the UK's 2020 energy targets, as well as longer term climate change objectives.

2.12.28 The Energy Bill has now been passed by Parliament following amendment.

2.13 The UK Renewable Energy Roadmap Update 2012[20]

2.13.1 The UK Renewable Energy Road Map Update was published on 27th December 2012. It sets out the progress and changes delivered in the renewable sector over the past year and sets out challenges and actions for the year ahead. The Executive Summary (page 6) states the Coalition Government "is committed to increasing the deployment of renewable energy across the UK".

2.13.2 Paragraph 1.3 states that whilst the Roadmap focuses on reaching 2020 targets:

> *"it is clear that renewables will have a pivotal role to play in the UK energy mix in the decades beyond".*

2.13.3 For example, it makes reference to the Climate Change Act requirement for the UK to reduce greenhouse gas (GHG) emissions by at least 80% below 1990 levels by 2050. It adds that recent DECC analysis shows that electricity demand is likely to increase by between 30% and 100% by 2050.

2.13.4 It is clear therefore, that whilst 2020 is an important milestone in relation to certain mandatory targets, Government policy and targets go well beyond this. This is recognised in the National Policy Statement (NPS) EN-1 and other more recent documents such as the Annual Energy Statement (2012).

2.13.5 On page 10 of the Update, DECC sets out an analysis of the deployment of renewable energy to 2020. Paragraph 2.5 states that the Government continues to believe that encouraging a diverse mix of energy sources including renewables is the best way to meet decarbonisation objectives and to "ensure the lights stay on". It adds that:

> *"it remains true, as stated in the overarching National Policy Statement for Energy, that there is an urgent need for new large scale renewable energy projects to ensure that we meet the 2020 target and wider decarbonisation ambitions".*

2.13.6 Paragraph 2.6 refers to the Roadmap of 2011 and states that it provided an analysis of potential deployment to 2020, taking into account factors such as technology costs, build rates and policy framework. However it adds that these variables were modelled:

> *"to produce illustrative 'central ranges' for deployment based on analysis using published literature and discussions with the industry overlain by industry high and low scenarios for each technology around central ranges".*
>
> *"These central ranges did not represent technology specific targets or the level of our ambition. We are committed to update our analysis annually to reflect the evolution of policy and observe levels of deployment".*

2.13.7 Paragraph 2.8 refers to key uncertainties which continue to include future energy demand, cost trajectories of various technologies and the level of actual renewable energy deployment which industry believes can be achieved. Deployment of offshore wind remains one of the main areas affected by high costs and paragraph 2.9 states with regard to offshore that there are "clearly big challenges to overcome".

2.13.8 In relation to onshore wind Paragraph 2.10 makes reference to the suggestion in the 2011 Roadmap that there could be around 13GW of onshore wind capacity by 2020. It states that over the last year there has been an increase of 1.3GW of operational onshore capacity and the onshore wind pipeline holds an additional 6.1GW of projects waiting or under construction, as well as 7GW awaiting planning approval.

2.13.9 Paragraph 2.4 records the onshore wind capacity as of the end of June 2012 as being 5.3GW.

2.13.10 The Update states that the current pipeline for onshore wind is likely to have the potential to provide the appropriate quantity of deployment:

> *"to fulfil our ambition outlined last year. However, we cannot be certain how much of the capacity in the pipeline project will go forward as not everything in the pipeline will be consented and not everything consented will be built".*

2.13.11 Paragraph 2.13 states that the potential for key technologies (namely biomass, offshore wind, onshore wind, marine energy, solar pv etc.) needed to deliver the 2020 target are similar to that anticipated in 2011. However, it adds that the uncertain nature of deployment across the portfolio of different technologies, as well as the relative cost effectiveness, means that generation could end up at the high end of one technology's deployment range and therefore requiring less deployment of others.

2.13.12 Paragraph 2.4 records that using the EU Renewable Energy Directive methodology, some 3.8% of UK energy consumption in 2011 came from renewable sources up from 3.2% in 2010. This needs to be read against the 15% target for 2020.

2.13.13 Page 25 of the Update addresses renewable electricity and paragraph 2.2 states the contribution of all renewables to UK electricity generation was 10.4% for the period July 2011 to June 2012. This needs to be read against the 30% target for 2020.

2.13.14 The Update addresses the various renewable technologies and onshore wind is addressed at page 36. Here it is stated 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*".

2.13.15 It adds that onshore wind provides substantial economic benefits and that Government is seeking to remove barriers to the development of appropriately sited projects, whilst giving local communities more influence. This is referenced in the context of the National Planning Policy Framework having delivered reform of the planning system to support growth and give local communities a stronger voice.

2.13.16 The onshore wind section (page 36) also makes reference to the results of the DECC public attitudes tracking survey which it states shows that the majority of the public support the growth of onshore wind in the UK. There is also reference to the Government's call for evidence on costs, engagement and benefits, "looking at how communities can have more of a say over, and receive greater benefit from, hosting onshore wind in their area".

2.13.17 Paragraph 2.31 reiterates that there is a healthy pipeline of projects that has entered the formal planning system, but adds that not everything in the pipeline will be consented and not everything consented will be built.

2.13.18 Paragraph 2.32 adds that there is expected to be significant attrition at the planning and pre-construction stages due to a number of factors such as project delays or extra costs associated with radar interference.

2.13.19 Paragraph 2.33 states that whilst the Government cannot be certain which projects will go forward; the current pipeline is likely to represent:

> *"the appropriate quantity of deployment to fulfil the central estimated range in the 2011 renewable energy road map for onshore wind deployment (around 10 – 13GW capacity).*

2.13.20 However, as noted above, section 2.6 of the Update states that this figure is an:

> *"illustrative central range for deployment" and do "not represent technology specific targets or the level of our ambition"* (my emphasis).

2.13.21 Moreover, at paragraph 2.5, the Update states that it remains true as set out in NPS EN-1, that there is an urgent need for new large scale projects to come forward to ensure we meet the 2020 target and the wider decarbonisation ambition that the Government has.

2.14 The Position in Wales

2.14.1 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 2003[21], 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.

2.14.2 This was carried forward into TAN8[22] in July 2005, with its approach to the identification of seven Strategic Search Areas for a further 800MW of additional onshore wind by 2010.

2.14.3 Since 2005, there have been further policy pronouncements including "One Wales"[23] in which the WAG set out its strong commitment to tackling climate change and the New Renewable Energy Route Map published in February 2008[24].

2.14.4 The publication of the March 2010 Energy Policy Statement[25] 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.

2.14.5 This can be seen as a formal response by the Welsh Government 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 Welsh Government in June 2010.

2.14.6 A new version of PPWales was published in 2011 and has since been revised again (Version 5, October 2012)[26], containing the Table from the EPS setting out the new target figure. PPWales also states that it remains the policy of the Welsh Government that the indicative boundaries of the Strategic Search Areas in TAN8 should not be amended significantly and this has since been confirmed in the written statement by John Griffiths AM of July 2011[27], addressed in more detail later on in this chapter. The latter expects a maximum of about 1666MW of onshore wind to be installed in the seven SSAs by the end of 2017.

2.14.7 Finally, the Welsh Government published in March 2012 "Energy Wales: A low Carbon Transition"[28] 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."*

2.15 Planning Policy Wales Version 5 - 2012

2.15.1 PPW 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.

2.15.2 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. Clearly this does not apply in the same way to a Section 36 Application under the

Electricity Act as it would to a planning application under the tests in Section 38(6) of the 2004 Act. This has been confirmed in various decisions on s.36 and s.37 projects and was considered by the High Court in January 2012 in the case of *R ex parte Samuel Smith Old Brewery (Tadcaster) v Secretary of State for Energy and Climate Change*[29]. In this case it was held that a 'direction' that planning permission shall be deemed to be granted does not constitute a 'determination' under the Planning Acts. The judge stated that 'as a matter of construction I consider that it is a direction that such determination is not required'. This approach has also been confirmed in Scotland by the Court of Session[30] in the case of the Dorenell Wind Farm in Moray. As such, there is no duty upon the Secretary of State to comply with s.38(6) of the Planning and Compulsory Planning Act 2004 but the Development Plan remains a material consideration along with the UK national energy and national policy advice (in the NPSs), and Welsh Government national energy and planning advice and as set out in the NPSs the Secretary of State (DECC) will have regard to relevant development plan provisions when dealing with applications which come before him in Wales.

2.15.3 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.

2.15.4 Section 6 deals with the historic environment and covers issues relating to archaeology, historic landscapes and conservation areas. It states that 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.

2.15.5 Sustainable energy is tackled in PPWales at paragraphs 12.8-12.10. The advice emphasises the Assembly's commitment to playing its part by delivering an energy programme which contributes to reducing carbon emissions. This revised version of PPW repeats the figures in the 2010 Energy Policy Statement (EPS) in place of the figures of 4TWh of renewable electricity production by 2010 and 7TWh for 2020 which had appeared in versions of PPW as recently as June 2010. It states that planning policy at all levels should facilitate delivery of both the Welsh Government's overall Energy Policy Statement and UK and European targets on renewable energy. The key issue that now has to be addressed is that of the accelerating need for delivery since the table indicates that it is looking for a total of 2000MW of installed capacity of onshore wind to be delivered "in the main" by 2015/17, with a further 6000MW of offshore wind by 2015/16. There is also an element of "local electricity generation" to the tune of 1000MW by 2020 provided for elsewhere in Table 12.1 which is stated to be mainly PV, wind and hydro, so the real level of onshore wind supply by the end of the decade will be higher, and perhaps considerably higher, than the 2000MW figure.

2.15.6 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."*

2.15.7 PPW then goes on to restate the approach to the Strategic Search Areas (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 renewable energy aspirations 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."

2.15.8 Para. 12.8.15 advises that renewable energy projects require different policy and development management considerations depending on their type, location and scale. The Llanbrynmair wind proposal 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.

2.15.9 This concern is highlighted also by PPW 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;
- the wider environmental, social and economic benefits and opportunities from renewable and low carbon energy development.

2.15.10 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 if local harm which may arise.

2.16 TAN8

2.16.1 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 Welsh Assembly Government for the year 2010.

2.16.2 The clear belief of the Assembly in publishing the TAN8 in 2005 was that an additional 800MW of installed capacity of onshore wind by 2010 could acceptably be met from the seven Strategic Search Areas (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 Assembly Government 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.

2.16.3 Following the final publication of TAN 8, Councils 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 Local Planning Authorities 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).”(*the emphasis is mine)

2.16.4 Although the refinement exercises led a number of Councils 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[31] 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.

2.16.5 SSA B, in which the Llanbrynmair Wind Farm site was located, was indicated in TAN8 as being intended to deliver of the order of 290MW of installed capacity of onshore wind by 2010, although these were only ever indicative targets and (paragraph 2.5 of TAN 8) 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.

2.16.6 The position in respect of Area B was that ARUP completed a first refinement exercise in January 2006[32] and made significant changes to their original boundaries. However, Llanbrynmair remained almost entirely within the “refined” area on this report. As a result of that exercise, Powys prepared draft Interim Development Control Guidance[33] 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[34], followed by a second draft IDCG[35] late that year. Again Llanbrynmair remained as one of the preferred sites in this new report and IDCG. However, the IDCG was never adopted as formal SPG, even though it had been intended to be used for development control purposes, 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 Llanbrynmair site was and is still within the SSA, both original and in its various refinement guises.

2.16.7 The capacity sought for SSA B 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 has done is to take the original Garrad Hassan figures of capacity (reduced by a third for TAN8) and restored 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 B is now given as 430MW. 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.

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

2.16.9 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 by 2010 from onshore wind sources. In respect of the forestry sites which were to provide they 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 has 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, no scheme has even been submitted for the 200MW of further capacity set out for SSA D.

2.16.10 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 110.45M. 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.

SSA	G. Hassan (Griffiths)	Built/u.c.	Consented	Total for SSA
Area A	212MW	30.5MW	90.5MW	121MW
Area B	430MW	79MW	30MW	109MW
Area C	98MW	0MW	0MW	0MW
Area D	212MW	10MW	0MW	10MW
Area E	152MW	60.5MW	48MW	108.5MW
Area F	430MW	131MW	250.8MW	381.8MW
Area G	132MW	23MW	84MW	107MW
Totals	**1666MW**	**334MW**	**503.3MW**	**837.3MW**

2.16.11 This table reveals that whereas PPWales (2012) shows a figure of 700MW as the position in respect of built and consented wind farms onshore in Wales, the position today is that within the SSAs the total is 837MW with a further 260MW on sites that are not within the SSAs. The strategic picture still reveals a very significant shortfall against the 1700MW which is required to be built in the SSAs within at the very most four and a half years, especially given that only 334MW of that 837MW figure has actually been built or under construction 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).

2.16.12 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 (one of them being Llanbrynmair Wind Farm) which did not come forward to public inquiry until June 2013 – an inquiry scheduled to last 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).

2.16.13 On the sites outside the SSAs, the figure of 219MW 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 219MW 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).

2.16.14 Having noted the overall position on the SSAs which points to a very significant shortfall against the 1700MW target envisaged in PPWales, it is necessary to look in more detail at the figures for Area B. The position here is set out in the table below:

Area B	Consented prior to TAN8	Carno A	33.6MW
		Mynydd y Cemmaes	15.3MW
		Mynydd Clogau	14.5MW
			Total 63.4MW
	Consented post-TAN8	Carno B	15.6MW
		Tir Gwynt	27.7MW
			Total 43.3MW
		Overall Area B	**106.7MW**
		Griffiths figure	**430MW**

2.17 Other National Planning Advice

2.17.1 With regard to issues relating to archaeology, there is advice in PPW and also in Circular 60/96 on Planning and the Historic Environment: Archaeology[36]. 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[37] 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).

2.18 Development Plan in Powys

2.18.1 The position on the adopted Development Plan is straightforward in Powys since their UDP was adopted in March 2010[38], 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).

2.18.2 In this case the key policy is E3 and reads as follows:

1. Applications for wind farms including extensions to existing sites and individual wind turbines generators will be approved where:
2. 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 exiting similar developments. Where the cumulative impact of proposals in combination with other approved or existing wind farms would be significantly detrimental to overall environmental quality they will be refused.
3. They do not unacceptably adversely affect wildlife habitats or species that are of international, national or local importance in accordance with policies ENV3-7.
4. 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.

5. They do not unacceptably impact on any buildings or features of conservation or archaeological interest.
6. 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).
7. 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.
8. 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.
9. 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.

2.18.3 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'*. The applicant for the Llanbrynmair Wind Farm supports the implementation of the strategic Transport Management Plan that has been approved by the Welsh Government. Finally Policy DC12: Overhead lines and pipelines has implications for a wind energy development, although the grid connection itself is not covered by the Section 36 application.

2.18.4 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 engage 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 involved 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.

2.18.5 The text supporting to policy E3 makes it clear that the County Council was looking to encourage the Welsh Government to undertake some form of review of the SSA position in TAN8 even though it was confirmed only in March 2010 in the Energy Policy Statement. 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.

2.18.6 The response to TAN8 as noted above was to commission refinement studies of the SSAs, following which the County Council issued draft Interim Development Control Guidance 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.

2.18.7 A final point on the development plan is that no part of the proposal lies within the Snowdonia National Park. The policies in the Development Plans for the Park can only be applied by them to their decisions on proposals inside the Park. However, the effects of the Development on the setting of the National Park or on the National Park purposes remain material considerations that need to be taken into account under the provisions of the Environment Act 1995.

2.19 References

(1). UK Government - Climate Change Programme 2006

(2). UK Government - White Paper Meeting the Energy Challenge 2007

(3). UK Government - Renewable Energy Strategy 2009

(4). UK Government - The Energy Challenge 2006

(5). UK Government - SI 243 – Promotion of the Use of Energy from Renewable Sources Regulations March 2011

(6). UK Government - Low Carbon Transition Plan 2010

(7). Coalition Agreement May 2010

(8). UK Government - National Renewable Energy Action Plan July 2010

(9). Letter from Lord Turner, Chairman of the Committee on Climate Change to the Rt. Hon Chris Huhne MP the Secretary of State for Energy and Climate Change, dated 9th September 2010.

(10). UK Government - Committee on Climate Change - Renewable Energy Review May 2011

(11). DECC Statement on the 4th Carbon Budget May 2011

(12). UK Government - National Policy Statement EN-1

(13). UK Government - National Policy Statement EN-3

(14). UK Government - Renewable Energy Roadmap 2011

(15). UK Government - The Carbon Plan 2011

(16). UK Government - Electricity Market Reform White Paper July 2011

(17). UK Government - Consultation on the Banding Review for the Renewables Obligation 2011

(18). UK Government - Energy Bill 2012

(19). UK Government - Annual Energy Policy Statement 2012

(20). UK Government - Roadmap Update 2012

(21). Welsh Assembly Government - Economic Development Committee Final Report on Renewable Energy 2003

(22). Welsh Assembly Government - TAN8 2005

(23). Welsh Assembly Government - One Wales 2006

(24). Welsh Assembly Government - New Renewable Energy Route Map for Wales 2008

(25). Welsh Assembly Government - Energy Policy Statement March 2010

(26). Welsh Government - PPWales Version 5 2012

(27). Letter from John Griffiths AM July 2011 on wind farm developments

(28). Welsh Government Energy Wales - A Low Carbon Transition 2012

(29). R ex parte Samuel Smith Old Brewery (Tadcaster) v Secretary of State for Energy and Climate Change 2012

(30). Court of Session decision on Dorenell Wind Farm Section 36 decision 2011

(31). Planning Inspectorate appeal decision APP/R6830/A/05/1185359 – Wern Ddu, Denbighshire

(32). ARUP SSAs B and C Refinement Exercise Final report 2006

(33). Powys Draft Interim Development Control Guidance 2006

(34). ARUP SSAs B and C Further Refinement Exercise Final Report 2008

(35). Powys Interim Development Control Guidance 2008

(36). Welsh Office Circular 60/96

(37). Welsh Assembly Government TAN5

(38). Powys Adopted Unitary Development Plan March 2010

(39). DECC - Press Notice entitled 'Government Agreement on Energy Policy sends clear, durable signal to investors' 23 November 2012

(40). DECC - 'Electricity Market Reform Policy Overview' 2012

3 DESCRIPTION OF THE PROJECT

3.1 Site Description

Location

3.1.1 The site lies to the north of the Nant yr Eira valley between Llanbrynmair and Llanerfyl in Montgomeryshire, Powys County, approximately 8km north of Carno. The site is centred on grid ref: E294500, N306500; OS Grid Ref SH 945 065, see Figure 1.1 (all figures are in Volume III).

Topography and Land Use

3.1.2 The site is located on Ordnance Survey Landranger 1:50,000 map sheet 125 and 136 and on OS Explorer 215.

3.1.3 The site covers approximately 1,648 hectares, or 4,072 acres. The entire project is located within the Carno North Strategic Search Area (SSA) B; one of the Welsh Government's designated areas for wind farm developments set out in Planning Policy Wales, Technical Advice Note (TAN) 8: Planning for Renewable Energy. The site consists of small to medium sized fields primarily used for grazing of sheep and cattle. Wind monitoring at the site for over a year has confirmed that mean wind speeds are greater than 7m/s and therefore sufficient to effectively supply the proposed wind farm.

Designations

3.1.4 There is one Scheduled Ancient Monument (SAMs) within the site boundary and 49 within 10km of the site; these are addressed in Chapter 7 – Cultural Heritage. Four Sites of Special Scientific Interest (SSSIs) lie within 1km of the site. Further details can be seen in Chapter 5 – Ecology and Chapter 8 - Hydrology.

3.2 The Proposal

3.2.1 The Proposal includes the erection of 30 three-bladed, horizontal axis wind turbines, each up to 126.5m maximum height to tip and associated infrastructure including, on-site tracks, underground cabling and crane hardstandings, a communications mast (25m high), a permanent (80m high) free standing lattice wind monitoring mast, borrow pits, water crossings, high voltage (HV) electrical enclosures, on-site cabling, a substation and control building and two permanent welfare buildings, for a period of 25 years (hereafter 'the Proposal').

3.2.2 During construction and commissioning there would be a number of temporary works including construction compounds, welfare facilities, a batching plant and ten guyed meteorological masts up to 80 metres high (hub height).

3.2.3 A detailed plan of the site showing the proposed positions of the turbines is shown on Figure 3.6.

3.2.4 The proposed permanent and temporary infrastructure is shown on Figure 3.6.

Land Take

3.2.5 Land take for a wind farm development is relatively small. The wind turbines (see Figure 3.6) have to be spaced apart, so as not to interfere aerodynamically with one another (array losses). The actual permanent land take is limited to the area of the towers themselves with a gravel path around them, the access tracks leading to them, the crane hardstandings, the control building and the substation.

3.2.6 At each wind turbine location, the completed foundation is overburdened with soil, leaving only the concrete or steel plinth to which the steel tower is attached, as shown in Figure 3.12. The plinth is approximately 4.5m to 5m in diameter with a crushed stone border up

to 1.5m wide. Additionally there is an external high voltage (HV) electrical enclosure, approximately 3m by 5m in area and 3m in height, on a concrete plinth 6.5m x 4m sited adjacent to each tower. Together each turbine and HV enclosure would use approximately 324 square metres of land; this would amount to 0.97ha in total.

3.2.7 There would be 3 points at which the onsite access tracks would join the public highway, as shown in Figure 3.6 and as described in Chapter 10. The onsite access tracks will be typically 5.5m wide on straight sections with widening at the bends, at passing places and track spurs to each turbine base.

3.2.8 The total length of access track across the site would be approximately 25.3km, which translates to an estimated land take of 16.70 hectares (25.3km length of track x 5.5m track width x 1.2 for general widening and site entrance). In addition, shoulders each side of the track would be required, which would be approximately 1m wide but these would be reinstated after construction.

3.2.9 Other permanent (for the length of the project) land take consists of:

- the primary substation compound (60 x 45m, 0.27ha), which includes a 1m wide gravel path on all sides (Figure 3.14);
- one control building adjacent to the primary substation compound, 32 x 14m, 0.045ha (Figure 3.14);
- a building for grid use adjacent to the primary substation compound, 10m x 14m, 0.014ha (Figure 3.14);
- one permanent crane hardstanding area at each tower base consisting of a land take of approximately 1,200m^2 (40m x 30m, 0.12ha) (Figure 3.11). This would equate to 3.60ha for all 30 turbines.
- 4m^2 (0.0004ha) is required for the permanent wind monitoring (met) mast (Figure 3.12 and 3.13).

3.2.10 The total permanent land take from new access tracks, turbine foundations, crane hardstandings, met mast, substation and welfare buildings would be approximately 16.5ha; roughly equivalent to 1.00% of the total site area.

3.2.11 Typically hardstandings consist of one main permanent area and four minor temporary locations for assembly and a rigging crane. Firstly, an area of approximately 30x40m (1,200m^2) for the main and tailing crane during construction. A temporary area is needed for the tail crane and turbine components awaiting installation depicting an area approximately 65mx5.5m (358m^2). Two further temporary areas of up to 12x5m (60m^2) would be used as the second and third centre positions of the rigging crane in addition to a final temporary area of 3 x 6m (18m^2) for the 60m boom support.

3.2.12 Temporary land take for the five site construction compounds which would each require an area of up to approximately 60m x 50m, see Figure 3.17. Three of these temporary site construction compounds would be by the entrances to the site, the other two would be created towards the centre and the south of the site respectively. These would require a total of 1.5ha maximum. It is proposed that a batching plant may be employed at the site to produce the concrete needed for the construction phase; this would measure 80m x 80m, 0.64ha. There would be six borrow pits measuring a maximum of 60 x 60m which would be landscaped and reseeded as necessary at the end of the construction period; these would take up to 2.16ha across the whole site. There would also be ten temporary calibration masts, 80m high. However these are of tubular design, approximately 150mm in diameter, with guy wires and therefore have very little actual land take. Maximum total temporary land take would amount to 5.29ha (excluding temporary masts).

The Wind Turbines

3.2.13 The wind turbine industry is evolving at a remarkable rate. Designs continue to improve technically and economically. The most suitable turbine model for a particular location can

change with time and therefore a final choice of machine for Llanbrynmair Wind farm has not yet been made and the most suitable machine for the proposed site would be chosen shortly before the time of construction, within the overall tip height limit of 126.5m mentioned above.

3.2.14 This SEI has been based for visual and acoustic purposes upon turbines of 2MW to 2.3MW nominal capacity as available candidates within the proposed tip height limit. Exact tower and rotor dimensions vary between manufacturers, but suitable turbines in the nominal 2MW upwards range are produced by companies such as Siemens and Vestas. The turbine type installed would have to meet the terms of conditions imposed by the determining authority, such as restriction on dimensions.

3.2.15 Details of Vestas and Siemens turbines are provided in Appendix 3.1 and a diagram of a typical 126.5m tip-height wind turbine is given in Figure 3.8.

3.2.16 The locations of the proposed turbines are shown on Figure 3.6, each turbine is labelled as R1, R2 etc. (the R denoting RES). RES would request 50m micro-siting (deviation from turbine coordinates shown on Figure 3.5) for turbines where constraints allow it. This would allow for possible variations in ground conditions across the site which would only become apparent as site investigations are carried out at the start of construction. In addition, 50 metres flexibility in turbine positioning would help to mitigate any potential environmental effects, e.g. avoidance of archaeological features not apparent from records or visual assessment. This degree of flexibility for micro-siting is needed as knock-on effects of moving individual turbines small distances could require larger movements (up to 50m) further across the site. Equally, RES would request that access tracks are able to be micro-sited to fit with the turbines and to avoid sensitive sub-surface features. Any repositioning would not encroach into environmentally or otherwise constrained areas. Infrastructure micro-siting has been considered in the different assessments within the SEI.

3.2.17 It is common to have a high voltage transformer enclosure for some models located alongside the base of each turbine. The transformer's function is to raise the generation voltage to the higher transmission level that is needed to transport the electricity into the grid. Switchgear is required by the utility to comply with regulation.

3.2.18 Some models of turbine are now integrating this transformation stage within the tower or nacelle assemblies, thus obviating the need for the external transformer, but this is by no means a universal design trend.

3.2.19 The colour and finish of the wind turbine rotor blades, nacelles and towers would be agreed with the determining authority and is normally the subject of a planning condition. A significant amount of research has been undertaken in relation to turbine colour and finish. A pale grey colour with a semi-matt finish is generally agreed to be the most appropriate.

3.2.20 The wind farm would be served by a central computer system located in the primary substation control building, which would control the performance and behaviour of each turbine. The control building would communicate with external operation and control systems via 25m high communications masts located adjacent to the substation compound, the use of masts will reduce the amount of cabling required to connect the site to external communication networks.

3.2.21 Turbines begin generating automatically at a wind speed of around 3-4 metres per second and have a shutdown wind speed of around 25 metres per second. Using on-site measured data, it is conservatively estimated that the turbines would be shut down owing to high wind speeds for 26.5 hours per year: 0.3 % of the time.

Electrical Connection

3.2.22 Assuming the use of currently available models, each wind turbine would generate electricity at 690V and would have its own transformer located adjacent to, or within, the base of the tower to step up the voltage to the on-site distribution voltage of 33kV. Each turbine would be connected by a length of underground cable and each group of turbines would be connected to the substation via similar underground cables. All high voltage cables on the site would be buried to an appropriate depth underground.

3.2.23 The on-site substation is proposed to be located in the centre of the site, as shown in Figure 3.6. A central substation minimises the length of the on-site cabling, and hence reduces electrical losses. The substation is described in greater detail below.

3.2.24 The location of the substation would be compatible with the proposed SPEN route corridor to Cefn Coch.

The On Site SubStation and Control Building

3.2.25 The substation compound would contain a grid transformer, up to two auxiliary transformers, and possibly a spare turbine transformer. The control building required at the substation would accommodate metering equipment, switchgear and electrical control panels. A toilet, wash basin and other welfare facilities would also be located in the control building. Although not permanently staffed, the buildings would be visited periodically by maintenance personnel.

3.2.26 A 25m high free-standing lattice type communications mast would be located adjacent to the substation compound.

3.2.27 Rain water would be collected from the roofs of the control buildings via a modified drain pipe system into a storage tank located within the toilet area of the control building. An overflow from the tank would drain to the outside of the building into a rainwater soak-away.

3.2.28 The storage tank would supply:

- raw/untreated water to the toilet;
- rainwater via a UV filter to the hand basin.

3.2.29 Should an extended period of no rainfall occur, water would be transported to the site in small tanks as required.

3.2.30 Both the toilet and wash basin would drain to a sealed cesspit constructed and located in accordance with the relevant Building Standards. The sizing and exact location of the cesspit would be agreed with Powys County Council and Natural Resources Wales prior to construction.

3.2.31 Appendix 3.2 provides further details of the cesspit arrangement and method of working for the proposed Llanbrynmair wind farm.

3.2.32 Further details on the construction of the site substation and control building are given in Section 3.4.29 below.

Welfare Buildings

3.2.33 Two welfare buildings will provide health and safety facilities for staff working on site during construction, as shown in Figure 3.6. There is no requirement for any other permanent buildings on the site.

Wind Monitoring Mast

3.2.34 For ongoing wind speed monitoring and assessment of the performance of the wind farm, a permanent meteorological mast would be required as part of the wind farm for the duration of its operation. This would be a free standing (non-guyed), steel lattice model, set into a small concrete base approximately 6m x 6m and 2m deep (Figure 3.12), and would be hub height (i.e. up to 80m) (see Figure 3.13). The proposed location of the wind monitoring mast is shown on Figure 3.6.

Main Road Access

3.2.35 Sections of the existing road would require widening to allow safe passage of the construction traffic and turbine components.

3.2.36 Field surveys have been undertaken along the route to establish the likely effects on cultural heritage, landscape and ecological features which are present along the route.

3.2.37 The proposed access route has been considered in consultation with Powys County Council and Natural Resources Wales (NRW) and has been assessed by a RES engineer and independent consultants.

3.2.38 Alternative routes were considered before the selected route was chosen. The routes proposed are considered to be the best environmental and technical solution and to be those that best minimise disturbance to local residents and road users.

3.2.39 A strategic Traffic Management Plan (sTMP) and associated strategic Transport Tool commissioned by RenewableUK Cymru addresses the impact on the trunk road network of abnormal load movements into the proposed mid-Wales wind farms. The scope of the sTMP covers the strategic and trunk road network from Ellesmere Port and the M53, south to Welshpool and to the west of Llanerfyl. The route to the Llanbrynmair Wind Farm for abnormal indivisible loads uses Section 2 and 3 of the sTMP - Section 2: Ellesmere Port to Welshpool and Section 3: Welshpool to SSA B.

3.2.40 The sTMP received approval in principle from the Welsh Government as Highways Authority for the Welsh trunk roads in April 2013.

3.2.41 A Local Traffic Management Plan (LTMP) (Appendix 10.1) has been produced for the Llanbrynmair wind farm which reviews the 17.5 kilometres of the minor road, C2031, from the A458 at Llanerfyl to the A470 at Talerddig, including the A470/Talerddig junction and the A458/Llanerfyl junction.

3.2.42 Some road improvement works and traffic management measures would be required to enable construction traffic to access the site and any management will be agreed with the relevant authorities. All improvements and upgrading will be carried out to the specifications of the relevant Highways Authorities. Vehicles exiting the site would pass over a waterless wheel wash to remove excess mud being carried onto public roads.

3.2.43 Further details are provided in Chapter 10 on Transportation and Access.

On-Site Access Tracks

3.2.44 Where possible the on-site access track layout has been designed to maximise use of existing farm tracks and to follow field boundaries where possible in order to minimise environmental disturbance and land take. Tracks are proposed to access the various turbine locations and would be up to approximately 25.3km in length with a running width of approximately 5.5m. Typical access track designs are shown in Figure 3.9.

3.2.45 Further details on the on-site access tracks are provided in paragraphs 3.4.4.

3.3 Design Evolution

Introduction

3.3.1 This section details the revisions that have been made to the Proposal since the 2009 submission of the Environmental Statement.

3.3.2 Changes to the infrastructure design have been in response to formal comments raised by statutory consultees following submission of: the first SEI package in 2010, a second SEI package in 2011 and the third, fourth and fifth sets of SEI packages in 2012. These changes have been made to reflect changing emphasis in concerns from consultees. Initially the major consultee concerns were in regard to visual impacts, curlew, black grouse and habitats. Lately concerns have been focussed on the impacts on peat, in particular an increasing emphasis on peat habitats and avoidance of deep peat (greater than 0.5m as defined by NRW). The final design has therefore been an iterative process taking into account of all of these concerns to avoid and minimise as far as possible.

3.3.3 This section summarises the design evolution of the project throughout this process and highlights the amendments undertaken to mitigate identified effects.

3.3.4 Several major changes to the project layout were undertaken between 2006 and the original submission, primarily the removal of a number of turbines and their associated sections of access track, including some unnumbered ones in the far NE of the site for habitat, peat and black grouse constraints. The layout presented in 2009 has therefore already been subject to substantial optimisation and the current layout is an improved version based on the acquisition of a substantial body of data to inform this.

3.3.5 Table 3.1 compiles the relevant infrastructure changes identifying the change between the original Environmental Statement design and the SEI design as proposed within this SEI.

3.3.6 Summary paragraphs follow detailing what, when and why the required amendments were made for individual infrastructure features. This is supported by a detailed justification for the current layout in Appendix 3.7. This table presents the specific reasons for the adjustment of the layout from 2009 with all movements of track completed on the basis of relocation from better to poorer habitat while at the same time reducing the impact on peat depth and ensuring the scheme is still possible from an engineering aspect.

Table 3.1 Llanbrynmair Design Evolution Summary

	Original ES Design	Current Proposed SEI Design	Change
Turbines			
Number	43	30	**-13**
Site - Foundation Area (m^2)	13,932	9,720	**-4,212**
Crane Hardstanding			
Individual Area – Permanent (m^2)	400	1200	+800
Individual Area – Temporary (m^2)	544	496	-48
Individual Area – Total (m^2)	944	1696	**+752**
Site Area – Permanent (m^2)	17,200	36,000	+18,800
Site Area – Temporary (m^2)	23,392	14,880	-8,512
Site Area – Total (m^2)	40,592	50,880	**+10,288**
Access Tracks (including existing track)			
Length (m)	29,700	25,300	-4,400
Running Width (m)	5.0	5.5	+0.5
Total Area (m^2)	148,500	139,150	**-9,350**
Substation			
Number	3	1	-2
Individual Area – Central (m^2)	3,350	2,700	-650
Individual Area – Northern (m^2)	80	75; Converted to Welfare Building	-5

	Original ES Design	Current Proposed SEI Design	Change
Individual Area – Southern (m^2)	80	75; Converted to Welfare Building	-5
Total Area (m^2)	3,510	2,850	**-660**
Borrow Pits			
Number	7	6	-1
Total Area (m^2)	25,200	21,600	**-3,600**
Temporary Site Compound			
Number	6	5	-1
Total Area (m^2)	18,000	15,000	**-3,000**
Batching Plant			
Number	1	1	0
Total Area (m^2)	1,400	6,400	**+5,000**

Turbines

3.3.7 The original ES submitted in March 2009 proposed 43 turbines. To minimise and avoid effects on ecology and visual impact 13 turbines were deleted.

3.3.8 In November 2010 Natural Resources Wales (NRW; previously CCW) raised concerns regarding the interaction of local ecology features: black grouse, hen harrier and curlew, with the proposed turbine arrangement; concerns were also raised regarding visual effects from specific turbines. Further visual effect concerns were raised by NRW and PCC in March 2012.

3.3.9 Nine turbines were deleted in the second round of SEI to address NRWs concerns in November 2010. Turbines R10 and R11 were deleted to avoid curlew habitat, turbines R20, R21, R22, R33 and R34 were removed to avoid adverse impact to hen harrier and black grouse, and turbines R29 and R30 were deleted to avoid visual impacts.

3.3.10 Four turbines were deleted in the third round of SEI to avoid visual effects raised in concerns expressed by NRW and PCC in 2012; R1, R2, R3 and R 28.

3.3.11 Deletion of the 13 turbines further reduced effects with concomitant reductions in: construction area, loss of access track and associated cabling.

3.3.12 The removal of these 13 turbines also reduced the potential impact on peat habitat and deep peat (<0.5m as defined by NRW). Eight of these turbines R10, R11, R20, R21, R22, R28, R33 and R34 were located on peat that was potentially greater than 0.5m depth.

3.3.13 The interaction with deep peat from the remaining 30 turbines is discussed in section 8.3.23 and indicates that 16 of these turbines are not located on deep peat and very minor micrositing will allow a further 10 turbine bases to avoid potentially deep peat. Therefore only 4 of the 30 turbines will actually be located on deep peat (although all of these are in degraded afforested bog which will be restored as part of the project) and which will be minimised through further micrositing.

3.3.14 The final submission proposes 30 turbines culminating in a 4,000m^2 reduction in foundation area across the Site.

Crane Hardstanding

3.3.15 The original application provided detailed information on the area of hardstanding required for each turbine. Permanent hardstanding was calculated to be 400m^2 with an additional temporary hardstanding area of 544m^2; resulting in a total temporary hardstanding area of 944m^2.

3.3.16 Several iterations followed through the SEI packages as further details emerged regarding contractor requirements. The current permanent crane hardstanding has increased to allow for a safer crane working area in compliance with turbine manufacturer best practice. Consequently, this reduced the temporary hardstanding area required.

3.3.17 The necessary increase in hardstanding area required to maintain safety standards results in a land take increase across the Site of 10,000m^2.

3.3.18 Micrositing would be used to ensure additional hardstanding is not positioned any closer to sensitive features than presented in the ES.

Access Tracks

3.3.19 The original ES design reported a total running length of access track at 29.7km.

3.3.20 Following the deletion of nine turbines in the second round of SEI the total running length was revised down to 28.5km; a reduction of 1,200m.

3.3.21 Four additional turbines were deleted in the third round of SEI; reducing the total running length to 27.7km. This equates to a further reduction of 800m in total running length and a 2,000m reduction from the original application.

3.3.22 Wind turbine and crane supplier requirements were confirmed during the third round of SEI requiring adjustment of the access track running width from 5.0m to 5.5m.

3.3.23 Following final design rationalisation the final access track length has been calculated at 25.3km, reducing the overall land take by 9,350m^2. 4,050m of this is existing track; consequently 21.25km of new access track would be constructed; a subsequent reduction of 8.45km from the original proposal.

3.3.24 The current layout of the access tracks has been developed as an iterative process taking into account the constraints of all the various disciplines. The final adjustments have been required to incorporate additional information to enable avoidance of good quality habitats, avoidance of deep peat and the continued economic engineering of the project infrastructure. The actual final layout was selected on site with a number of disciplines being involved and the overall final decision being taken by the ecologist on the basis of the presence of the least valuable habitats.

3.3.25 The table of layout justification in Appendix 3.7 presents the reasoning behind each adjustment of the track. The most significant alterations have been:

- Removal of the access tracks between turbines R19, R20, R21 and R22. These turbines were removed for ornithological purposes, however this also reduces the impact on peat habitat and sections of deep peat along these sections. The area in which these turbines is located is included within the Habitat Management Plan for restoration.
- Removal of the access track between turbines R1, R2, R3, R28 and R4 and also between turbines R29, R30 and R31. These turbines were removed for visual impact issues, however the removal of the track has reduced the impact on a number of habitats included peat as well as avoidance of a number of sections of potentially deep peat (detail provided in Appendix 3.7).
- Removal of the access track between turbines R9, R10 and R11. The turbines were removed to avoid potential curlew habitat, however the removal of the track has also reduced the impact on a number of habitats included peat as well as avoidance of a number of sections of potentially deep peat (detail provided in Appendix 3.7).

- Removal of the access track between turbines R41 and R18 to reduce the impact on habitats and to avoid the potential section of deep peat.
- Re-routing of access tracks around R4, R5, R6, R7, R8 and R9 to avoid the more valued habitats including peat as well as reducing the amount of track on deep peat. In particular the track has been moved to be located outside of the surface water catchment of the soligenous fen.
- Re-routing of the access track between R42 and R16 to avoid the more valued habitats including peat as well as reducing the amount of track on deep peat.
- Re-routing of the access track between R12 and R13 to avoid and reduce the land take on the more valued habitats including peat as well as reducing the amount of track on deep peat.

Substation

3.3.26 The original infrastructure design identified three substations serving the northern, central and southern groups of turbines.

3.3.27 NRW expressed concerns during the third round of SEI about the potential significant effects of the substations from a visual perspective. In particular, this related to effects on Glyndwr's Way and other recreational routes.

3.3.28 The central substation was redesigned to act as the primary substation, carrying out all of the electrical functions of the project. Having undertaken an environmental review to determine the most appropriate location, in consultation with NRW, the central substation was relocated 1.2km to the east to SH947053.

3.3.29 The northern and southern substations would now be electrically redundant providing health and safety (H&S) and welfare facilities.

3.3.30 The revised area of the central substation has reduced by approximately 650m^2; whilst the northern and southern substations have reduced in area by approximately 5m^2 each.

Borrow Pits

3.3.31 Up to seven borrow pits were proposed in the original ES design to supply aggregate for construction materials on site; each measuring a maximum of 60m x 60m. The current design proposes six borrow pits; the proposed location for the borrow pit to the south of turbine R23 is no longer required.

3.3.32 Borrow pit 4 has been relocated to the north side of the track but is still retained within the current forestry block.

Temporary Site Compound

3.3.33 Six temporary site compounds were originally proposed; three by the entrances to the site and three to be created toward the centre of the site.

3.3.34 The temporary site compound proposed adjacent to turbine R36 in the original ES submission has been removed.

Batching Plant

3.3.35 The temporary batching plant has been relocated from its original submission location adjacent to turbine R4 to a revised location between turbines R6 and R9. The original dimension presented in the ES was 25m x 56m this has been increased to 80m x 80m. Following preliminary consultation with mobile batching plant contractors, additional working areas, welfare facilities and storage space have been provided. The additional working area is to ensure there is adequate space for the safe manoeuvring of the construction vehicles and machines required during the peak production periods. Additional welfare facilities have been provided for the permanent batching plant operators and

additional storage has been included to allow materials deliveries to be distributed over longer periods reducing peak traffic movements.

3.4 Construction

3.4.1 Construction of the wind farm is expected to take approximately 24 months (see Appendix 3.3) between January 2017 and December 2018. The overall length of the construction period is somewhat weather dependent and could be affected by ground conditions found at the site. Site working would be Monday to Saturday from 7am to 7pm.

Construction Program

3.4.2 The expected sequence of events for the construction programme would be:

- Construct track to construction compound and first borrow pit;
- Excavate borrow pits and construct temporary construction compounds and batching site;
- Construct the site access tracks and crane hardstandings, field gates and temporary fencing (if required);
- Excavate and construct the turbine foundations;
- Construct the substation and install the grid connection;
- Excavate the trenches and lay the power and instrumentation cables;
- Erect the turbines;
- Commission the turbines;
- Remove temporary works and carry out site clearance and land reinstatement.

3.4.3 See Appendix 3.3 for the proposed construction timetable.

Site Access Tracks

Layout

3.4.4 The layout of site access tracks is shown in Figure 3.6. The tracks would permit access by construction vehicles and are required throughout the life of the wind farm for maintenance vehicles.

3.4.5 Through the design evolution process the final layout of the wind turbines and access tracks has been designed to avoid environmental constraints where possible. The movement of heavy construction vehicles on the site may cause some localised soil compaction, however, the effect of this is considered negligible since most construction work would be carried out from the site access tracks.

3.4.6 The track layout would result in 18 new minor water crossing and upgrade of four existing minor crossings. A typical water crossing design is shown at Figure 3.10 and a steep-sided water crossing is shown in Figure 3.20. Further information about the water crossings is given in Chapter 8 - Hydrology.

3.4.7 Any off-track movements would be avoided where possible but where unavoidable, would only occur in a very local context, thus any effect is not considered significant.

Construction Design

3.4.8 The detailed design of the access tracks and the selection of the method of construction would be carried out after a detailed site investigation prior to construction. Designs that are likely to cover the expected site conditions are shown in Figure 3.9. The tracks are typically designed for an axle load limit of 16 tonnes.

3.4.9 The access tracks have been designed to run along existing tracks and field boundaries where practicable to avoid disruption to farming activity. In addition, the tracks have been routed with consideration of existing ecological and archaeological features on site.

3.4.10 The access tracks would have a running width of 5.5m, with local widening on bends, at passing bays and around turbine bases. The access tracks would be constructed of crushed and graded stone (to be extracted from borrow pits within the development boundary where possible). A stone thickness of approximately 250mm to 1000mm (average 400mm), dependent on ground conditions, would be used. Shoulders each side of the track would be approximately 1m in width and would be reinstated post construction. Turning heads (16m long and 5.5m wide) would be constructed at locations identified on Figure 3.6, such as the end of tracks, to prevent vehicles having to reverse long distances.

3.4.11 The access tracks would be designed and constructed with sufficient drainage channels to prevent erosion of the road structure and to allow the efficient drainage of rainwater. Water running down the channels would be intercepted and diverted onto the surrounding vegetation for the natural filtering of any suspended silt before it reaches any watercourse. Positive drainage into existing streams would be avoided.

3.4.12 Field drains and streams would be piped directly under the track through appropriately sized drainage pipes which would be designed to cope with storm water flows. The relevant consents and approvals for any culverts will be obtained from Natural Resources Wales prior to construction. Detailed design for any culverts would be modified following detailed site inspection prior to construction and agreed with Natural Resources Wales. A typical water course crossing is shown in Figure 3.10 and a typical site drainage features are shown in Figure 3.18. Further details about the RES sustainable drainage design philosophy are provided in Appendix 3.6.

3.4.13 Chapter 7 (Cultural Heritage) of this SEI details mitigation where works may affect areas identified as potentially having features of cultural heritage interest. Chapter 8 (Hydrological Assessment) of this SEI describes the mitigation measures that will be incorporated into the construction of the tracks to reduce effects on drainage and hydrology.

Construction Method

3.4.14 The vegetation and soil would be stripped to the subsoil. The stone track (on average 400mm thick dependent on ground conditions) would be constructed on the subsoil. Approximately 100-150mm of the upper topsoil layer, together with turfs, would be stored separately from the rest of the subsoil in piles near the tracks for later reinstatement.

3.4.15 Following construction the appropriate topsoil and vegetation would be used to reinstate the track shoulders and turbine foundation areas. Any excess material produced from access track construction would be spread along the track shoulders and reseeded as necessary.

3.4.16 Once the soil has been removed to the depth of a suitable founding layer, the road and running surface would be constructed by tipping and compacting stone to the required shape and thickness. Cross sections of the final road profile can be seen in Figure 3.9.

3.4.17 Following construction any excess material and the appropriate topsoil would be used to reinstate any excess track areas such as passing places at the turbines and crane hardstanding areas.

3.4.18 RES considered using a ‘floated track’ design on areas of deep peat on the Site, however, the track layout has avoided areas of deep peat and so this method would not be appropriate. If a floated track design were to be used for the small sections of track that cross shallow peat frequent maintenance work would be required to maintain the levels where the two types of track meet.

Reinstatement and Final Appearance

3.4.19 The road surface would be left clear. The final section would be similar to those shown in Figure 3.9. More detail on reinstatement is contained in Section 3.5.

Crane Hardstandings

3.4.20 During the erection of the turbines, crane hardstanding areas are required at each turbine base. Typically these consist of one main permanent area and four minor temporary locations for assembly and a rigging crane. Firstly, an area of approximately 30x40m (1,200m^2) for the main and tailing crane during construction. A temporary area is needed for the tail crane and turbine components awaiting installation depicting an area approximately 65mx5.5m (358m^2). Two further temporary areas of up to 12x5m (60m^2) would be used as the second and third centre positions of the rigging crane in addition to a final temporary area of 3 x 6m (18m^2) for the 60m boom support. These areas would be constructed using compacted stone on average 1m deep and potentially up to 1.2m deep. This involves removal of the topsoil, excavation of earth, and replacing with hardcore to ground level. Figure 3.11 shows the crane hardstanding layout. The temporary hardstanding areas would be covered over by top soil and reseeded after construction.

Turbine Foundations

3.4.21 It is anticipated that the foundations for the turbines would be of gravity base design. Excavation of the rock at the turbine location is likely to require tools mounted with rock picks together with hydraulic breaking equipment.

3.4.22 For a typical 2.3MW turbine the foundation would characteristically comprise between approximately 200-350m^3 of concrete reinforced by between 50-60 tonnes of steel bar, in a tapered octagonal block of approximately 16-18m diameter and from 1.5 to 3.5m depth, (Figure 3.12). If the stone found on site is not suitable for concrete batching each turbine base would require approximately 60 concrete deliveries, based on 6m^3 of concrete in a truck. Concrete would be supplied from the on-site batching plant or be brought to the site from local ready mix suppliers. Each base would be poured over the course of a day and generally one base would be poured per day. The exact foundation design is very dependent on the turbine type, hub height, wind and ground conditions and is finalised during foundation design prior to construction.

3.4.23 The top of foundation surface lies up to 1m below the normal ground surface and is back filled with soil and reinstated. Approximately 1000m^3 of spoil would be excavated for each turbine base. All rock and most spoil that is excavated would be put back on top of the foundations. Any excess spoil would be used to fill the on-site borrow pits, or spread in areas that are not environmentally sensitive and agreed with the landowner and local authority. Spoil management and reinstatement would be carried out with regard to the SUDS philosophy (Appendix 3.6) and habitat management plan (Appendix 5.2). The excess spoil would be layered into the contours of the existing topography and re-seeded as required.

3.4.24 An earth electrode consisting of up to three interconnected concentric rings of bare stranded copper conductor is laid around the foundation of each tower, transformer, met mast and substation approximately 0.5m below the final ground level. In addition earthing rods padded by bentonite (a water retaining clay mineral) are required at each of these locations. Design of the earthing arrangement is dependent upon the electrical resistivity of the soil which is confirmed prior to building the foundations.

3.4.25 A layer of crushed rock 100mm in depth would surround each turbine and its associated HV enclosure, for a distance of 1500mm from the associated structure.

3.4.26 The exact quantities of concrete, reinforcement, diameters and depths would vary depending on the actual make of turbine used. Different turbine foundations may also be considered for different turbine locations depending on the local ground conditions. In the development of the foundation, geo-technical tests are carried out to determine the

strength of the soil layers beneath the turbines, and the soil behaviour under loading over time. This information is used to produce the foundation design into which are also incorporated factors of safety.

Cabling, Substation and Welfare Buildings

3.4.27 All cabling between the turbines and the substation on the site would be underground. All power and control cabling between the substations and the turbines would be laid in trenches typically 0.5m wide by 1m (minimum) deep on the turbine side of the access tracks, trench width and depth varies depending on the number and size of the cables. These trenches would be partially backfilled with adjacent topsoil. The top 100mm of soil would be stripped and laid beside the trench, and used to reinstate to original ground level immediately after the cables have been installed. Where practicable vegetation over the width of the cable trench would be lifted as turfs, and replaced after trenching operations, to reduce disturbance.

3.4.28 Between the turbines, 33kV cable would be used to connect together the individual turbine transformers at the tower bases. All cables would be buried according to current best practice and below typical cultivation depths. During backfill of trenches, warning tape would be laid 300mm above the cables in case of future excavation.

3.4.29 A substation would be required to house switch-gear and associated equipment. The substation compound would be approximately 60m x 45m, with standard security palisade fencing approximately 2.4m in height; the substation location is identified in Figure 3.6. The wind farm and grid company control buildings would be adjacent to the substation compound measuring 32m by 14m and 10 x 14m respectively. Both control buildings would be constructed from local building materials where possible and finished with a pitched roof, subject to agreement with the consenting authority. The control buildings would house switch gear, computer control equipment and small spares. A separate grid company control building may be necessary because the district network operator may require separate operating and isolating equipment from the wind farm operator, should this requirement not be enforced only one control building would be constructed. A typical layout and substation elevations are illustrated in Figures 3.14 and 3.15.

3.4.30 Two permanent welfare buildings would be constructed, one in the north of the site and one in the south; their locations are identified in Figure 3.6. Each welfare building would be 5 x 4m (20m^2); a typical layout with elevations is illustrated in Figure 3.16.

Temporary Works

3.4.31 Temporary construction compounds of up to 3,000m^2 (60m x 50m) would be located by three of the site entrances and another two of similar dimensions would be constructed towards the centre and south of the site, as shown in Figure 3.6. The site entrance compounds will allow site staff to coordinate deliveries and will provide parking space for non- site vehicles. The central compound would provide shelter facilities and office facilities for workers on site. All compounds may include:

3.4.32 Temporary 'Portacabin' type structures to be used for site offices, the monitoring of incoming vehicles and welfare facilities.

- Chemical toilets (self-contained) with provision for sealed waste storage and removal;
- Containerised storage areas for tools, small plant and parts;
- Bunded refuelling area;
- Parking for staff and visitor cars or construction vehicles;
- A receiving area for incoming vehicles.

3.4.33 Figure 3.17 shows a typical layout for the site construction compounds.

3.4.34 The compound areas would be constructed by topsoil excavation in a similar manner to the access tracks. Stone may be laid over a geotextile membrane. Following construction the temporary facilities would be removed and the compounds would be reinstated.

3.4.35 Up to six borrow pits could yield the majority of the stone required for construction of on-site infrastructure and would be located as shown on Figure 3.6. The volume and quality of stone available at these locations would be determined by intrusive site investigation. The borrow pits have been located adjacent to proposed tracks where reasonably practicable to minimise the overall length of track or at the sites of existing quarry locations to minimise environmental impact. Details of the borrow pit design and location will be agreed with the relevant authority once the application is determined.

3.4.36 Typically the borrow pits would measure approximately 60m x 60m and would be up to 13m deep as shown in Figure 3.19. A sump leading to a soakaway would disperse water accumulating in the pit during construction; this would ensure unacceptable levels of suspended particles are not discharged into local watercourses. Any turves removed for the borrow pit excavation would be stored on the downslope of the storage mounds to stabilise them.

3.4.37 There would also be chemical toilets located at various places around the wind farm construction site for site workers. Disposal of the waste would be offsite at suitable facilities.

3.4.38 Prior to commissioning there would be ten temporary guyed tubular wind monitoring masts up to 80 metres high (i.e. hub height). Five of the masts would be installed at the start of the construction phase and would be located at five of the proposed turbine locations (R19, R32, R39, R41 and R43) and would be in place for 6 months. At the same time corresponding temporary masts would be located about 2.5 rotor diameters (about 230m) upwind from the masts installed at the turbine locations, and would be in place for 18 months. Figure 3.13 shows a temporary mast and their locations are shown on Figure 3.6. These masts are approximately 150mm in diameter, with guy wires and therefore have very little actual land take.

3.4.39 During construction temporary fencing may be erected around the construction compounds , working areas, areas under restoration and, if necessary, areas identified as sensitive to disturbance to prevent inadvertent access of personnel or vehicles. Permanent fencing of the development site and individual turbines would not be required. Gates would be provided at the three site entrances in agreement with the relevant landowners and local authority.

Batching Plant

3.4.40 A mobile concrete batching plant may be utilised on the site to further reduce the number of delivery vehicles during the construction phase of the project. The batching area will be set-up on a level area of ground of approximately 80m x 80m. The temporary batching plant compound would be constructed using similar methods to the construction compounds and the area would be reinstated post construction. The concrete batching machinery sits on this prepared area and would typically comprise of container units for cement, water and admixtures, a generator and testing laboratory container, along with areas for graded aggregates of stone and gravel - the number of which will depend on the final concrete design mixture and production rate required. A plan view of a typical mobile concrete batching plant is shown on Figure 3.21; the proposed location is identified in Figure 3.6.

3.4.41 The constituent concrete materials of stone and gravel are scooped from their respective storage areas into a self-weighing hopper and moved in correct proportions for the required mix to the central batching unit. Similarly water, cement and admixtures are pumped into the batching unit which then blends the materials to form the concrete mix. The mix is then added to mixer trucks. Alternatively the batched aggregates, cement and water can be fed directly into mixer trucks for final mixing in the truck. The mixer trucks would then convey the concrete to the turbine foundation in a succession of deliveries and allow each turbine foundation to be poured in approximately 60 deliveries from within the site area.

3.4.42 Since the turbine foundation concrete pour must be carried out in one continuous sequence, the use of on-site batching removes the associated disruption to public highway on days of concrete pouring. The number of deliveries can be further reduced if stone won from borrow pits on-site is suitable for the concrete design mix, as described in Chapter 10. This will be confirmed post-planning approval following site investigation and site-specific design of foundations across the proposed wind farm. If the stone from borrow pits is suitable then grading and processing will take place at the borrow pit locations before transport to the batching plant.

3.4.43 The batching plant would be designed, constructed and operated to ensure there would be no unauthorised discharges to watercourses and groundwater; such detailed design would be set out in the Construction Method Statement which would be agreed between the relevant stakeholders prior to the start of construction. The nearest watercourses are over 150m away. The RES Emergency Preparedness and Response and Spillage Procedures (Appendix 3.4) would apply to the batching plant and a specifically designed washdown and contaminant containment area will be included at the batching plant.

Pollution Control Measures & Environmental Management

3.4.44 Appropriate site management measures would be taken to ensure that runoff from the construction site is not contaminated by fuel or lubricant spillages. Earth and concrete spillages into any watercourses would also be avoided. There would be no discharge of trade effluent, sewage effluent or contaminated drainage into any watercourse system or ditch. Any dewatering from excavations would be via surface silt traps to ensure sediment does not enter surrounding watercourses. A concrete lorry wash out pit would be located adjacent to the batching plant compound. Waterless wheel washing facilities, located at site entrances, would ensure excess mud is not taken onto public roads.

3.4.45 The operation of wind generators produces no discharges and, other than lubricants, uses no chemicals. Provided that reasonable care is taken during their routine maintenance and that vehicles using the access tracks are well maintained, the effect of the operation of the wind turbines on surface and ground waters would be negligible.

3.4.46 In the unlikely event of an environmental pollution incident, RES has an emergency response procedure to address any accidental pollution incident during construction and operation. Appendix 3.4 summarises the RES Emergency Preparedness and Response and Spillage Procedures, which are being implemented under the RES Environmental Management System (EMS).

3.4.47 RES has a policy that no wind turbines, auxiliary and electrical equipment shall contain askarels or polychlorinated biphenyls (PCBs).

3.4.48 An Environmental Management Plan would be prepared and implemented for the construction, operation and maintenance and decommissioning phases, to ensure that any planning conditions associated with the consent are adhered to. As part of the EMS all sub-contractors commissioned to work on the Llanbrynmair wind farm site will be required to follow this plan. In addition there is a standard RES Environmental Requirements for Contractors document (Appendix 3.5) which outlines best practice on construction sites. This is sent out to all contractors and subcontractors so that they can allow for such mitigation measures in their working practices.

3.4.49 In addition, prior to construction commencing on site, civil engineering contractors would be inducted specifically on pollution prevention and controlling water pollution from construction sites in line with the guidelines recommended by Natural Resources Wales such as within its Pollution Prevention Guidelines 5 and 6 for construction sites.

Construction Noise and Vibration

3.4.50 Any construction noise effects will be temporary during the construction phase of the wind farm.

3.4.51 It is proposed that construction and civil engineering works would be Monday to Saturday from 7.00am to 7.00pm.

3.4.52 The sources of construction noise would vary both in location and their duration as the different elements of the wind farm are constructed. Construction noise will arise through the operation of large items of plant such as excavators, dump trucks, cranes, hoists & heavy goods vehicles delivering equipment. Whilst miscellaneous equipment including compressors, hand tools and generators would also be required, these have significantly lower noise output than the larger items of plant and any potential noise impacts will be effectively controlled by means of siting and screening.

3.4.53 Though no specific effects are identified as significant at this stage, it is proposed that a Construction Method Statement be prepared prior to construction that would identify specific construction activities and work areas that have potential to generate nuisance noise. Throughout the construction period methods of working on site will be selected to reduce noise generated and its potential effects.

3.4.54 It is not anticipated that there would be any significant reduction in residential amenity owing to construction noise at properties near the wind farm.

3.4.55 It is expected that decommissioning of the wind farm will be generally similar to, or quieter than, the construction phase.

Reinstatement

3.4.56 After completion of construction the temporary construction compounds and batching plant areas would be fully reinstated.

3.4.57 Cable trenches would be similarly covered with topsoil and reseeded.

3.4.58 Some parts of the crane hardstandings and track spurs would be covered in topsoil and reseeded after turbine construction is completed.

3.4.59 Material arising from excavations on site that cannot be accommodated close to the point of excavation would be placed in the borrow pits. The borrow pits would be landscaped at the end of the construction period and reseeded as appropriate.

3.5 Operation and Maintenance

3.5.1 Wind turbines and wind farms are designed to operate largely unattended. Each turbine at Llanbrynmair wind farm would be fitted with an automatic system designed to supervise and control a number of parameters to ensure optimal performance (e.g. start-up and shut-down, rotor direction, blade pitch angles etc.) and to monitor wellbeing (e.g. generator temperature). The control system would automatically shut the turbine down should the need arise. Sometimes the turbines would re-start automatically (if the shut-down had been for high winds or if the grid voltage had fluctuated outwith range), but other shut-downs (e.g. generator over temperature) would require investigation and manual restart.

3.5.2 The wind farm itself will have a sophisticated overall supervisory control and data acquisition system (SCADA) that would continuously interrogate each of the turbines and the high voltage (HV) connection. If a fault were to develop which required an operator to intervene then the SCADA system would make contact with on duty staff via email or a mobile messaging system. The supervisory control system could be interrogated remotely. The SCADA system would have a feature to allow a remote operator to shut down one or all of the wind turbines.

3.5.3 An operator would be employed to monitor the turbines, largely through remote routine interrogation of the SCADA system. The operator would also look after the day-to-day logistical supervision of the site and would periodically be on site.

3.5.4 After construction wind turbines require routine maintenance and engineers would be on site periodically. Site traffic would be limited to small maintenance vehicles with up to four maintenance crew visits per month. A maintenance crew consists of two people for safety.

There is no requirement for the provision of any services other than electricity and a telephone connection.

3.5.5 Routine maintenance of the turbines would usually be carried out approximately twice a year. This would not involve any large machinery or vehicles. In exceptional circumstances, a mobile crane and/or lorry may be required where large turbine components need to be repaired. These maintenance works would be scheduled to occur outwith the bird breeding season (April – July) as far as reasonably practicable to minimise disturbance to the bird assemblage. The cesspits at the substation and welfare buildings will be emptied approximately twice a year or as required from routine inspections.

3.5.6 Should a fault occur the operator would diagnose the cause; if repair warranted the wind farm being disconnected from the grid then the operator would make contact with the relevant District Network Operator. However, this is a highly unlikely occurrence as most fault repairs can be rectified without reference to the network utility. If the fault was in the electrical system then the faulty part or the entire wind farm would be automatically disconnected.

3.5.7 Prominent signs would be placed on the site (substation, site entrance, and each turbine / transformer housing) giving details of emergency contacts. This information would also be made available to the local police station and the relevant District Network Operator to which the wind farm would be connected.

3.6 Decommissioning

3.6.1 The anticipated operational life of the wind farm is 25 years from the date of commissioning. At the end of this period a decision would be made as to whether to refurbish, remove, or replace the turbines. If refurbishment or replacement were to be chosen, relevant consents would be obtained. If a decision were to be taken to decommission the wind farm this would entail the removal of all the turbine components, transformers, monitoring masts, crane hardstandings, the substation and associated buildings. Some of the access tracks could be left on site to ensure the continued benefit of improved site access for the landowners or they could be reinstated. It is not usual to remove the buried cables or the concrete foundations from the site as this would cause more land damage than leaving them in situ: the entire foundation would be graded over with soil.

3.6.2 Should alkaline or neutral pH ground conditions be found at Llanbrynmair wind farm site no chemical degradation of the concrete foundation would take place. The concrete mass would remain intact and have no effect on the local soil or groundwater. Should detailed site investigation find areas of acidic ground conditions the concrete mix used would be designed to withstand sulphate attack in accordance with BS 5328. The chemical effects of leaving concrete foundations in the ground after decommissioning at the end of the wind farm's working life are therefore not expected to be significant.

3.6.3 It would be left to the determining authority to determine if appropriate conditions should be included for the establishment of a decommissioning bond to be set aside until the wind farm is decommissioned after its operational life, as suggested in TAN8. Prior to decommissioning of the site a method statement would be prepared and agreed with the determining authority.

4 LANDSCAPE AND VISUAL AMENITY

4.1 Topic Glossary

AIL – Abnormal Indivisible Load

CCW – Countryside Council for Wales

CZTV – Cumulative Zone of Theoretical Visibility

GLVIA – Guidelines for Landscape and Visual Impact Assessment

HMP – Habitat Management Plan

LCA – Landscape Character Assessment; or Landscape Character Areas

LCT – Landscape Character Types

LVIA – Landscape and Visual Impact Assessment

NRW – Natural Resources Wales[1]

PCC – Powys County Council

SNPA – Snowdonia National Park Authority

SSA – Strategic Search Area (relating to TAN 8)

ZTV – Zone of Theoretical Visibility

4.2 Introduction

4.2.1 This chapter provides an assessment of the landscape and visual effects of the Llanbrynmair Wind Farm (**Figure 4.1**) and its access route (**Figure 4.2**). It replaces the original LVIA and subsequent SEIs undertaken by Enviros Consulting Ltd.

4.2.2 This chapter considers the potential effects of the Proposal on:

- landscape character and resources, caused by changes in the elements, characteristics, character and qualities of the landscape; and
- visual amenity, including effects upon potential viewers and viewing groups caused by change in the appearance of the landscape as a result of the wind farm.

4.2.3 The updated assessment has been undertaken by chartered Landscape Architects at Land Use Consultants (LUC).

Study Area

4.2.4 A Zone of Theoretical Visibility (ZTV) has been modelled to 30km, as requested by NRW in their scoping response (see **Figure 4.2**), and this area represents the study area considered for potential landscape and visual effects arising from turbines. However, likely significant effects occur within a more limited area as illustrated in this assessment.

Effects Assessed in Full

4.2.5 The following effects have been assessed in full:

- Effects on landscape character within 30km of a turbine;
- Effects on views from representative viewpoints within 30km;
- Effects on views from settlements/villages and routes within the ZTV;

[1] From 01 April 2013, Natural Resources Wales took over the functions previously carried out by the Countryside Council for Wales and Forestry Commission Wales, the devolved functions of Environment Agency Wales and some functions that were carried out within the Welsh Government.

- Effects on views from individual properties within 2.5km of a turbine (a small number of properties which lie outside of this 2.5km boundary have also been included in the assessment, where open views exist towards the Development Site from the property or grounds of the property);
- Effects on landscape designations within 30km;
- Cumulative effects of Llanbrynmair in the context of other existing and proposed wind energy developments in SSA B.

Effects Scoped Out

4.2.6 The following effects have been scoped out:

- Effects on landscape character over 30km from the turbines;
- Effects on views at greater distances than 30km from the turbines;
- Effects on views from settlements/villages and routes outside the ZTV or those unlikely to be affected by changes in view;
- Effects on views from individual properties more than 2.5km of a turbine (albeit a small number of properties which lie outside of this 2.5km boundary have been included in the assessment where open views exist towards the Development Site from the property or grounds of the property);
- Effects on Registered Historic Parks and Gardens (all of which lie at least 16km away and the previous LVIA concluded no significant effects)[2].

4.3 Local Planning Policy

4.3.1 Overarching national policy is contained in Chapter 2. This indicates that renewable energy, including wind energy development, will become increasingly present in the landscape. This section of chapter 4 sets out further detail on local planning policy relevant to landscape and visual issues.

Local Planning Policy

Powys Unitary Development Plan (UDP) 2001 – 2016

4.3.2 Since the 2009 Llanbrynmair application the Powys County Structure Plan and Montgomeryshire and Radnorshire Local Plan policies have been superseded by the Powys UDP. The key policy in relation to renewable energy is Policy is E3, as set out in Chapter 2. This sets requirements for acceptability of wind farm developments, one of which is that "*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 wind farms would be significantly detrimental to overall environmental quality*".

4.3.3 Chapter 2 notes that, as E3 is 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. Nevertheless it is useful to be aware of other policies relating to landscape and visual issues and these include:

- **SP3** – Natural, Historic and Built Heritage – this strategic policy includes the provision that development proposals should "*take account of the need to protect, conserve and wherever possible enhance sites and features of importance for their aesthetic, amenity, biodiversity, ecological, geological, nature conservation, physio-graphical and scientific value*".

[2] The previous LVIA also concluded no significant effect on Landscapes of Historic Interest in Wales – this updated ES deals with Landscapes of Historic Interest in Chapter 7: Cultural Heritage.

- **ENV2** – Safeguarding the Landscape – requires development proposals to be "*appropriate and sensitive to the character and surrounding landscape*".

Powys Local Development Plan (LDP) - Preferred Strategy

4.3.4 In progressing towards the implementation of a Local Development Framework the Powys LDP Preferred Strategy was published for consultation in March 2012. Paragraph 13 of the Preferred Strategy states that "*The landscape of Powys is extremely diverse and includes upland landscapes and valleys that are scenically and historically important. Development which impacts on the landscape must be carefully managed.*" Reference is made to two plan objectives which reflect this statement:

- Objective 14: To conserve, protect and where possible enhance the built heritage, landscape and cultural assets of Powys. (Links to Key issues: 8, 9, 10, 11, 12, 13, 14, 15, 42).
- Objective 15: To conserve and protect land important for environmental quality and biodiversity interests and where possible to promote development that enhances them. (Links to Key issues: 10, 11, 12, 13, 18, 42).

4.3.5 The following 'key issues' to which the above objectives are linked are relevant to landscape and visual effects:

- 11. As a rural county, Powys' natural resources and ecosystems are important for carbon storage (soil and vegetation), food, materials, water, flood alleviation, recreation and amenity. Development must be managed carefully to protect these resources.
- 13. The landscape of Powys is extremely diverse and includes upland landscapes and valleys that are scenically and historically important. Development which impacts on the landscape must be carefully managed.

4.3.6 The objectives and key issues translate into a number of 'strategic policies', of which **SP3** - Natural, Historic Environment and Landscape - is most relevant to this LVIA. It includes the following provisions:

- 1. To safeguard the natural heritage of Powys, development proposals shall protect, positively manage and wherever possible enhance biodiversity and geodiversity interests, including designated and non-designated sites, and habitats and species of importance.
- 3. Development proposals shall seek to maintain the character and quality of the landscape by recognising, protecting and, where appropriate, enhancing the distinctive landscape qualities that comprise of historical, cultural, ecological and geological heritage features. This shall include the protection of key views and vistas and the conservation of characteristics such as hedges, trees and ponds and connective features.

Powys UDP – Supplementary Planning Guidance

4.3.7 The Second Draft Interim Development Control Guidance: Wind farm Development in Powys (2008) sets out the basis on which Powys County Council interpret TAN 8, as refined by the local assessment detailed in Annex D, and includes the introduction of refined boundaries for the SSAs in Powys.

4.3.8 Paragraph 7.1 of the guidance states that "*Notwithstanding the environmental performance of any other site located outside the Refined Carno North SSA B, the Refined Newtown South SSA C and the Refined Nant y Moch (Powys) SSA these will be the only areas within Powys where applications for wind farms of over 25MW will be permitted*".

4.3.9 Paragraph 11.3 states that "*Visual and landscape effects will be given special consideration. Impacts on the skyline, views and panoramas will be important considerations. These features would be identified not only in relation to the wider landscape but also in terms of significant receptors (e.g. local residents or communities). The effects of the impacts*

should be assessed both in relation to the landscape and the impact on visual amenity, including views."

4.3.10 Paragraph 11.5 notes that "*PPW advises the use of LANDMAP as the basis of a consistent all Wales approach to landscape assessment. There should be recognition of the need to distinguish between the value and significance of the landscape and its sensitivity to change. Proposals should in all cases seek to minimise impacts on local communities and avoid creating the impression of communities being hemmed in by large-scale wind farms. The Council will expect turbines to be moved back from plateau edges and skylines.*"

4.3.11 Amongst the issues listed in Appendix 1.2 for consideration when preparing wind farm proposals are:

- cumulative visual impact
- cumulative impact on recreation and amenity
- the scale and character of the landscape - large developments are noted as being more suited to open larger scale landscapes
- the relationship between turbines and the visual horizon
- impact on existing features in the landscape
- disruption caused during the construction period
- impact on overall character and amenity of the surrounding area
- the siting of buildings, transformer equipment and power lines, the need to avoid clutter and to bury cables
- impact of access tracks.

4.3.12 Requirements are set out for landscape and visual assessment to be included in the ES:

- should include the classification and evaluation of the landscape setting, including quality, value, and scale of the landscape
- viewpoint analysis covering both long and short range visibility and including a photomontage or videomontage
- determination of the zone of theoretical visibility of the proposed development
- evaluation of the visual impact and the scope for mitigation of those impacts
- visual impacts of roads and ancillary structures
- details of the location, visual impact and the restoration of borrow pits
- evaluations of impacts should include consideration of alternative siting of individual turbines, colouring, borrow pits and ancillary equipment.

4.4 Approach and Methods

Consultation

4.4.1 LVIA scoping was originally carried out in Spring 2006 and included the agreement on viewpoints to be assessed within the LVIA and on other wind farms to be assessed cumulatively. A further informal LVIA scoping exercise was undertaken in Spring 2008 to confirm viewpoints to be assessed and other wind farms to be assessed cumulatively. Copies of the scoping checklist and scoping responses are included in Appendix 1.2 and Appendix 1.4 respectively; the consultation summary is provided in Section 1.8.

4.4.2 This assessment has also drawn on information provided from consultations with PCC, CCW (now NRW) and SNPA – including those undertaken by Enviros Consulting Ltd as part of the original ES and subsequent SEIs, and further consultation undertaken by LUC as part of this update. Table 4.1 sets out consultation undertaken by LUC (see Table 1.2 for previous statutory and non-statutory responses to the Llanbrynmair ES and subsequent SEI packages).

Table 4.1: Consultation by LUC

Organisation	Reason for Consultation	Response	Action by RES/LUC
Natural Resources Wales (NRW)	To request comment on viewpoints to be used for the updated LVIA.	NRW responded by letter 11 April 2013 to request inclusion of grid in visualisations, request inclusion of ancillary infrastructure in visualisations from VPs 4 and 6, an additional viewpoint from Nant yr Eira, and a wireframe from Ffrwd Fawr. NRW also suggested moving VP13 further south and invited further discussion about cumulative assessment viewpoints.	Infrastructure has been included in VPs 4 and 6 as requested by NRW. An additional viewpoint from Nant yr Eira has been included and VP13 has been moved as recommended by NRW. A wireframe from Ffrwd Fawr indicates no visibility of turbines (so this VP has not been included). As the route of the 132kV grid connection for Llanbrynmair has not yet been fixed by SPEN, it is not possible for RES to include the grid connection in the visualisations. Following a site visit with NRW/PCC it was agreed that a further viewpoint from Glyndwr's Way crossing Pen Coed would be included to illustrate potential visibility of the offsite access works at Gosen bridge.
Powys County Council (PCC)	To request comment on viewpoints to be used for the updated LVIA.	No response	

Guidance

4.4.3 The LVIA has been carried out in accordance with the principles contained in:

- Countryside Council for Wales (2008) LANDMAP Information Guidance Note 3;
- Countryside Agency and Scottish Natural Heritage (2002) Landscape Character Assessment Guidance for England and Scotland and accompanying Topic Paper 6 'Techniques and Criteria for Judging Capacity and Sensitivity' (2004);
- Landscape Institute and Institute of Environmental Assessment, 2nd edition (2002) Guidelines for Landscape Visual Impact Assessment;
- Landscape Institute and Institute of Environmental Assessment, 3rd edition (2013) Guidelines for Landscape Visual Impact Assessment[3];
- Landscape Institute Advice Note 01/11 Photography and photomontage in landscape and visual impact assessment;
- Natural Resources Wales (2013) LANDMAP Information Guidance Note 3;

[3] The 2nd and 3rd Edition LVIA Guidelines have been referred to. Assessments started prior to publication of the 3rd Edition (as is the case with this assessment) are generally completed complying with the 2nd Edition as advised by the Landscape Institute. However, this assessment also takes on board the principles of the recently published 3rd Edition.

- Scottish Natural Heritage (March 2006) Visual Representation of Wind Farms, Good Practice Guidance. Prepared by Horner & Maclennan / Envision;
- Scottish Natural Heritage (March 2012) Assessing the Cumulative Impact of Onshore Wind Energy Developments.

Field Survey

4.4.4 Since LUC's involvement in late 2012 numerous site visits have been undertaken at different times of the years and in different weather conditions. These site visits were undertaken to examine the site and surrounds, provide input to the siting of the on-site access tracks and sub-station, develop a consolidated list of assessment viewpoints, develop proposals to minimise effects of the offsite access route on landscape features, landscape character and visual amenity, undertake the assessment of views from properties and viewpoints to inform the updated assessment, prepare mitigation proposals for the substation and off-site access route, and to take photographs from new viewpoints included in the updated LVIA.

Key Steps

4.4.5 The key steps in the methodology were as follows:

- zones of theoretical visibility (ZTVs) calculated to hubs and tips were prepared based on a turbine hub height of 80m and a blade tip height of 126.5m and covering distances up to 30 km from the turbines;
- the wind farm site and surrounds were analysed in terms of character and sensitivity (definitions of sensitivity are described further below);
- viewpoints across the ZTV were selected as representative of the range of views and types of viewer likely to be affected by the wind farm, selected in consultation with CCW and PCC, and the character/ sensitivity of each view was determined;
- existing views from settlements were considered and residential properties within 2.5km were assessed;
- wireline and photomontage images of the wind farm from various viewpoints and locations were prepared (the methods used are described below);
- the nature of change to landscape character and views was described; and
- a judgement on the level of effect on each landscape and visual receptor was made.

Method for Creating Zones of Theoretical Visibility

4.4.6 The 'Zone of Theoretical Visibility' (ZTV) describes the area over which a development can theoretically be seen. The intervisibility between each point in the digital terrain model (DTM) and each turbine hub and tip height is calculated to identify the locations which will have theoretical visibility of the scheme. Since the LVIA seeks to assess the maximum case scenario, all ZTV's have been calculated from the maximum tip height of 126.5m and a hub height of 80m.

4.4.7 Typically ZTVs are based on a bare ground terrain model and therefore do not take account of vegetation or buildings and show only a theoretical situation. A development is often not visible from all areas within the ZTV due to localised screening which is not represented by the DTM. The ZTVs for the hubs and tips of this scheme have been processed using a digital terrain model based on Ordnance Survey Landform Panorama data and produced using ESRI ArcGIS Spatial Analyst. The results of the ZTV have been overlaid on a greyscale 1:50,000 Ordnance Survey map in accordance with page 34, para. 61 of `Visual Representation of Wind farms: Good Practice Guidance' (SNH, 2006).

Method for Wireline and Photomontage Production

4.4.8 Photographs were taken using SLR cameras with fixed lenses, equivalent to a focal length of 50mm, mounted on a Panoramic head and levelled tripod (see Appendix 4.2 for camera details).

4.4.9 Wireline images were generated by LUC using Resoft Wind farm software. The wirelines were generated as cylindrically projected views of the terrain model with an included angle of 90° from the grid referenced viewpoint locations. Ordnance Survey Landform Panorama DTM (with a 50m resolution) was used to create the landform seen in the wireline view. The wireline views were taken from a set viewer height of 2 metres above the terrain model. These simulations take into account the curvature of the earth.

4.4.10 AutoCAD was used to alter the ground level contours around the proposed substation site and components such as the sub-station and control buildings and compound components were modelled to their correct size and design in Autodesk 3DS Max directly from a geo-referenced CAD drawing showing the site compound footprint and an indicative substation layout plan and elevations. Additionally both the on-site access tracks and offsite road proposals associated with the development such as the Neinthirion bypass and bridge widening works at Gosen were modelled within the topography directly from geo-referenced CAD drawings.

4.4.11 43D Topos R2 software was used to bring together the modified Digital Terrain Model (DTM), 3D components and infrastructure data. Viewpoints were created within the model using the OS Grid Coordinates of Photography taken and the view extent and bearing were set to mirror the parameters of the panoramic photography for each camera location.

4.4.12 The photomontages were generated by aligning the wirelines to the panoramic photography from viewpoints in Resoft Wind farm. Turbines were rendered using realistic lighting conditions (selected in Resoft Wind farm to match conditions in which photographs were taken) and these renders together with views exported from Topos were then composited with the original photography in Adobe Photoshop. Any necessary edits were then made, for example, the removal of turbines/infrastructure screened out by foreground features not accounted for by the bare ground terrain model.

Cumulative Visualisations

4.4.13 Photographs were taken using SLR cameras with fixed lenses, equivalent to a focal length of 50mm, mounted on a Panoramic head and levelled tripod (see Appendix 4.2 for camera details). A set of cumulative photomontages were produced for the cumulative assessment viewpoints using Resoft Wind farm.

Assessing Significance

4.4.14 The assessment of landscape and visual effects considers the 'nature of the receptor' (sensitivity) and 'nature of the effect' (magnitude of change) on that receptor before coming to a judgement on significance of effect.

Nature of the Receptor

4.4.15 Landscape and visual receptors are identified and their sensitivity evaluated.

4.4.16 Landscape sensitivity is defined in relation to the specific type of change envisaged and depends on landscape character and how vulnerable this is to change. Landscapes which are highly sensitive are at risk of having their key characteristics fundamentally altered, leading to a changed landscape character. The criteria for judging landscape sensitivity to wind energy development are drawn from guidance contained in the Countryside Agency and SNH (2002) Landscape Character Assessment Guidance for England and Scotland and the accompanying Topic Paper 6 'Techniques and Criteria for Judging Capacity and Sensitivity' (2004). Topic Paper 6 suggests that landscape sensitivity is "*related to landscape character and how vulnerable this is to change… Landscapes which are highly sensitive are at risk of*

having their key characteristics fundamentally altered, leading to a different landscape character… Sensitivity is assessed by considering the physical characteristics and the perceptual characteristics of landscapes in light of particular forms of development" (page 3). Attributes that may indicate sensitivity to wind farm development include those listed in Table 4.2 below.

Table 4.2: Indicators of Landscape Character Sensitivity to Wind Energy Development

Characteristic/ attribute	**Aspects indicating lower sensitivity to wind energy development**	⟷	**Aspects indicating higher sensitivity to wind energy development**
Scale	Large scale	⟷	Small scale
Landform	Absence of strong topographical variety Featureless, convex or flat	⟷	Presence of strong topographical variety or distinctive landform features
Landscape pattern and complexity	Simple Regular or uniform	⟷	Complex Rugged and irregular
Settlement and man-made influence	Presence of contemporary structures e.g. utility, infrastructure or industrial elements	⟷	Absence of modern development Presence of small scale, historic or vernacular settlement
Skylines	Non-prominent/screened skylines Presence of existing modern man-made features	⟷	Distinctive, undeveloped skylines Skylines that are highly visible over large areas or exert a large influence on landscape character Skylines with important historic landmarks
Inter-visibility with adjacent landscapes	Little inter-visibility with adjacent sensitive landscapes or viewpoints	⟷	Strong inter-visibility with sensitive landscapes Forms an important part of the panorama from sensitive locations
Perceptual aspects	Close to visible or audible signs of human activity and development	⟷	Remote from visible or audible signs of human activity and development

4.4.17 For the visual and sensory LANDMAP aspect areas, NRW's overall evaluation has been used as a proxy for sensitivity so that areas with a High or Outstanding evaluation are categorised as being of High sensitivity, aspect areas having an overall evaluation score of moderate are judged to be of medium sensitivity and those with an overall evaluation score of low are judged to be of low sensitivity. This accords with the approach undertaken in the second SEI (2011).

4.4.18 Viewpoint sensitivity in this LVIA is used as a proxy for viewer sensitivity. The sensitivity of a viewpoint depends upon the location of the viewpoint and the type of receptor experiencing the view. For example viewpoints representing views from a settlement, tourist destination, designated landscape, an advertised viewpoint, or a location where people gather are considered to have a higher sensitivity than viewpoints representing views from motorways, main roads where motorists are travelling at speed or mainline railways or where the attention of people is focussed elsewhere e.g. at a place of work.

4.4.19 In this assessment sensitivity is described as low, medium or high as defined and illustrated in Table 4.3.

Table 4.3: Definitions of Sensitivity

Sensitivity	Receptor	Definition
High	Landscape	Attributes that make up the character of the landscape offer very limited opportunities for the accommodation of change without key characteristics being fundamentally altered, leading to a different landscape character. The landscape may be highly valued.
	Visual	A viewpoint where people's attention or interest is most likely to be focussed on the landscape e.g. an advertised view or designated viewpoint, a viewpoint within a National Park/AONB, a viewpoint at a popular outdoor recreational destination where focus in on the landscape, or a viewpoint representing views available to residents.
Medium	Landscape	Attributes that make up the character of the landscape offer some opportunities for the accommodation of change without key characteristics being fundamentally altered. The landscape may be valued at a regional or county level.
	Visual	A viewpoint where people's attention or interest is likely to be less focussed on the landscape and from where views of the landscape are judged to be more incidental.
Low	Landscape	Key characteristics of the landscape are resilient to being changed by wind energy development. The landscape may be locally valued.
	Visual	A viewpoint where people's attention or interest is not specifically focussed on the landscape.

Nature of Effect

4.4.20 The nature of effect may be described as the magnitude of change affecting a receptor.

4.4.21 The magnitude of change to landscape character will require consideration of the loss of, or change in a characteristic aspect or feature of a landscape character area, as described or defined in a landscape character assessment. This may include a change in the backdrop to, or outlook from, the landscape that affects its character.

4.4.22 The magnitude of change to views will depend on the distance from the viewpoint (which affects the apparent scale of the development in the view), the angle of view occupied by the development, the extent of shielding by intervening features, the degree of obstruction of existing features, and the degree of contrast with the existing view.

4.4.23 In this assessment magnitude of change is described as being imperceptible/ barely perceptible, low, medium or high as defined in **Table 4.4**.

Table 4.4: Definitions of Magnitude

Magnitude	Receptor	Definition
High	Landscape	An obvious change in landscape characteristics and character potentially leading to the creation of a new landscape character type.
	Visual	Large change in view, perhaps where the development is in close proximity in a direct line of vision, or affecting a substantial part of the view, or providing contrast with the existing view.
Medium	Landscape	Discernible changes to landscape characteristics and character..
	Visual	Clearly perceptible change in view, perhaps where the development is relatively close but at an oblique angle or further away in the direct line of vision, creating a distinct new element in the view.
Low	Landscape	A perceptible but small change to landscape characteristics and character.
	Visual	Small change in view, perhaps where the development is at a distance or oblique angle, or where the scale of the landscape absorbs the development well.
Imperceptible/ barely perceptible	Landscape	An imperceptible/ barely perceptible change to landscape characteristics and character.
	Visual	Change in view which is imperceptible/ barely perceptible.

Significance of Effects

4.4.24 In accordance with the 2nd and 3rd Edition Guidelines for Landscape and Visual Impact Assessment (GLVIA), significance is determined by considering the sensitivity of the landscape or visual receptor (the nature of the receptor) and the magnitude of change expected as a result of the development (the nature of effect). However, as the 2nd Edition GLVIA notes, the relationship between the variables is not linear (Paragraph 7.47) and therefore each case is assessed on its own merits, using professional judgement and experience to identify broad levels of effect.

4.4.25 The levels of effect are described as being negligible/none, minor, moderate or major. Note that there is a gradual, blurred transition between levels of effects.

4.4.26 Major and moderate effects are considered significant in the context of the EIA Regulations.

Direction of Effects

4.4.27 Landscape means “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Article 1 of the European Landscape Convention – Definitions). Since perception is relevant to landscape, both positive and negative reaction to landscape change may take place. With regard to wind energy development there is a broad spectrum of response from the strongly positive to the strongly negative. However, to cover the ‘maximum effect’ situation, potential effects are assumed to be adverse unless otherwise specifically stated in the text.

Duration and Reversibility of Effects

4.4.28 Duration of effect is judged as short term (0-5 years), medium term (5-10 years) or long term (10-25 years). These figures are based on the 3rd Edition Guidelines for Landscape and Visual Impact Assessment (para. 5.51). The assessment also comments on whether the effects are reversible.

4.5 Baseline Conditions

4.5.1 This section presents an overview of the landscape and visual context of the study area and provides details on:

- Landscape character;
- Designated landscapes; and
- Views/visual amenity.

Overview

4.5.2 The site is located to the north east of the village of Llanbrynmair in Powys County, approximately 15km east of Machynlleth (see Figure 4.2). The site falls within TAN 8 Strategic Search Area (SSA) B and within the Refined Boundary of Strategic Search Area (SSA) B (see Figure 3.2). The site comprises an area of upland grassland with blocks of coniferous woodland. A minor road (the C2031) between the settlements of Talerddig and Llanerfyl linking the A470(T) and A458(T) marks the south-eastern boundary of the site.

4.5.3 The site forms part of an area of gently undulating plateau bounded by the valleys of the River Banwy to the north and the River Twymyn, a tributary of the Dyfi, to the south. The majority of the local streams drain to the Banwy via the Afon Gam, which flows north-eastwards along Nany y Eira. To the west, the plateau falls more steeply from a high point of 451m at Panylau Gwynion towards the valley of the Afon Rhiwsaeson, which drains to the Twymyn.This is an area of upland rather species-poor acid, marshy or improved pasture with conifer plantations. It also includes a mosaic of mire, marshy and acid grassland, and heath. The site is mainly divided by fences and sheep and cattle graze parts of the area. There are a number of scattered, geometrically-shaped, coniferous plantations, outliers of a much larger-scale forestry block to the north. Some small areas of broadleaved woodland occur on the west-facing slope overlooking the Afon Rhiwsaeson, and there is also a major coniferous plantation immediately to the south east of the site boundary.

4.5.4 Several farmsteads are sited on the lower ground along the Afon Gam, linked by the minor road between the two main valleys. Several tracks give access to the larger forestry blocks, and a number of footpaths also traverse the site, including a section of the Glyndwr's Way National Trail.

4.5.5 The most extensive views are generally to the higher parts of similar plateau areas to the south-east, north-east and south-west. Views to the west, north-west and north tend to be enclosed by the major forestry block.

Landscape Character

4.5.6 CCW's 'Landscape Character Map for Wales'[4] provides information on landscape character at a regional scale while the Powys Landscape Character Assessment and CCW's LANDMAP Geographical Information System provide information on landscape character at a more local level.

Character Map for Wales

4.5.7 The site lies within the Cambrian Mountains Regional Character Area (RCA). Regional character areas within 30km of the Llanbrynmair Wind farm are shown on **Figure 4.3**. Eight

[4] http://www.ccw.gov.uk/idoc.ashx?docid=dc3096a3-4149-409d-8a45-50ffc1ad72b4&version=-1

of these areas have theoretical visibility of the proposed development. The six key areas with theoretical visibility of the proposed development are described in **Table 4.5** below. The Upper Wye Valley and Aberdovey Coast are so far away and have so little potential visibility that they are not included in the table.

Table 4.5: Regional Character Areas

RCA Name	**Key Characteristics** [interpreted from the Landscape Character Map for Wales Report]
Cambrian Mountains (the proposed development lies in this RCA)	The Cambrian Mountains is a belt of wild and relatively remote moorland landscape orientated in a northeast southwest direction. This landscape is characterised by landform of extensive undulating plateau and incised valleys. Its upland landscape is large in scale and includes high summits such as Pumlumon. Such elevated summits provide extensive panoramic views across and beyond this LCA. Glacial features are evident throughout in the form of U-shaped valleys, corries, tarns and moraines. The Cambrian Mountains to the north provide a transition to the upland moorland landscape of LCA 16 Y Berwyn. Sheep grazed open moorland landcover predominates this LCA with some bracken scrub, wind blown oaks, coniferous forest plantations and upland blanket bog. The valley edges of this LCA give way to pastoral fields bound by hedges and woodland. Man-made reservoirs and dams are located within valleys. There is a dense pattern of historic features and elements throughout in the form of funerary and ritual monuments.
Berwyn	Berwyn forms an extensive area of upland moorland in North Wales, centred on the elevated slate/shale spine of mountains, with the highest point (827m AOD) being found at Cadair Berwyn. It is characterised by extensive areas of upland moorland that is recognised as being of significant interest for moorland breeding bird species. Large scale upland forest is also apparent. The uplands are dissected by valleys and waterfalls to the north west of Llanrhaeadr-ym-Mochnant (relating to an area of localised geological variation including Ordovician volcanic/tuff rock) are a distinctive hydrological feature. Key elements of the cultural landscape include prehistoric ritual and funerary monuments such as Cairns and round barrows and there is evidence of prehistoric and medieval occupation both in the uplands and in the Tanat Valley. Much of Berwyn has a remote and unsettled character, with the few areas of settlement formed by compact linear valley villages such as Llangynog, served by a network of winding 'B' Roads. The plantation surrounded reservoir at Lake Vyrnwy is a notable feature, providing localised variation in what is predominantly an open and elevated moorland landscape.
Montgomeryshire Hills & Vales (part of the proposed offsite access route passes through this RCA)	Montgomeryshire Hills and Vales is an undulating landscape of distinctly undulating ridges and valleys which are aligned broadly east-west, including a number of large rivers, such as the lower Tanat and much of the Vyrnwy. Ridges and scarp slopes create sinuous, curved skylines. The highest points, in excess of 350m AOD, are found in the ridges to the north western part of the character area, adjoining Berwyn. Landcover is predominantly pastoral agriculture and a network of hedgerows with trees defines the field boundaries, interspersed with blocks of deciduous woodland - steep sided valleys are typically wooded. Principal historic features include moated sites and settlements from the Roman and medieval periods, in addition to a number of registered historic parklands e.g. Llangedwyn and Bodfach. Settlement is confined to isolated farmsteads and compact nucleated valley villages associated primarily with historic river crossing points. A network of 'A' roads follows the valley floors.
Snowdonia	Snowdonia forms a vast upland massif in north west Wales, being largely contiguous with the boundary of the National Park. This is a landscape of great perceptual variation and spatial experience with angular mountain ranges contrasting with hills softened by moorland heather and plantations, and often juxtaposed with deeply dissected valleys. Slates and shales underlie much of the central part of the area, with volcanic outcrops (lava and tuff) and igneous intrusions creating the extensively

RCA Name	**Key Characteristics** [interpreted from the Landscape Character Map for Wales Report]
	faulted mountain ranges, often with angular skylines, which include Snowdon (1085m AOD) and Cadair Idris. A mountainous topography with the principal mountain range orientated broadly north east to south west. U shaped glacial valleys are distinctive. Landcover includes hill sheep grazing, forestry, heather dominated moorland and upland grassland. Rock outcrops and slate/shale ridges are frequently apparent. The areas of upland moorland and blanket bog are of significant ecological interest and hydrological elements include river valleys such as the Dysinni, the Llugwy River and waterfalls at Betws-y- Coed, the source of the River Conwy, and lakes including the largest natural lake in Wales at Bala (Llyn Tegid). Prehistoric ritual and funerary sites including cairns, standing stones and stone circles are strategically located along hill crests, mountains and ridges, forming a strong visual feature. The exploitation of minerals has left industrial archaeological remains in the landscape. The few areas of settlement are primarily defined by small towns e.g. Dolgellau and compact valley villages in slate and stone e.g. at Beddgelert and Betws-y-Coed.
Severn Valley	The Severn Valley is a broad well defined river valley, with the source of the river occurring in the Cambrian Mountains. It is a broad and well defined vale with a sense of containment created by wooded valley sides. The character area includes the confluence of a number of rivers and minor streams which drain the valley sides are a distinctive hydrological feature. Landcover is predominantly lowland pastoral farmland and wetland rush pasture associated with the course of the Severn and occasionally interspersed with broadleaf and wet woodland. Historic and cultural elements include prehistoric encampments, parts of Offa's Dyke, the Roman fort at Caersws and a number of castles which indicate the strategic importance of the Vale, e.g. Montgomery and Dolforwyn. Settlement pattern relates to this strategic importance with nucleated valley floor settlements having grown up around former military sites, e.g. Caersws. The planned medieval/walled town of Montgomery on the foothills below the castle is significant. Other settlement e.g. Newtown relates to the industrial significance of the valley and associated transport developments such as the Shropshire Union Canal and the railway. Parts of the vale have a tranquil and pastoral character, although this is often interrupted by the influence of large valley floor settlements such as Newtown and Welshpool.
Radnorshire Hills	Radnorshire Hills is an undulating upland landscape in mid Wales which is dissected by a series of minor river valleys. Topography is in excess of 350m AOD to many of the ridges, with a high point of 660m AOD at Radnor Forest. It is predominantly characterised by pastoral landcover, including hill sheep farmland and lowland pasture, although heather dominated moorland is apparent in the most elevated parts of the character area. A network of geometric fields of small to large scale, defined by mixed native hedgerows interspersed with broadleaf woodland and extensive blocks of coniferous forestry. Cultural pattern is represented by the presence of prehistoric ritual and funerary monuments such as round barrows and standing stones at elevated points. Offa's Dyke illustrates the historic strategic importance of this marchland landscape. Other historic elements include remnants of medieval and post medieval settlement, including motte and bailey castles, earthworks and moated sites. Settlement pattern is defined by compact linear villages in the river valleys, together with a small number of larger nucleated valley towns at river crossing points. Wind turbines are a feature of the uplands in the north western part of the character area.

Powys Landscape Character Assessment

4.5.8 The Powys Landscape Character Assessment provides a more detailed classification of landscape character. The site lies within LCA 5 - Dyfnant Forest/Llanbrynmair Moors. Landscape character areas within 10km of the Llanbrynmair Wind farm are shown on **Figure**

4.4. Areas with theoretical visibility of the proposed development are described in **Table 4.6**.

Table 4.6: Powys Landscape Character Areas

LCA Name	Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) [quoted directly from the Powys Landscape Character Study 2008]
LCA 5 - Dyfnant Forest/Llanbrynmair Moors (the proposed development lies within this area)	*There are limited views within and out of the area due to dense forestry planting, which gives rise to an enclosed, dark and oppressive character within the area, in stark contrast with surrounding open upland areas that are predominantly rough grazing. The coniferous afforestation blankets the subtleties of the underlying landform and produces intrusive conifer fringes and harsh plantation edges into an otherwise open expanse of upland moorland.* • *Although there are many parts of this area which have very large blocks of coniferous woodland, the semi-natural vegetation and the small fields which intersperse the forests enhance the local biodiversity.* • *There is a wide range of BAP species and other significant species recorded within this large area, with a good range of important upland communities.*
LCA M1 - Berwyn Mountains	*The aspect is very strongly linked visually to Snowdonia with the moorland plateau taking on the characteristic of upland peak hinterland. There is a strong sense of exposure with wide open skies dominant. Land cover is heather/ bilberry and rough grazing with bracken growth to lower plateau sides. Some upland lakes are evident with a number of large boggy areas in lower lying and poorly drained areas. There are some extensive high quality long distance views out towards the Snowdonia mountains, and within the area. However, some internal views are degraded in places by the broad expanses of upland coniferous plantation that sit at odds with the overall open moorland character of the area.* • *Close links to the landscape of the adjacent Snowdonia National Park. There are some extensive high quality long distance views out towards the Snowdonia mountains, and within the area.* • *Very large expanse of internationally important wildlife habitats, especially for upland breeding birds, including areas of the Berwyn National Nature Reserve - Special Protection Area for rare, vulnerable and migratory birds and SSSI.* • *The upper parts of the western section of the Tanat Valley Registered Landscape of Outstanding Historic Interest in Wales include the higher ground of the upper valley slopes and moorland tops above Cwm Rhiwarth, Cwm Pennant and the summit and southern flanks of Cadair Berwyn. Whilst the landscape of much of the valley is the result of medieval and post-medieval agriculture, the upper reaches of the valley around Llangynog bear the marks of an industrial past. The main period of exploitation was from the 16th century to modern times, with the remains of mining still evident in readily identifiable ruined buildings, tramways, levels, inclines, filter beds and spoil tips - and the former railway, closed in 1960.*
LCA M7 - Pont Llogel	*Characterised by a strongly defined field pattern that follows the underlying topography, with small-scale, irregular field parcels spreading over a succession of rolling ridges. Locally, hilltop grouped trees and marshy damp grazing is common. Wooded areas congregate around watercourses and follow small scale valleys to the edges of the area. There is a domestic, settled character with traditional land management techniques, such as hedge laying and coppiced woodland areas. To the north is a clearly defined area of upland grazing with a varied field pattern - small scale well-defined field parcels in lower lying areas and open, weakly defined larger fields at higher levels. Land use is predominantly livestock grazing with some small to medium sized blocks of forestry plantation. Vegetation comprises largely of the mixed tree and*

LCA Name	Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) [quoted directly from the Powys Landscape Character Study 2008]
	overgrown hedgerow boundaries and rough grazing with bracken/gorse scrub. • *High biodiversity value resulting from the mosaic of different habitats present, especially for birds.* • *A number of small streams run through this area which support several small but significant Sites of Special Scientific Interest, and roadside nature reserves which carry a very diverse range of grassland species. The local biodiversity is greatly increased by this range of unimproved grasslands, carr woodlands and valley mires.* • *Some nationally important geology, including the Ffridd Mathrafal Track Section SSSI.*
LCA M11 - Mynydd y Cemmaes	*Open, exposed and with a remote wilderness air to the area, it forms an important topographic feature. Dramatic and extensive clear views are available over the surrounding rolling lowland farmland of the Dyfi Valley and towards the rising upland and mountains of Snowdonia. Much of the exposed ridge is occupied by an extensive wind farm development that, although obviously alien to this landscape, provides a contrasting visual experience. The rising hillside slopes preceding the upland area of Mynydd y Cemmaes are traditionally farmed with small scale fields reflecting the underlying landform and displaying a well-defined pattern. Hedgerows and hedgerow trees are the dominant landscape feature, with some incidental mixed woodland patches mostly in lower lying areas and by watercourses.* • *Dramatic and extensive clear views are available over the surrounding rolling lowland farmland of the Dyfi Valley and towards the rising upland and mountains of Snowdonia. The Snowdonia National Park abuts this LCA along the northern boundary.* • *Major landscape features, some with characteristic surface features controlled by bedrock geology and extensive Quaternary drift.* • *Topographically and scenically varied and distinctive, comprising bare upland moorland and fertile valleys, the latter containing a variety of field patterns.* • *The Cemmaes wind farm visually dominates both the adjacent and distant landscapes within the LCA. The wind farm has been built on landscapes bearing evidence of (largely) prehistoric occupation, and which have historically been used for grazing. The Cultural Aspect specialist ascribed a high cultural value to this area as a response to the perceived need for 'sustainable' energy. However, much of the valley which separates Mynydd y Cemmaes from the eastern section of the LCA around Mynydd Lluest fach and Mynydd Rhiw-Saeson remains substantially unspoilt and attractive, and there are only certain sections of the valley where the wind turbines are visible.*
LCA M12 - Banwy Valley	*Narrow river corridor with dispersed small to medium settlements dominated by the surrounding steep valley sides. Lower slopes and valley bottoms tend to carry the main arterial transport routes through the study area - the A458 (T) is the principal transport corridor - and detract from the overall aesthetic quality of the aspect. Predominantly semi-improved grassland with a proportion of damp pasture land associated with the river course. Damp woodland is also a strong characteristic of the area. Primarily arable and dairy farming, with a regular medium-sized field pattern. Managed hedgerow and fence lines predominate with wide open views over the valley floor and relatively open skies dominant. It is mainly settled and domestic in character with sporadic clustered developments. Llanfair Caereinion itself still retains much of its original character as a rural agricultural centre, and has a range of traditional architectural styles and vernacular detailing, and distinct town centre based around the river crossing and traditional core.* • *There is a strong sense of place, partly contributed by the Llanfair*

LCA Name	Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) [quoted directly from the Powys Landscape Character Study 2008]
	Light Railway in the easternmost section. • *Major river system, broad in its lower part with a wide well developed floodplain and meanders, with some minor development of terraces.* • *River habitats and associated ribbon woodlands and ancient/species-rich hedgerows provide important elements of biodiversity in an otherwise rather intensively managed productive agricultural landscape.* • *The eastward-trending river valleys such as that of the Afon Banwy dominate the landscape of Montgomeryshire. Their streams mostly flow from Pumlumon, Berwyn and lesser ranges. They are variously broad or steep-sided (or both) and contain most of the historic settlements in the middle and north of Montgomeryshire. They have evidence of long-term settlement and exploitation of the adjacent terrain caused by topography. Without exception, each displays more than average aesthetic qualities. These form the background canvas on which the county's vivid culture is painted.* • *Llanfair Caereinion is a small town on the river Banwy which appears to have originated during the earlier medieval or medieval periods in association with an early church site. 18th to early 20th-century buildings and structures including, houses, shops, public houses, nonconformist chapels, public buildings and former hotel. Modern expansion for housing and schools to the north, east, south and south-west of the historic core. Early industrial remains include the site of late 18th to early 19th-century woollen mill. The extant, early 20th-century Welshpool and Llanfair Light Railway terminates here.*
LCA M13 - Tregynon/Llanerfyl (part of the proposed offsite access route passes through this area)	*The farmland in the north is characterised by low rolling hills with gently sloping sides and rounded tops. The small scale irregular field patterns are very strongly defined by field boundaries typified by overgrown and managed hedgerows with a significant proportion of mature hedgerow trees. Small to medium sized mixed broadleaved woodland is common in lower lying areas and especially along watercourses. The central and southern areas are formed by an extensive area of rolling hillsides and pasture land with gently sloping sides and rounded tops. Vegetation is predominantly oak/mixed broadleaved woodland combined with a strong field pattern defined by hedgerows.* • *Overall this large area is a well-defined example of a traditionally farmed landscape - generally settled, safe and relatively intimate, except for the broader sweep of the exposed valley of Cwm Nant-yr-Eira, south west of Llanerfyl running up towards the Llanbrynmair Moors.* • *General landscape character is defined strongly by the rolling farmed landscape, with traditional farming techniques common, such as hedge laying. Blocks of 20th-century conifer plantation in the northern part of the area, with some residual ancient broadleaved woodland in steep-sided stream valleys and on steeper ridge slopes.* • *Views across the area are generally from a succession of rolling ridges and, due to the size of the area, long distance views are limited to far distant ridgelines of upland areas.* • *Part of this area contains key geological sites of regional importance* • *Topographically and scenically varied and distinctive, comprising bare upland and fertile valleys, the latter containing a variety of field patterns* • *Gregynog Hall, immediately to the south west of Tregynon, is a Registered Historic Landscape. This is a Grade I site, being listed as a formal and informal woodland garden incorporating various historic overlays. It has fine wooded parkland including part of the ancient Great Wood of Tregynon. It is described as one of the most important gardens and parks in Powys, dating from at least 1500. William Emes produced proposals in 1774 and some of them were carried out. In*

LCA Name	Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) [quoted directly from the Powys Landscape Character Study 2008]
	1920 it became the home of the artistic patrons Gwendoline and Margaret Davies. H.A.Tipping worked on the gardens 1930-33 and Dame Sylvia Crowe in 1972. Any management of the landscape within the site or having an effect upon its essential setting must take account of its landscape significance.
LCA M14- Esgair Cwmowen	*Exposure and wind are dominant features with isolated more intimate areas with small irregular hedged fields in sheltered areas to the edge of the area. The area is a good example of an upland grazing patchwork of vegetation -rough and poorly drained grazing, bracken, heather.* • *Exposure and wind are dominant features, with isolated more intimate areas with small, irregular, hedged fields in sheltered areas to the edges of the LCA.* • *Important upland massif with unique steeped topography, unusual periglacial features (NE of the hill of Y Foel) and at least one pRIG site (Tan y Foel Quarry).* • *There is an important oligotrophic lake, Llyn Mawr SSSI, with some interesting plant and bird species.* • *Topographically and scenically varied and distinctive, comprising bare upland and fertile valleys, the latter containing a variety of field patterns.* • *There is a recently-constructed wind farm along the Mynydd Clogau ridge in the south east of the LCA.*
LCA M15 - Dyfi Valley Catchment	*The regular small to medium scale field patterns are predominantly livestock and dairy farming in a picturesque landscape setting with rolling farmland rising steeply to the north and southern upland moorland. It is flanked to the north and south by a very extensive network of valleys containing tributaries leading into the River Dyfi. To the north, views are over a picturesque traditionally farmed landscape, edged by sporadic rock exposure and marginal grazing land facing onto the meandering Dovey Valley, with a northerly backdrop of steeply rising upland on the edge of Snowdonia.* • *The area has a dramatic backdrop to the south with the upland moorland of the Trannon and Plynlimon moors.* • *A traditionally-farmed landscape with a high incidence of grouped trees and mixed oakwood parcels.* • *The northern, western and south-western boundaries of this LCA abut the Snowdonia National Park.* • *The valley's northern part is overshadowed by banks of wind turbines on the high ground above it along the Mynydd Cemmaes ridge.* • *Includes part of the Afon Dyfi ger Mollnyd SSSI for geological interest.* • *Includes a very important woodland SSSI. The Dyfi estuary west of Machynlleth is a Ramsar site and a SSSI.* • *The Dyfi, or Dovey, Valley trends north-east to south-west and contains the sole river of any size in Montgomeryshire that flows westwards into Cardigan Bay. It contains the major transport routes of the west coast rail line and the A487(T) and A489(T) along the valley.* • *The Valley is the western gateway to Montgomeryshire and previously shared with Welshpool the distinction of being one of only two places where trade goods were received and despatched by boat.* • *Although remains of human occupation are not so dense or numerous as in the eastern valleys, the Valley is becoming increasingly popular as a place of recreation, as well as for artists and anglers.* • *The Centre for Alternative Technology near Machynlleth, in the valley of the Afon Dulas, is of national cultural importance for its research and development works and is currently undergoing a major expansion of buildings on the main site.*
LCA M17 -Dyfi &	*It exhibits a wide range of vegetation cover with scattered grouped*

LCA Name	Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) [quoted directly from the Powys Landscape Character Study 2008]
Twymyn Hillsides	*broadleaf trees a typical feature to the west of the area, together with rough grazing, bracken and heather scrub with outcrops of rock. An extensive area of semi improved grazing forms the transitional landform between the upland moorland and unimproved grazing of the Plynlimon Moors and the fertile farmlands of the Dyfi floodplain. It is characterised by small to medium scale irregular field patterns, bounded by a mixture of boundary treatments - gappy hedgerows and fences together with limited examples of stone walling - and numerous scattered farmsteads and small clustered settlements.* • *The north western boundary of this LCA overlooks the narrow floodplain of the River Dovey/Afon Dyfi and faces the Snowdonia National Park, which lies a short distance beyond to the north west. A major upland block with a number of geo-conservation sites and areas of distinctive tectonically controlled topography.* • *Where the areas of the Plynlimon scarp slope are too steep for intensive use, they have developed a range of internationally significant plant communities.* • *A very small strip of land at the southern extremity of the LCA north of the minor road from Staylittle to Dylife and beyond lies within the Clywedog Valley Registered Landscape of Special Historic Interest in Wales, but its extent here is insufficient to classify the whole of the LCA as having special historical significance.* • *At the head of the Afon Carog valley running up from Aberhosan is a renowned roadside viewpoint, near Foel Fadian, with a memorial to the famous and decorated Welsh war correspondent Wynford Vaughan-Thomas. The memorial is not sited here because he had connections with the area, but because he considered the view from here towards Snowdon was the best in Wales.*
LCA M22 - Trannon	*It is characterised by wide expanses of heather and bilberry low vegetation with numerous stream courses – including the sources of the River Severn and River Wye – and exposed rock outcrops and screes in the higher areas. This is an open landscape with exposed wide skies and long distance dramatic views north towards the upland peaks of Cadair Idris and Ceredigion. An extensive wind farm development dominates the central and southern half of the area. To the north is a transitional landscape between the open and exposed moorland of the Trannon Moors and the more domesticated hill slopes mosaic grazing leading into the Dovey Valley. Largely enclosed marginal grazing land with an area of small scale irregular fields associated to the centre of the area. To the SW is an extensive coniferous plantation, predominantly single-species, with little variation in texture or diversity of elements.* • *Topographically and scenically varied and distinctive, comprising bare upland moorland and fertile valleys, the latter containing a variety of field patterns.* • *20th-century wind farm development in the central part of the area at Carno wind farm.* • *In the central area there is mostly a complex mosaic of habitats which includes nationally important upland vegetation types. A wide range of interesting species has been recorded.*
LCA M23 - Carno Valley (part of the proposed offsite access route passes through this area)	*The northern area is a traditional livestock farming landscape with a strongly defined field pattern - managed hedgerow boundaries and small to medium sized field patterns, with some areas of well wooded and overgrown hedgerow boundaries and intermittent broadleaf trees are typical features. Grazing types range from semi-improved grassland to marginal grazing on the upper slopes. It is characterised by a small scale field pattern and rich patchwork vegetation cover of well-defined hedgerow, with hedgerow trees, and small incidental parcels of mixed woodland. To the south is a relatively small area of irregular, well defined small to medium scale field pattern.*

LCA Name	Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) [quoted directly from the Powys Landscape Character Study 2008]
	• *The area forms part of the A470(T) and rail transport corridor and as such is an important thoroughfare and tourist route, attracting development.* • *Generally, settlements tend to be small and clustered. It has a domestic settled feel and a well maintained marginal farming landscape.* • *Includes well developed lobate landforms in probable head deposits in the Esgair Draenllwyn area of potential RIGS status on the extreme western edge of the LCA.* • *Topographically and scenically varied and distinctive, comprising bare upland moorland and fertile valleys, the latter containing a variety of field patterns.*

LANDMAP

4.5.9 LANDMAP is a GIS (Geographical Information System) based landscape resource where landscape characteristics, qualities and influences on the landscape are recorded and evaluated into a nationally consistent data set. LANDMAP separates information into five 'aspect layers' as follows:

- Visual & Sensory: identifies perceptual landscape qualities as well as including information on individual physical attributes of landform and land cover, and the relationships between them;
- Geological Landscape: identifies those landscape qualities which are linked to the control or influence exerted by bedrock, surface processes, landforms and hydrology;
- Landscape Habitats: identifies the characteristics and spatial relationships of habitats and vegetation;
- Historic Landscape: identifies those qualities that depend on key historic land uses, patterns and features; and
- Cultural Landscape: includes information on the relationship between people and places, meaning of places to people, how landscape has shaped peoples actions and how peoples' actions have shaped the landscape.

4.5.10 LANDMAP also includes evaluation scores which are defined as 'Outstanding' (important at an international or national level), 'High' (important at a regional or county level), 'Moderate' (important at a local level), or 'Low' (little or no importance).

4.5.11 This LVIA assesses:

- areas directly affected by any part of the Proposal for Geological Landscape;
- areas directly affected by any part of the Proposal for Landscape Habitats;
- areas directly affected by any part of the Proposal, plus those areas with visibility of turbines up to 5km for Cultural and Historic landscapes (to take into account indirect effects);
- all aspect areas with visibility of the turbines within 10km for Visual & Sensory.

4.5.12 Aspect areas for all aspect layers (Geological Landscape; Visual & Sensory; Landscape Habitats; Historic Landscape and Cultural Landscape) are mapped in **Figures 4.5 -4.9**.

4.5.13 Summary descriptions, evaluations (with justification) and management recommendations and/or guidelines for each aspect area are recorded in **Appendix 4.2**.

4.5.14 15 turbines lie within the Banwy Forest Visual & Sensory Aspect Area, 11 turbines in the Banwy Upland Aspect Area and 4 turbines in the Pen Coed Upland Aspect Area.

Designated Landscapes

4.5.15 The designation of landscapes indicates a recognised value placed by society on a landscape.

4.5.16 The site is not located within an internationally or nationally designated landscape. However, beyond the site, parts of the study area are subject to designation at the national and local level for their landscape quality. **Figure 4.10** shows the location of designated landscapes within the study area and **Table 4.7** sets out the baseline information for these, including their special qualities and reasons for designation.

Table 4.7: Designated landscapes within the study area

Designated Landscape	Description
National Level	
National Park: The statutory purposes of National Parks are to conserve and enhance their natural beauty, wildlife and cultural heritage and to promote opportunities for public understanding and enjoyment of their special qualities.	
Snowdonia National Park	Snowdonia National Park falls within 5.8km of a turbine at its closest point. It is the second largest designated National Park in England and Wales and includes Snowdon, the highest mountain in England and Wales. The Snowdonia National Park Management Plan 2010-15[5] sets out the following special qualities that have been identified as important and distinctive to the area, and which should be safeguarded and enhanced: • "*the diversity of high quality landscapes and coastal areas within a small geographic area - ranging from coast to rolling uplands to the rugged mountains for which Snowdonia is famed;* • *the robust sense of community cohesion, belonging and vibrancy which combine to give a strong 'sense of place';* • *continuing vibrancy of the Welsh language as the primary language in many social and professional environments. This aspect is evident in local place names that reflect the area's cultural heritage;* • *an area which has inspired some of the nation's most notable culture, folklore, art, literature and music, an influence which continues to the present day;* • *the opportunity for people to understand and enjoy the National Park actively, whilst maintaining areas of tranquillity and solitude, thus promoting aspects of health, well-being and personal reflection;* • *extensive opportunities for recreation, leisure and learning for people of all ages and ability;* • *landscapes and townscapes which chart human interaction over centuries, from Neolithic times to the present day. This is evident in archaeological remains, place and field names, oral and written history and present day land management practices;* • *Snowdonia's architectural heritage is reflected in the density of Listed Buildings and the wider historic environment;* • *complex, varied and renowned geology, vital in influencing the disciplines of geology and geography internationally;* • *varied biodiversity reflecting Snowdonia's landscapes, geology, land management practices and climate. Some species and habitats are of national and international significance, for example species which are remnants of the last Ice-Age, providing a glimpse of semi-Arctic habitats. Snowdonia is the most southerly point in the UK for many such species*" (para. 3.1).

[5] http://www.nationalparks.gov.uk/eryri2010/snpa_mp_2010/

Designated Landscape	Description
	Planning Policy Wales[6] states that "*The duty to have regard to National Park and AONB purposes applies to activities affecting these areas, whether those activities lie within or outside the designated areas*" (para 5.3.7). Policy ENV2 of the Powys UDP[7] states "*Proposals for the development and use of land should take account of the high quality of the landscape throughout Powys and be appropriate and sensitive to the character and surrounding landscape. Where appropriate, account will also need to be taken of the special qualities or reasons for designation of the Brecon Beacons and Snowdonia National parks.*" Key Issue 13 of the Powys Local Development Plan (LDP) - Preferred Strategy (March 2012) states "*The landscape of Powys is extremely diverse and includes upland landscapes and valleys that are scenically and historically important. Development which impacts on the landscape must be carefully managed*". Policy B14 of the Gwynedd UDP[8] states "*Development and land use changes will not be permitted where these would adversely affect the qualities and special character of the Snowdonia National Park by: 1.causing significant visual intrusion, and/or 2.being insensitively and unsympathetically sited within the landscape*".
Local Level	
Sensitive Landscape Areas (SLA): SLAs "*have been seen by local authorities as a means of both protecting sensitive landscapes and developing an understanding and awareness of those features and characteristics that give a locality its sense of place*" (para 2.1, Ceredigion County Council Designation of Special Landscape Areas, October 2010).	
North Ceredigion Uplands Special Landscape Area (SLA)	Upland Ceredigion SLA falls within 16km of the site at its nearest point. Primary Landscape Qualities and Features may be summarised, from Ceredigion CC's 'Designation of Special Landscape Areas'[9], as: • A wild, open, expansive upland area focused on Pumlumon, which rises to over 700 metres AOD. • Shows extensive evidence of glacial action and deposition in terms of its landforms and features including an irregular, patterned, upland moorland with 'peaks' and 'knobs' with exposed rocks and areas of scree on side slopes in the north and a more rugged texture to the south. • Around Trisant the area has a more distinctive pattern of ridges and valleys with a mixed pattern of land cover and fields of an irregular field pattern. • The upland edges have a strong sense of place and character being somewhat off the "beaten track" for visitors. A similar pattern to the landscape can be found around Moel Fferm. • Evidence of man's activities over many centuries, from early settlements, agricultural expansion and developments such as the drove roads across the mountains, and extensive evidence of mineral working and processing of mineral ores (a key reason for its inclusion on the ICOMOS/Cadw/CCW register). • Exploitation of natural resources including extensive conifer plantations for timber production, the Nant-Y-Moch hydroelectric scheme in 1962, and development of wind farms.

[6] Planning Policy Wales (Edition 5, November 2012) [http://wales.gov.uk/topics/planning/policy/ppw/?lang=en]
[7] Powys UDP 2001-2106 [http://static.powys.gov.uk/uploads/media/Written_statement_final_web_en_05.pdf]
[8] Gwynedd UDP 2001-2016 [http://www.cartogold.co.uk/gwynedd/text/english/00_contents.html]
[9] Ceredigion County Council (October 2010) Designation of Special Landscape Areas
[http://www.ceredigion.gov.uk/utilities/action/act_download.cfm?mediaid=24003&langtoken=eng]

Designated Landscape	Description
	• Historical features such as Strata Florida Abbey and their associated land holdings – an important contributor and influence on the cultural life of medieval Wales. Key Policy and management Issues are: • *"Management of historic landscape elements.* • *Management of habitats – both in terms of those with statutory protection and increase in variety elsewhere.* • *Consideration of replacement planting for conifer plantations – should they be replaced like for like, with greater variety or not at all?* • *Cumulative effects of wind farm development upon the overall quality and value of the area.* • *Management of grazing patterns and rates to minimise loss of habitats*". Planning Policy Wales[10] states that "*Local planning authorities should apply these designations to areas of substantive conservation value where there is good reason to believe that normal planning policies cannot provide the necessary protection. Such designations should not unduly restrict acceptable development*" (para. 5.3.11). Policy DM18 of Ceredigion's LDP[11] states that "*Proposals for development within Special Landscape Areas (SLAs) will be assessed in relation to scale and nature of development and their ability to be accommodated without significant damage to, and where possible the enhancement of, the valued visual, historic, geological, ecological and cultural characteristics of the SLA.*"

Views and Visual Amenity

4.5.17 In order to define the area of influence of the wind farm, two ZTVs have been produced showing the extent of theoretical visibility of the tips and hubs of the turbines within a 30km radius of the outermost turbines. These are presented in **Figure 4.11** and **Figure 4.12**. The theoretical ZTV is based on a bare ground model and does not take into account screening by buildings and vegetation, but it provides a starting point for identifying broad patterns of visibility, visual receptors that may be affected, and viewpoint selection.

4.5.18 The ZTV indicates that theoretical visibility of the turbines is patchy and largely confined to hill tops and the areas immediately around the site. This includes the south-eastern edges of the Snowdonia National Park at just over 10km.

4.5.19 Potential visual receptors include:

- People in villages along the A470 Corridor and Caersws Basin (including Llanbrynmair, Llan, Dolfach, Talerddig, and Carno).
- People in villages along the A458 corridor (including Llangadfan and Llanerfyl), as well as some more distant villages e.g Llanfihangel-yng Ngwynfa.
- People in other villages in the ZTV such as Llan, Bont and Dolgadfan;
- Travellers on the A470, A458, and the Shrewsbury/Aberystwyth Rail Line.
- Recreational users of local footpaths in the surrounding hills, the Glyndwr's Way National Trail and visitors to Snowdonia National Park.

[10] Planning Policy Wales (Edition 5, November 2012) [http://wales.gov.uk/topics/planning/policy/ppw/?lang=en]
[11] Ceredigion County Council (2013) Ceredigion Local Development Plan 2007 – 2022

Views from Representative Assessment Viewpoints

4.5.20 Representative viewpoints form the basis for the assessment of the potential effect of the proposal on views and visual amenity.

4.5.21 An updated list of 24 assessment viewpoints for this LVIA was agreed in consultation with NRW and PCC (following on from previous consultation with CCW, Powys County Council and Snowdonia National Park as set out in the "History of Viewpoint Selection" as summarised in **Appendix 4.3**). The agreed list is set out below, including reasons for selection and relationship to previous ES/SEI. Viewpoint locations are mapped on **Figures 4.11 and 4.12**:

Table 4.8: Viewpoints for the LVIA

ID	Viewpoint	Grid Reference		Relationship to Previous ES/ SEI	Reason for Selection
VP 1	Glyndwr's Way above Cwmderwen	294933	306080	None – new for this assessment	Representative of views experienced by users of this trail. Provides a view over the site and will illustrate visibility of on-site tracks, turbines and sub-station.
VP 2	Cwmderwen	295734	305343	None – new for this assessment	Representative of views experienced by motorists on the road passing the site. Provides a view over the site and will illustrate visibility of on-site tracks, turbines and sub-station.
VP 3	Minor road above Ffridd Fawr	294763	303064	Track VP 8 in SEI 3	Representative of views experienced motorists on the road (also representative of views experienced by users of the footpath to Ffridd Fawr). Provides a view over the site, including on-site tracks and turbines.
VP 4	Glyndŵr's Way, Cefnllys-uchaf	297436	307411	VP2 ES	Representative of views experienced by users of this trail.
VP 5	Glyndwr's Way/ minor road east of Neinthirion	296642	306946	Track VP 7 in SEI 3	Representative of views experienced by users of this trail – provides a view over the site, including on-site tracks and off-site access track
VP 6	Glyndwr's Way at Moel Ddolwen	298307	307896	New viewpoint in SEI 1	Representative of views experienced by users of this trail – added to SEI 1 at CCW's request
VP 7	Dolfach	291310	301705	Wireframe in SEI 3	Representative of views from people in this village – requested by CCW and PCC.
VP 8	Llanbrynmair Village	289852	302803	VP12 ES	Located within a public park in the centre of Llanbrynmair Village - representative of people in this village.
VP 9	Talerddig	293173	300062	VP4 ES	The viewpoint is representative of people in/passing through this village and motorists travelling on the A470(T).
VP 10	Glyndŵr's	288445	304953	VP1 ES	Representative of views experienced

ID	Viewpoint	Grid Reference		Relationship to Previous ES/ SEI	Reason for Selection
	Way, Brynaere				by users of this trail.
VP 11	Llan Village	288467	300784	VP14 ES	Located in a parking area within the village of Llan - representative of people in this village.
VP 12	A470 north of Carno	295554	297575	VP13 ES	Located to the north of Carno at the entrance to a farm track - representative people passing through the village of Carno.
VP 13	Glyndwr's Way at Penyfford	301807	312533	A nearby VP was included in SEI 1. This exact location is new for this assessment	Representative of views experienced by users of this trail – added to SEI 1 at CCW's request, but location altered in May 2013 at NRW's request.
VP 14	Bryn y Gadair	296223	294102	VP5 ES	Within an area of access land and representative of views experienced by recreational receptors.
VP 15	Wynford Vaughan Thomas Memorial	283587	295946	VP15 ES	Located near the Wynford Vaughan Thomas Memorial adjacent to the minor road between Dylife and Machynlleth (the minor road is part of Route 8 of the National Cycle Network). Representative of recreational receptors visiting the viewpoint.
VP 16	Summit of Foel Dinas, SNP	284404	314412	VP18 ES	Located within a belt of lower hills at to the east of the main mountain massifs of this part of the Snowdonia National Park. Representative of recreational receptors using the access land (included in the original LVIA at the request of CCW).
VP 17	Minor Road near Llanfihangel-yng Ngwynfa	308185	316459	VP6 ES	Representative of views that would be experienced by receptors using the network of minor roads in the vicinity of Llanfihangel-yng Ngwynfa.
VP 18	Bwlch y Groes, SNP	291304	323242	VP7 ES	A viewpoint in a car park within the Snowdonia National Park - representative of recreational receptors.
VP 19	Aran Fawddwy, SNP	286258	322374	VP11 ES	Located at the summit of Aran Fawddwy within Snowdonia National Park - representative of recreational receptors climbing the mountains in this part of the national park.
VP 20	Plynlimon	278976	286945	VP9 ES	Located near the summit of Plynlimon within the County of Ceredigion - representative of views experienced by recreational receptors.
VP 21	Cadair Idris,	271115	313041	VP8 ES	Located near the summit of Cadair

ID	Viewpoint	Grid Reference		Relationship to Previous ES/ SEI	Reason for Selection
	SNP				Idris within the Snowdonia National Park - representative of views experienced by recreational receptors.
VP 22	Kerry Ridgeway, Two Tumps	311818	285139	VP10 ES	Located on the Kerry Ridgeway Recreational Trail - representative of views experienced by recreational receptors using the trail.
VP23	Minor road within Nant yr Eira	299693	307271	None – new for this assessment	Representative of views experienced motorists on this local road through the valley. Provides a view over the site, including on-site tracks and turbines.
VP24	Glyndwr's Way at Pen Coed	298741	308597	None – new for this assessment	Viewpoint included at request of NRW to show Gosen Bridge works. Representative of views experienced by recreational receptors using the footpath.

Views from Settlements

4.5.22 The ZTV indicates that people in the following settlements could theoretically be affected by changes to views:

- Caersws, Carno, Talerddig, Dolfach and Llanbrynmair along the A470 corridor;
- Llangadfan just off the A458 to the north;
- Llan, Bont and Dolgadfan to the south-west;
- Llanfihangel-yng Ngwynfa to the north-east of the site; and
- Little London to the south-east of the site.

4.5.23 These have therefore been taken forward to the assessment. Welshpool, Montgomery, Newtown, Machynlleth, Llanfair Caereinion, Llanidloes, Cemmaes Road, and Llanerfyl lie outside the ZTV for the scheme.

4.5.24 An assessment of effects on residential visual amenity of individual properties within 2.5km of the turbines (to inform judgements on living conditions) is presented in **Appendix 4.1**.

Views from Routes

4.5.25 Main roads tend to follow the principal river valleys, including the Dyfi, Severn, Wye, Banwy, and Vyrnwy. Minor roads traverse the uplands linking adjoining valleys. The principal routes in the study area include the A494, A495, A483, A487, A470(T), and A458(T). The minor road between Llanerfyl and Talerddig borders the site.

4.5.26 The railway line linking Shrewsbury and the Midlands with Aberystwyth also crosses the study area via the valleys of the Severn and Dyfi.

4.5.27 There are also numerous Public Rights of Way within the study area. Of particular note is the Glyndŵr's Way National Trail, which is so named as it passes many sites associated with the 15th century hero Owain Glyndŵr. It begins at Knighton on the English border and meanders through the landscape of mid Wales, entering the study area to the south east of Llanidloes, then heading to the town of Machynlleth and then east to Welshpool. The route was originally established by Powys County Council and has since been upgraded and partially re-routed and re-opened as a National Trail in April 2002.

4.5.28 A very short stretch of Offa's Dyke National Trail is located within the study area, to the south of Welshpool, in the vicinity of the village of Forden.

4.5.29 In addition, three other long distance routes are located within the study area; the Severn Way, the Wye Valley Walk and the Kerry Ridgeway. The Severn Way and Wye Valley Walk follow the routes of these rivers through the southern part of the study area, commencing at their sources on the slopes of Plynlimon. The Kerry Ridgeway is a relatively short route following the ridge that extends eastwards from Kerry Hill, then heading east from the B4355 in Powys (approximately 2.5km to the south of Dolfor) to Bishop's Castle in Shropshire. A short stretch of the Kerry Ridgeway, in the vicinity of Kerry Hill itself is located within the study area.

4.5.30 The ZTV indicates that, assuming no vegetation cover, there will be patchy visibility from some sections of the A470(T) and the railway line linking Shrewsbury and the Midlands with Aberystwyth (particularly within 10km), and patchy visibility from the A458(T). Other main road routes will be beyond 10km and at that distance, and considering motorists attention will be focussed on the road, any change to views from these routes is not anticipated to be significant. Of the main road and rail routes only the railway line, A470(T) and A458(T) are therefore taken forward for further assessment. Most of the route of the minor road between Llanerfyl and Talerddig lies within the ZTV so this is also carried forward for assessment.

4.5.31 The ZTV indicates that, assuming no vegetation cover, there will be visibility of the proposed development from the Glyndŵr's Way National Trail at relatively close proximity – this route is therefore assessed further. The ZTV also indicates theoretical visibility from a short stretch of Offa's Dyke National Trail but at almost 30km change to views from this route is not anticipated to be significant. The Severn Way and Wye Valley Walk are mostly outside the ZTV and at some distance from the proposed development – these other three routes are therefore not taken forward for further assessment.

Future Baseline ('Do Nothing' Scenario)

4.5.32 In the absence of the Llanbrynmair Wind farm it is likely that the land would continue under the same land use. However, even if the Llanbrynmair Wind farm were not to go ahead, it is likely that another wind energy proposal would be proposed in this location due to its location within a TAN 8 Strategic Search Area for large scale (over 25MW) onshore wind developments.

4.5.33 Climate can be viewed as having been a highly influential factor in the development of today's landscapes and it is widely accepted that mainly due to anthropological activities and the burning of fossil fuels, climates are changing. Whilst there appears to be no certainty of what the effects of such climatic changes will be in the future, it is clear that these changes will affect the landscape. These concerns have been recognised in a number of papers in recent years. Natural England's Climate Change Policy states that "Climate change represents the most serious long-term threat to the natural environment" (Ref.6-23, Preface). The policy document states that "*climate change is already occurring*", and stresses the "*urgent need to develop strategies to enable the natural environment to adapt to the impacts of 'locked in' climate change*", i.e. the effects of past activity that are yet to manifest in the climate system.

4.6 Design Evolution and Mitigation

4.6.1 This section sets out design evolution from a landscape and visual perspective. A commentary on the overall design process is provided in **Chapter 3**.

Wind farm

4.6.2 The original design (for the submission of a planning application to Powys County Council in March 2009) comprised forty-three (43) wind turbines and associated electrical transformers, three electrical sub-station and control buildings, a communications mast, a

permanent (80m high) freestanding lattice wind monitoring mast and on-site infrastructure (comprising underground cabling, access tracks and crane hardstandings).

4.6.3 The number of wind turbines was subsequently reduced by nine to 34 in response to landscape and visual concerns and ornithology constraints as follows:

- Turbines R10-R11 were removed to avoid curlew habitat;
- Turbines R20-R22 and R33-R34 were removed for the benefit of hen harrier and black grouse; and
- Turbines R29-R30 were removed for visual reasons.

4.6.4 On-site access tracks were amended following the removal of the nine turbines reducing the total running length from 29.7km to approximately 28.5km.

4.6.5 Following submission of the 2011 SEI turbines R1, R2, R3, and R28 were removed in response to landscape and visual concerns raised by CCW and PCC, resulting in a 30 turbine scheme. The on-site access tracks were also amended following the removal of the four turbines and the total running length of on-site access tracks reduced at that stage to approximately 27.7km.

4.6.6 In addition, the access track leading to Turbine R18 was relocated due to the concerns raised by CCW on the impact to peat habitats close to the Afon Garn, and the turning head between Turbines R7 and R8 was altered (due to CCW's concerns about impact on flush and raised bog habitats). Tracks are now approximately 25.3km in length.

4.6.7 CCW raised concerns about the potential significant impacts of the substations from a visual perspective in April 2012 (in particular impact on Glyndwr's Way and other recreational routes). In particular, CCW identified the central sub-station (which SEI2 showed as being located near the summit of Eithin-llwyn near the route of Glyndwr's Way) as being of particular concern due to the potential impacts on Glyndwr's Way and indicated that an alternative location should be sought on lower slopes to the east of the location proposed in SEI2, if Glyndwr's Way were to be re-routed along the existing bridleway that leads from Eithin-llwyn to Neinthirion. RES contacted Powys CC Countryside Services who considered that the proposed re-routing was, in principle, feasible.

4.6.8 Two areas of search were identified by SKM Enviros. CCW considered that the location proposed within an area of improved grassland opposite a proposed construction compound near Dolau-ceimion offered scope for mitigation. It was agreed that the northern and southern substations would serve no electrical purpose (although each would provide health and safety and welfare facilities for staff working on-site).

4.6.9 In winter 2012/2013 the substation was relocated adjacent to the proposed Carnedd Wen substation and next to an area of woodland. It is proposed that the substation will be cut into the slope and landform has been modelled to hide as much of the development as possible while also blending seamlessly into the natural contours of the hillside (see **Figure 3.26** and visualisations from viewpoints 1 and 2). These indicate that from viewpoint 1 just the roof, and possibly a small part of the façade, of the control building will be visible and from viewpoint 2 the southerly end of the substation control building and some of the external fencing will be visible adjacent to an area of conifer forestry. All electrical components will be hidden in both views.

4.6.10 A local slate roof will ensure that the building fits with its local environment. In addition, an area of shrub/tree planting to match the deciduous edge in front of the conifer plantation will help screen the control building walls and fencing.

4.6.11 The edges of tracks, particularly in peaty areas, will be reinstated using turf that is removed prior to construction and stored appropriately. This action will allow the construction areas to revegetate to match the surrounding habitat quickly and thereby reduce visual effects of the construction.

4.6.12 Reserved topsoil stripped from other construction areas will be used to reinstate disturbed areas on completion of the construction phase.

4.6.13 Construction of the Proposal would involve felling areas of conifer plantation within the site boundary in order to make room for turbines and infrastructure. Felling will follow best practice in forest design in order that remaining areas of plantation fit with the surrounding landscape. This will include felling and thinning of forest coupes and/or forest edges to create more open areas. The overall quality of the blanket bog habitat will be improved (including restoration of currently afforested areas to blanket bog) and any loss or degradation of habitats due to the development offset, as set out in the Habitat Management Plan (Appendix 5.2). There will also be planting of native woodland along river edges.

Offsite Highway Works

4.6.14 SEI4 originally detailed that construction traffic would travel to and from the site via the A458 at Llanerfyl. This routeing meant that the construction traffic and the Abnormal Indivisible Load (AIL) traffic used the same route which ran through existing settlement at Llanerfyl. Further to the comments made in the September 2012 Cabinet Report produced by PCC an iterative approach of review and assessment has been undertaken including detailed discussions with the Welsh Government, PCC and NRW. Following the further work and taking account of the further consultation, the decision was made to route HGVs, Cars and Vans associated with construction via the A470 westbound and turning right onto the Talerddig to Llanerfyl road to Accesses 4 to 1 and to route AIL deliveries via the A458 turning left onto the Llanerfyl to Talerddig road to Accesses 1 to 4 (due to existing gradients in the vicinity of Talerddig being unsuitable for AILs). This solution results in fewer interventions on the road. The access route is shown on **Figure 3.24** and details of the proposals are shown in Appendix 10.1.

4.6.15 Refinements have been made to the design of works along these routes to mitigate or limit landscape and visual effects and to introduce features to assimilate the road into the landscape. This has included:

- minimising loss of landscape features as far as possible (particularly mature trees, hedge banks and hedgerows);
- using grass reinforcement surfacing for road widening and laybys (a compacted unbound sub-base with an interlocking geogrid surfacing infilled with topsoil, salvaged from excavation where possible, and local grass seed) to minimise impact on the character of the road;
- making sure earthworks are as subtle as possible, feathered into the existing landform and seeded with local grass seed to ensure they blend seamlessly with the surrounding landscape – landforms will be agreed on site with a technical banksman;
- using open ditches rather than culverts where possible;
- ensuring any signage is temporary;
- maintaining ground flora by re-using soil to ensure the same groundcover reinstates in its new position;
- using root balled extra heavy standards for all replacement trees (to be 14-16cm girth and around 4m tall) so they make an immediate contribution to landscape character;
- using species typical of the immediately surrounding area e.g. Section 1 and more enclosed lower lying western section of section 3 to be oak; the eastern part of section 3 and section 2 in more exposed locations to be rowan or hawthorn;
- translocating particularly valuable or species rich historic hedges (e.g. the hawthorn/hazel hedges at Ch4120-4200, Ch5175-5315, Ch700=7780 and including allowance for replanting if any of the plants fail);
- ensuring that any replacement hedges are species rich to match, or enrich, existing hedges;

- using wooden gates over metal where possible and avoiding urbanising features such as black and white posts along ditches;
- replacing any coppice lost with the same species mix (e.g. at Ch 3000 and 3400) and hazel on the approach to the Dolwen Isaf Bridge;
- using stone facing on new retaining structures to blend them into their rural setting e.g. at Gosen Bridge;
- replacing the crushed stone finish of the Gosen Access track with grass reinforcement and local seed topsoil infill during the operational period to blend it into its surroundings;
- surfacing the Neinthirion bypass track with a reinforced grass surface to blend it into its surroundings;
- strengthening lines of trees in the area between Glyndwr's Way and the Neinthirion bypass track to help filter views of this new route;
- replacing tarmac surfaces with a sprayed tar and chip surface at site entrances in the post construction phase to make them blend into their rural surroundings;
- improving the condition of features e.g. through reinstatement of poor quality hedge banks and introducing management that reflects local character (e.g. coppicing and laying hedges where appropriate and trimming using the traditional Powys rounded form to shed snow more effectively);
- replacing all vegetation lost ensuring the same placement of features e.g. hedgerows at the top or bottom of embankments) to maintain the character of the road in the longer term using plants of sufficient size to minimise the time taken to restore character;
- reconstructing any hedge banks (clawdd or cloddiau[12]) affected using the North Wales branch of the Dry Stone Wall Association's guidance notes[13] to ensure appropriate construction and successful establishment.

4.6.16 Different bridge designs were considered at Gosen Bridge (a masonry faced arch bridge and a masonry faced beam bridge). Since the bridge arch will not be seen from the road or from the public footpaths to the north, either design was considered to be suitable in terms of visual amenity and the beam bridge was favoured for engineering reasons.

4.7 Potential Effects

4.7.1 The assessment of effects is based upon the project description outlined in **Chapter 3: Description of the Project** and is structured as follows:

- construction effects;
- operational effects;
- decommissioning effects;
- cumulative effects.

Construction Effects

Sources of Effects during Construction

4.7.2 During construction, there will be potential short term landscape and visual effects arising from the presence of activities on the site including:

[12] Clawdd or cloddiau are traditional Welsh stone-lined earth banks which over time green up to hide the stones, and often have hedges planted on top.
[13] Dry Stone Walling Association North Wales Branch (2012) Clawdd Construction

- localised clearance of vegetation to make way for the borrow pits, temporary batching plant, temporary storage compounds, substation, turbine bases, and tracks (5m wide plus 1m shoulder on each side and local widening on bends);
- excavation of borrow pits;
- cable trench working corridors parallel to the tracks;
- machinery and material storage, mostly focussed in the construction compound;
- plant movements in and around the site;
- excavation for the foundations and cable trenches;
- in-situ concrete works for buried foundations;
- cranes used in the erection of the turbine; and
- construction of the substation.

4.7.3 In addition, there will be potential short term landscape and visual effects arising from the construction works associated with the upgrades to the offsite access routes between Llanerfyl and Talerddig, and the presence of construction traffic using the access routes.

4.7.4 The construction of the wind farm will take approximately 24 months (see **Appendix 3.3** for a construction programme).

4.7.5 The works along the offsite access road will take 18 months with phasing as follows:

- A458 and A470 junction improvements – Months 1 to 3;
- Section 3 Works – Construction of Passing Bays and Construction Traffic Enabling works – Months 1 to 3;
- Section 2A Works Between Access 4 and Access 2 – Construction of Passing Bays, Laying of Grass Reinforcement, Culverts and Structures – Months 4 to 7;
- Section 2B Works between Access 2 and Access 1 – Construction of Passing Bays, Laying of Grass Reinforcement, Structures and Neinthirion Bypass – Months 7 to 11;
- Section 1A Works between Access 1 and Gosen Bridge – Construction of AIL widening, grass reinforcement, structural works to bridges and Gosen Bridge – Months 11 to 15
- Section 1B Works between Gosen Bridge and Diosg – Construction of areas of AIL widening, grass reinforcement and bridge works at Diosg and Glen Menial – Months 16 to 18.

Predicted Construction Effects on the Landscape

4.7.6 Construction of the turbine foundations, crane hardstanding areas, tracks and substation foundations will inevitably result in a large change in site character. In addition, the construction activity and movement of personnel and machinery will add to the activity in and around this area. These effects will be of high magnitude and are judged to be of **major** significance but will be temporary and localised.

4.7.7 Works to the offsite access route will inevitably result in effects on landscape features along the route, such as hedgerows and trees, which will affect the character of the road in the short term. Areas of particular note are Gosen bridge, Glen Menial bridge, Dolwen Isaf bridge, Neinthirion and the road widening/laybys between Llanerfyl and the northern site access. These effects will be of high magnitude and are judged to be of **major** significance but will be temporary (3-5 years) and localised.

4.7.8 In terms of wider landscape character section 1 of the route (between Llanerfyl and the northernmost site access) and section 2 between the northernmost and southernmost site accesses is located in the LANDMAP Visual and Sensory aspect area MNTGMVS422 Llanerfyl Mosaic Farmlands (Powys LCA Tregynon/Llanerfyl). Section 3 of the route starts off at Talerddig in LANDMAP area MNTGMVS696 Carno Grazing (Powys LCA Carno Valley) before

climbing up over the LANDMAP area MNTGMVS264 Banwy Upland (Powys LCA Dyfnant Forest/Llanbrynmair Moors) and back into the MNTGMVS422 Llanerfyl Mosaic Farmlands (Powys LCA Tregynon/Llanerfyl) just after Ffridd Fawr. There will inevitably some effects on the character of the road, particularly in section 1, but these will be short term, until replacement vegetation has established (i.e. 3-5 years). These effects will be localised, largely confined to the road corridor itself, and the proposed mitigation will ensure that there are not likely to be long term adverse effects on the wider character of the Llanerfyl Mosaic Farmlands, Carno Valley or the Banwy Uplands of the Dyfnant Forest/Llanbrynmair Moors.

Predicted Construction Effects on Views

4.7.9 Predicted effects of wind farm construction activities on views are considered in the tables in the section on Operational Effects [NB levels of effect at construction and operation are judged to be the same because the erection of the turbines will be as prominent in views as the operational turbines]. Erection of the turbines will take approximately 8 months.

4.7.10 The following bullet point list presents a summary of potential visual effects during construction, drawing on information from these tables alongside field survey:

- Residents of Llan (high sensitivity) will see cranes constructing up to 11 turbines on the skyline, along the village street resulting in a medium magnitude of change and a **moderate** short term effect.
- Residents of Dolfach (high sensitivity) will not see any construction works.
- Residents of Talerddig (high sensitivity) may just see glimpses of the turbines being erected on the skyline but any change in views will of low magnitude and the effect will be **minor**.
- Most residents of Carno (high sensitivity) are unlikely to see construction of turbines due to the presence of buildings and vegetation – however there may be some views from open areas such as playing fields and side roads, but these will form a small component of any views, resulting in a low magnitude of change at most. Although sensitivity is high, the magnitude of change and distance from the Proposal means that the effect on views is judged to be **minor**.
- Residents of the small hamlet of Little London (high sensitivity) will see the erection of up to 10 turbines on the skyline, but these will be 17km away and at this distance any change to views will be low magnitude at most. Although sensitivity is high, the magnitude of change and distance from the Proposal means that the effect on views is judged to be **minor**.
- Travellers on the A470 between Carno and Talerddig and west of Llanbrynmair (low sensitivity) will see turbines being constructed against the skyline between about 2 and 6km, resulting in a medium magnitude of change and a **moderate** effect on these localised stretches.
- Travellers on the A458 (low sensitivity) will see the tops of cranes erecting turbines on the skyline from short sections around Llangadfan and about 4km west of Llangadfan resulting in a low magnitude of change and a **minor** change to views.
- Travellers on shorts sections of the Shrewsbury/Aberystwyth Rail Line (between Carno and Talerddig), (low sensitivity), will see the top of cranes erecting some of the turbines where gaps in vegetation allow resulting in a low magnitude of change and a **minor** effect on views from this localised stretch of the line.
- Recreational users on the Glyndwr's Way National Trail between Moel Ddolwen and Brynaere (high sensitivity) will see constriction of the wind farm (including turbines, tracks, ancillary components and offsite access works including the Neinthirion bypass) resulting in a high magnitude of change and a **major** effect on views during construction.

- Visitors to the belt of lower hills to the east of the main mountain massifs in the Snowdonia National Park (e.g. the summit of Foel Dinas), (high sensitivity), will see turbines being constructed on the distant skyline resulting in alow magnitude of change to views. Although sensitivity is high, the magnitude of change and distance from the Proposal means that the effect on views is judged to be **minor**. There will be a negligible effect on views from further inside the National Park.

4.7.11 Other receptors (e.g. people in the villages of Llanbrynmair, Dolfach, Caersws, Bont Dolgadfan, Llangadfan, Llanfihangel-yng Ngwynfa) will experience negligible or no effects.

4.7.12 Predicted effects of road upgrades associated with the offsite access routes and presence of construction traffic during the construction period will affect a number of additional receptors including:

Section 1:

- Residents around the junction in Llanerfyl (high sensitivity), who will see the construction activities associated with the creation of the Llanerfyl access and occassional AIL loads (medium magnitude) resulting in a **moderate** temporary effect;
- Receptors at the school just south of Llanerfyl (medium sensitivity) who will experience short term visual effect as a result of the construction of a passing place opposite the school and occassional AIL loads (low magnitude) resulting in a **minor** temporary effect;
- A few properties (less than 5) in Diosg (Ch 875-950, high sensitivity) who will experience short term visual effect as a result of online widening works including realignment of the hedge outside one property, widening of the Diosg Bridge and occassional AIL loads (high magnitude) resulting in a **major** temporary effect;
- Three properties on the approach to, and at, Gosen Bridge (Ch4350-4550, high sensitivity) who will experience views of the road widening and bridge widening works and AIL traffic on the road for short periods during delivery of the turbines (high magnitude) resulting in a **major** temporary effect;
- Residents at Sychtyn Farm (high sensitivity) who will see road widening and AIL traffic on the road for short periods during delivery of the turbines (medium magnitude) resulting in a **moderate** temporary effect;
- Road users between Llanerfyl and site entrance 1 (medium sensitivity) who will see the road upgrades being constructed and AIL traffic on the road for short periods during delivery of the turbines (high magnitude) resulting in a **major** temporary effect;

Section 2:

- 3-4 Properties in Neinthirion (high sensitivity) who will see construction of the new bypass from backs of properties (there may also be filtered views of construction traffic and AILs during the construction period, medium magnitude) resulting in a **moderate** temporary effect;
- 2 properties at Cwmderwen (high sensitivity) who will see the road upgrades being constructed and both construction traffic and AILs during the construction period (low magnitude) resulting in a **minor** temporary effect;
- Walkers on the Glyndwr's Way National Trail (high sensitivity) between Dolwen and Site Access 3 who will see the road upgrades being constructed and both construction traffic and AILs during the construction period (high magnitude) resulting in a **major** temporary effect;
- Road users between the northern and southern site access (medium sensitivity) who will see the road upgrades being constructed and both construction traffic and AILs during the construction period (high magnitude) resulting in a **major** temporary effect;

Section 3:

- A property at Nant-yr-esgair-wen Farm (Ch14700, high sensitivity) who will see the resurfacing works to the area outside their gate, as well as HGVs, cars and vans

associated with construction using the resurfaced layby (medium magnitude) resulting in a **moderate** temporary effect;

- The roadside property at Pantglas Farm (Ch16450-16500, high sensitivity) who will see HGVs, cars and vans associated with construction using the existing layby (low magnitude) resulting in a **minor** temporary effect;
- A couple of residents in Talerddig (high sensitivity) who will see filtered views of the upgrading of the junction in Talerddig and delivery vehicles during the construction of the wind farm (low magnitude) resulting in a **minor** temporary effect;
- Road users between Talerddig and the southern site entrance (medium sensitivity) who will see the road upgrades being constructed and HGVs, cars and vans associated with construction of the wind farm (medium magnitude) resulting in a **moderate** temporary effect.

4.7.13 These effects will be short-lived (i.e. during the 24 month construction period).

Mitigation of Effects arising during Construction

4.7.14 Mitigation measures have already been designed into the scheme. In addition, a Construction Method Statement (CMS) and a Construction Environmental Management Plan (CEMP) will be conditioned and submitted post-planning. In order to minimise effects arising from construction, specific measures will include:

- Maintenance of tidy and contained working area, and control of mud etc. upon local roads;
- Spreading of topsoil and re-vegetating disturbed areas as soon as possible; and
- Limiting movement of vehicles outside specified routes, thus avoiding soil compaction from vehicles tracking over undisturbed areas.

Residual Effects

4.7.15 The implementation of these mitigation measures will help to minimise adverse effects locally. However, the significance of effects arising from construction will remain as set out in the section above.

Operational Effects

Sources of Effects during Operation

4.7.16 The main potential effects of the wind farm on landscape and visual amenity once it is built will be as a result of the:

- presence of 30 turbines 126.5m maximum height with a maximum rotor diameter of 93m for 25 years (transformers to be located by the base of each turbine);
- presence of an anemometer mast of lattice design, 80m high, present for 25 years;
- tracks finished in crushed stone and an average of 5.5m wide leading to each turbine;
- a control building/ substation on a 60m x 60m level platform;
- permanent borrow pit faces;
- three upgraded site entrances; and
- new and improved areas of blanket bog habitat and native woodland along river edges.

4.7.17 In addition, the upgrades to the Llanerfyl to Talerddig access road will persist into the operational phase, although effects will reduce as newly planted vegetation matures.

Predicted Effects on the Landscape during Operation

Character Map for Wales

4.7.18 Effects on the character of regional character areas within 30km of the Llanbrynmair Wind farm assessed in **Table 4.9** below.

Table 4.9: Effects on Regional Character Areas

RCA Name	Nature of the Receptor & Judgement on Sensitivity [*Key Characteristics interpreted from the Landscape Character Map for Wales Report*]	Nature of the Effect & Judgement on Significance
Cambrian Mountains (the proposed development lies in this RCA)	The Cambrian Mountains is a belt of wild and relatively remote moorland landscape orientated in a northeast southwest direction. This landscape is characterised by landform of extensive undulating plateau and incised valleys. Its upland landscape is large in scale and includes high summits such as Pumlumon. Such elevated summits provide extensive panoramic views across and beyond this LCA. Glacial features are evident throughout in the form of U-shaped valleys, corries, tarns and moraines. The Cambrian Mountains to the north provide a transition to the upland moorland landscape of LCA 16 Y Berwyn. Sheep grazed open moorland landcover predominates this LCA with some bracken scrub, wind blown oaks, coniferous forest plantations and upland blanket bog. The valley edges of this LCA give way to pastoral fields bound by hedges and woodland. Man-made reservoirs and dams are located within valleys. There is a dense pattern of historic features and elements throughout in the form of funerary and ritual monuments. **High sensitivity** due to the distinctive skylines and sense of remoteness that is typical of much of the RCA.	There will be a direct effect on part of the Cambrian Mountains RCA. The wind farm will introduce large turbines, tracks, borrow pits and a substation into part of this area resulting in a high magnitude of change in this localised area. Effects on the perceptual character of the landscape will occur immediately surrounding the site but will substantially reduce with distance. The key characteristics of the RCA (including the extensive undulating plateau, incised valleys, extensive panoramic views and glacial features) will remain. It is predicted that the operational wind farm will result in a high magnitude of change to the character of the site (within the red line boundary) changing the site from open grassland/forestry to open grassland/forestry with a wind farm generating energy. This is judged to result in a **major** effect on the site itself within the red line boundary. This effect on landscape character will extend beyond the boundary of the site and will have a characterising influence up to about 3km (on areas with the ZTV as shown in **Figure 4.3**). However, the characterising influence will decline with distance and overall the effect on the Cambrian Mountains RCA is judged to be **negligible** taking account of the geographic extent of the characterising effect. **Long-term**
Berwyn	Berwyn forms an extensive area of upland moorland in North Wales, centred on the elevated slate/shale spine of mountains, with the highest point (827m AOD) being found at Cadair Berwyn. It is characterised by extensive areas of upland moorland that is recognised as being of significant interest for moorland breeding bird species. Large scale upland forest is also apparent. The uplands are dissected by	The Proposal will not be located within this RCA. However, the ZTV (Figure 4.3) illustrates that there will be intervisibility with the Proposal, particularly between 5 and 10km (see VP13), which will affect views from the south-western tip of the Berwyn RCA. However, this is not considered to have a characterising effect and the

RCA Name	Nature of the Receptor & Judgement on Sensitivity [*Key Characteristics interpreted from the Landscape Character Map for Wales Report*]	Nature of the Effect & Judgement on Significance
	valleys and waterfalls to the north west of Llanrhaeadr-ym-Mochnant (relating to an area of localised geological variation including Ordovician volcanic/tuff rock) are a distinctive hydrological feature. Key elements of the cultural landscape include prehistoric ritual and funerary monuments such as Cairns and round barrows and there is evidence of prehistoric and medieval occupation both in the uplands and in the Tanat Valley. Much of Berwyn has a remote and unsettled character, with the few areas of settlement formed by compact linear valley villages such as Llangynog, served by a network of winding 'B' Roads. The plantation surrounded reservoir at Lake Vyrnwy is a notable feature, providing localised variation in what is predominantly an open and elevated moorland landscape. **High sensitivity** due to the distinctive skylines and relative sense of remoteness that is typical of much of the RCA.	key characteristics referred to opposite will be retained. There will be an imperceptible magnitude of change to the character of the RCA. Although this area has a high sensitivity, the imperceptible magnitude of change means the effect on this RCA as a whole is judged to be **negligible**.
Montgomeryshire Hills & Vales (part of the proposed offsite access route passes through this RCA)	Montgomeryshire Hills and Vales is an undulating landscape of distinctly undulating ridges and valleys which are aligned broadly east-west, including a number of large rivers, such as the lower Tanat and much of the Vyrnwy. Ridges and scarp slopes create sinuous, curved skylines. The highest points, in excess of 350m AOD, are found in the ridges to the north western part of the character area, adjoining Berwyn. Landcover is predominantly pastoral agriculture and a network of hedgerows with trees defines the field boundaries, interspersed with blocks of deciduous woodland - steep sided valleys are typically wooded. Principal historic features include moated sites and settlements from the Roman and medieval periods, in addition to a number of registered historic parklands e.g. Llangedwyn and Bodfach. Settlement is confined to isolated farmsteads and compact nucleated valley villages associated primarily with historic river crossing points. A network of 'A' roads follows the valley floors. **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity – including the rural nature of the landscape and distinctive skyline features (indicating higher sensitivity), but presence of human activity and development	Part of the proposed offsite access route passes through this RCA between Llanerfyl and Diosg which will result in some localised change to the character of the road. However, the character of the RCA as a whole will remain unchanged. The ZTV (Figure 4.3) illustrates that there will be intervisibility with the Proposal, particularly between 5 and 10km (see VP13 and 17), which will affect views from the western edge of this RCA. However, this is not considered to have a characterising effect and the key characteristics referred to opposite will be retained, resulting in an imperceptible magnitude of change to the character of the RCA. Taking account of the medium sensitivity of the area and the imperceptible magnitude of change, the effect on this RCA as a whole is judged to be **negligible**.

RCA Name	Nature of the Receptor & Judgement on Sensitivity [*Key Characteristics interpreted from the Landscape Character Map for Wales Report*]	Nature of the Effect & Judgement on Significance
	(indicating lower sensitivity).	
Snowdonia	Snowdonia forms a vast upland massif in north west Wales, being largely contiguous with the boundary of the National Park. This is a landscape of great perceptual variation and spatial experience with angular mountain ranges contrasting with hills softened by moorland heather and plantations, and often juxtaposed with deeply dissected valleys. Slates and shales underlie much of the central part of the area, with volcanic outcrops (lava and tuff) and igneous intrusions creating the extensively faulted mountain ranges, often with angular skylines, which include Snowdon (1085m AOD) and Cadair Idris. A mountainous topography with the principal mountain range orientated broadly north east to south west. U shaped glacial valleys are distinctive. Landcover includes hill sheep grazing, forestry, heather dominated moorland and upland grassland. Rock outcrops and slate/shale ridges are frequently apparent. The areas of upland moorland and blanket bog are of significant ecological interest and hydrological elements include river valleys such as the Dysinni, the Llugwy River and waterfalls at Betws-y- Coed, the source of the River Conwy, and lakes including the largest natural lake in Wales at Bala (Llyn Tegid). Prehistoric ritual and funerary sites including cairns, standing stones and stone circles are strategically located along hill crests, mountains and ridges, forming a strong visual feature. The exploitation of minerals has left industrial archaeological remains in the landscape. The few areas of settlement are primarily defined by small towns e.g. Dolgellau and compact valley villages in slate and stone e.g. at Beddgelert and Betws-y-Coed. **High sensitivity** due to the distinctive skylines, remote character and high scenic quality, recognised through national level designation.	The Proposal will not be located within this RCA. Although there will be views of the turbines from this area (particularly from higher hills, see VP16, 18, 19 and 21), the turbines will be mostly over 10km away and will not affect the key characteristics of the landscape, resulting in an imperceptible magnitude of change to the character of the RCA. Although this area has a high sensitivity, the imperceptible magnitude of change means the effect on this RCA as a whole is judged to be **negligible**.
Severn Valley	The Severn Valley is a broad well defined river valley, with the source of the river occurring in the Cambrian Mountains. It is a broad and well defined vale with a sense of containment created by wooded valley sides. The character area includes the confluence of a number of rivers and minor streams which drain the valley sides are a	The Proposal will not be located within this RCA. There will only theoretically be views of turbines from a small area south-west of Caersws, over 10km away. The presence of the turbines will not affect the key characteristics of the landscape. There will be an imperceptible magnitude of change to the characteristics of the Severn

RCA Name	Nature of the Receptor & Judgement on Sensitivity [*Key Characteristics interpreted from the Landscape Character Map for Wales Report*]	Nature of the Effect & Judgement on Significance
	distinctive hydrological feature. Landcover is predominantly lowland pastoral farmland and wetland rush pasture associated with the course of the Severn and occasionally interspersed with broadleaf and wet woodland. Historic and cultural elements include prehistoric encampments, parts of Offa's Dyke, the Roman fort at Caersws and a number of castles which indicate the strategic importance of the Vale, e.g. Montgomery and Dolforwyn. Settlement pattern relates to this strategic importance with nucleated valley floor settlements having grown up around former military sites, e.g. Caersws. The planned medieval/walled town of Montgomery on the foothills below the castle is significant. Other settlement e.g. Newtown relates to the industrial significance of the valley and associated transport developments such as the Shropshire Union Canal and the railway. Parts of the vale have a tranquil and pastoral character, although this is often interrupted by the influence of large valley floor settlements such as Newtown and Welshpool. **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity – including large scale and presence of human influence (indicating lower sensitivity), but areas of highly rural character and historic skyline features (indicating higher sensitivity).	Valley. Taking account of the medium sensitivity of the area and the imperceptible magnitude of change, the effect on this RCA is judged to be **negligible.**
Radnorshire Hills	Radnorshire Hills is an undulating upland landscape in mid Wales which is dissected by a series of minor river valleys. Topography is in excess of 350m AOD to many of the ridges, with a high point of 660m AOD at Radnor Forest. It is predominantly characterised by pastoral landcover, including hill sheep farmland and lowland pasture, although heather dominated moorland is apparent in the most elevated parts of the character area. A network of geometric fields of small to large scale, defined by mixed native hedgerows interspersed with broadleaf woodland and extensive blocks of coniferous forestry. Cultural pattern is represented by the presence of prehistoric ritual and funerary monuments such as round barrows and standing stones at elevated points. Offa's Dyke illustrates the historic strategic importance of this	Although there will be views of the turbines from the upper hillsides (see VP22, Kerry Ridgeway), the turbines will be over 15km away and will not affect the key characteristics of the landscape. There will be an imperceptible magnitude of change to the characteristics of the Radnorshire Hills. Taking account of the medium sensitivity of the area and the imperceptible magnitude of change, the effect on this RCA is judged to be **negligible.**

RCA Name	Nature of the Receptor & Judgement on Sensitivity [*Key Characteristics interpreted from the Landscape Character Map for Wales Report*]	Nature of the Effect & Judgement on Significance
	marchland landscape. Other historic elements include remnants of medieval and post medieval settlement, including motte and bailey castles, earthworks and moated sites. Settlement pattern is defined by compact linear villages in the river valleys, together with a small number of larger nucleated valley towns at river crossing points. Wind turbines are a feature of the uplands in the north western part of the character area. **Medium sensitivity** due to the mix of attributes indicating higher and lower sensitivity – including smaller scale areas and prominent skylines with cultural/historic monuments (indicating higher sensitivity) and presence of some large scale areas and existing human influence and activity (indicating lower sensitivity).	

Powys Landscape Character Assessment

4.7.19 Effects on the character of the Powys landscape character areas within 10km of the Llanbrynmair Wind farm are assessed in **Table 4.10** below.

Table 4.10: Effects on Powys Landscape Character Areas

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
LCA 5 - Dyfnant Forest/Llanbrynmair Moors (the proposed development lies within this area)	*1.1 There are limited views within and out of the area due to dense forestry planting, which gives rise to an enclosed, dark and oppressive character within the area, in stark contrast with surrounding open upland areas that are predominantly rough grazing. The coniferous afforestation blankets the subtleties of the underlying landform and produces intrusive conifer fringes and harsh plantation edges into an otherwise open expanse of upland moorland.* • *Although there are many parts of this area which have very large blocks of coniferous woodland, the semi-natural vegetation and the small fields which intersperse the forests enhance the local*	There will be a direct effect on the south-eastern part of LCA 5 (see **Figure 4.4**). The wind farm will introduce large turbines, tracks, borrow pits and a substation into part of this area resulting in a large change to the character of the site. Effects on the perceptual character of the landscape will occur immediately surrounding the site, reducing with distance from the turbines. It is predicted that the operational wind farm will result in a high magnitude of change to the character of the site (within the red line boundary) changing the site from open grassland/forestry to open grassland/forestry with a wind farm generating energy. Taking account of the medium sensitivity of this LCA and high magnitude of change this is judged to result in a **major** effect on the site itself within the red line boundary. This effect on landscape character will

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	biodiversity. • *There is a wide range of BAP species and other significant species recorded within this large area, with a good range of important upland communities.* **Medium sensitivity** – due to the presence of prominent skylines and sense of remoteness, but large scale landscape with influence of human activity (coniferous forestry).	extend beyond the boundary of the site and will have a characterising influence up to about 3km (on areas with the ZTV as shown in **Figure 4.4**). Magnitude of change will be medium in these areas. Taking account of the medium sensitivity of this LCA and medium magnitude of change up to about 3km from the site, this is judged to result in a **moderate** effect on this localised area up to approximately 3km from the turbines. There will be no significant effect beyond this. **Long-term**
LCA M1 - Berwyn Mountains	*1.2 The aspect is very strongly linked visually to Snowdonia with the moorland plateau taking on the characteristic of upland peak hinterland. There is a strong sense of exposure with wide open skies dominant. Land cover is heather/ bilberry and rough grazing with bracken growth to lower plateau sides. Some upland lakes are evident with a number of large boggy areas in lower lying and poorly drained areas. There are some extensive high quality long distance views out towards the Snowdonia mountains, and within the area. However, some internal views are degraded in places by the broad expanses of upland coniferous plantation that sit at odds with the overall open moorland character of the area.* • *Close links to the landscape of the adjacent Snowdonia National Park. There are some extensive high quality long distance views out towards the Snowdonia mountains, and within the area.* • *Very large expanse of internationally important wildlife habitats, especially for upland breeding birds, including areas of the Berwyn National Nature Reserve - Special Protection Area for rare, vulnerable*	Only a small part of this LCA falls within 10km of the Proposal. Although the ZTV (Figure 4.4) illustrates that there will be intervisibility with the Proposal between 8 and 10km, which will affect views from the southern tip of the Berwyn Mountains LCA, this is not considered to have a characterising effect on the area and the key characteristics referred to opposite will be retained, resulting in an imperceptible magnitude of change to the character of the LCA as a whole. Although this area has a high sensitivity, the imperceptible magnitude of change means the effect on this LCA as a whole is judged to be **negligible**.

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	and migratory birds and SSSI. • *The upper parts of the western section of the Tanat Valley Registered Landscape of Outstanding Historic Interest in Wales include the higher ground of the upper valley slopes and moorland tops above Cwm Rhiwarth, Cwm Pennant and the summit and southern flanks of Cadair Berwyn. Whilst the landscape of much of the valley is the result of medieval and post-medieval agriculture, the upper reaches of the valley around Llangynog bear the marks of an industrial past. The main period of exploitation was from the 16th century to modern times, with the remains of mining still evident in readily identifiable ruined buildings, tramways, levels, inclines, filter beds and spoil tips - and the former railway, closed in 1960.* **High sensitivity** due to the distinctive skylines of 'upland peaks' and relative sense of remoteness that is typical of much of the LCA.	
LCA M7 - Pont Llogel	*1.3 Characterised by a strongly defined field pattern that follows the underlying topography, with small-scale, irregular field parcels spreading over a succession of rolling ridges. Locally, hilltop grouped trees and marshy damp grazing is common. Wooded areas congregate around watercourses and follow small scale valleys to the edges of the area. There is a domestic, settled character with traditional land management techniques, such as hedge laying and coppiced woodland areas. To the north is a clearly defined area of upland grazing with a varied field pattern - small scale well-defined field parcels in lower lying areas and open, weakly defined larger fields at higher levels. Land use is predominantly livestock grazing with some small to medium sized blocks of forestry plantation. Vegetation comprises largely of the mixed tree and overgrown hedgerow*	Part of this LCA falls between 5 and 10km of the Proposal. Although the ZTV (Figure 4.4) illustrates that there will be intervisibility with the Proposal between 5 and 10km, which will affect views from the south-western edge of this LCA, this is not considered to have a characterising effect on the area ole and the key characteristics referred to opposite will be retained, resulting in an imperceptible magnitude of change to the character of the LCA. Taking into account the medium sensitivity of the area and the imperceptible magnitude of change, it is judged that the effect on this LCA as a whole will be **negligible**.

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	boundaries and rough grazing with bracken/gorse scrub. • *High biodiversity value resulting from the mosaic of different habitats present, especially for birds.* • *A number of small streams run through this area which support several small but significant Sites of Special Scientific Interest, and roadside nature reserves which carry a very diverse range of grassland species. The local biodiversity is greatly increased by this range of unimproved grasslands, carr woodlands and valley mires.* • *Some nationally important geology, including the Ffridd Mathrafal Track Section SSSI.* **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity, including the rural nature of the landscape and distinctive skyline features (indicating higher sensitivity), but presence of human activity and development (indicating lower sensitivity).	
LCA M11 - Mynydd y Cemmaes	*Open, exposed and with a remote wilderness air to the area, it forms an important topographic feature. Dramatic and extensive clear views are available over the surrounding rolling lowland farmland of the Dyfi Valley and towards the rising upland and mountains of Snowdonia. Much of the exposed ridge is occupied by an extensive wind farm development that, although obviously alien to this landscape, provides a contrasting visual experience. The rising hillside slopes preceding the upland area of Mynydd y Cemmaes are traditionally farmed with small scale fields reflecting the underlying landform and displaying a well-defined pattern. Hedgerows and hedgerow trees are the dominant landscape feature, with some incidental mixed woodland patches mostly in lower lying areas and by watercourses.* • *Dramatic and extensive clear views are available over the surrounding rolling lowland farmland of the Dyfi Valley and towards the rising upland and mountains of Snowdonia. The Snowdonia National Park abuts this LCA along the northern boundary.* • *Major landscape features, some with*	This LCA is located 2.5km away from a turbine at its closest point. There will be views of the Proposal from the higher hillsides in this LCA (e.g. VP10). This will affect views. However, the characterising effect will only extend to about 3km from the turbines, resulting in a medium magnitude of change to perceptual character on the south-eastern corner of this LCA. The characterising effect will reduce with distance, and the key characteristics listed opposite will remain. The Proposal will not affect the views into the Dyfi Valley or towards the mountains of Snowdonia. Noting the medium sensitivity of the area and the magnitude of change, this will result in a **Moderate** effect on the south-eastern extremity of the LCA within about 3km. **Long-term**

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	characteristic surface features controlled by bedrock geology and extensive Quaternary drift. • *Topographically and scenically varied and distinctive, comprising bare upland moorland and fertile valleys, the latter containing a variety of field patterns.* • *The Cemmaes wind farm visually dominates both the adjacent and distant landscapes within the LCA. The wind farm has been built on landscapes bearing evidence of (largely) prehistoric occupation, and which have historically been used for grazing. The Cultural Aspect specialist ascribed a high cultural value to this area as a response to the perceived need for 'sustainable' energy. However, much of the valley which separates Mynydd y Cemais from the eastern section of the LCA around Mynydd Lluest fach and Mynydd Rhiw-Saeson remains substantially unspoilt and attractive, and there are only certain sections of the valley where the wind turbines are visible.* **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity, including the open exposed and remote character (indicating higher sensitivity), but presence of human activity (indicating lower sensitivity).	
LCA M12 - Banwy Valley	*Narrow river corridor with dispersed small to medium settlements dominated by the surrounding steep valley sides. Lower slopes and valley bottoms tend to carry the main arterial transport routes through the study area - the A458 (T) is the principal transport corridor - and detract from the overall aesthetic quality of the aspect. Predominantly semi-improved grassland with a proportion of damp pasture land associated with the river course. Damp woodland is also a strong characteristic of the area. Primarily arable and dairy farming, with a regular medium-sized field pattern. Managed hedgerow and fence lines predominate with wide open views over the valley floor and relatively open skies dominant. It is mainly settled and domestic in character with sporadic clustered developments. Llanfair Caereinion itself*	Part of the valley lies between 2.5 and 10km from the Proposal (only tips theoretically visible within 5km). Although the ZTV indicates some theoretical visibility from the valley, the presence of vegetation means that the turbines are likely to go unnoticed from this valley and there will be a barely perceptible change to the character of the valley. Although this area has a high sensitivity, the imperceptible magnitude of change means the effect on this LCA as a whole is judged to be **negligible**.

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	still retains much of its original character as a rural agricultural centre, and has a range of traditional architectural styles and vernacular detailing, and distinct town centre based around the river crossing and traditional core. • *There is a strong sense of place, partly contributed by the Llanfair Light Railway in the easternmost section.* • *Major river system, broad in its lower part with a wide well developed floodplain and meanders, with some minor development of terraces.* • *River habitats and associated ribbon woodlands and ancient/species-rich hedgerows provide important elements of biodiversity in an otherwise rather intensively managed productive agricultural landscape.* • *The eastward-trending river valleys such as that of the Afon Banwy dominate the landscape of Montgomeryshire. Their streams mostly flow from Pumlumon, Berwyn and lesser ranges. They are variously broad or steep-sided (or both) and contain most of the historic settlements in the middle and north of Montgomeryshire. They have evidence of long-term settlement and exploitation of the adjacent terrain caused by topography. Without exception, each displays more than average aesthetic qualities. These form the background canvas on which the county's vivid culture is painted.* • *Llanfair Caereinion is a small town on the river Banwy which appears to have originated during the earlier medieval or medieval periods in association with an early church site. 18th to early 20th-century buildings and structures including, houses, shops, public houses, nonconformist chapels, public buildings and former hotel. Modern expansion for housing and schools to the north, east, south and south-west of the historic core. Early industrial remains include the site of late 18th to early 19th-century woollen mill. The extant,*	

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	early 20th-century Welshpool and Llanfair Light Railway terminates here. **High sensitivity** due to the small scale of the landscape and domestic character.	
LCA M13 - Tregynon/Llanerfyl (part of the proposed offsite access route passes through this area)	*1.4 The farmland in the north is characterised by low rolling hills with gently sloping sides and rounded tops. The small scale irregular field patterns are very strongly defined by field boundaries typified by overgrown and managed hedgerows with a significant proportion of mature hedgerow trees. Small to medium sized mixed broadleaved woodland is common in lower lying areas and especially along watercourses. The central and southern areas are formed by an extensive area of rolling hillsides and pasture land with gently sloping sides and rounded tops. Vegetation is predominantly oak/mixed broadleaved woodland combined with a strong field pattern defined by hedgerows.* *Overall this large area is a well-defined example of a traditionally farmed landscape - generally settled, safe and relatively intimate, except for the broader sweep of the exposed valley of Cwm Nant-yr-Eira, south west of Llanerfyl running up towards the Llanbrynmair Moors.* • *General landscape character is defined strongly by the rolling farmed landscape, with traditional farming techniques common, such as hedge laying. Blocks of 20th-century conifer plantation in the northern part of the area, with some residual ancient broadleaved woodland in steep-sided stream valleys and on steeper ridge slopes.* • *Views across the area are generally from a succession of rolling ridges and, due to the size of the area, long distance views are limited to far distant ridgelines of upland areas.* • *Part of this area contains key geological sites of regional*	Part of the proposed offsite access route passes through this LCA between Llanerfyl and the southern entrance to the site which will result in a localised change to the character of the road which will persist for up to 5 years into the operational phase. However, the character of the wider area will remain unchanged. There will also be effects on the perceptual character of the landscape as a result of views of the turbines, particularly from the Eira Valley adjacent to the site (see VP2, 4, 5, and 6). It is anticipated that the operational wind farm will result in a medium magnitude of change within the Eira Valley, declining with distance from the site. **Moderate** localised effect within the Eira Valley (western part of the LCA). **Long-term**

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	importance • *Topographically and scenically varied and distinctive, comprising bare upland and fertile valleys, the latter containing a variety of field patterns* • *Gregynog Hall, immediately to the south west of Tregynon, is a Registered Historic Landscape. This is a Grade I site, being listed as a formal and informal woodland garden incorporating various historic overlays. It has fine wooded parkland including part of the ancient Great Wood of Tregynon. It is described as one of the most important gardens and parks in Powys, dating from at least 1500. William Emes produced proposals in 1774 and some of them were carried out. In 1920 it became the home of the artistic patrons Gwendoline and Margaret Davies. H.A.Tipping worked on the gardens 1930-33 and Dame Sylvia Crowe in 1972. Any management of the landscape within the site or having an effect upon its essential setting must take account of its landscape significance.* **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity, including the small scale landscape pattern and strong features of traditional farmland (indicating higher sensitivity), but presence of human activity and gently rolling landform (indicating lower sensitivity).	
LCA M14- Esgair Cwmowen	*1.5 Exposure and wind are dominant features with isolated more intimate areas with small irregular hedged fields in sheltered areas to the edge of the area. The area is a good example of an upland grazing patchwork of vegetation -rough and poorly drained grazing, bracken, heather.* • *Exposure and wind are dominant features, with isolated more intimate areas with small, irregular, hedged fields in sheltered areas to the edges of the LCA.* • *Important upland massif with unique steeped topography, unusual periglacial features (NE of the hill of*	This LCA lies at approximately 2.3km from a turbine at its nearest point. Although the ZTV (Figure 4.4) illustrates that there will be patchy visibility of the turbines up to 10km, which will affect views from the elevated parts of this LCA. However, the characterising effect will only extend to about 3km from the turbines, resulting in a medium magnitude of change to perceptual character on the north-western edge of this LCA. The characterising effect will reduce with distance and the key characteristics referred to opposite will be retained. Noting the medium sensitivity of the area and the magnitude of change, this will result in a **Moderate** effect on the north-western extremity of the LCA

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	Y Foel) and at least one pRIG site (Tan y Foel Quarry). • *There is an important oligotrophic lake, Llyn Mawr SSSI, with some interesting plant and bird species.* • *Topographically and scenically varied and distinctive, comprising bare upland and fertile valleys, the latter containing a variety of field patterns.* • *There is a recently-constructed wind farm along the Mynydd Clogau ridge in the south east of the LCA.* **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity, including the distinctive topography (indicating higher sensitivity), but presence of human activity (indicating lower sensitivity).	within about 3km. There will be no significant effects beyond this. **Long-term**
LCA M15 - Dyfi Valley Catchment	*1.6 The regular small to medium scale field patterns are predominantly livestock and dairy farming in a picturesque landscape setting with rolling farmland rising steeply to the north and southern upland moorland. It is flanked to the north and south by a very extensive network of valleys containing tributaries leading into the River Dyfi. To the north, views are over a picturesque traditionally farmed landscape, edged by sporadic rock exposure and marginal grazing land facing onto the meandering Dovey Valley, with a northerly backdrop of steeply rising upland on the edge of Snowdonia.* • *The area has a dramatic backdrop to the south with the upland moorland of the Trannon and Plynlimon moors.* • *A traditionally-farmed landscape with a high incidence of grouped trees and mixed oakwood parcels.* • *The northern, western and south-western boundaries of this LCA abut the Snowdonia National Park.* • *The valley's northern part is overshadowed by banks of wind turbines on the high ground above it along the Mynydd Cemmaes ridge.*	This LCA lies within 650m of a turbine at its nearest point. Although the ZTV indicates some theoretical visibility from the valley, this will mostly be confined to tips (see VP 7, 8, 11). Any change to the character of the valley will be low in magnitude and only perceived in localised areas. **Minor** effect **Long-term**

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	• *Includes part of the Afon Dyfi ger Mollnyd SSSI for geological interest.* • *Includes a very important woodland SSSI. The Dyfi estuary west of Machynlleth is a Ramsar site and a SSSI.* • *The Dyfi, or Dovey, Valley trends north-east to south-west and contains the sole river of any size in Montgomeryshire that flows westwards into Cardigan Bay. It contains the major transport routes of the west coast rail line and the A487(T) and A489(T) along the valley.* • *The Valley is the western gateway to Montgomeryshire and previously shared with Welshpool the distinction of being one of only two places where trade goods were received and despatched by boat.* • *Although remains of human occupation are not so dense or numerous as in the eastern valleys, the Valley is becoming increasingly popular as a place of recreation, as well as for artists and anglers.* • *The Centre for Alternative Technology near Machynlleth, in the valley of the Afon Dulas, is of national cultural importance for its research and development works and is currently undergoing a major expansion of buildings on the main site.* **High sensitivity** due to the steep topography and 'picturesque' landscape.	
LCA M17 -Dyfi & Twymyn Hillsides	*1.7 It exhibits a wide range of vegetation cover with scattered grouped broadleaf trees a typical feature to the west of the area, together with rough grazing, bracken and heather scrub with outcrops of rock. An extensive area of semi improved grazing forms the transitional landform between the upland moorland and unimproved grazing of the Plynlimon Moors and the fertile farmlands of the Dyfi floodplain. It is characterised by small to medium scale irregular field patterns, bounded by a mixture of boundary*	This LCA lies within 3.8km of a turbine at its nearest point. There will be views of turbines , particularly at close proximity and it is predicted that the operational wind farm will result in a low magnitude of change to perceptual character of the north-eastern tip of this LCA, closest to the Proposal. **Minor** localised effect on the north-eastern tip of this LCA (i.e. the hills above Llanbrynmair). **Long-term**

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	treatments - gappy hedgerows and fences together with limited examples of stone walling - and numerous scattered farmsteads and small clustered settlements. • *The north western boundary of this LCA overlooks the narrow floodplain of the River Dovey/Afon Dyfi and faces the Snowdonia National Park, which lies a short distance beyond to the north west. A major upland block with a number of geo-conservation sites and areas of distinctive tectonically controlled topography.* • *Where the areas of the Plynlimon scarp slope are too steep for intensive use, they have developed a range of internationally significant plant communities.* • *A very small strip of land at the southern extremity of the LCA north of the minor road from Staylittle to Dylife and beyond lies within the Clywedog Valley Registered Landscape of Special Historic Interest in Wales, but its extent here is insufficient to classify the whole of the LCA as having special historical significance.* • *At the head of the Afon Carog valley running up from Aberhosan is a renowned roadside viewpoint, near Foel Fadian, with a memorial to the famous and decorated Welsh war correspondent Wynford Vaughan-Thomas. The memorial is not sited here because he had connections with the area, but because he considered the view from here towards Snowdon was the best in Wales.* **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity, including the small to medium scale irregular field patterns (indicating higher sensitivity), but presence of human activity (indicating lower sensitivity).	
LCA M22 - Trannon	*It is characterised by wide expanses of heather and bilberry low vegetation with numerous stream courses – including the sources of the River Severn and River Wye – and exposed rock outcrops and screes in the higher areas. This is an open landscape with*	This LCA lies within 2.6km of a turbine at its nearest point. There will be views of the Proposal from the higher hillsides in this LCA. However, the characterising effect will only extend to about 3km from the turbines, resulting in a medium

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	exposed wide skies and long distance dramatic views north towards the upland peaks of Cadair Idris and Ceredigion. An extensive wind farm development dominates the central and southern half of the area. To the north is a transitional landscape between the open and exposed moorland of the Trannon Moors and the more domesticated hill slopes mosaic grazing leading into the Dovey Valley. Largely enclosed marginal grazing land with an area of small scale irregular fields associated to the centre of the area. To the SW is an extensive coniferous plantation, predominantly single-species, with little variation in texture or diversity of elements. • *Topographically and scenically varied and distinctive, comprising bare upland moorland and fertile valleys, the latter containing a variety of field patterns.* • *20th-century wind farm development in the central part of the area at Carno wind farm.* • *In the central area there is mostly a complex mosaic of habitats which includes nationally important upland vegetation types. A wide range of interesting species has been recorded.* **Medium sensitivity.**	magnitude of change to perceptual character of the very northern tip of this LCA. The characterising effect will reduce with distance, and the key characteristics listed opposite will remain. Noting the medium sensitivity of the area and the magnitude of change, this will result in a **Moderate** effect on the northern extremity of the LCA within about 3km (i.e. around Newydd Fynddog). **Long-term**
LCA M23 - Carno Valley (part of the proposed offsite access route passes through this area)	*1.8 The northern area is a traditional livestock farming landscape with a strongly defined field pattern - managed hedgerow boundaries and small to medium sized field patterns, with some areas of well wooded and overgrown hedgerow boundaries and intermittent broadleaf trees are typical features. Grazing types range from semi-improved grassland to marginal grazing on the upper slopes. It is characterised by a small scale field pattern and rich patchwork vegetation cover of well-defined hedgerow, with hedgerow trees, and small incidental parcels of mixed woodland. To the south is a relatively small area of*	Part of the proposed offsite access route including the Talerddig junction lies within this which will result in some localised change to the character of the road that will persist into the operational phase. However, the character of the wider area will remain unchanged. Turbines will be visible from some parts of the valley, particularly from the A470 and adjacent hills (see VP9 and 12). However this is not considered to have a characterising effect and the key characteristics will remain. **Moderate** localised effect at the northern end of the LCA (i.e. around the Talerddig junction and the hills north of Talerddig). **Long-term**

LCA Name	Nature of the Receptor & Judgement on Sensitivity [Visual and Sensory Characteristics and Special Qualities (Key Landscape Characteristics) quoted directly from the Powys Landscape Character Study 2008. Judgement on sensitivity made by LUC.]	Nature of the Effect & Judgement on Significance
	irregular, well defined small to medium scale field pattern. • *The area forms part of the A470(T) and rail transport corridor and as such is an important thoroughfare and tourist route, attracting development.* • *Generally, settlements tend to be small and clustered. It has a domestic settled feel and a well maintained marginal farming landscape.* • *Includes well developed lobate landforms in probable head deposits in the Esgair Draenllwyn area of potential RIGS status on the extreme western edge of the LCA.* • *Topographically and scenically varied and distinctive, comprising bare upland moorland and fertile valleys, the latter containing a variety of field patterns.* **Medium sensitivity** due to the combination of attributes indicating higher and lower sensitivity, including the small scale field pattern and rich patchwork vegetation (indicating higher sensitivity), but presence of human activity (indicating lower sensitivity).	

LANDMAP

4.7.20 Effects on the five LANDMAP aspect layers are assessed in the tables in **Appendix 4.2**.

4.7.21 The tables indicate that there will be effects on the visual and sensory character of localised parts of the landscape from where there are views of turbines within approximately 5km of the Proposal.

Implications for Designated Landscapes

4.7.22 This section uses the outputs of the assessment above to consider the implications for designated landscapes in terms of how the special qualities of the designated landscape will be affected.

Snowdonia National Park

4.7.23 National Parks are designated to conserve and enhance their natural beauty, wildlife and cultural heritage and to promote opportunities for public understanding and enjoyment of their special qualities.

4.7.24 Planning Policy Wales states that there is a duty to have regard to National Park purposes resulting from activities that lie outside, as well as inside, designated areas.

4.7.25 The Powys UDP[14] states account must be taken of the "*special qualities or reasons for designation*" of the Snowdonia National Park when planning development (see Policy ENV2) and the Gwynedd UDP states that "*development will not be permitted where it would adversely affect the qualities and special character of the Snowdonia National Park by: 1.causing significant visual intrusion, and/or 2.being insensitively and unsympathetically sited within the landscape*".

4.7.26 Snowdonia National Park is 5.8km from a turbine at its closest point. There will be visibility of turbines from the south-eastern part of the park (to the east of the range of hills defined by Cadair Idris and Aran Fawddwy), see VPs 16, 18, 19 and 21.

4.7.27 Special qualities of the National Park are set out in the Snowdonia National Park Management Plan 2010-15. Not all of these are landscape related (e.g. the robust sense of community cohesion; continuing vibrancy of the Welsh language; the culture, folklore, art, literature and music; the extensive opportunities for recreation, leisure and learning for people of all ages and ability; and oral and written history). None of the landscape related special qualities will be affected by the Proposal (the diversity of high quality landscapes; strong 'sense of place'; the opportunity for people to understand and enjoy the National Park actively whilst maintaining areas of tranquillity and solitude; the archaeological remains; Snowdonia's architectural heritage; its complex, varied and renowned geology; and biodiversity including species and habitats of national and international significance). These characteristics will remain as special qualities of the National Park.

4.7.28 Although there will be views of turbines from the National Park (see VPs 16, 18, 19 and 21), at this distance they will appear small and will not cause "significant visual intrusion".

North Ceredigion Uplands Special Landscape Area (SLA)

4.7.29 SLAs have been seen by local authorities as a means of both protecting sensitive landscapes and developing an understanding and awareness of those features and characteristics that give a locality its sense of place.

4.7.30 The Proposal will not directly affect the North Ceredigion Uplands. Turbines lie 16km away at their closest point and they will not result in a significant effect on perceptual character or the 'primary landscape qualities and features' (as set out in Ceredigion CC's 'Designation of Special Landscape Areas') - reference VP20 which is located in this SLA. The wild, open, expansive upland area; evidence of glacial action and deposition; the distinctive pattern of ridges and valleys; the strong sense of place "off the beaten track"; the evidence of man's activities over many centuries, the exploitation of natural resources; and the historical features which have an influence on the cultural life of medieval Wales will remain the primary landscape qualities of this area.

Predicted Operational Effects on Views

4.7.31 The predicted views from each of the 24 viewpoint locations are illustrated using wireframes and photomontages in **Figures 4.13** to **4.36**.

4.7.32 The predicted effects of the wind farm on the assessment viewpoints are set out in **Tables 4.11 to 4.34**.

[14] Powys UDP 2001-2106 [http://static.powys.gov.uk/uploads/media/Written_statement_final_web_en_05.pdf]

Table 4.11: Viewpoint 1 Glyndwr's Way above Cwmderwen

Viewpoint 1: **Glyndwr's Way above Cwmderwen**	**Grid Reference:** **294933 306080**	**Distance to Nearest Turbine:** **72m**
Location: Located on Glyndwr's Way within the red line boundary of the site at an altitude of 373m, within the Dyfnant Forest/Llanbrynmair Moors landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by recreational walkers on the Glyndwr's Way trail. Views are focussed south-west across the valley of the Nant y Graig Lwyd. To the west, north and east is a landscape of rough grassland and post and wire fencing on large scale rolling landform typical of the Llanbrynmair Moors. Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) The Llanbrynmair turbines will be seen in two groups – one group to the south-west and one group to the north. Both groups together will occupy up to 180 degrees of the view. The turbines will be close to this viewpoint, in particular turbine 24 at 72m is very close. The on-site tracks will also be visible. The top of the substation control building will be visible but this will be constructed from local materials and will blend with the existing built character of the local area. All electrical component will be hidden. The earthworks associated with the ground modelling will be visible in early years, but this will blend into the view in time as the ground cover establishes. The magnitude of change to this view will be **high** taking account of the close proximity to turbines.		
Significance of Effect The significance of effect is judged to be **Major**, long-term		
Construction/ decommissioning activities: Construction of the wind farm including activity on site and earthworks will also be highly visible from this viewpoint.		

Table 4.12: Viewpoint 2 Cwmderwen

Viewpoint 2: Cwmderwen	Grid Reference: 295734 305343	Distance to Nearest Turbine: 1.07km
Location: Located on the minor road that passes through the Eira Valley on the boundary of the red line boundary of the site, within the Tregynon/Llanerfyl landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by motorists passing through the Eirsa Valley on this minor road. Views are focussed along the Eira valley (in the direction of travel) and up the valley sides to the surrounding hills of the Dyfnant Forest/Llanbrynmair Moors landscape character area. The foreground is formed by an improved grassland field with Cwmderwen Farm in the middle ground. In the backdrop are the Llanbrynmair Moors comprising open moorland grass and dark patches of forestry. Viewer sensitivity at this viewpoint is **medium** because motorists are passing through the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The Llanbrynmair turbines will be seen on the skyline, occupying almost a 180 degree field of view. The turbines will be close to this viewpoint (just over 1km away at their nearest point) and some of the on-site tracks will also be visible. The southerly end of the substation control building and some of the external fencing will be visible adjacent to an area of conifer forestry but this will be constructed from local materials and an area of shrub/tree planting to match the deciduous edge in front of the conifer plantation will help screen the building and fencing. All electrical component will be hidden. The earthworks associated with the ground modelling will be visible in early years, but this will blend into the view in time as the ground cover establishes. The magnitude of change to this view will be **high**.		
Significance of Effect: The significance of effect is judged to be **Major**, long-term		
Construction/ decommissioning activities: Construction of the wind farm including activity on site and earthwork operations will also be visible from this viewpoint.		

Table 4.13: Viewpoint 3 Minor road above Ffridd Fawr

Viewpoint 3: Minor road above Ffridd Fawr	**Grid Reference:** 294763 303064	**Distance to Nearest Turbine:** 1.2km
Location: Located the minor road to the south of Ffridd Fawr overlooking the headwaters of the Afon Gam, within the Dyfnant Forest/Llanbrynmair Moors landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): Representative of views experienced motorists on the road (also representative of views experienced by users of the footpath to Ffridd Fawr). Views are focussed along the Eira valley (north-east). The hills of the Llanbrynmair Moors forma backdrop to the view, where dark patches of conifers can be seen overlying the open grassland moor. Viewer sensitivity at this viewpoint is **medium** because motorists are passing through the landscape. The viewpoint is also representatives of users of the local footpath to Ffridd Fawr.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The Llanbrynmair turbines will be seen on the skyline, seen in two groups, together occupying approximately a 100 degree field of view. The turbines will be relatively close to this viewpoint (just over 1km away at their nearest point) and fairly extensive sections of the on-site tracks will also be visible. The magnitude of change to this view will be **high**.		
Significance of Effect: The significance of effect is judged to be **Major**, long-term		
Construction/ decommissioning activities: Construction of the wind farm including activity on site and earthwork operations will also be visible from this viewpoint.		

Table 4.14: Viewpoint 4 Glyndŵr's Way, Cefnllys-uchaf

Viewpoint 4: Glyndŵr's Way, Cefnllys-uchaf	**Grid Reference:** 297436 307411	**Distance to Nearest Turbine:** 1.2km
Location: Located on Glyndwr's Way within the within the Tregynon/Llanerfyl landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by recreational walkers on the Glyndwr's Way trail. Views are focussed along the valley (in the direction of travel) as well as up to the hills enclosing the valley. The foreground is formed by lush green fields of the valley (and the minor road bounded by post and wire fencing) while the surrounding hills have a variety of landcover including grassland and conifer plantation. There are some existing tracks visible on the hills. Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The Llanbrynmair turbines will be seen on the skyline, seen in two groups, together occupying approximately a 115 degree field of view. Users of Glyndŵr's Way are likely to be focussed upon views in the direction of the trail i.e. facing south west or north east and would view the Proposal on their left or right. Nevertheless the turbines will be relatively close to this viewpoint (just over 1km away at their nearest point) and some short sections of the on-site tracks will be visible (although the majority of the access tracks would be present on the plateau summit and therefore not visible from this location). The magnitude of change to this view will be **high**.		
Significance of Effect: The significance of effect is judged to be **Major**, long-term		
Construction/ decommissioning activities: Construction of the wind farm including activity on site will also be visible from this viewpoint.		

Table 4.15: Viewpoint 5 Glyndwr's Way/ minor road east of Neinthirion

Viewpoint 5:	**Grid Reference:**	**Distance to Nearest Turbine:**
Glyndwr's Way/ minor road east of Neinthirion	**296642 306946**	**1.36km**
Location: Located on Glyndwr's Way, just inside the red line application boundary, within the Tregynon/Llanerfyl landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by recreational walkers on the Glyndwr's Way trail. Views are focussed along the valley (in the direction of travel) as well as up to the hills enclosing the valley. The foreground is formed by improved grassland fields/ rushy pastures of the valley and minor roads while the surrounding hills tend to be rough grassland and conifer plantations. There are some existing tracks visible on the hills. Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The Llanbrynmair turbines will be seen on the skyline, seen in two groups, together occupying approximately a 145 degree field of view. Users of Glyndŵr's Way are likely to be focussed upon views in the direction of the trail and will view the Proposal in front, and to the right when travelling south-west along the valley. The turbines will be relatively close to this viewpoint (under 1.5km away at their nearest point) and some of the on-site tracks will also be visible (although the majority of the access tracks would be present on the plateau summit and therefore not visible from this location). The route of the reinforced grass track[15] bypassing the hamlet of Neinthirion will also be seen from this viewpoint, although as vegetation matures it will blend into the landscape. The magnitude of change to this view will be **high**.		
Significance of Effect: The significance of effect is judged to be **Major, long-term**		
Construction/ decommissioning activities: Construction of the wind farm including activity on site, construction traffic on the road and traffic using the reinforced grass track bypassing the hamlet of Neinthirion.		

[15] The new track bypassing the hamlet of Neinthirion is shown on Figure 4.17.6 as a grey surface on the photomontages to represent the maximum effect scenario. In reality this track will be constructed from stone with a grass reinforced surfacing to ensure it blends into the surrounding landscape post construction.

Table 4.16: Viewpoint 6 Glyndwr's Way at Moel Ddolwen

Viewpoint 6: **Glyndwr's Way at Moel Ddolwen**	**Grid Reference:** **298307 307896**	**Distance to Nearest Turbine:** **1.6km**
Location: Located on Glyndwr's Way where it skirts Moel-Ddolwen Hill fort, within the Tregynon/Llanerfyl landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by recreational walkers on the Glyndwr's Way trail. Views are focussed along the valley (in the direction of travel) as well as up to the hills enclosing the valley. The foreground is formed by grassland fields while the surrounding hills tend to be rough grassland and conifer plantations. There are some existing tracks visible on the hills. Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The Llanbrynmair turbines will be seen on the skyline, occupying approximately a 65 degree field of view. Users of Glyndŵr's Way are likely to be focussed upon views in the direction of the trail and will view the Proposal straight ahead when travelling west along the path. The turbines will be relatively close to this viewpoint (just over 1.5km away at their nearest point) and some on-site tracks will also be visible, although these will be seen in the context of existing tracks on the hills. The top of the roof of the substation control building and part of one of the gantries will just be visible in front of the dark plantation forestry in the distance, but the turbines will draw the eye more than these structure. The magnitude of change to this view will be **high**.		
Significance of Effect: The significance of effect is judged to be **Major, long-term**		
Construction/ decommissioning activities: Construction of the wind farm including activity on site will also be visible from this viewpoint.		

Table 4.17: Viewpoint 7 Dolfach

Viewpoint 7: **Dolfach**	**Grid Reference:** **291310 301705**	**Distance to Nearest Turbine:** **2.25km**
Location: Located in the village of Dolfach, within the Dyfi Valley & Catchment landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by residents. Views are focussed along the village street, although the hills either side form a backdrop to views. The foreground is formed by the main road through the village and the stone or rendered cottages, hedgerows and trees that line the road. The surrounding hills are open grassland with hedgerows and woodland on lower slopes. Viewer sensitivity at this viewpoint is **high** because this represents views from a local community who have prolonged views.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: Although a few turbine tips would theoretically be visible on the skyline, vegetation will screen these and the magnitude of change to this view will be **imperceptible**.		
Significance of Effect: **Negligible**		
Construction/ decommissioning activities: None.		

Table 4.18: Viewpoint 8 Llanbrynmair Village

Viewpoint 8: **Llanbrynmair Village**	**Grid Reference:** **289852 302803**	**Distance to Nearest Turbine:** **2.74km**
Location: Located within a public park in the centre of Llanbrynmair Village, within the Dyfi Valley & Catchment landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by this local community. Views are focussed towards the pub in the village (the white building) and to the hills that form a backdrop to the village. Viewer sensitivity at this viewpoint is **high** because this represents views from a local community who have prolonged views.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: Although one turbine tip would theoretically be visible on the skyline, it will be **barely perceptible** in this view.		
Significance of Effect: **Negligible**		
Construction/ decommissioning activities: None.		

Table 4.19: Viewpoint 9 Talerddig

Viewpoint 9: Talerddig	**Grid Reference:** 293173 300062	**Distance to Nearest Turbine:** 3.16km
Location: Located on the edge of the village of Talerddig on the A470(T), within the Carno Valley landscape character area (Powys LCA). The viewpoint was chosen in preference to one in the village itself as a suitable publicly accessible location, giving clear views of the Proposal, could not be found.		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by motorists travelling on the A470(T), including people heading into Talerddig village. Views are focussed along the A470 and towards the prominent hill of Moel Caelwpa. Viewer sensitivity at this viewpoint is **medium** because, although this this represents passing views from a main road, it includes people accessing Talerddig village.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The upper parts of up to 13 turbines would be visible on the skyline to the right of Moel Caelwpa. The turbines would be partially hidden by woodland and would not detract from Meol Caelwpa as a feature of views. Nevertheless, at this distance, the magnitude of change to this view will be **medium**.		
Significance of Effect: The significance of effect is judged to be **Moderate, long-term**		
Construction/ decommissioning activities: Cranes erecting the turbines.		

Table 4.20: Viewpoint 10 Glyndŵr's Way, Brynaere

Viewpoint 10: Glyndŵr's Way, Brynaere	**Grid Reference:** 288445 304953	**Distance to Nearest Turbine:** 4km
Location: Located on Glyndŵr's Way National Trail, within the Mynydd y Cemmaes landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This view is representative of views experienced by users of this section of the trail. Views are panoramic. Views are focussed towards the dramatic skyline of the Snowdonia National Park. However, when descending the path to the east views are across a valley and towards the Llanbrynmair Moors – conifer plantations are visible on the skyline. The valley sides are comprised of pasture interspersed with deciduous woodland. Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The upper parts of up to 16 turbines and the tips of another 11 will be visible from this elevated location, located on the Llanbrynmair Moors and seen against an open sky. The views towards Snowdonia will be unaffected. Nevertheless the presence of these turbines will result in a **high** magnitude of change to the view.		
Significance of Effect: The significance of effect is judged to be **Major, long-term**		
Construction/ decommissioning activities: Construction of the wind farm including activity on site will also be visible from this viewpoint.		

Table 4.21: Viewpoint 11 Llan Village

Viewpoint 11: Llan Village	**Grid Reference:** 288467 300784	**Distance to Nearest Turbine:** 4.95km
Location: Located in a parking area within the village of Llan, within the Dyfi Valley & Catchment landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by this local community. Views tend to be focussed north east along the village street (for people passing through the village) or eastwards towards Newydd Fynyddog (for houses along the village street). Viewer sensitivity at this viewpoint is **high** because this represents views from a local community who have prolonged views.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The upper parts of 11 turbines would be clearly visible on the skyline in views up the village street (they would be oblique in views from most properties since properties tend to face east or west). The presence of the turbines would not detract from Newydd Fynyddog as a feature of views and views south will not be affected. At this distance the magnitude of change to this view will be **medium**.		
Significance of Effect: Noting the high sensitivity of the location, the medium magnitude of change and the distance from the turbines, the significance of effect is judged to be **Moderate, long-term**		
Construction/ decommissioning activities: Cranes constructing/ removing turbines on the skyline.		

Table 4.22: Viewpoint 12 A470 north of Carno

Viewpoint 12:	**Grid Reference:**	**Distance to Nearest Turbine:**
A470 north of Carno	**295554 297575**	**5.97km**
Location: Located on the A470 to the north of Carno at the entrance to a farm track within the Carno Valley landscape character area (Powys LCA). [NB this point was chosen in preference to one in the village itself as a suitable publicly accessible location, giving clear views of the Proposal, could not be found].		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by motorists travelling on the A470(T), including people heading out of Carno. Views are focussed along the A470 and towards the prominent hills of Moel Caelwpa and Newydd Fynyddog. Viewer sensitivity at this viewpoint is **low** because it is representative of motorists on a main road who will be passing at speed.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: Only the tips of two turbines would be visible from this location – **barely perceptible** change in view.		
Significance of Effect: **Negligible**		
Construction/ decommissioning activities: Negligible		

Table 4.23: Viewpoint 13 Glyndwr's Way at Penyfford

Viewpoint 13: Glyndwr's Way at Penyfford	**Grid Reference:** **301807312533**	**Distance to Nearest Turbine:** **6.2km**
Location: Located on the Glyndwr's Way where it emerges from coniferous woodland into the rolling farmland of the Pont Llogel landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by recreational users of the trail. It is an expansive view across the Banwy Valley towards Pen Coed and the Llanbrynmair Moors. Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: 23 of the 30 turbines (plus the tips of two more) will appear as a compact group on the skyline and will be accommodated within this large scale landscape, occupying a relatively small part of the overall view. They will be located on the Llanbrynmair Moors and will not affect the scale or texture of the valley in the middle ground. Some of the tracks between turbines may just be visible in clear conditions. The magnitude of change to this view is judged to be **medium**.		
Significance of Effect: Noting the high sensitivity of the location, the medium magnitude of change, and taking account of the distance of the proposal from the viewpoint, the significance of effect is judged to be **Moderate, long-term**		
Construction/ decommissioning activities: Cranes constructing/ removing turbines on the skyline		

Table 4.24: Viewpoint 14 Bryn y Gadair

Viewpoint 14: Bryn y Gadair	**Grid Reference:** **296223 294102**	**Distance to Nearest Turbine:** **9.5km**
Location: Located within an area of access land in the Trannon landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by recreational receptors using this open access area and local footpath. It is an expansive view across the Banwy Valley north-east towards Esgair Cwmowen and Mynydd Clogau, and north towards the Llanbrynmair Moors. Viewer sensitivity at this viewpoint is **medium** because it is located on a local footpath.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The towers and blades of 20 turbines, and the blade tips of another 4 or so turbines, will be visible on the distant Llanbrynmair Moors where they will be seen partially against a backdrop of land and partially against the sky. The turbines will appear as two groups and can be accommodated within this large scale landscape. Some of the tracks between turbines will be visible from this vantage point. Since the wind farm will create a distinct new element in the view the magnitude of change to this view is judged to be **medium**.		
Significance of Effect: It is judged that the significance of effect will be **Moderate**, long-term		
Construction/ decommissioning activities: Cranes constructing/ removing turbines on the skyline		

Table 4.25: Viewpoint 15 Wynford Vaughan Thomas Memorial

Viewpoint 15: Wynford Vaughan Thomas Memorial	Grid Reference: 283587 295946	Distance to Nearest Turbine: 11.8km
Location: Located near the Wynford Vaughan Thomas Memorial adjacent to the minor road between Dylife and Machynlleth (the minor road is part of Route 8 of the National Cycle Network) at the junction of three landscape character area: Dyfi & Twymyn, Llyn Clywedog and Plynlimon LCAs (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by recreational receptors visiting this viewpoint. Views are focussed north-west across the Dyfi Valley and towards the skyline of the Snowdonia National Park. To the north-east (in the direction of the site) rising ground in the foreground screens views of the valley, but the skyline of Mynydd y Cemmaes, the Llanbrynmair Moors and Esgair Cwmowen is visible in the distance. This skyline is fairly level in profile. The Cemmaes wind farm is visible on Mynydd y Cemmaes, but this does not detract from the focus of the view (Snowdonia National Park). Viewer sensitivity at this viewpoint is **high** because this is an advertised/designated viewpoint.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: Parts of all 30 turbines will be visible on the distant Llanbrynmair Moors to the right of the Cemmaes Wind farm and 90 degrees to the main direction of view (main direction of view is towards Snowdonia National Park). The turbines will appear as a dense group and can be accommodated within this large scale landscape, occupying a relatively small part of the overall view. Some of the tracks between turbines may just be visible from this vantage point, although at this distance they may go unnoticed except in the clearest conditions. The wind farm will appear clearly separate from the Cemmaes wind farm. The magnitude of change to the view will be **low**.		
Significance of Effect: Noting the high sensitivity of the location, and taking account of the distance to the proposal and of the fact that the main direction of view is north-west towards Snowdonia, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Cranes constructing/ removing turbines on the skyline		

Table 4.26: Viewpoint 16 Summit of Foel Dinas

Viewpoint 16: Summit of Foel Dinas	**Grid Reference:** **284404 314412**	**Distance to Nearest Turbine:** **12.1km**
Location: Located at approximately 478m within a belt of lower hills to the east of the main mountain massifs in the Snowdonia National Park, close to the south-eastern boundary.		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by recreational receptors using the access land within which Foel Dinas is located. There are panoramic views from this summit, including views north-west into the interior of Snowdonia National Park and south-east out towards the flatter profiled moors of Mynydd y Cemmaes, the Llanbrynmair Moors and Esgair Cwmowen. The Cemmaes wind farm is visible on the skyline of Mynydd y Cemmaes. The turbines of the Carno group are also visible on a clear day. Since this is a viewpoint within a National Park viewer sensitivity at this viewpoint is considered to be **high.**		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The hubs and blades of three turbines and the tips of another 12 turbines will just be visible, appearing above skyline to the left of (and more distant than) the Cemmaes Wind farm. They will occupy a relatively small part of the overall view and will be in the opposite direction to the main focus of the view (towards the interior of the Snowdonia National Park). No tracks will be visible. The magnitude of change to the view will be **low**.		
Significance of Effect: Noting the high sensitivity of the location, the low magnitude of change and taking account of the fact that the main direction of view is north-west into the interior of Snowdonia National Park, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Cranes constructing/ removing turbines on the skyline		

Table 4.27: Viewpoint 17 Minor Road near Llanfihangel-yng Ngwynfa

Viewpoint 17: Minor Road near Llanfihangel-yng Ngwynfa	**Grid Reference:** **308185 316459**	**Distance to Nearest Turbine:** **13.6km**
Location: Located on the minor road network in the Pont Llogel landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by receptors using the network of minor roads in the vicinity of Llanfihangel-yng Ngwynfa. This is a view from a field gate at a gap in the hedge that borders this hedged lane. From here there is a panoramic view across the undulating farmland of Pont Logel towards a distant backdrop of Mynydd Waun Fawr. Since this is a viewpoint is on a local road viewer sensitivity at this viewpoint is considered to be **medium.**		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: All 30 turbines will be seen on the distant skyline of the Llanbrynmair Moors, to the right of the Carno turbines. It will appear in three unequal size clusters. The turbines will occupy a relatively small part of the overall view. The magnitude of change to the view will be **low**.		
Significance of Effect: Noting the medium sensitivity of the location, the low magnitude of change and the distance to the nearest turbine, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Cranes constructing/ removing turbines on the skyline		

Table 4.28: Viewpoint 18 Bwlch y Groes

Viewpoint 18: Bwlch y Groes	Grid Reference: 291304 323242	Distance to Nearest Turbine: 14.9km
Location: Located at a viewpoint on the Bwlch y Groes pass on the eastern edge of the Snowdonia National Park (marked on the OS 1:50K map).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of views experienced by visitors to this recognised viewpoint. Views are focussed north-west towards the dramatic skyline of the Snowdonia National Park (a viewing board is located in this direction). To the south-east (in the direction of the site) there are views across rough moorland towards the skyline of the Llanbrynmair Moors which is fairly level in profile and of less visual interest than the skyline of Snowdonia. Since this is a recognised viewpoint in a National Park viewer sensitivity at this viewpoint is considered to be **high.**		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: Only the very tips of a few turbines will theoretically be visible in this view and they are likely to go unnoticed. The magnitude of change to the view will be **barely perceptible**.		
Significance of Effect: **Negligible**		
Construction/ decommissioning activities: Negligible		

Table 4.29: Viewpoint 19 Aran Fawddwy

Viewpoint 19: Aran Fawddwy	Grid Reference: 286258 322374	Distance to Nearest Turbine: 16.5km
Location: Located at the summit of Aran Fawddwy at an altitude of 907m within the Snowdonia National Park.		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of recreational receptors climbing the mountains in this part of the national park. There are 360 degree views from this elevated viewpoint. The focus of views tends to be south-west towards Cadair Idris and north-west towards Snowdon. Views to the south-east (towards the site) contain a series of interlocking ridges and valleys in the fore and middle grounds, with simple plateau landscapes (including the Llanbrynmair Moors) beyond, outside the National Park. In clear conditions the turbines of Cemmaes 2 and Carno 1 and 2 are just visible. Since this viewpoint is within a National Park (and visitors will have their view focussed on the landscape) viewer sensitivity at this viewpoint is considered to be **high.**		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: All 30 turbines will be visible, as three similarly sized groups, on the Llanbrynmair Moors in the backdrop to views to the south-east. The wind farm will be nearer to the viewer than other existing wind farms (Cemmaes, Carno 1 and 2, Mynydd Clogau, Llandinam and Cefn Croes). However, at this distance the turbines will be small and the wind farm will occupy a small part of the view. Views south-west towards Cadair Idris and north-west towards Snowdon will be unaffected. The magnitude of change to the view will be **low**.		
Significance of Effect: Noting the high sensitivity of the location, the low magnitude of change, and the distance to the proposal, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Negligible		

Table 4.30: Viewpoint 20 Plynlimon

Viewpoint 20: Plynlimon	Grid Reference: 278976 286945	Distance to Nearest Turbine: 21.5km
Location: Located near the summit of Plynlimon within the County of Ceredigion at an altitude of approximately 750m – Plynlimon forms the focus of the North Ceredigion Uplands SLA.		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of recreational receptors visiting this notable landmark in the North Ceredigion Uplands SLA. There are 360 degree views from this elevated viewpoint. There are long distance views across the upland rugged moorland towards the sea to the west, the Snowdonia National Park to the north-west and lower lying landscapes to the east and south. The turbines of Carno 1 and 2 are just visible in clear conditions to the north-east. Viewer sensitivity at this viewpoint is considered to be **high** because this viewpoint is a popular outdoor recreational destination where focus in on the landscape.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: All 30 turbines will be theoretically visible on the Llanbrynmair Moors in the backdrop to views to the north-east, in between Cemmaes 2 (to the left) and Carno 1 and 2 (to the right). At this distance they will occupy a small part of the view. The magnitude of change to the view will be **low**.		
Significance of Effect: Noting the high sensitivity of the location, the low magnitude of change and the distance to the proposal, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Negligible		

Table 4.31: Viewpoint 21 Cadair Idris

Viewpoint 21: Cadair Idris	Grid Reference: 271115 313041	Distance to Nearest Turbine: 23km
Location: Located near the summit of Cadair Idris at an altitude of approximately 885m within the Snowdonia National Park.		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of recreational receptors climbing the hills in this part of the National Park. There are 360 degree views from this elevated viewpoint. Views to the north and west are characterised by complex topography associated with these glaciated uplands while views to the east and south are characterised by smoother topography and less variation in landform. The turbines of Cemmaes 2 are visible to the east. Since this viewpoint is within a National Park (and visitors will have their view focussed on the landscape) viewer sensitivity at this viewpoint is considered to be **high.**		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: All 30 turbines will be visible on the Llanbrynmair Moors in the backdrop to views to the east/south-east. They will be set behind the existing Cemmaes turbines, but will appear larger due to the larger size of turbine. They Nevertheless they will occupy a small part of the view and the magnitude of change to the view will be **low**.		
Significance of Effect: Noting the high sensitivity of the location, the low magnitude of change and the distance to the proposal, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Negligible		

Table 4.32: Viewpoint 22 Kerry Ridgeway, Two Tumps

Viewpoint 22: Kerry Ridgeway, Two Tumps	Grid Reference: 311818 285139	Distance to Nearest Turbine: 25.7km
Location: Located on the Kerry Ridgeway Recreational Trail at an altitude of 506m within the Kerry Hill landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of recreational receptors using the trail. There are long distance views from this elevated location across the lowlands of the Caersws and Carno valleys to the moors that surround the valleys (including the Llanbrynmair Moors). The skyline of the Snowdonia National Park, and the turbines of Cemmaes 2 and Carno 1 and 2, are visible in the far distance to the north-west on a clear day. Since this viewpoint is on an advertised recreational long distance trail viewer sensitivity at this viewpoint is considered to be **high**.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: All 30 turbines will be visible on the Llanbrynmair Moors in the backdrop to views to the north-west mostly in between Cemmaes 2 (to the left) and Mynydd Clogau (to the right). They will be set against a backdrop of land and will occupy a small part of the view. They will not detract from the skyline of Snowdonia. The magnitude of change to the view will be **low**.		
Significance of Effect: Noting the high sensitivity of the location, the low magnitude of change and the distance to the proposal, the significance of effect is judged to be **Minor, long-term**		
Construction/ decommissioning activities: Negligible		

Table 4.33: Viewpoint 23 Minor Road within Nant yr Eira

Viewpoint 23: Minor Road within Nant yr Eira	**Grid Reference:** **299693307271**	**Distance to Nearest Turbine:** **3.1km**
Location: Located on a minor road at an altitude of 240m within the Tregynon/Llanerfyl landscape character area (Powys LCA).		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint may be available to people using this local road passing through the valley. The view is taken from a field gate at a gap in the hedge that otherwise borders the lane. The majority of the lane has a hedgerow beside it which restricts views from the road. From the viewpoint location there are views west along the Nant yr Eira, enclosed by green hills and with the Llanbrynmair Moors in the background. Since this is a viewpoint is on a local road viewer sensitivity at this viewpoint is considered to be **medium**.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The towers and blades of seven turbines (and the blades of five more) will be visible on the skyline in the backdrop of views to the west. Although not all of the turbines will be visible from here, they will be in the direct line of vision and contrast with the existing view. Some of the tracks between turbines may also be visible from this location. The magnitude of change to this view will be **high**. However, it is noted that this view is not continuously available.		
Significance of Effect: Overall the significance of effect is judged to be **moderate**, long-term, because while the sensitivity of the location is medium and the magnitude of change is high from the specific viewpoint, motorists will only glimpse the view momentarily while passing this gap (and other similar gaps) in the hedge.		
Construction/ decommissioning activities: Construction of the wind farm including activity on site will also be visible from this viewpoint.		

Table 4.34: Viewpoint 24 Glyndwr's Way at Pen Coed

Viewpoint 24: Glyndwr's Way at Pen Coed	Grid Reference: 298741308597	Distance to Nearest Turbine: 1.9km
Location: Located on Pen Coed (on the Glyndwr's Way) at an altitude of 332m within the Dyfnant Forest/Llanbrynmair Moors landscape character area (Powys LCA). It is within an area of open access land.		
Nature of Receptor (Visual receptors, existing view & viewer sensitivity): This viewpoint is representative of recreational walkers on the national trail. There are views into and across Nant yr Eira. The patchwork of fields, hedgerows and woodlands within the valley contributes to the scenic quality of the view. To the south west there are views towards the distant Trannon Moors where the Carno turbines are visible in clear conditions (at least 13km away). Since this viewpoint is on a national trail viewer sensitivity at this viewpoint is considered to be **high**.		
Nature of Effect (Predicted Visibility & Magnitude of Change) & Judgement on Level of Effect: The top parts of 26 or so turbines will be visible as a group rising above the skyline to the west at a distance of 1.9km at their nearest point. They will be clearly visible just to the right of the direction of travel, but will not detract from views across the valley. Within the valley the works to the Gosen Bridge will result in some loss if vegetation which, although replanted after construction, will reduce the extent of tree cover in this location in the short term. The widened bridge and retaining wall will be clad in stone and any glimpses of these structures will be integrated well into the view at this distance (the bridge itself is likely to be completely screened by vegetation). The crawler lane will be visible to the right of Gosen Bridge in the short term. However, in the longer term it will blend with its surrounds. The overall patchwork that characterises the valley will be maintained. Overall, the magnitude of change to the view will be **high** (attributable to the views of turbines rather than the offsite road upgrades).		
Significance of Effect: Noting the high sensitivity of the location and the high magnitude of change the significance of effect is judged to be **Major, long-term**		
Construction/ decommissioning activities: It is unlikely that activity on the wind farm site will be visible from here. However cranes will be visible during the construction of the turbines and the works to widen Gosen Bridge and create the crawler lane will just be visible in the valley below. These operations will affect a relatively small part of the overall view.		

Predicted Operational Effects on Settlements

4.7.33 The ZTV indicates that people in the following settlements could theoretically be affected by changes to views:

- Caersws, Carno, Talerddig, Dolfach and Llanbrynmair along the A470 corridor;
- Llan and Bont Dolgadfan to the south-west;
- Llangadfan just off the A458 to the north;
- Llanfihangel-yng Ngwynfa to the north-east of the site; and
- Little London to the south-east of the site.

4.7.34 Although Llanerfyl is not within the ZTV of the turbines, road upgrades associated with the offsite access route will occur within this village – it is therefore also included in the assessment table below.

4.7.35 **Table 4.35** summarises effects on views from these settlements.

Table 4.35 Effects on Settlements

Nature of the Receptor (Settlement, Existing Views and Sensitivity)	Nature of Effect (Magnitude of Change)	Judgement on Level of Effect
Settlements in the A470 Corridor		
Caersws – a large village focussed around the A470 but with more modern development on side roads off the A470. Just over 14km to nearest turbine. High sensitivity	Only the tips of one turbine would theoretically be visible on the skyline 15km away. At this distance the tip would likely go unnoticed in views in and around the village.	**Negligible**
Carno – a linear settlement on the A470 – including some industry and modern development located on closes off the main street. Just over 7km to nearest turbine. High sensitivity	There will be no views from the village street due to the presence of buildings and vegetation. There may be views of the tops of some of the turbines from open areas such as playing fields and side roads, but these will form a small component of any views. Overall there will be a **low** magnitude of change to views from the village.	Noting the high sensitivity of the location, the low magnitude of change and the fact that there will be no views from the village street, the significance of effect is judged to be **Minor**, long-term
Talerddig – a small village between the A470 and a small side turning off the A470 containing a bakery. Views tend to be focussed along the village street or towards Moel Caelwpa. Just under 3km to nearest turbine. High sensitivity	Although the upper parts of up to 13 turbines would be theoretically visible, views from within the village are largely restricted by buildings and vegetation. Nevertheless there may be some glimpses of tops of turbines on the skyline. The road junction within the village will be widened and new hedgerows planted resulting in some short term changes to the character of the road, but the realigned road and planting will blend into the existing landscape in the long term. Overall there will be a **low** magnitude of change to views from the village.	Noting the high sensitivity of the location and the low magnitude of change (only glimpses of tops of turbines on the skyline and road junction upgrade), the significance of effect is judged to be **Minor**, long-term
Dolfach – a small village on the A470. Houses tend to face the	Although a few turbine tips would theoretically be visible on the skyline,	**Negligible**

Nature of the Receptor (Settlement, Existing Views and Sensitivity)	Nature of Effect (Magnitude of Change)	Judgement on Level of Effect
village street (the A470) and hills form the backdrop to views. Approximately 2km from nearest turbine. High sensitivity	vegetation will screen these and the magnitude of change to this view will be **imperceptible**.	
Llanbrynmair – a village on the A470 with some modern expansion to the south. Approximately 2.5km from nearest turbine. High sensitivity	Although one turbine tip would theoretically be visible on the skyline from the central recreation ground, it is likely to go unnoticed in this view – the magnitude of change to this view will be **imperceptible**.	**Negligible**
Other settlements within the ZTV		
Llan – a small linear settlement on the B4518. Approximately 5km from nearest turbine. High sensitivity	The upper parts of 11 turbines would be clearly visible on the skyline in views up the village street (they would be oblique in views from most properties since properties tend to face east or west). The presence of the turbines would not detract from Newydd Fynyddog as a feature of views. The magnitude of change to views from the village will be **medium.**	Noting the high sensitivity of the location, the medium magnitude of change and the fact that turbines will be oblique in views from most properties, the significance of effect is judged to be **Moderate**, long-term
Bont Dolgadfan – a village in the Twymyn Valley, focussed around the crossing point of the river and sheltered by landform/ vegetation. Approximately 4.8km from nearest turbine. High sensitivity	Buildings and vegetation will screen views of any turbines, except from the very northern edge of the village. Imperceptible change in views.	**Negligible**
Llangadfan – a village located along and just off the A458. The post office, church and hotel are located on the A458, although most properties are located on the minor road off the A458. There is also a caravan park. Approximately 4.5km from nearest turbine. High sensitivity	The tips of a couple of turbines would theoretically be visible on the skyline to the south-west. However, these are likely to go unnoticed in views in and around the village.	**Negligible**
Llanfihangel-yng Ngwynfa – a small village secluded in the hills of the Pont Llogel landscape character area. Just under 14km from nearest turbine. High sensitivity	Although a number of turbines are theoretically visible on the distant skyline 14km to the south-west of the village, views from the village to this distant skyline are screened by buildings and vegetation and there will be an imperceptible change to views from this village.	**Negligible**
Little London – a small hamlet located on the rising ground of	Although parts of up to 10 turbines will be visible on the distant skyline, at over	Noting the high sensitivity of the

Nature of the Receptor (Settlement, Existing Views and Sensitivity)	Nature of Effect (Magnitude of Change)	Judgement on Level of Effect
the 'Llandinam to Llandyssil Hillsides' landscape character area from where there are views north-west across the Caersws and Carno Valleys to the upland moors including Mynydd y Cemmaes and Llanbrynmair Moors. High sensitivity	17km away the turbines will result in a low magnitude of change in views from this hamlet.	location, the low magnitude of change and the distance to the Proposal, the significance of effect is judged to be **Minor**, long-term.
Settlements potentially affected by offsite access route		
Llanerfyl – a village located on the A458. A pair of Wellingtonia trees create a distinctive landmark at the junction with the minor road that leads towards the site. Some upgrades to the road access will be located in this village. High sensitivity	During the operational phase the only changes to the existing situation will be the presence of a wooden fence in place of hedgerow at either end of the access track. The line of the reinforced grass access track may also be discernible, although it will be blended into the landscape as far as possible. The existing roadside hedge will be improved by planting of a greater range of species, resulting in a positive effect. The Wellingtonias will be retained. In the long term there will be a **low** magnitude of change to views from the village.	Noting the high sensitivity of the location, the low magnitude of change to views post construction and the positive effect resulting from the improved hedge, the significance of effect is judged to be **Minor**, long-term

Predicted Operational Effects on Routes

4.7.36 The ZTV indicates that, assuming no vegetation cover, there will be patchy visibility from some sections of the A470(T) and the railway line linking Shrewsbury and the Midlands with Aberystwyth (particularly within 10km), and patchy visibility from the A458(T).

4.7.37 It also indicates that, assuming no vegetation cover, there will be visibility of the proposed development from the Glyndŵr's Way National Trail at relatively close proximity.

4.7.38 **Table 4.36** summarises effects on views from these routes.

Table 4.36 Effects on Routes

Nature of the Receptor (Route and Sensitivity)	Nature of Effect (Magnitude of Change)	Judgement on Level of Effect
Railway line linking Shrewsbury and the Midlands with Aberystwyth Low sensitivity	The top parts of some of the turbines will be visible from shorts sections of line between Carno and Talerddig (about 3km of line) and west of Llanbrynmair (about 3km of line) where gaps in vegetation allow. However, the Proposal will not be visible from the majority of the route. Any change in views from this railway line will be low in magnitude.	**Minor** on localised sections and route as a whole Long term
A470(T) Low sensitivity	The ZTV indicates theoretical visibility of the turbines for about 3km of road between Carno and Talerddig, and about 2.5km of road west of Llanbrynmair. There will be clear views of turbines from these stretches of road, located on the skyline above. This will result in a	**Moderate** along localised sections. **Minor** on route as a whole. Long term

Nature of the Receptor (Route and Sensitivity)	Nature of Effect (Magnitude of Change)	Judgement on Level of Effect
	medium magnitude of change along these short sections and a low magnitude of change in views overall from this route.	
A458(T) Low sensitivity	The ZTV indicates theoretical visibility of the turbines from short sections east of Llanerfyl, around Llangadfan and a short section about 4km west of Llangadfan. Vegetation will most likely screen views of the turbine tops from the section east of Llanerfyl. Some turbine tips are likely to be visible from the other short route sections, although these will result in no more than a low magnitude of change to views.	**Minor** along localised sections. **Negligible** on route as a whole. Long term
Minor road between Llanerfyl and Talerddig Medium sensitivity	The Llanbrynmair turbines will be prominent in views from this route and ancillary features (particularly the site accesses and tracks entering the site) will also be visible, resulting in a high magnitude of change to views from about 6km of this route as it passes close to the site. There will also be a number of interventions along this route including road widening, introduction of passing bays, structural works to bridges and construction of new sections of track that will be visible from the route. This will particularly affect Gosen bridge, Glen Menial bridge, Dolwen Isaf bridge, Neinthirion and the road widening/laybys on the section of road between Llanerfyl and the northern site access. During operation works will be assimilated successfully into the landscape within a period of approximately 5 years.	**Major** along approximately 6km of the route. Long term
Glyndŵr's Way National Trail High sensitivity	There will be some clear views of the wind farm (including ancillary components and tracks) from approximately 15km of this National Trail, particularly between Pen Coed (see VP24) and the hill above Brynaere (VP10). The trail passes through the site and from here there will be particularly clear views (see VPs 1, 4 and 5). There will also be views of the offsite access road upgrades, including the new section of track to by-pass Neinthirion (see VP5). There will be a high magnitude of change to views from this section of the route. Since the route is 135 miles long overall there will be a low to imperceptible magnitude of change to views form the route as a whole.	**Major** along localised section between Pen Coed and Brynaere. **Minor to negligible** on route as a whole. Long term

Additional Receptors Affected by the Offsite Access Road

4.7.39 During operation the landscape proposals associated with the permanent road upgrades will mature and the proposals will be assimilated into the landscape with limited visual effect.

Most receptors along the route will not have any adverse effects on their visual amenity beyond the short-term (i.e. beyond 5 years). However, it is likely that:

- **moderate** effects will persist for the three properties on the approach to, and at, Gosen Bridge (Ch4350-4550) due to the extent of works and vegetation loss in this area and the length of time it will take for vegetation (and especially trees) to re-establish (*this effect will reduce over time*).
- **minor** effects will persist for the settlement of Neinthirion due to filtered views of the bypass from this hamlet;
- **minor** effects will persist for walkers on the Glyndwr's Way National Trail who will see some areas of widened road, widened site accesses and the line of the Neinthirion bypass, particularly where it leaves the road.

Mitigation of Effects arising during Operation

4.7.40 The purpose of mitigation is to avoid, reduce and where possible remedy or offset, significant negative (adverse) effects on the environment arising from the proposed wind farm. It is very difficult (if not impossible) to mitigate the visual impact of wind turbines of this size. However, opportunities for mitigation have been incorporated into the design of the scheme where possible, as described in Section 4.6 (Design Evolution and Mitigation). This includes the replacement planting alongside the offsite access route (see drawings in Appendix 10.1 - A) and ground modelling and planting around the substation (see **Figure 3.26**).

Residual Effects

4.7.41 Since mitigation forms part of the scheme design, the residual effects are as identified above.

4.8 Decommissioning Effects

4.8.1 The projected operational lifespan of the wind farm is 25 years. At the end of this period, subject to planning conditions, an application may be submitted to retain the existing wind turbines or replace them with new ones. Alternatively the wind farm may be decommissioned and removed from the site. During decommissioning of the wind farm, there will be short term landscape and visual effects from plant and activities on the site, which will include dismantling and removing the wind turbines, demolition and removal of the substation and buildings, spreading of peat/topsoil over tracks, breaking out the exposed upstand section of the turbine foundations below ground level and backfilling, and removing the Neinthirion Bypass Bridge and its associated infrastructure. On-site cabling will be left buried and the rest of the highway works will be retained past the operational lifespan of the wind farm (the reinforced grass track bypassing Neinthirion will remain in place to grow over, or be used as an access route by the landowner). It is assumed that materials arising from the breaking up of the turbine foundations will be placed in the former borrow pits or used as backfill for the tops of the turbine foundations to minimise the visibility of these features in the long term.

4.8.2 Decommissioning is expected to take less time than construction, but will result in similar on-site effects to those reported during construction. The off-site construction effects associated with the highway works will not occur at decommissioning.

Long-term Landscape Effects on the Site after Decommissioning

4.8.3 After decommissioning the tracks and backfilled turbine platforms will be revegetated and the borrow pit faces will have partially revegetated. Nevertheless there will be some long-term change in the character of the site as a result of minor landform changes and borrow pits. After decommissioning these remnant changes will result in a low magnitude of change (**minor** effect).

Long-term Effects on Landscape Character Types after Decommissioning

4.8.4 After decommissioning the tracks and backfilled turbine platforms will be revegetated, the borrow pit faces will have partially revegetated and the permanent highway works and replanted vegetation will have matured. The minor alterations to the landscape of the Llanbrynmair Moors will result in a small change to a localised part of this landscape character area. However, the majority of the Dyfnant Forest/Llanbrynmair Moors LCA (LCA 5, Powys LCA) will not be affected and the effect on this LCA as a whole is judged to be **negligible** after decommissioning.

4.8.5 Permanent highway works will also affect small parts of LCA M13 Tregynon/Llanerfyl and LCA M23 Carno Valley, but by this stage they will have matured and any change to the character of these LCAs will be **negligible** after decommissioning.

Long-term Effects on Designated Landscape Areas after Decommissioning

4.8.6 There will be no post-decommissioning effects on the Snowdonia National Park or Cereidigion Special Landscape Area.

Long-term Visual Effects after Decommissioning

4.8.7 After decommissioning the tracks and backfilled turbine platforms will be revegetated, the borrow pit scars will have partially revegetated and the permanent highway works and replanted vegetation will have matured. The minor alterations to the landscape resulting from these will not result in any significant long terms effects on visual amenity.

4.9 Local Cumulative Effects

Aim

4.9.1 The aim of Cumulative Landscape and Visual Impact Assessment (CLVIA) is to "*describe, visually represent and assess the ways in which a proposed wind farm would have additional impacts when considered together with other existing, consented or proposed wind farms*" (para. 55, SNH, 2012).

4.9.2 This cumulative assessment considers the local cumulative effects arising as a result of adding Llanbrynmair to a baseline containing other existing and proposed wind farms within SSA B.

Relevant Guidance

4.9.3 The CLVIA has been carried out in accordance with the principles contained in:

- Landscape Institute and Institute of Environmental Assessment, 2nd edition (2002) Guidelines for Landscape Visual Impact Assessment;
- Landscape Institute and Institute of Environmental Assessment, 3rd edition (2013) Guidelines for Landscape Visual Impact Assessment[16];
- Scottish Natural Heritage (2012) Guidance: Assessing the Cumulative Impact of Onshore Wind Energy, Developments.

Identification of Sites to be included in the CLVIA

4.9.4 All existing and proposed wind farms (for which planning applications have been submitted) within, or on the boundary of, SSA B were identified by contacting developers. Carno III, although outside the SSA, was included because it forms a continuation of the Carno cluster. In addition, the proposed Dyfnant Forest Wind farm was included because, although a planning application has not yet been submitted, the project is well developed and may be submitted to the Major Infrastructure Unit of PINs within the timescale of the public inquiry.

[16] The 2nd and 3rd Edition LVIA Guidelines have been referred to. Assessments started prior to publication of the 3rd Edition (as is the case with this assessment) are generally completed complying with the 2nd Edition as advised by the Landscape Institute. However, this assessment also takes on board the principles of the recently published 3rd Edition.

4.9.5 Data on single turbine schemes were provided by NRW, but since no turbines over 50m were found to be within or just outside the SSA no single turbines were included in the assessment.

4.9.6 It should be noted that the baseline situation is constantly changing, but the developments listed in **Table 4.37** below represents the current situation as of 1st June 2013. The locations of these wind energy developments in relation to SSA B are shown on **Figure 4.37**.

Table 4.37 Wind Energy Developments in SSA B

Wind Energy Development	Status[17] (June 1st 2013)	Hub Height (m)	Rotor Diam (m)	Tip Height (m)	No. of Turbines
Carno I	Operational	32	45	54	56
Carno II	Operational	49	62	80	12
Carno III	Application submitted	80	93	126.5	18
Cemmaes 2	Operational	40	52	66	18
Cemmaes 3	Application submitted	80	70	115	12
Mynydd Clogau	Operational	40	52	66	17
Tirgwynt	Consented	70	92	116	12
Esgair Cwmowen	Application submitted	80	100	125	18
Mynydd Waun Fawr	Application submitted	70	80	110	15
Carnedd Wen	Application submitted	90	90	137	50
Llanbrynmair	Application submitted	80	93	126.5	30
Dyfnant Forest	Pre-application	100	90	145	32

Assessment Scenarios

4.9.7 Operational schemes form part of the LVIA baseline. In accordance with good practice guidance this assessment considers two cumulative scenarios:

a) The addition of Llanbrynmair in the context of operational, under construction and consented developments i.e. the most certain scenario (this adds Tirgwynt to the LVIA baseline situation); and

b) The addition of Llanbrynmair in the context of operational, under construction, consented developments, undetermined planning applications/ schemes at appeal and Dyfnant Forest i.e. a less certain scenario (this adds Cemmaes 3, Esgair Cwmowen, Carnedd Wen, Mynydd Waun Fawr, Carno III, and Dyfnant Forest to the baseline);

Key Steps

4.9.8 The key steps in the assessment were as follows:

- creation of ZTVs for each of the other existing or proposed wind farms (see method below);

[17] 'Application submitted' includes schemes that have been refused and are the subject of appeals. In the case of Cemmaes 3, although this was refused on 22 January 2013, it included because it is still in the planning system until the appeal period has passed (6 months from the date on the decision notice).

- these were combined to create a cumulative zone of theoretical visibility (CZTV) for each cumulative scenario;
- 14 viewpoints were selected to inform the assessment of combined and successive cumulative effects;
- six routes were selected to inform the assessment of sequential cumulative effects;
- cumulative wireframes and photomontages were produced for 14 viewpoints;
- the cumulative effects on the landscape and visual resource were evaluated for each scenario.

Method for Creating Cumulative Zones of Theoretical Visibility

4.9.9 To construct the cumulative ZTVs (CZTVs), ZTVs to tip height for each of the other wind farms were generated separately to a fixed radius depending on the tip height of the turbines according to **Table 4.38** below (these are based on distances provided within SNH's guidance (SNH, 2006).

Table 4.38 Distance to which individual ZTVs were modelled

Height of turbines including rotors i.e. tip height (m)	Extent of ZTV required (expressed as radius from nearest turbine, in km)
Up to 50	15
51-70	20
71-85	25
86-100	30
101-130	35

4.9.10 These were combined with the ZTV of the Llanbrynmair Wind farm to create a cumulative ZTV (CZTV) for each assessment scenario (see **Figures 4.38-4.39**).

4.9.11 The CZTV shows the number of wind energy developments visible and is colour coded to distinguish between areas where the proposed Llanbrynmair Wind farm is predicted to be visible (either on its own, or in conjunction with other wind turbines), and areas where other wind energy developments will be visible but the Llanbrynmair Wind farm will not.

4.9.12 It should be noted that the CZTVs do not include vegetation or buildings which can play an important role in screening.

Assessment Method

Baseline

4.9.13 The sensitivity of each landscape and visual resource is the same as that recorded in the LVIA.

Magnitude of Cumulative Change to Landscape Character

4.9.14 The magnitude of cumulative change to landscape character is the extent to which the Llanbrynmair Wind farm extends or intensifies the landscape effects of the developments in the baseline. This is influenced by:

- how the proposed wind farm fits with existing pattern of cumulative development in terms of siting and relationship to landscape character types and areas;
- the design of the proposed wind farm in relation to other existing and proposed wind energy developments (including size and scale).

4.9.15 Magnitude of change is expressed as high, medium, low or imperceptible/ barely perceptible according to the following definitions:

High: An obvious additional change, in conjunction with other developments, to landscape character.

Medium: Discernible but not obvious additional change, in conjunction with other developments, to landscape character.

Low: Minor additional change, in conjunction with other developments, to landscape character.

Imperceptible/ barely perceptible: Imperceptible/ barely perceptible additional change, in conjunction with other developments, to landscape character.

Magnitude of Cumulative Change to Views

4.9.16 The magnitude of cumulative change to views is the additional influence the extent to which the Llanbrynmair Wind farm extends or intensifies the visual effects of the developments in the baseline. This is influenced by:

- the visibility/prominence of the proposed wind farm compared to the other existing and proposed schemes;
- whether the proposed wind farm appears as an extension to an existing wind farm or introduces development into a new part of the view;
- the extent to which the proposed wind farm increases the angle of view occupied by wind energy developments (or the degree to which the proposed wind farm adds to the extent of visible turbines);
- the relationship between the proposed wind farm and other schemes in terms of design, size and layout (i.e. the design compatibility of the different schemes);
- the apparent relationship of cumulative schemes to landscape character types/ areas;
- the relative duration of views of wind energy developments from routes.

4.9.17 Magnitude of cumulative change to views is expressed as high, medium, low or imperceptible/ barely perceptible according to the following definitions:

High: An obvious additional change, in conjunction with other developments, to the view.

Medium: Discernible additional change, in conjunction with other developments, to the view.

Low: Minor additional change, in conjunction with other developments, to the view.

Imperceptible/ barely perceptible: Imperceptible/ barely perceptible additional change, in conjunction with other developments, to the view.

4.9.18 There has to be clear visibility of more than one wind energy development (of which one is the proposed wind farm) for there to be a cumulative effect. Where the Llanbrynmair Wind farm is clearly visible and other wind energy developments are not, the effect will be the same as recorded in the LVIA (i.e. the effect is not a cumulative effect).

Significance

4.9.19 The significance of cumulative effects is judged in the same way as for the LVIA using professional judgement to identify broad levels of significance. The levels of significance are described as being negligible/none, minor, moderate or major.

4.9.20 Major and moderate effects are considered significant in the context of the EIA Regulations.

Assessment of Cumulative Effects: SSA B

General Observations

4.9.21 Existing wind energy developments are located at Carno (phases I and II, total of 68 turbines up to 80m tip height) in the south of the SSA, Cemmaes (18 turbines 66m to tip) in the west of the SSA, and Mynydd Clogau (17 turbines 66m to tip) in south-east of the SSA.

4.9.22 Tirgwynt (12 turbines 116m to tip) has been consented to the north-west of Mynydd Clogau.

4.9.23 Planning applications for another five wind farms (Carno III, Cemmaes 3, Esgair Cwmowen, Mynydd Waun Fawr and Carnedd Wen) have been submitted, as well as Llanbrynmair.

4.9.24 Dyfnant Forest Wind farm (32 turbines 145m max to tip) is currently being planned for the northern part of the SSA.

4.9.25 Of these developments Cemmaes 2 and 3 would appear as one development (although the turbines will be different sizes); Carno phases I, II and III will also appear as a cluster (although turbines will be three different sizes); and Llanbrynmair and Carnedd Wen will appear as one development (with the turbines designed to have similar rotor diameters).

Cumulative Landscape Effects

4.9.26 All of the existing and proposed wind energy developments in SSA B (except for Dyfnant Forest Wind farm) fall within the Cambrian Mountains Regional Character Area (see Figure 4.40). Llanbrynmair is also within this area and therefore fits with the existing pattern of cumulative development in terms of siting and relationship to regional character areas. The development of all of the proposed wind farms in this SSA will inevitably result in a significant change to a localised area at the northern end of the Cambrian Mountains RCA as a result of the change to the accessibility and sense of naturalness (due to lack of visible built influences) that are noted as some of the key characteristics of this RCA.

4.9.27 In the context of Powys, the existing wind turbines at Carno (phases I and II) and proposed phase III of Carno are located within the Trannon LCA; the existing and proposed turbines at Cemmaes are located in the Mynydd y Cemmaes LCA; and the existing Mynydd Clogau scheme, consented Tirgwynt scheme and proposed Esgair Cwmowen and Mynydd Waun Fawr schemes are all located in the Esgair Cwmowen LCA. Llanbrynmair and Carnedd Wen (and Dyfnant Forest), all proposed, fall within the Dyfnant Forest/ Llanbrynmair Moors LCA (see Figure 4.40). The development of all of the proposed wind farms in this SSA will inevitably result in a significant change to localised parts of these character areas. The role of Llanbrynmair and the part it plays in this change to the landscape of the SSA, according to two potential scenarios[18], is set out below.

Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt

4.9.28 The number of turbines proposed for the Llanbrynmair Wind farm (30) is in scale with other existing and consented developments in the SSA (which vary between 12 and 56 in number). It is sited sufficiently distant from existing /consented wind farms for the difference in size of turbine not to show and will be clearly separated from other schemes.

4.9.29 Assuming other existing /consented wind farms are present, the addition of the Llanbrynmair Wind farm to this SSA will result in an additional 30 turbines (to a baseline containing 115). It will introduce a new group of turbines to an area already containing four groups and will be the largest group after the Carno group. This will result in a discernible additional change, in conjunction with other developments, to landscape character i.e. a medium magnitude of additional change to the character of the SSA.

4.9.30 The sensitivity of this area to wind energy development is judged to be medium, and this combined with the medium magnitude of change is judged to result in an additional cumulative effect of **moderate** significance.

Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest

4.9.31 The number of turbines proposed for the Llanbrynmair Wind farm (30) is also in scale with proposed developments in the SSA (which vary between 12 and 50 in number). It has been designed to fit seamlessly with the Carnedd Wen scheme, increasing the size of this cluster from 50 turbines to 80 turbines. The Carnedd Wen/Llanbrynmair cluster would be about the same size as the Carno group (which would comprise 86 turbines).

[18] Scenarios have been using the principles set out in SNH's Guidance on assessing the cumulative impact of onshore wind energy developments, para 68.

4.9.32 Assuming other proposed wind farms are present, the addition of the Llanbrynmair Wind farm to this SSA will result in an additional 30 turbines (to a baseline containing 260) in an area already containing turbines (Carnedd Wen). This will result in a minor additional change, in conjunction with other developments, to landscape character i.e. a low magnitude of change to the character of the SSA.

4.9.33 The sensitivity of this area to wind energy development is judged to be medium, and this combined with the low magnitude of change is judged to result in an additional cumulative effect of **minor** significance.

Cumulative Visual Effects

Combined/Successive

4.9.34 Combined and successive visual effects have been investigated through analysis of 14 representative assessment viewpoints, of which nine are the same as used in the LVIA. These viewpoints were selected in consultation with the landscape consultant for Carnedd Wen and the reasons for selection are set out below:

- CVP1: Glyndwr's Way, Brynaere (LVIA VP10) from close to Mynydd Cemmaes – will show schemes in SSA B from the west edge of the SSA.
- CVP2: Glyndwr's Way, Penyfford (LVIA VP 13, also similar to Carnedd Wen VP "V") – will show schemes in SSA B from this National Trail, to the north-east of the SSA.
- CVP3: Wynford Vaughan Thomas Memorial (LVIA VP15 – also Carnedd Wen VP "I WVTM") – will show schemes in SSA B from this designated viewpoint to south-west of the SSA.
- CVP4: Foel Dinas in Snowdonia National Park (LVIA VP16 and similar to Carnedd Wen VP "M" Lyn Foeldinas) – will show most schemes within SSA B against the skyline from the north-west.
- CVP5: Aran Fawddwy in Snowdonia National Park (LVIA VP19 – also Carnedd Wen VP "W9") – will show most schemes within SSA B from the north-west (the elevated location means schemes will be seen against land rather than sky);
- CVP6: Plynlimon (LVIA VP20) – will show most schemes in SSA B from the highest point in the Cambrian Mountains to the south-west of the SSA.
- CVP7: Cadair Idris in Snowdonia National Park (LVIA VP21 – also Carnedd Wen VP "W1") – will show views from an elevated part of the National Park.
- CVP8: Kerry Ridgeway Two Tumps (LVIA VP22 – also Carnedd Wen VP "SNPA2") – from the south-east - will show schemes in SSA B in views looking towards the Snowdonia National Park.
- CVP9: Glyndwr's Way crossing Pen Coed (LVIA VP24) – view from this National Trail within the SSA B which will provide a closer perspective of schemes from the north-east.
- CVP10: Garreg Hir (Carnedd Wen VP "E") – viewpoint within the SSA B giving a closer perspective of schemes from the south-east.
- CVP11: Glyndwr's Way at Pont Llogel (Carnedd Wen VP "P") – will show schemes in SSA B from this National Trail, to the north-east of the SSA.
- CVP12: Pen yr Allt Uchaf in Snowdonia National Park (Carnedd Wen VP "G") – will show views from an elevated part of the National Park.
- CVP13: North-west of Mynydd Waun Fawr: Llyn y Grinwydden open access land (Carnedd Wen VP "N") – will show schemes in SSA B from the east edge of the SSA from an area of open access land.
- CVP14: Beacon Ring Hillfort (Carnedd Wen VP "SNPA 3") – will show schemes in SSA B in views looking towards the Snowdonia National Park.

Table 4.39 Cumulative Effects on Visual Amenity at Representative Viewpoints

Viewpoint and sensitivity	Cumulative effect on view
CVP1: Glyndwr's Way, Brynaere 288445 304953 Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape. Refer to **Photomontage from Cumulative Viewpoint 1**	***Baseline*** Views are panoramic but the main focus is towards the dramatic skyline of the Snowdonia National Park. The existing Cemmaes Wind farm is clearly visible in the foreground of these views, just to the left of Snowdon. When descending the path to the east views are directed across the valley and towards the Llanbrynmair Moors – conifer plantations and the Carno turbines are visible on the skyline. The valley sides are comprised of pasture interspersed with deciduous woodland.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Llanbrynmair will add turbines in front of Tirgwynt to the east of the viewpoint (i.e. away from the Snowdonia National Park). Although Tirgwynt will already be in this direction, Llanbrynmair will be closer to the viewpoint (and more prominent) than Tirgwynt and will extend the angle of view occupied by wind turbines. However, Llanbrynmair will be further away, and less prominent, than the existing Cemmaes 2 scheme. Llanbrynmair will be seen as clearly separate from other wind energy developments and the difference in turbine sizes between the schemes will not be noticeable. Nevertheless, the addition of Llanbrynmair to this view containing other existing and consented turbines is judged to be of medium magnitude and the significance of additional effect is judged to be **moderate**.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be small because it will appear as an extension to Carnedd Wen and will not introduce development into a new part of the view. Llanbrynmair will not be in the view towards Snowdonia. The addition of Llanbrynmair to this view containing other existing, consented and proposed turbines is judged to be of low magnitude and the significance of effects is judged to be **minor**.
CVP2: Glyndwr's Way, Penyfford 301807 312533 Viewer sensitivity at this viewpoint is **high** because recreational walkers on this National Trail are likely to have their attention focussed on the landscape. Refer to **Photomontage from Cumulative Viewpoint 2**	***Baseline*** This viewpoint is representative of views experienced by recreational users of the trail. It is an expansive view across the Banwy Valley towards Pen Coed and the Llanbrynmair Moors. The group of Carno turbines is just visible on the distant skyline in clear conditions.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Llanbrynmair will add a turbine group to the right of Tirgwynt and the Carno group on the skyline of the Llanbrynmair Moors. Llanbrynmair will be the nearest (and therefore most prominent) of the three schemes. However, all three groups will be clearly separate and any difference between turbine sizes will not be perceptible. The addition of Llanbrynmair to this view containing other existing and consented turbines is judged to be of medium magnitude and the significance of effects is judged to be **moderate**.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional

Viewpoint and sensitivity	Cumulative effect on view
	change resulting from Llanbrynmair will be small because it will appear as an extension to Carnedd Wen and will not introduce development into a new part of the view. The addition of Llanbrynmair to this view containing other existing, consented and proposed turbines is judged to be of low magnitude and the significance of effects is judged to be **minor**.
CVP3: Wynford Vaughan Thomas Memorial 283587 295946 Since this is an advertised/designated viewpoint viewer sensitivity is **high**. Refer to **Photomontage from Cumulative Viewpoint 3**	***Baseline*** Views are focussed north-west across the Dyfi Valley and towards the skyline of the Snowdonia National Park. To the north-east rising ground in the foreground screens views of the valley, but the skyline of Mynydd y Cemmaes, the Llanbrynmair Moors and Esgair Cwmowen is visible in the distance. This skyline is fairly level in profile. The Cemmaes wind farm is visible on Mynydd y Cemmaes, but this does not detract from the focus of the view (Snowdonia National Park).
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Llanbrynmair will add another group of turbines to the right of Cemmaes 2. They will be seen as a clearly separate group which will be greater in number, but about the same prominence as Cemmaes 2. Neither group will detract from the view of Snowdonia. The change in the view will be the same as recorded in the LVIA i.e. low magnitude of change and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be even smaller because it will appear as an extension to Carnedd Wen. Although the addition of Llanbrynmair will intensify the number of turbines in the view it will not introduce development into a new part of the view and the development will be compatible with other existing and proposed turbine groups in terms of numbers and sizes of turbine. The additional change to the view will be of low magnitude of change and the effect is judged to be of **minor** significance.
CVP4: Foel Dinas in (Snowdonia National Park) 284404 314412 Since this is a viewpoint within a National Park viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 4**	***Baseline*** There are panoramic views from this summit, including views north-west into the interior of Snowdonia National Park and south-east out towards the flatter profiled moors of Mynydd y Cemmaes, the Llanbrynmair Moors and Esgair Cwmowen. The Cemmaes wind farm is visible on the skyline of Mynydd y Cemmaes. The turbines of the Carno group may also just be visible on a clear day.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt As well as the operational schemes at Cemmaes and Carno, Tirgwynt may just be visible on the distant skyline on a clear day. Llanbrynmair will add turbines to the left of (and more distant than) the Cemmaes Wind farm where they will be less prominent than the Cemmaes turbines. The change in the view will be the same as recorded in the LVIA i.e. low magnitude of change and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be even smaller because it will appear behind, and less prominent than, Carnedd Wen. However, where

Viewpoint and sensitivity	Cumulative effect on view
	tips are visible, it will appear to fill the gap between Carnedd Wen and Cemmaes. The additional change to the view would be of a low magnitude and the effect is judged to be of **minor** significance.
CVP5: Aran Fawddwy (Snowdonia National Park) 286258 322374 Since this viewpoint is within a National Park (and visitors will have their view focussed on the landscape) viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 5**	***Baseline*** There are 360 degree views from this elevated viewpoint. The focus of views tends to be south-west towards Cadair Idris and north-west towards Snowdon. Views to the south-east (towards the site) contain a series of interlocking ridges and valleys in the fore and middle grounds, with simple plateau landscapes (including the Llanbrynmair Moors) beyond, outside the National Park.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt As well as the operational schemes at Mynydd Clogau, Cemmaes and Carno, Tirgwynt may just be visible on the distant skyline on a clear day. Llanbrynmair will add turbines in front of Mynydd Colgau and Tirgwynt where they will be about as prominent as the Cemmaes turbines. At this distance the turbines will be small and the wind farm will occupy a small part of the view – views south-west towards Cadair Idris and north-west towards Snowdon will be unaffected. The change in the view will be the same as recorded in the LVIA i.e. low magnitude of change and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be even smaller because it will appear behind, and less prominent than, Carnedd Wen. The additional change to the view would be of a low magnitude and the effect is judged to be of **minor** significance.
CVP6: Plynlimon 278976 286945 Since this viewpoint is a popular outdoor recreational destination where focus in on the landscape it is considered to have a **high** sensitivity. Refer to **Photomontage from Cumulative Viewpoint 6**	***Baseline*** This viewpoint is representative of recreational receptors visiting this notable landmark in the North Ceredigion Uplands SLA. There are 360 degree views from this elevated viewpoint including long distance views across the upland rugged moorland towards the sea to the west, the Snowdonia National Park to the north-west and lower lying landscapes to the east and south.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt As well as the operational schemes at Mynydd Clogau, Cemmaes and Carno, Tirgwynt may just be visible on the distant skyline on a clear day. Llanbrynmair will add a group of turbines between Cemmaes to the left of the view and the Carno/Mynydd Clogaur/ Tirgwynt group to the right of the view. They will be about as prominent as the Carno II turbines (which are smaller, but nearer). At this distance the turbines will be small and the change in the view will be the same as recorded in the LVIA i.e. low magnitude of change and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the Llanbrynmair turbines will extend the Carnedd Wen group to the right (and marginally closer to the viewpoint). However, the Carno group will be the closest to the viewpoint and additional change to the view would still be of a low magnitude and the additional effect of **minor**

Viewpoint and sensitivity	Cumulative effect on view
	significance.
CVP7: Cadair Idris (Snowdonia National Park) 271115 313041 Since this viewpoint is within a National Park (and visitors will have their view focussed on the landscape) viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 7**	***Baseline*** This viewpoint is representative of recreational receptors climbing the hills in this part of the National Park. There are 360 degree views from this elevated viewpoint. Views to the north and west are characterised by complex topography associated with these glaciated uplands while views to the east and south are characterised by smoother topography and less variation in landform.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt As well as the operational schemes at Mynydd Clogau, Cemmaes and Carno, Tirgwynt may just be visible on the distant skyline on a clear day. Llanbrynmair will add a group of turbines behind Cemmaes where they will be more distant, but about the same prominence due to their slightly larger size compared to existing operational turbines. Nevertheless, at this distance the turbines will not be noticeable except in the clearest conditions and the magnitude of change in the view will be the same as recorded in the LVIA i.e. low magnitude of change and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the Llanbrynmair turbines will extend the Carnedd Wen group to the right. However, the Cemmaes group will be the closest to the viewpoint and additional change to the view would still be of a low magnitude and the additional effect of **minor** significance.
CVP8: Kerry Ridgeway Two Tumps 311818 285139 Since this viewpoint is on an advertised recreational long distance trail viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 8**	***Baseline*** There are long distance views from this elevated location across the lowlands of the Caersws and Carno valleys to the moors that surround the valleys (including the Llanbrynmair Moors). The dramatic skyline of the Snowdonia National Park is visible in the far distance to the north-west on a clear day.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Llanbrynmair will add a turbine group just to the right, and in front of, the operational Cemmaes turbines and behind the operational Mynydd Clogau and consented Tirgwynt turbines. The Llanbrynmair turbines will be more prominent than Cemmaes but not be as prominent as Tirgwynt. They will also be slightly more prominent than, and clearly separated from, the Carno group. The addition of Llanbrynmair to this view containing other existing and consented turbines is judged to be the same as recorded for VP22 in the LVIA i.e. low magnitude of change and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the Llanbrynmair turbines will be seen amongst many other turbines that will be more prominent than the Llanbrynmair turbines. Nevertheless the Llanbrynmair turbines will still result in a perceptible additional change to the view, albeit of a low magnitude. In this context, the additional effect is judged to be of **minor** significance.
CVP9: Glyndwr's Way	***Baseline***

Viewpoint and sensitivity	Cumulative effect on view
crossing Pen Coed 298741 308597 Since this viewpoint is on a national trail viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 9**	This is a viewpoint on the national trail from where there are views into and across Nant yr Eira. The patchwork of fields, hedgerows and woodlands within the valley contributes to the scenic quality of the view. To the south west there are views towards the distant Trannon Moors where the Carno turbines are visible in clear conditions (at least 13km away).
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Llanbrynmair will add a third group of turbines to the view (the Carno turbines would form one group and Tirgwynt another). The Llanbrynmair turbines would be the most prominent as a result of proximity to the viewpoint and number of turbines. The overall patchwork that characterises the valley will be maintained. The addition of Llanbrynmair to this view containing other existing and consented turbines is judged to be of medium magnitude and result in an additional effect of **moderate** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the Llanbrynmair turbines will form an extension of the Carnedd Wen group (the turbines would be seen in the foreground of the Carnedd Wen turbines). This group will be clearly separate from the Tirgwynt/Esgair Cwmowen group and the Carno group which lies on the distant skyline between the two. Although the Llanbrynmair turbines will have comparatively less influence on the view compared to Scenario A, their addition will still result in a clearly noticeable additional change to the view (of medium magnitude). In this context, the additional effect resulting from the addition of Llanbrynmair is judged to be of **moderate** significance.
CVP10: Garreg Hir 299892 297802 Since this viewpoint is a recreational destination with views to the Snowdonia National Park (i.e. focus in on the landscape) it is considered to have a **high** sensitivity. Refer to **Photomontage from Cumulative Viewpoint 10**	***Baseline*** This is a panoramic view from a footpath across Garreg Hir from where surrounding valleys and ridges are visible. Of particular note are the views north-west towards the skyline of Snowdonia. Although the existing Cemmaes II Wind farm is visible in this direction, the turbines do not break the skyline or detract from the dramatic skyline. The existing turbines at Mynydd Clogau are visible to the far right of the view and the Carno turbines are visible to the far left of the view, located on the flatter ridges in the middle ground of the view.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt Tirgwynt will add a group of 12 turbines in front of the viewer, between the extended Carno group to the left of the view and Mynydd Clogau to the right of the view. If Llanbrynmair were to be added to this baseline, this would result in an additional 30 turbines located behind and to the left of Tirgwynt but in front of and to the right of Cemmaes – effectively filling the gap between these schemes and extending the angle of view occupied by turbines. The Llanbrynmair turbines will be located on the flatter moors in the middle ground of the view and will be seen against land. As a result they will not break the dramatic skyline of the Snowdonia National Park. Nevertheless the addition of these turbines will result in a medium magnitude of additional change to the view. The significance of this effect is judged to be **moderate**.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the turbines of

Viewpoint and sensitivity	Cumulative effect on view
	Cemmaes 3, Carnedd Wen, Dyfnant Forest, Tirgwynt, Esgair Cwmowen and Mynydd Waun Fawr will form a group of turbines in the middle ground of this view. Some of the turbines (particularly the Tirgwynt, Esgair Cwmowen and some of Carnedd Wen) will break the skyline. The Llanbrynmair turbines will be located in front of the Carnedd Wen turbines (they will appear to form an extension to these) but behind the Tirgwynt/ Esgair Cwmowen schemes. They will form part of this large group of turbines in the middle ground of the view. They will not extend the field of view occupied by turbines and will not break the skyline in the way that other turbines do. In this context the Llanbrynmair turbines will result in a perceptible additional change to the view of a low magnitude and the additional effect is judged to be of **minor** significance.
CVP11: Glyndwr's Way at Pont Llogel 305717 315153 Since this viewpoint is on a national trail viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 11**	***Baseline*** This is an elevated view from this National Trail west/south-west across the Banwy Valley (characterised by a patchwork of fields, farms and woodlands) towards the hills of the Llanbrynmair Moors/Dyfnant Forest. No wind farms are currently visible in this view (the Carno turbines are theoretically on the distant moors to the left of the view but these will be screened by intervening vegetation).
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt None of these existing or consented wind farms are visible from this viewpoint. Therefore the change in view resulting from Llanbrynmair will not be a cumulative effect.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Three of the proposed wind farms would be visible in this view – the most prominent would be Dyfnant Forest which would be on the skyline of the hills to the west, the other side of the Banwy Valley. The turbines of Carnedd Wen would be more distant and less prominent, but would extend the field of view occupied by turbines to the left across the Llanbrynmair Moors so that almost the whole skyline across the valley is occupied by wind turbines. The Llanbrynmair turbines would also be located on the Llanbrynmair Moors but they will be located behind, and appear less prominent than, the Carnedd Wen turbines. They will appear to form an extension to the Carnedd Wen turbines and will only extend the field of view occupied by turbines by a small degree. In this context, the addition of Llanbrynmair will result in a barely perceptible additional magnitude of change to the view and the effect is judged to be **negligible**.
CVP12: Pen yr Allt Uchaf in Snowdonia National Park 286761 319252 Since this viewpoint is within a National Park (and visitors will have their view focussed on the landscape) viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative Viewpoint 12**	***Baseline*** From this elevated point views are focussed south, down the Cywarch Valley and towards the skyline of the Cambrian Mountains. Views towards the site are to the left of the view, beyond the interlocking ridges and valleys in the fore and middle grounds.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt As well as the operational schemes at Cemmaes, Carno and Mynydd Clogau (perhaps just visible on a very clear day), Tirgwynt will also be visible on the distant skyline on a clear day. Llanbrynmair will add turbines to the left of Tirgwynt and in front of Mynydd Colgau where they will be about as prominent as the Cemmaes turbines. They will not break the skyline. At this distance the turbines will appear small and the wind farm will occupy a small part of the view – views down the Cywarch Valley and towards the skyline of the Cambrian Mountains will not be

Viewpoint and sensitivity	Cumulative effect on view
	affected. The magnitude of additional change to this view, assuming the existing and consented schemes are present, will be low. It is judged that the additional effect will be of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be even smaller because it will appear behind, and less prominent than, Carnedd Wen. In this context the additional change to the view would be of a low magnitude and the effect is judged to be of **minor** significance.
CVP13: North-west of Mynydd Waun Fawr: Llyn y Grinwydden open access land 302105 306994 Since this viewpoint is a recreational destination with views to the Snowdonia National Park (i.e. focus in on the landscape) it is considered to have a **high** sensitivity. Refer to **Photomontage from Cumulative Viewpoint 13**	***Baseline*** This is a panoramic view from an area of open access land, across the Eira and Banwy valleys to the moorland and forest mosaic of the Dyfnant Forest/Llanbrynmair Moors. Beyond this is the dramatic skyline of the Snowdonia National Park. The existing Carno turbines are visible on the skyline to the left of the view, beyond the Carno Valley. They do not interrupt views of the Snowdonia skyline. Cemmaes 2 and Mynydd Clogau are not visible.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt When built, Tirgwynt will be visible in front of the Carno turbines to the left of the view. The addition of Llanbrynmair will add turbines to the middle of the view where (at about 5km away at the closest point) they will be more prominent than the existing/consented turbines. The addition will introduce wind energy development into a new part of the view and therefore extend the angle of view occupied by wind turbines. However, they will be accommodated within this large scale landscape and continue the relationship of wind energy schemes to landscape character (occupying elevated land outside the National Park). The difference in size between the turbines of different schemes will not be perceptible from this distance. The addition of Llanbrynmair to this baseline will result in a medium magnitude of change to the view and the effect is judged to be of **moderate** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be smaller because it will appear in the same direction of view, and appear as an extension to, Carnedd Wen. Although Llanbrynmair is closer, Carnedd Wen will be more prominent on the skyline than Llanbrynmair. In this context the additional change to the view would be of a low magnitude and the effect is judged to be of **minor** significance.
CVP14: Beacon Ring Hillfort, Offa's Dyke Path 326418 305802 Since this viewpoint is at a hillfort on a national trail viewer sensitivity at this viewpoint is considered to be **high**. Refer to **Photomontage from Cumulative**	***Baseline*** This is an elevated view across the Severn Valley towards the hills that comprise SSA B. On a clear day there are views beyond to the skyline of the Snowdonia National Park. Welshpool is clearly visible in the valley below. On a clear day the turbines at Mynydd Clogau (23km away) are just visible against a backdrop of land and the turbines at Carno I and II (35km away) may also be visible on the distant skyline in exceptionally clear conditions.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt When built, Tirgwynt (27km away) will be visible in clear conditions on the skyline to the right of the Carno turbines. The addition of

Viewpoint and sensitivity	Cumulative effect on view
Viewpoint 14	Llanbrynmair (at least 30km away) will add turbines to the distant skyline to the right of Tirgwynt. They will only be visible in clear conditions where they will introduce wind energy development into a new part of the view and therefore extend the angle of view occupied by wind turbines. However, they will be accommodated within this large scale landscape and continue the relationship of wind energy schemes to landscape character (occupying elevated land outside the National Park). They will not interfere with views of the skyline of Snowdonia. The addition of Llanbrynmair to this baseline will result in a low magnitude of change to the view and the effect is judged to be of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming other proposed schemes are also in the baseline, the additional change resulting from Llanbrynmair will be barely perceptible because it will appear in the same direction as Carnedd Wen. Although Llanbrynmair is closer, Carnedd Wen will be more prominent on the skyline than Llanbrynmair. Llanbrynmair will not interfere with views of the skyline of Snowdonia. In this context the additional change to the view would be of a barely perceptible magnitude and the effect is judged to be **negligible**.

Sequential

4.9.35 Sequential visual effects have been investigated through analysis of six routes. These routes were selected in consultation with the landscape consultant for Carnedd Wen and the reasons for selection are set out below:

- A470(T) – main road between Newtown and Dolgellau which passes through the south of the SSA and up the western side of SSA B into the National Park;
- A458(T) – main road between Welshpool and Mallyd which passes through the north of the SSA;
- Minor road between Llanerfyl and Talerddig – passes through the centre of the SSA;
- Minor road between Staylittle and Llanbrynmair – approaches the SSA from the south;
- Minor road between Bwlch y Groes and the A470 – pass within the National Park linking the Bwlch y Groes viewpoint with the A470;
- Glyndŵr's Way National Trail – long distance recreational route that passes through the SSA.

Table 4.40 Sequential Cumulative Effects on Routes

Route and sensitivity	Cumulative effect on views from route
A470(T) Viewers have a **low** sensitivity because they are passing at speed through the landscape	***Baseline*** The first section of this route is a main road between Caersws and Cemmaes Road, passing through a number of villages including Carno, Talerddig and Llanbrynmair. The road is in a valley between hills and is typically bounded by hedges with views to the adjacent hills. The second part of this route heads north, passing through Cemmaes and entering the National Park at Mallwyd before heading west towards Dollgellau. There are some glimpses of the Carno turbines from the area around Carno and glimpses of the Cemmaes turbines from the section of road around Cemmaes Road/ Cemmaes. There are no views of any of these schemes from the section of route in the National Park.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt For much of the route the ZTV indicates theoretical visibility of other

Route and sensitivity	Cumulative effect on views from route
	wind farms (but not Llanbrynmair) or Llanbrynmair only. For a short section between Carno and Talerddig the bare ground ZTV indicates that Llanbrynmair would theoretically be seen at the same time as the turbines at Carno I and II, Cemmaes 2 and Tirgwynt (albeit in different directions). From this section the Llanbrynmair turbines will be more visible than the other turbines. However, they will only be visible from a small part of the route and there will be no visibility from the section of route in the National Park. Overall, it is judged that the addition of Llanbrynmair will result in a low magnitude of change to views from the route and an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Assuming the other proposed wind farms are also present, the same pattern of visibility would occur (with Esgair Cwmowen and Carnedd Wen adding to the turbines visible from the area north of Carno and Cemmaes 3 adding to visibility of turbines from the area around Cemmaes Road/ Cemmaes). However, the Llanbrynmair turbines would still only affect a small part of the route and when driving this route vegetation would screen views of the more distant turbines. The addition of Llanbrynmair would result in a low magnitude of change to views from this road and this would result in an additional effect of **minor** significance.
A458(T) Viewers have a **low** sensitivity because they are passing at speed through the landscape	***Baseline*** A main road between Welshpool and the Snowdonia National Park, passing through a number of villages including Llanfair Caereinion, Llanerfyl, Llangadfan, and Foel. The road is in a valley between hills and is typically bounded by hedges with views to the adjacent hills. There are currently no wind farms visible from this road.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The bare ground ZTVs for Tirgwynt and Llanbrynmair indicate patch visibility from some parts of the route. However, in reality vegetation will most likely screen views of the turbine tips from this road and the addition of Llanbrynmair would result in a barely perceptible magnitude of change to views from this main road. The introduction of Llanbrynmair would result in a **negligible** additional effect.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest Even if other proposed wind farms are more visible, the additional change in views arising from the introduction of Llanbrynmair will be barely perceptible and the effect **negligible**.
Minor road between Llanerfyl and Talerddig Viewers have a **medium** sensitivity since they are passing at slower speeds along this minor road	***Baseline*** A minor road between Llanerfyl and Talerddig, passing through Nant yr Eira between the hills of the Llanbrynmair Moors and Esgair Cwmowen. The road has high hedges in the lower sections and open verges in higher areas. The turbines of Carno I and II are visible from the section of road that descends towards Talerddig.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The turbines at Tirgwynt may be glimpsed from a couple of very short sections of this route, but Llanbrynmair will be the most prominent schemes seen from this route. The introduction of Llanbrynmair will result in a high magnitude of change to views from about 6km of this route, as recorded in the LVIA, resulting in an effect of **major** significance.

Route and sensitivity	Cumulative effect on views from route
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest The presence of Carno III will intensify the number of turbines visible from the section of road that descends towards Talerddig. The turbines of Carnedd Wen will be visible from much of the route. In addition, the turbines at Mynydd Waun Fawr will be visible in the opposite direction from Carnedd Wen and the turbines at Dyfnant Forest will be visible in the distance when driving north towards Llanerfyl. The turbines at Llanbrynmair will be the closest to, and therefore most prominent when viewed from, this route. Despite the presence of other proposed wind farms, the introduction of Llanbrynmair will result in a high magnitude of change to views from this route, resulting in an effect of **major** significance.
Minor road between Staylittle and Llanbrynmair Viewers have a **medium** sensitivity since they are passing at slower speeds along this minor road	***Baseline*** A minor road between Staylittle and Llanbrynmair, passing through valley landscapes and the villages of Pont Crugnant, Pennant, Bont Dolgadfan and Llan. Only the turbines of Cemmaes 2 are visible from short sections of road when travelling north (from the southern part of the route and the northern part on approaching Llanbrynmair).
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Tirgwynt would not affect this baseline (Tirgwynt will not be visible from this route). Llanbrynmair will be visible from the northern part of the route e.g. through Llan and approaching Llanbrynmair, in a different direction from Cemmaes 2. However, views will only be available for part of the route resulting in a low magnitude of change to views from the route as a whole. The introduction of Llanbrynmair will result in an additional effect of **minor** significance.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest If other proposed wind farms were present, the Cemmaes 3 turbines would be visible from a short section south of Pennant and Carnedd Wen would be visible from much of the route north of Pennant. The Llanbrynmair turbines would be visible to the right of the Carnedd Wen turbines from the northern part of the route between Llan and Llanbrynmair where they would increase the angle of view occupied by turbines, but will not introduce turbines into a new direction of view. The introduction of Llanbrynmair in this context will result in a low additional change to views from the route and an effect of **minor** significance.
Minor road between Bwlch y Groes (Pass of the Cross) and the A470 Since this local road traverses the National Park, and focus is likely to be on the landscape, viewer sensitivity is judged to be **high**	***Baseline*** Bwlch y Groes is the highest pass in Wales. This route starts at Lake Vyrnwy but the section of route included in this assessment starts at the high point at Bwlch y Groes and descends southwards towards the A470. The northern part of the road is narrow and open with dramatic views south towards the flat topped hills outside the National Park. It then descends into a valley landscape where high hedges border the road, restricting views out (although there are glimpses to the surrounding hills). On the initial descent some of the turbines of Carno II (25km away) and Cemmaes 2 (13km away) are visible in clear conditions – on the hills at the end of the valley. Carnedd I and Mynydd Clogau are not visible from the route.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Tirgwynt would not affect this baseline (Tirgwynt will not be visible from this route). A few tips of the Llanbrynmair turbines will be

Route and sensitivity	Cumulative effect on views from route
	visible from a very short section at the top of the pass to the left of the Carno turbines. Any additional change in views from the route will be barely perceptible. The introduction of Llanbrynmair will result in a **negligible** additional effect.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest If other proposed wind farms were present, the introduction of Llanbrynmair would still result in a barely perceptible change to views from this route and a **negligible** additional effect.
Glyndŵr's Way National Trail Since this is a National Trail, and focus is likely to be on the landscape, viewer sensitivity along this route is considered to be **high**	***Baseline*** Glyndŵr's Way National Trail is a 217km long trail starting at Knighton on the English border and finishing by the Montgomeryshire Canal in Welshpool. Within 10km of the Llanbrynmair turbines the route runs from Ddol Cownwy, up and through Dyfnant Forest, through Penyfford (CVP2), crosses the Banwy Valley At Llangadfan, over Pen Coed (CVP9) and into the Eira Valley (following a minor road along part of its route through this valley), up onto the Llanbrynmair Moors west of Neinthirion, through an area of forestry and across Terrig y Tan before dropping down into Llanbrynmair, and rising back up on Mynydd y Cemmaes (CVP1) before heading west to Cemmaes Road. The existing turbines at Carno are visible from high points e.g. short sections at Penyfford, Pen Coed, Llanbrynmair Moors and Mynydd y Cemmaes. Cemmaes 2 is visible from the western parts of the Llanbrynmair Moors and Mynydd y Cemmaes and Mynydd Clogau is visible from the upper open parts of the Llanbrynmair Moors.
	Assessment Scenario A: Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt The addition of Tirgwynt would increase visibility of turbines from some of the more elevated parts of the route e.g. from the edge of Dyfnant Forest/ Penyfford, Pen Coed, the Llanbrynmair Moors and upper parts of Mynydd y Cemmaes. Llanbrynmair would also be visible from these areas, as well as from the whole of the Eira Valley and large parts of the Llanbrynmair Moors. The turbines at Llanbrynmair will be closer to the route than any other existing or consented wind energy development in SSA B and will therefore be more prominent in views from the route. It will introduce development into a new part of the view and increase the relative duration of views of wind energy developments from this route. The effect of adding Llanbrynmair to this baseline will be the same as reported in the LVIA i.e. a high magnitude of additional change to views from this route within 5km (between Pen Coed and Brynaere), but a low magnitude of change to the 217km long route as a whole. The significance of effect will be **major** within 5km (between Pen Coed and Brynaere) and **minor to negligible** on the route as a whole.
	Assessment Scenario B: Carno I II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest If other proposed wind farms were present, the route would pass through the Dyfnant Wind farm and the Carnedd Wen Wind farm. Although the addition of Llanbrynmair would not increase the relative duration of views of wind energy developments from this path (there are no areas from which Llanbrynmair alone would be visible) and would not introduce turbines into a new direction of view (due to the presence of Carnedd Wen on the Llanbrynmair Moors), it would be more prominent than others schemes in views from the Eira Valley section of the route. In this context the addition of Llanbrynmair would result in a medium magnitude of additional change to views from this route within 5km (between Pen Coed and Brynaere), but a barely perceptible magnitude of change to the 217km long route as a whole. The significance of effect will be **moderate**

Route and sensitivity	Cumulative effect on views from route
	within 5km (between Pen Coed and Brynaere) and **negligible** on the route as a whole.

4.10 Micrositing

4.10.1 Micrositing is necessary to allow for minor changes in site layout at the construction stage to minimise environmental effects.

4.10.2 The effect of micrositing distances on landscape and visual amenity will vary according to the size and layout of the wind farm, and the proximity to residential receptors. In this instance it is considered that micrositing distances of up to 50m are unlikely to result in a material change in the appearance of the wind farm or alter landscape and visual effects reported. It is considered that the results of this landscape and visual impact assessment hold true for micrositing distances of up to 50m.

4.11 Summary

4.11.1 A summary of significant effects is provided below.

Construction Effects

4.11.2 During construction there will be **major** temporary and localised effects on the character of the site and along the offsite access road between Llanerfyl and Talerddig (where road widening, passing bays, structural works to bridges and new sections of track are being constructed) as a result of the presence of construction activities and loss of landscapes features alongside the road. This will particularly affect Gosen bridge, Glen Menial bridge, Dolwen Isaf bridge, Neinthirion and the road widening/laybys between Llanerfyl and the northern site access.

4.11.3 There will be a significant (**major**) temporary effect on recreational users on the Glyndwr's Way National Trail between Pen Coed and Brynaere as a result of seeing construction of the wind farm (including turbines, tracks, ancillary components and offsite access works including the Neinthirion bypass).

4.11.4 In addition, there will be significant (**major**) temporary effects on the following receptors as a result of the offsite access works:

- A few residents (less than 5 properties) in Diosg;
- Residents of three properties on the approach to, and at, Gosen Bridge;
- Motorists on the road between Llanerfyl and site access 4 (ie sections 1 and 2 of the route).

4.11.5 There will be significant (**moderate**) temporary effects on the following receptors as a result of the offsite access works:

- Residents around the junction in Llanerfyl;
- Residents at Sychtyn Farm;
- Residents of 2 properties at Cwmderwen;
- Residents of one property at Nant-yr-esgair-wen Farm;
- Motorists on the road between Talerddig and site access 4 (ie section 3 of the route).

4.11.6 There will be significant (**moderate**) temporary effects on residents of Llan, travellers on the A470 (on localised sections between Carno and Talerddig and west of Llanbrynmair) as a result of seeing the turbines being constructed on the skyline at relatively close proximity.

Operational Effects: Landscape

Table 4.41: Summary of Significant Effects on Landscape Character

Receptor	Sensitivity	Magnitude of Change	Significance of Effect
Regional Character Areas within 30km (A Character Map for Wales)			
Cambrian Mountains RCA	High	High magnitude of change to the landscape on the site within the red line boundary. Imperceptible magnitude of change to the character of the RCA as a whole.	**Major** effect on the site within the red line boundary. **Negligible** effect on the character of the Cambrian Mountains RCA as a whole.
Landscape Character Areas within 10km (Powys LCA)			
Powys LCA 5 - Dyfnant Forest/Llanbrynmair Moors	Medium	High magnitude of change to the landscape on the site within the red line boundary. Medium magnitude of change up to 3km.	**Major** effect on the site within the red line boundary. **Moderate** effect on a localised area up to 3km
Powys LCA M11 - Mynydd y Cemmaes	Medium	Medium on the eastern edge of the LCA	**Moderate** effect on the eastern edge up to 3km
Powys LCA M13 - Tregynon/Llanerfyl	Medium	Medium within the Eira Valley (western part of the LCA)	**Moderate** localised effect within the Eira Valley (western part of the LCA)
Powys LCA M14- Esgair Cwmowen	Medium	Medium magnitude of change to perceptual character in a localised area on the north-western edge of this LCA, up to about 3km	**Moderate** localised effect on the north-western edge of this LCA, up to about 3km
LCA M22 - Trannon	Medium	Medium magnitude of change to perceptual character at the northern tip of the LCA, up to about 3km	**Moderate** localised effect on the northern tip of this LCA up to about 3km (i.e. around Newydd Fynddog)
Powys LCA M23 - Carno Valley	Medium	Medium magnitude of change to a localised part of this LCA due to the upgrade of the Talerddig junction)	**Moderate** localised effect at the northern end of the LCA (i.e. at the site of the Talerddig junction)
LANDMAP: ***Visual & Sensory***			
Visual and Sensory Aspect Area MNTGMVS320 Banwy Forest	Low evaluation	High on the site within the red line boundary. .	**Major** localised effect on the site within the red line boundary. .
Visual and Sensory Aspect Area MNTGMVS264 Banwy Upland	Moderate evaluation	High on the site within the red line boundary. Medium on the remainder.	**Major** localised effect on the site within the red line boundary. **Moderate** effect on the remainder of the aspect area.
Visual and Sensory	Moderate evaluation	Medium on the	**Moderate** effect on the

Receptor	Sensitivity	Magnitude of Change	Significance of Effect
Aspect Area MNTGMVS363 Newydd Ffynddog		northern extremity up to about 3km	northern extremity at Newydd Ffynddog
Visual and Sensory Aspect Area MNTGMVS571 Pen Coed Upland	Moderate evaluation	High on the site within the red line boundary. Medium up to about 3km from the turbines	**Major** localised effect on the site within the red line boundary. **Moderate** localised effect on Pen Coed.
Visual and Sensory Aspect Area MNTGMVS733 Esgair Cwmowen Uplands	High evaluation	Medium up to about 3km from turbines	**Moderate** localised effect on the north-west edge of the area (up to about 3km from turbines).
Visual and Sensory Aspect Area MNTGMVS422 Llanerfyl Mosaic Farmlands	High evaluation	Medium change to a localised part of this Aspect Area up to about 3 km (i.e.in the Eira Valley).	**Moderate** effect immediately surrounding the site (i.e.in the Eira Valley).
Visual and Sensory Aspect Area MNTGMVS337 Cwm Tafalog	Moderate evaluation	Medium on high ground in the southern extremity of this area	**Moderate** localised effect on high ground in the southern extremity of this area.
Visual and Sensory Aspect Area MNTGMVS696 Carno Grazing	Moderate evaluation	Medium change to site of Talerddig junction (due to junction improvements).	**Moderate** localised effect on the site of the Talerddig junction.

Visual Effects

Table 4.42: Summary of Significant Effects on Views

Receptor	Sensitivity	Magnitude of Change	Significance of Effect
Views from Representative Assessment Viewpoints			
Viewers at viewpoint 1: Glyndwr's Way above Cwmderwen	High	High	Major
Viewers at viewpoint 2: Cwmderwen	Medium	High	Major
Viewers at viewpoint 3: Minor road above Ffridd Fawr	Medium	High	Major
Viewers at viewpoint 4: Glyndŵr's Way, Cefnllys-uchaf	High	High	Major
Viewers at viewpoint 5: Glyndwr's Way/ minor road east of Neinthirion	High	High	Major
Viewers at viewpoint 6: Glyndwr's Way at Moel Ddolwen	High	High	Major
Viewers at viewpoint 9:	Medium	Medium	Moderate

Receptor	Sensitivity	Magnitude of Change	Significance of Effect
Talerddig			
Viewers at viewpoint 10: Glyndŵr's Way, Brynaere	High	High	Major
Viewers at viewpoint 11: Llan Village	High	Medium	Moderate
Viewers at viewpoint 13: Glyndwr's Way at Penyfford	High	Medium	Moderate
Viewers at viewpoint 14: Bryn y Gadair	Medium	Medium	Moderate
Viewers at viewpoint 23: Minor Road within Nant yr Eira	Medium	High	Moderate
Viewers at viewpoint 24: Glyndwr's Way at Pen Coed	High	High	Major
Views from Settlements			
Llan	High	Medium	Moderate
Views from Routes			
Motorists on localised sections of the A470(T)	Low	Medium	Moderate
People on approximately 6km of the minor road between Llanerfyl and Talerddig	Medium	High	Major
People walking the Glyndwr's Way between Pen Coed and Brynaere	High	High	Major
Additional Receptors Affected by Offsite Road Access			
Residents of three properties on the approach to, and at, Gosen Bridge	High	Medium	Moderate

Cumulative Effects

Table 4.43: Summary of Significant Cumulative Effects

Receptor	Sensitivity	Magnitude of Change	Significance of Effect
Additional effect of Llanbrynmair in context of existing and consented wind farms (Scenario A)			
Landscape character of SSA B	Medium	Medium	Moderate
Viewers at cumulative viewpoint 1:Glyndwr's Way, Brynaere	High	Medium	Moderate
Viewers at cumulative viewpoint 2: Glyndwr's Way, Penyfford	High	Medium	Moderate
Viewers at cumulative viewpoint 9: Glyndwr's Way crossing Pen Coed	High	Medium	Moderate

Viewers at cumulative viewpoint 10: Garreg Hir	High	Medium	Moderate
Viewers at cumulative viewpoint 13: Open access land north-west of Mynydd Waun Fawr	High	Medium	Moderate
People using the minor road between Llanerfyl and Talerddig	High	High	Major
People walking the Glyndwr's Way between Pen Coed and Brynaere	High	High	Major
Additional effect of Llanbrynmair in context of existing, consented and proposed wind farms (Scenario B)			
Viewers at cumulative viewpoint 9: Glyndwr's Way crossing Pen Coed	High	Medium	Moderate
People using the minor road between Llanerfyl and Talerddig	Medium	High	Major
People walking the Glyndwr's Way between Pen Coed and Brynaere	High	Medium	Moderate

4.12 Statement of Significance

During Construction

4.12.1 During construction, the landscape and visual impact assessment identifies a significant (major) effect on the landscape character of the site and along localised parts of the offsite access road between Llanerfyl and Talerddig (where road widening, passing bays, structural works to bridges and new sections of track are being constructed) as a result of the presence of construction activities and loss of landscapes features alongside the road. This will particularly affect Gosen bridge, Glen Menial bridge, Dolwen Isaf bridge, Neinthirion and the road widening/laybys between Llanerfyl and the northern site access. However, landscape features will be replanted and this effect will be localised and temporary. The agreed mitigation measures will ensure that the works will be assimilated successfully into the landscape within a period of approximately 5 years.

4.12.2 These construction activities will also result in a significant (major) temporary visual effect on people walking along the Glyndwr's Way National Trail between Pen Coed and Brynaere.

4.12.3 There will be significant (moderate) temporary visual effects on residents of Llan and travellers on the A470 (on localised sections between Carno and Talerddig and west of Llanbrynmair) as a result of seeing the turbines being constructed on the skyline at relatively close proximity.

4.12.4 In addition, the offsite access works will result in a significant (major) temporary effect on views from a few properties (less than 5) in Diosg, three properties on the approach to, and at, Gosen Bridge, and motorists on the section of road between Llanerfyl and site access 4; and a lesser, but still significant, (moderate) effect on views from residents around the junction in Llanerfyl, residents at Sychtyn Farm, 3-4 Properties in Neinthirion, two properties at Cwmderwen, a property at Nant-yr-esgair-wen Farm and motorists on the section of road between Talerddig and site access 4. These effects will be short-lived (ie during the 24 month construction period).

Operational Effects

4.12.5 During operation, landscape and visual effects have been minimised through careful siting and design. Nevertheless, the landscape and visual impact assessment identifies a significant (major) long-term effect on the character of the proposed Site – this will affect a localised part of the Cambrian Mountains Regional Character Area, a localised part of the Dyfnant Forest/ Llanbrynmair Moors LCA, and localised parts of three of the LANDMAP visual & sensory aspect areas (Banwy Forest, Banwy Upland, and Pen Coed Upland).

4.12.6 The operational wind farm will also have a characterising effect on the landscape around the site, affecting perceptual character (visual and sensory characteristics) up to approximately 3km from the turbines. This will affect a localised part of the Cambrian Mountains Regional Character Area, localised parts of six of the Powys Landscape Character Areas (the Dyfnant Forest/ Llanbrynmair Moors, Mynydd y Cemmaes, Tregynon/ Llanerfyl, Esgair Cwmowen, Trannon and Carno Valley) and parts of seven Visual and Sensory Aspect areas that cover this same area.

4.12.7 The assessment also identifies that there will be some significant (major) long term effects on viewers close to the site (e.g. from points along the Glyndwr's Way between Moel Ddolwen and Brynaere and points along the minor road between Llanerfyl and Talerddig) as a result of the addition of turbines, tracks and ancillary features at close proximity which will inevitably change views. There will be moderate (also significant) effects on viewers within 10km of the site (e.g. from points more distant locations on Glyndwr's Way and the minor road between Llanerfyl and Talerddig, on Llan Village, on the A470 at Talerddig and on elevated locations within 10km such as Bryn y Gadair). Viewers at viewpoints beyond 10km will not experience significant effects.

4.12.8 The assessment identifies a significant (major) long term effect on views from one route (the Glyndwr's Way between Pen Coed and Brynaere) due to the proximity of the development to this National Trail; and a significant (moderate) effect on views from localised sections of the A470(T) as a result views of the turbines. However, there will be minor (not significant) changes to views from other more distant routes (e.g. the A458 and the railway line linking Shrewsbury and the Midlands with Aberystwyth). It should be noted that any wind farm development in this TAN 8 area would result in a significant effect on the Glyndwr's Way National Trail.

4.12.9 There will be a significant (moderate) long term effect on views from the settlement of Llan due to the upper parts of 11 turbines being clearly visible on the skyline in views up the village street; and a significant (moderate) medium term effect on views of residents in three properties around Gosen Bridge due to the extent of works required to widen Gosen Bridge and the length of time it will take for vegetation (particularly trees) to re-establish. There will be no other significant effects on views from any other settlement.

4.12.10 Of the individual properties assessed, eight of the 63 assessed will experience a high magnitude of change to views as a result of a large proportion of the Proposed Development being visible from their primary outlook or curtilage. For these properties an assessment of the changes in visual amenity 'in the round' was undertaken to inform an assessment of effects on the visual component of 'living conditions'. In all cases it was found that the Proposed Development will not appear dominant, oppressive or overwhelming.

4.12.11 None of the special qualities of the Snowdonia National Park (as set out in the Snowdonia National Park Management Plan 2010-15) will be affected by the Proposal and, although there will be views of turbines from the National Park (see VPs 16, 18, 19 and 21), they will not cause "significant visual intrusion".

4.12.12 The Proposal will not result in a significant effect on the perceptual character or the 'primary landscape qualities and features' set out in Ceredigion CC's 'Designation of Special Landscape Areas'.

4.12.13 All the operational effects identified are reversible.

Cumulative Effects

4.12.14 The cumulative assessment concludes that the presence of all existing and proposed wind farms in Strategic Search Area B (Carno North) would inevitably result in a significant change to landscape character in a localised area at the northern end of the Cambrian Mountains RCA. This will create a landscape with wind farms in an area which is recognised at a national level as being a suitable area for wind farm development, and in which landscape change is expected.

4.12.15 The role that the Llanbrynmair Wind farm plays in this change was assessed according to two potential scenarios:

Scenario A: Llanbrynmair in the context of existing and consented wind farms (Carno I and II, Cemmaes 2, Mynydd Clogau and Tirgwynt)

Scenario B: Llanbrynmair in the context of existing, consented and proposed wind farms (Carno I, II and III, Cemmaes 2 and 3, Mynydd Clogau, Tirgwynt, Esgair Cwmowen, Mynydd Waun Fawr, Carnedd Wen and Dyfnant Forest)

4.12.16 The cumulative assessment concludes that the addition of Llanbrynmair in the context of Scenario A would result in a significant (moderate) additional change to landscape character, but the addition of Llanbrynmair in the context of Scenario B would not result in a significant additional change. This is because in Scenario A Llanbrynmair would introduce a new group of turbines and would be the largest group (after the Carno group) whereas in Scenario B Llanbrynmair would appear to form an extension to the Carnedd Wen Wind Farm and would fit with the pattern of other proposed developments in the SSA.

4.12.17 The same two scenarios were assessed for cumulative visual effects.

4.12.18 The cumulative assessment concludes that in the context of Scenario A, there will be a significant (moderate) additional effect on views at cumulative viewpoints within 10km of the Proposed Development (CVPs 1, 2, 9, 10, 13) largely due to the prominence of the Llanbrynmair turbines compared to other existing/ consented turbines in these views. In the case of CVP10 Llanbrynmair would fill the gap between Cemmaes and Tirgwynt. This cumulative scenario would also result in a significant (major) additional effect on views from the minor road between Llanerfyl and Talerddig and the Glyndwr's Way National Trail between Pen Coed and Brynaere due to Llanbrynmair being more prominent in views from these routes than other existing/consented schemes.

4.12.19 In the context of Scenario B there would be fewer significant cumulative (additional) visual effects resulting from Llanbrynmair because other proposed schemes would have a greater influence on views than Llanbrynmair in most cases. There will still be a significant (albeit lesser) moderate additional effect on views from the Glyndwr's Way National Trail between Pen Coed and Brynaere. Although other proposed turbines will also be close to this route the Llanbrynmair turbines will remain prominent thereby resulting in a significant additional effect on views. This additional change will also affect CVP8 which is on the Glyndwr's Way crossing Pen Coed. There will continue to be a significant (major) additional effect on views from the minor road between Llanerfyl and Talerddig due to Llanbrynmair having a greater visual influence on views from this route than other existing and proposed schemes.

4.12.20 The residential visual amenity assessment considered potential cumulative change to views and visual amenity as a result of introducing the Proposed Development to a baseline which already contained Carnedd Wen Wind Farm. Of the 63 properties assessed six properties were judged to experience a high magnitude of cumulative change as a result of the addition of Llanbrynmair. For these properties an assessment of the changes in visual amenity 'in the round' was undertaken to inform an assessment of effects on the visual component of 'living conditions'. In all cases it was found that the turbines of Llanbrynmair, if present in isolation or alongside the proposed turbines of Carnedd Wen Wind Farm, would not appear dominant, oppressive or overwhelming.

4.13 References

Countryside Council for Wales (2008) LANDMAP Information Guidance Note 3;

Countryside Agency and Scottish Natural Heritage (2002) Landscape Character Assessment Guidance for England and Scotland and accompanying Topic Paper 6 'Techniques and Criteria for Judging Capacity and Sensitivity' (2004);

Landscape Institute and Institute of Environmental Assessment, 2nd edition (2002) Guidelines for Landscape Visual Impact Assessment;

Landscape Institute and Institute of Environmental Assessment, 3rd edition (2013) Guidelines for Landscape Visual Impact Assessment;

Landscape Institute Advice Note 01/11 Photography and photomontage in landscape and visual impact assessment;

Natural Resources Wales (2013) LANDMAP Information Guidance Note 3;

Scottish Natural Heritage (March 2006) Visual Representation of Wind Farms, Good Practice Guidance. Prepared by Horner & Maclennan / Envision;

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

Powys Unitary Development Plan (UDP) 2001 – 2016.

Powys Local Development Plan (LDP) - Preferred Strategy.

Powys CC (2008) Second Draft Interim Development Control Guidance: Wind farm Development in Powys.

Powys County Council (2006) TAN 8 Annex D Study of Strategic Search Areas B (Carno North) and C (Newtown South).

5 ECOLOGICAL ASSESSMENT

5.1 Introduction

5.1.1 This Chapter has been undertaken by Ecology Matters Ltd and assesses the potential effects of the proposed wind farm development near Llanbrynmair in Powys, mid Wales, on the ecology of the vegetation and mammals. Please note the assessment of bats will follow in a separate SEI package and avian features are considered in Chapter 6: Ornithology.

5.1.2 The assessment provides baseline information, identifies potential impacts on the ecology of the area, 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 Chapter also discusses ongoing management and monitoring measures.

5.1.3 The proposed development site (the Site) is shown in Figure 1.1 and is situated in the old county of Montgomery in Powys. The area is in the uplands north-east of Llanbrynmair. The Site is an undulating plateau, bounded to the east by Afon Gam in Cwm Nant yr Eira and by Clegyrnant watercourse to the west. It lies over Silurian geology, covers approximately 17 square kilometres and runs from roughly 200 metres a.s.l. in Cwm Nant yr Eira up to 475 metres near Llyn Gwyddior. It is bordered by conifer plantations and agriculturally improved pasture, but also unimproved upland habitats, such as acid grassland and smaller areas of heath and mire.

5.1.4 Rather species-poor acid, marshy or improved pasture and conifer plantations cover large parts of the site, but there are also large areas with a mosaic of mire (some rather modified), marshy and acid grassland, and heath. The site is mainly divided by fences. Sheep and cattle graze parts of the area.

5.1.5 The Proposal has undergone several major revisions which are detailed in Chapter 3, Section 3.3. The current proposal will include 30 wind turbines, associated transformers, crane hardstandings, temporary and permanent anemometer masts, access tracks, underground cabling, a substation compound with control buildings and HV electrical enclosures, borrow pits and temporary construction compounds (See Chapter 3 for details).

5.1.6 This Chapter provides the details of the various surveys for vegetation and mammals that have been completed during the development of the project. Most have previously been submitted in the original Environmental Statement (ES) and further Supplementary Environmental Information (SEI) sections but are now brought together in one chapter. The Chapter also includes some further assessment following the latest design changes. Further assessment of the ecology of the site is to be found in Chapter 6 – Ornithology; an additional SEI package on and in Chapter 8 Hydrology for peat.

5.2 Ecological Impact Assessment (EcIA) Principles & Methodology

5.2.1 This is a brief overview of the process employed in this assessment, and gives definitions used in this chapter. Full details of the process are found in Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM, 2006).

Scoping

5.2.2 Scoping for this study involved a formal scoping report sent to consultees. From replies to this report, discussions between consultants and the developer, and using knowledge from other such developments, the necessary surveys and appropriate methodologies are identified, as well as the area requiring survey and the key possible impacts.

Identifying the Baseline

5.2.3 The surveys identified during scoping are employed to identify the key ecological features and describe the baseline ecology of the site. Standard methodologies are employed where these exist and are suitable. If novel techniques are required these are described.

Identifying Value

5.2.4 An assessment is made of the ecological and conservation value of the habitats and species identified. This is based on a number of criteria, including statutory designations, local designations, rarity, sensitivity and ecological significance. The value or potential value of an ecological resource or feature should be determined within a defined geographical context. The following frame of reference is used:

- International;
- UK;
- National (i.e. England/Northern Ireland/Scotland/Wales);
- Regional;
- County;
- District;
- Local or Parish; and
- within zone of influence only (which might be the project site or a larger area).

5.2.5 The sensitivity of the resources valued in the above exercise is then assessed.

Assessment of Impacts

5.2.6 Having identified the possible impacts, and identified the key species and habitats likely to be impacted, the level and significance of the impacts are assessed.

5.2.7 In order to be clear about the confidence of prediction the following terms are used:

- Certain/near-Certain: probability estimated at 95% chance or higher.
- Probable: probability estimated above 50% but below 95%.
- Unlikely: probability estimated above 5% but less than 50%.
- Extremely Unlikely: probability estimated at less than 5%.

5.2.8 Significance is a concept often used, but is difficult to define. In the Guidelines, an ecologically significant impact is defined as 'an impact (negative or positive) on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical area'.

5.2.9 The integrity of a site is described in Government guidance on the application of the EU Habitats Directive (EU 1992) as:

> *' the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified.'*

5.2.10 In assessing whether the integrity of a site will be changed it is usual to examine the extent of any possible change, whether any ecosystem processes will be changed and whether the average population size and viability of any species will be affected.

5.2.11 The conservation status is derived from The EC Habitats Directive (Article 1, sections (e) and (i)) which provides a helpful definition of 'conservation status' for habitats and species. This guidance uses slightly modified versions of these definitions so that evaluation of conservation status can be applied to habitats or species within any defined geographical area:

> *'for habitats, conservation status is determined by the sum of the influences acting on the habitat and its typical species, that may affect its long-term distribution, structure and functions as well as the long-term survival of its typical species within a given geographical area; and*

for species, conservation status is determined by the sum of influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within a given geographical area.'

Mitigation, Compensation and Enhancement

5.2.12 The guidelines state that 'There is a growing body of opinion that new developments should deliver net ecological gain rather than simply being designed to achieve mere damage limitation. Therefore, right from the start, proponents of any scheme should incorporate, as part of the proposals for scheme design and implementation, measures that are required to deliver ecological enhancements as well as measures to:

- avoid negative ecological impacts - especially those that could be significant;
- reduce negative impacts that cannot be avoided; and
- compensate for any remaining significant negative ecological impacts.'

Residual Impacts

5.2.13 Any impacts remaining after mitigation are residual impacts and will be clearly identified and assessed.

5.3 Site Surveys Overview

5.3.1 In order to establish a baseline and identify potentially sensitive species and habitats, surveys were undertaken to establish the mammal (other than bat) and plant communities at Llanbrynmair and were carried out in 2006, 2007 and 2008. Standard survey techniques were employed to:

- Identify and map plant communities.
- Record any other mammal species of conservation interest.

5.3.2 As with all time limited ecological surveys, the results outlined below give a snapshot of conditions at the time of survey. They are not necessarily an indication of every species on the Site but recognised sampling techniques are used to give sufficient information to assess the overall possible ecological impact of the proposed development.

5.4 Legal and Policy Context

5.4.1 The following legislation relates to species and habitats that could potentially occur within the study area:

- The Conservation (Natural Habitats, &c.) Regulations 2010;
- The Wildlife and Countryside Act 1981 (as amended);
- The Countryside and Rights of Way (CRoW) Act 2000;
- The Badgers Act 1992;
- The Natural Environment and Rural Communities Act 2006.

5.4.2 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).

5.4.3 TAN 5 sets out policies on different aspects of planning in Wales regarding nature conservation that planning bodies should adhere to. The document provides advice on protected areas and protected species, but it also states that:

> *'Statutory sites and non-statutory sites, together with features which provide wildlife corridors, links or stepping stones from one habitat to another, all contribute to the network necessary to ensure the maintenance of the current range and diversity of our flora, fauna, geological and landform features and the survival of important species. Sensitive landscaping and planting, the creation, maintenance and management of landscape features important to wildlife and the skilled adaptation of derelict areas can provide extended habitats (3.2.2 [Para 28])'.*

5.4.4 This has been taken into account in this assessment.

5.4.5 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 ENV 7 – Protected Species.

5.4.6 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.

5.5 Scope of Work

Spatial

5.5.1 A desk study identified any statutory designated sites within the survey area for the Site. Non-statutory designated sites, habitats and notable species were also identified within the Site survey area and the surrounding 1 km. The extent of individual field surveys reflected the likely limits of any ecological impacts of the proposed wind farm on the particular species and habitats surveyed.

Temporal

5.5.2 The assessment considers effects with and without development, currently, prior to construction, during construction, during operation, and at decommissioning.

5.6 Consultation

5.6.1 Consultation was undertaken by RES at scoping stage in 2005. The responses are shown in Table 5.1 below.

Table 5.1.Responses to consultation.

Consultee	Comments
Natural Resources Wales	Details of surveys required
Natural Resources Wales	Water crossings and impacts on hydrology should be minimised to avoid impacts on protected species. Opportunities for habitat creation and enhancement should be fully taken.
Wildlife Trust	General comments given, along with details of known sites in the wider area, none of which were on or adjacent to this site.

5.6.2 Following consultation the scope of the original field surveys was agreed between Ecology Matters and RES. Following submission of the initial Environmental Statement, and following site re-design as described in Chapter 3 Section 3.3 further consultation took place and further surveys were agreed and carried out. All are all described below.

5.7 Methodology

5.7.1 The determination and appraisal of the baseline conditions present at the Site were undertaken through a combination of desk study and field surveys.

5.7.2 A desk study was carried out to collate existing records from the Site and surrounding area and to inform the necessary field surveys. CCW (now NRW) and Powys Biodiversity Records Centre were approached for background records of statutory and non-statutory designated sites and protected species and species of local interest.

5.7.3 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 automatically mean that they do not occur in the study area. Likewise, the presence of records for protected species does not automatically mean that these species still occur within the area of interest, only that conditions were once suitable. This is particularly true with older records.

5.7.4 The field survey work undertaken comprised the following elements:

- Vegetation survey
- Protected mammals survey.

Access Route

5.7.5 The proposed access route along roads off the Site required a number of road improvement works. As this would involve some effects on roadside habitats, the northern access route between the Site and the A487 was surveyed in October 2008. Any sensitive habitats were identified and mitigation measures developed. Following amendments to the Site access route, habitats were surveyed along the entire minor road between the A470 in the south and the A487 in the north. These surveys took place in the spring of 2013.

Vegetation Survey

5.7.6 The plant communities were originally classified according to Phase 1 habitat survey methodology (JNCC 2003) The Site was walked in July 2007 and vegetation encountered in each area was assessed by eye, noting the frequency and abundance of plant species and any areas of bare ground. Following the Site turbine layout design, further visits were made in 2008 to assess areas identified as sensitive.

5.7.7 Following further discussion with CCW the site was re-surveyed in 2010 using the National Vegetation Classification. The methodology for NVC survey followed that outlined in Rodwell

(1991 *et seq.*). The plant communities were assessed mainly by eye by walking the site, particularly along the proposed track and turbine layout, and communities confirmed by taking sample quadrats. Sample peat depths were also taken and are discussed in the Hydrology section (Chapter 8).

Mammal Species

5.7.8 The Site's main ridges and tops were walked from various access points over a period of 4 field days, (9th /30th May and 28th/ 31st July 2006), and the area searched for any signs of mammals.

5.7.9 Interesting areas above mid-slope were looked at with particular reference to possible water vole usage. The surrounds of Llyn Gwyddior and some of the conifer plantation boundaries were also targeted as possible sites for otter, water vole and badger use respectively.

5.7.10 Records of mammal sightings and signs were taken during all other surveys during 2006. 2007, 2008 and 2010.

Access Route

5.7.11 The access routes to the site from Llanerfyl and Talerddig involve a range of works. Areas where works were proposed have been subject to a range of surveys as the access routes evolved. At all sites these involved surveys for badger and vegetation. Where tree works were proposed assessment of the need for bat surveys were undertaken (discussed further in subsequent SEI) and where there was habitat considered suitable, dormouse (nut) surveys were undertaken. At river crossing otter surveys were also carried out. For the dormouse survey Best practice methods from the Dormouse Conservation Handbook[19] were followed. A desk study was undertaken, and then a search for gnawed nuts was undertaken at each site. As there was not sufficient habitat available to survey replicate 10 x 10 metre plots the alternative method of collecting at least 100 nuts was employed. These were then examined using a hand lens to ascertain which species had opened the nut.

5.8 Results of the Desk Study

5.8.1 The results of the desk study are shown in Figure 5.2; Table 5.7 below assesses their relative nature conservation values.

Table 5.2 Results of Desk Study.

Organisation	Response Obtained
NRW	Information on habitats, potential ecological issues and statutory designated sites (Sites of Special Scientific Interest) – none within the application Site, one adjacent.
Powys Biodiversity Records Centre	All species and designated site details held for this Site.

5.8.2 There are no local or international statutory ecological designations within the Site. There is one SSSI – Gweunydd Dolwen – situated approximately 200 metres from the consultation boundary.

5.8.3 There are no local non-statutory sites within the survey area.

[19] Paul Bright, Pat Morris and Tony Mitchell-Jones 2006. The dormouse conservation handbook Second edition. Natural England

5.8.4 The Biodiversity Records Centre held no records of any species considered to be specifically at risk from this development. White sedge – a species of local conservation concern, has been recorded within the site

5.9 Results of Field Surveys: Vegetation (NVC Surveys)

5.9.1 The main vegetation and plant species of conservation value found on the Site are described below. A Vegetation Map is presented in Figure 5.1 (a-c). The vegetation has generally been modified by grazing and NVC categories were often not a very good fit.

5.9.2 Afforestation has covered large areas of the adjacent land and of the site itself, and was particularly widespread on areas of peat. Under the dense cover of trees, mainly Sitka Spruce (*Picea sitchensis*), classification to NVC was not possible, and although these areas were largely bare or very sparsely vegetated, an assessment of the rides and larger clearings was made. Due to the effects of the surrounding plantation (the main ones probably being shading and drying effects) the plant communities of the rides were largely modified mire, with M25 *Molinia caerulea – Potentilla erecta* (Purple Moor-grass – Tormentil) mire, and the drier H12 *Calluna vulgaris – Vaccinium myrtillus* (Heather – Bilberry) heath, being the most widespread communities. In wetter areas of plantation the vegetation was closer to M19 *Calluna vulgaris – Eriophorum vaginatum* (Heather – Hare's-tail Cottongrass) mire, with constant bog-mosses (*Sphagnum spp.*) including Red Bog-moss (*Sphagnum capillifolium*) and Papillose Bog-moss (*Sphagnum papillosum*). Plantations and former plantations were almost the only parts of the Site to be fenced from livestock, which meant heath species and bog-mosses were largely ungrazed. Management of part of the plantation for Black Grouse has left the area around Llanerch Wen with large open areas dominated by recovering mire. The area was mainly drier H12 heath community but bog-mosses were more widespread in other areas where the vegetation fitted M19 mire.

5.9.3 The two most common and widespread mire communities were M25 and M6 *Carex echinata – Sphagnum fallax/denticulatum* (Star Sedge – Bog-moss) mire. Those communities covered large areas of both deep and shallow peat, as well as mineral soils and graded from one into the other. Some areas were wetter with deeper peat, indicating modified mire, whereas on the steeper slopes there was extensive flushing and often shallower peat. On these steeper slopes there were also small flushes along streams, dominated by Bog Pondweed (*Potamogeton polygonifolius*), classified as M29 *Hypericum elodes - Potamogeton polygonifolius* (Marsh St John's-wort – Bog Pondweed) soakway.

5.9.4 Most of the site was grazed by sheep and some areas by cattle. This has a very visible effect on the vegetation, depending partly on the intensity of the grazing. Heath species (ericoids) and bog-mosses are particularly sensitive to grazing, and some grasses and rushes become more widespread and abundant. Heath species were most abundant on the higher uplands where there was M19 mire and smaller areas of H12 heath. The M19 mire community included scattered but widespread Cranberry (*Vaccinium oxycoccos*), and bog-mosses in wetter parts of the community included Papillose Bog-moss (*Sphagnum papillosum*), although other species such as Red Bog-moss (*Sphagnum capillifolium*) were more widespread and often more constant. Cross-leaved Heath (*Erica tetralix*) was also common. In places this category was not a very good fit and could be considered to be M17 on occasion. The H12 heath community appeared to be derived from mire and graded into it.

5.9.5 On the deeper, wettest areas, communities were a poor fit to the NVC, seeming to have lost much of the heath cover and other interest, to grazing or drainage. M6 and M25 mire were common here, and there were also patches of M15 *Trichophorum cespitosum – Erica tetralix* (Deergrass – Cross-leaved Heath) wet heath in places. Also present were small areas that appeared to be derived from impoverished M18 *Erica tetralix – Sphagnum papillosum* (Cross-leaved Heath – Papillose Bog-moss) mire in a few of the deepest, wettest areas of peat. These areas displayed very low cover and limited range of heath species, with only Cross-leaved Heath being constant. A few areas held characteristic species, such as Bog Asphodel (*Narthecium ossifragum*) and Round-leaved Sundew (*Drosera rotundifolia*). No Magellanic Bog-moss (*Sphagnum magellanicum*) or Bog Rosemary (*Andromeda polifolia*) was recorded – two of the more uncommon plants that occur in this community. The mire often appeared to be in transition to very soft, wet M20 *Eriophorum vaginatum* (Hare's-tail Cottongrass)

mire, which was present in some small areas of remnant mire. There were also one or two small bog pools here, dominated by Common Cotton-grass (*Eriophorum angustifolium*) or Feathery Bog-moss (S*phagnum cuspidatum*). Patches of wet, soft remnant mire with mixed communities lay around Esgair y Ffordd, where there is a small area of M18. The forestry (which is just off this site) was planted on the wettest area of mire, and in a more modified form, next to the small plantation to the east of this. There was also an area south-east of Llyn Gwyddior. Round-leaved Sundew and Bog Asphodel were present on the mire on the east side of the Esgair y Ffordd plantation. A final community that was present in small patches of the wettest peat areas, for example in clearings in the plantation at Esgair Garnedd, was S27 *Carex rostrata – Potentilla palustris* (Bottle Sedge – Marsh Cinquefoil) tall-herb fen.

5.9.6 Marshy areas fitted best with the NVC community M23 *Juncus effusus/acutiflorus – Galium palustre* (Soft/Sharp-flowered Rush – Common Marsh Bedstraw) rush-pasture. Most of it was not diverse, often with Common Marsh-bedstraw (*Galium palustre*) being the only poor fen species found, with no Greater Bird's-foot Trefoil (*Lotus pedunculatus*) or other typical species. Soft Rush (*Juncus effusus*) was usually the dominant rush species.

5.9.7 The most agriculturally improved areas were mainly MG6 *Lolium perenne – Cynosurus cristatus* (Perennial Rye-grass – Crested Dog's-tail) grassland, some with a high cover of Soft Rush over the more typical grassland species and MG7 *Lolium perenne* (Perennial Rye-grass) leys. There were also areas of fairly species-poor, usually acidic grassland, mainly U4 *Festuca ovina – Agrostis capillaris – Galium saxatile* (Sheep's Fescue – Common Bent – Heath Bedstraw) grassland and U5 *Nardus stricta – Galium saxatile* (Ma Grass – Heath Bedstraw) grassland. In some steep narrow stream gullies Bracken (*Pteridium aquilinum*) was abundant and was classified as U20 *Pteridium aquilinum – Galium saxatile* (Bracken – Heath Bedstraw) community, although it often lacked the typical acid grassland species beneath.

5.9.8 In general the peat across the Site was found to be mainly between 0 and 1 metre in depth under the proposed infrastructure. Fewer probes were between 1 and 1.5 metres and very few over 1.5. Full details of peat depths and peat surveys are given in Chapter 8.

5.9.9 Further work in 2012 was carried out to look at the vegetation underneath the trees within the forest blocks. Turbines R35, R36 and R37 are located in forestry at the NE end of the site. There is no vegetation under the thicket stage trees at the turbine locations. The tracks to the turbines do cross narrow rides containing sparse vegetation. Some were being grazed by cattle at the time of the survey and these contained mainly *Molinia* with considerable bare ground. The more northern ungrazed rides still contain large amounts of *Molinia* but also have some areas of *Calluna* developing probably moving towards M19 community.

5.9.10 There is also no vegetation under the trees at R4 or along the majority of the road to R39. . There are some patches of mosses adjacent to R18 – mainly *Polytrichum* spp. and *Sphagnum* spp. These indicate areas where light penetrates but also appear to show pockets of deep peat.

5.9.11 There is an area of open vegetation crossed by the track to R19. This was assessed as M19 in the original survey. Further survey has confirmed this and shows vegetation in the open area by the stream and the rides within the plantation near proposed turbine 19 varied, but were mainly dominated by Heather (Calluna vulgaris) and Bilberry (Vaccinium myrtillus), with bog-mosses (mainly Sphagnum capillifolium) and Hare's-tail Cotton-grass (Eriophorum vaginatum). Other widespread species here included Red-stemmed Feather-moss (Pleurozium scheberi), and Purple Moor-grass (Molinia caerulea). Much of it fitted reasonably with the M19 Calluna vulgaris - Eriophorum vaginatum blanket mire NVC community. The location of the turbine itself is within thicket trees with no vegetation on the ground.

Table 5.3.Total Area of NVC Categories on Site.

NVC Category	Total Area

M20	8.6ha
M19	91.3ha
M18	2.8ha
M17	10.5ha
M15	3.9 ha
M6	325.6 ha
M25	225.6 ha
M23	69.6 ha
H12	34.6 ha
H8	1.5 ha
Other grasslands (U4, U5, MG6, MG7)	631.0 ha
U20	42.8 ha
S27	0.2 ha
Plantation	249.0 ha

5.9.12 The total area of each NVC category found on the site is shown in Table 5.3 . Much of the habitats were in complicated mosaics and total loss has been calculated by estimating proportions of each habitat within the mosaic by eye.

5.10 Condition of the Habitats

5.10.1 Much of the habitat across the site has been highly modified by agricultural practice over the years. This includes agricultural improvement and re-seeding, draining, afforestation and heavy grazing. The southern part of the site in particularly is highly modified and the remaining semi-natural habitats are generally in a poor ecological condition due to heavy grazing and drainage. This was confirmed by the peat coring (See Chapter 8) that showed little or no active layer (acrotelm) in much of the peat habitats.

5.10.2 The northern section has been less heavily modified and much of the area had a more active layer than in the southern section (apart from where has been afforested) but is still not considered to be in a favourable ecological condition.

5.11 Results of Field Surveys: Mammals

Badger

5.11.1 Whenever possible, fence lines and particularly plantation fences were checked for badger entry/exit points. Very little evidence was found around the upper plantations and judging from the wear on the ground and the amount of badger hair found on the fences, the few entry/exit points were only very infrequently used. There is a badger sett on a south facing mid-slope, remote from the tops. Activity was also noted nearby. Badgers are occasionally foraging over the higher ground and appear to be infrequently using the thicket plantations for temporary shelter. There was no evidence of a permanent sett within any of the

plantations. Exact details of the locations of badger activity were provided separately to CCW (now NRW).

Brown Hare

5.11.2 A considerable area appears suitable for brown hares and several were seen. This was especially the case on mid to upper slopes, which are areas of semi-improved pasture and improved grassland, often where it is beginning to revert, with clumps of *Juncus* appearing. Hares were also seen on unimproved and slightly ranker grassland on heavily grazed top. None were seen in the deeper heather/*Molinia* and *Juncus* dominated areas of the higher access land where they might be missed visually. However they are likely to be less frequent in this ranker habitat. With 5 sightings of at least 3 individuals it appears there is a good population of brown hares in the area.

Dormouse

5.11.3 No suitable habitat for dormouse was found from mid-slope to any of the ridges or tops. All the higher elevation conifer plantations are young monocultures of Sitka spruce and poorly connected to any of the native woodland in the valley bottoms. Most of the hedges at lower elevations are also of very limited potential and have poor, if any, connectivity to the conifer plantations. Dormouse surveys were undertaken along the off-site access route – see Section 5.9.25

Otter

5.11.4 There was no sign of otter presence or usage at Llyn Gwyddior or along any of the stream headwaters. Llyn Gwyddior is quite isolated and only likely to be infrequently visited by passing otters. Inflow is via seepage from the surrounding slopes and the outflow is through thicket Sitka spruce, an obvious but not ideal approach for otters. Signs of otter were found during other surveys on watercourses in the valleys below the survey area.

Water Vole

5.11.5 No signs of water vole were found. There is suitable habitat at mid elevation in several areas, particularly at Hen Ffridd (SH924041), where there is a large basin mire (dominated by Juncus) that has several small watercourses running through it. There is also a wide stream margin through the conifer plantation near Esgair Garnedd (SH936035).

Other Species

5.11.6 Plantations are as yet too young to be of interest to red squirrel and/or pine marten, neither of which are known in this region. It is likely that polecat occur mainly in the valley bottoms where prey species will be much more abundant.

5.12 Access Route

5.12.1 Full details of the access route ecology assessment, shown section by section, is given in Appendix 5.3. Surveys carried out in 2010 for badger, otter and general habitat were repeated in 2013. Details of the possible impacts and the proposed mitigation is given in Appendix 5.3. The key points are given in the following paragraphs.

5.12.2 Signs of badger activity were found within a small plantation at SJ979073 in 2010, but no fresh signs in 2013. No badger setts were found at any of the sites where work is currently proposed.

5.12.3 No signs of otter were found at any of the water crossings or where bridge works are proposed.

5.12.4 A desk study was undertaken in 2010. No Dormouse records were found from Cwm Eira at all. The only record within the two 10 km squares that cover the area was as a record from

1988 in Coed Cwm Byr (SH917023) of hazel nuts with signs of dormouse. This wood is over 4.5 km from the nearest proposed access works and 10 km from the nearest suitable habitat that may be affected along the route. There is no direct connectivity between the sites.

5.12.5 At Section 1.17, following further investigation in December 2010, very little suitable habitat was found after close inspection, and no hazel nuts found. At Section 1.14a total of 148 gnawed nuts were collected. The species responsible were identified as follows:

- Bank vole - 11;
- Wood mouse – 5;
- Squirrel – 103;
- Bird – 28;
- Unknown – 1.

5.12.6 Therefore there was no signs of dormouse on the sections of potentially suitable habitat that may be impacted. No further Sections of potential dormouse habitat were identified in surveys following changes to designs in Spring 2013.

5.13 Nature Conservation Value of the Identified Resources

5.13.1 An analysis of the nature conservation value of the resources identified for the Site, in the desk and field surveys, has been undertaken and the results are presented in Table 5.4 (below). The analysis has been undertaken based upon the standard methodology developed by the Institute of Ecology and Environmental Management (2006).

5.13.2 The species and habitats identified in Table 5.4 are listed due to their inclusion in national, regional and local lists and/or due to legal protection. The inclusion of species and habitats in BAPs and species in lists of conservation concern does not imply any specific level of value for those species or habitats (IEEM 2006).

Table 5.4 Summary of the Nature Conservation Value of Identified Resources

Resource		Value	Comment
Protected Areas			None on Site
Habitats	Marshy Grassland	Local	Section 42 (if *Molinia* / *Juncus* pasture)
	Ponds	Local	UK BAP, Section 42.
	Species-rich hedge	Local	UK and Powys BAP. Section 42.
	Ffridd	Local	Powys BAP
	Heath	County	UK BAP, Section 42
	Mire (inc Blanket Bog)	UK	UK BAP, Habitats Regs, Section 42
Mammals	Otter	Local	Habitats Regs, Section 42. UK and Powys BAP.
	Brown Hare	Local	UK and local BAP. Section 42
	Badger	Local	Badgers Act 1992

Notes on comments: Conservation Status is given as follows: Habitats Regs – Protected under the Conservation (Natural Habitats, &c.) Regulations 1994.BAP = Biodiversity Action Plan, Local, Wales and /or UK (UKBAP 2007). Section 42 means listed under Section 42 of the NERC Act 2006. Requires Welsh Assembly to 'have regard, in exercising its functions, to conserving biodiversity' and a duty to list species and habitats of principle importance (WAG 2007).

Areas of Habitat Considered to be of Conservation Importance

Mire

5.13.3 The more important areas of mire (blanket bog and acid flush) were those that were less modified by drainage and other activities, so they were wetter, often more species-rich and held abundant bog-mosses. These are UK priority habitats in the UK Biodiversity Action Plan (UKBAP) and, when active bog, also a priority habitat in the European Habitats Directive, and listed under Section 42 of the NERC Act 2006, requiring the Welsh Assembly to 'have regard, in exercising its functions, to conserve biodiversity' and a duty to list species and habitats of principle importance. Much of the area marked as blanket bog contained significant amounts of *Sphagnum* mosses and / or cotton grasses. These are the bog-forming species that indicated active bog. The mire and heath were therefore the areas of most conservation importance on the survey and are considered as of UK importance.

5.13.4 Much of the blanket bog appeared to fit NVC categories M19 (*Calluna vulgaris – Eriophorum vaginatum* mire) and M20 (*Eriophorum vaginatum* blanket and raised mire) although the fit was not always good. *Calluna vulgaris – Eriophorum vaginatum* mires form part of Great Britain's blanket bog vegetation and are internationally important (Averis *et al.* 2004). *Eriophorum vaginatum* mires are less species-rich than M19, due to past management and are generally less important in conservation terms than the stands of less modified bogs from which they are derived (Averis *et al.* 2004). The vegetation types at this site are often in a mosaic, with richer patches interspersed with species-poor bog, semi-improved or modified areas, and small patches of heath vegetation. Due to the difficulty in defining individual patches and the integral hydrological conditions of bogs the mosaics have been all treated as sensitive.

5.13.5 Different conservation values were not given to differing NVC categories – all areas of mire vegetation were considered of conservation value.

Heath

5.13.6 The heath (small patches of the mosaics mapped as mire) is of at least of county importance and is also a priority habitat within the UK Biodiversity Action Plan.

Marshy Grassland

5.13.7 From the point of view of the vegetation alone, the marshy grassland appears to be only of local interest. However, in places marshy grassland forms a border to, or a mosaic with, acid flush and other mire habitats. These areas are marked as mosaics on the habitat map and are of conservation importance due to their proximity to the acid flushes.

Broad-leaved Woodland, Scrub and Dense Bracken / Ffridd

5.13.8 The small patches of broad-leaved woodland and scrub, and dense bracken (ffridd here, as it was mixed in with gorse patches and acid grassland) are of local importance. This is a Powys priority BAP habitat.

Areas of Habitat Considered to be of Lesser Conservation Importance

Waterbodies and Watercourses

5.13.9 The watercourses are not of significant importance for the aquatic vegetation. Ponds are a priority UK BAP habitat.

Boundaries, Tracks and Bare Ground

5.13.10 Most boundaries are fenced. Occasional species-rich hedges occur, which is a local BAP habitat in Powys and a priority UK BAP habitat.

Conifer plantation

5.13.11 The conifers themselves are of little conservation value, but have potential for restoration to mire (see below) as they are planted on peat habitats. There were also small patches of mire remaining within the plantations.

Mammals Considered to be of Conservation Value

Otters

5.13.12 Otters are protected under the Habitats Directive and are listed under Section 42 of the NERC Act. They are also subject to the UK and Powys BAPs.

Badgers

5.13.13 One badger sett was identified within the survey area but away from any development areas. Badgers and badger setts are protected under the Badger Act 1992. Individual brown hares were seen on several site visits. Hares are included in the UK and Powys BAPs.

5.14 Sensitivity of the Valued Resources

Habitats

5.14.1 All the valued habitats identified above are considered sensitive to developments. They will be sensitive to both direct loss from construction and, especially the wetter habitats, may be sensitive to changes in hydrology caused by construction. Peat especially is considered a relatively scarce and fragile resource in Wales and the UK resource is of European importance. Peat is also increasingly seen as of importance as a sink for CO_2. Blanket peat is widespread on hilltops in Wales, and the better areas, in conservation terms, have been designated as SSSIs or SACs. This site has no designation at any level. Large parts of Llanbrynmair Moor have been damaged by inappropriate afforestation in the 1980's. However the peat resource in Wales is limited in total and is increasingly seen as valuable in its own right. There is no guidance available from CCW (now NRW) as to how to value this resource outside traditional vegetation classifications. The remnant, unforested areas can

be seen as important refuges of upland peat moor vegetation. In this assessment all areas of peat land have been considered sensitive. No differentiation has been given to differing NVC categories, and both the existing vegetation and the restoration potential was taken into account in defining sensitivity and in informing layout revisions to avoid sensitive habitats as far as possible.

5.14.2 Waterbodies and species-rich hedges are only sensitive if directly impacted upon. They have been avoided in the design of this site and are therefore not considered further. Watercourses are assessed where there is a crossing proposed.

Mammals

5.14.3 Badgers are not considered sensitive to the development – the sett was located well away from most planned development. Hares are also not considered sensitive to this type of development as there will be very little loss of habitat.

5.14.4 Otters are not considered directly sensitive to wind farm developments as long as feeding and resting habitat are not affected. None of the watercourses in the lower valleys, where signs of otter were seen, will be directly affected by the development and no water crossings are planned on the stream where otter signs were seen. Although the possible effects on otter are considered minimal, as they are a European protected species an assessment of potential impact is made.

5.15 Future Baseline Conditions

5.15.1 Foreseeable changes in the baseline conditions without the construction of the scheme would likely be limited if the present farming regime continues. However, during the period of the preparation of this report several new deep drains have been dug, or old drains cleaned out, in some mire areas. If left unblocked, or if new drains continue to be dug then further deterioration of these areas of mire will occur. The levels of grazing in many areas of Wales have declined since the de-coupling of payments from headage of sheep. It is not clear if this has happened on the holdings at Llanbrynmair, but levels of grazing over most of the site are considered too high to allow real recovery of the vegetation. If the farming regime altered, especially grazing levels, then grassland habitats would change. Reduced or abandonment of grazing would lead to an improvement in the structure of the grassland habitats but complete abandonment over time is likely to lead to scrub encroachment in the long-term.

5.15.2 Management of the conifer plantations will depend of the economic situation when trees reach maturity. Without the proposed development, the trees are currently planned to be felled for timber at maturity (or probably before given the exposed nature of the blocks where thinning to allow maturity would lead to windblow). At this time the plantations will either be re-planted or the area changed to other land use.

5.16 Constraints

5.16.1 Constraints were identified following the ecological surveys. These were used to inform the final layout of the development to minimise its ecological impact.

5.16.2 Areas of semi-natural habitat, especially mire and bog, were identified to be avoided where possible.

5.16.3 No constraints were identified for mammals. Loss of habitat is minimal, and mammal use of this Site very low.

5.17 Ecological Impact Assessment

5.17.1 The following assessment looks at the potential impacts on the ecological resources identified above as sensitive. These are the areas of valuable vegetation. The assessment is based on existing information, especially from other wind farm developments, and the knowledge and experience of the assessor. As wind farms are a relatively new type of

development there are some uncertainties. These are identified and discussed in the following sections.

Proposed Site Layout

5.17.2 Following an analysis of ecological and other constraints, a final site layout minimising potential environmental impacts was produced as shown in Figure 3.6, Volume III. The development of this layout is described in Chapter 3 Section 3.3

5.17.3 The project has been designed so that land take is restricted to the minimum required for the construction and operation of the wind farm. Where existing tracks can be used they have been incorporated into the scheme, but will require upgrading. Within other, non-ecological, constraints habitats identified as sensitive have been avoided as far as possible.

General Effects on Vegetation

5.17.4 The effect on vegetation will be a permanent loss of approximately 27 hectares to tracks (the main loss), turbine bases and other infrastructure described in Chapter 3. In addition, there will be temporary losses during the construction phase for site compounds and other incidental activities.

5.17.5 The loss of vegetation to turbine bases, tracks and borrow pits on improved or semi-improved pasture with little identified conservation interest is thought unlikely to have any negative effect on the overall conservation status of the site – it will not affect the populations of species found within these habitats.

5.17.6 The construction phase will also require the installation of crane hardstandings and tailing pads at each of the wind turbine locations. The tailing pad and approximately half of the crane hardstandings will be covered with topsoil after the construction phase has ended. Whilst this will mean that the re-vegetated areas are no longer visible they will continue to exert an ecological effect. For this assessment they are considered as total habitat loss, although once they are re-vegetated they will provide an area of altered habitat and will decrease the overall impact of the development.

5.18 Specific Impacts on Peat Habitats

5.18.1 In general the peat across the Site was found to be mainly between 0 and 1 metre in depth under the proposed infrastructure. Fewer probes were between 1 and 1.5 metres and very few over 1.5. Of the habitats surveyed just under two thirds were considered to be on peat. Full details of peat depths are given in Chapter 8.

5.18.2 During the design development emphasis from authorities and developing guidance changed the emphasis towards concerns on the impact on peat itself rather than peatland habitat. This has caused some issues as the depth of peat is not directly related to the quality of the vegetation growing upon it. For example, early in the design turbines were moved off semi-natural vegetation into forestry. Later site investigation showed that this meant they had been moved onto deeper peat deposits, albeit with little ecological interest. This is addressed further in the Hydrology / Peat section (Chapter 8) but overall a compromise has needed to be made, within other constraints, over the loss of peat and the loss or peatland habitat.

5.18.3 Table 2 shows the total loss of each category and show that there will be a direct loss of 14.8 hectares of peat habitat. 10.2 ha of this is semi-natural vegetation with a further 5 ha of peat under forestry. There is 4.5 ha of M6, which was of varied quality (See 5.10.1 and 5.10.2 above). Much of the habitats were in complicated mosaics and total loss has been calculated by estimating proportions of each habitat within the mosaic by eye. This is 1.3% of the total existing peatland habitat within the site boundary.

Table 5. Loss of Peatland Vegetation by NVC Category.

NVC Category	Area of loss
M20	<0.1 ha
M19	0.6 ha
M15	0.3 ha
M6	4.5 ha
M25	4.3 ha
M23	0.5 ha
Plantation	4.6 ha
Total	**14.8**

5.18.4 The area of loss has been calculated as all the mire communities likely to be disturbed during construction. This includes areas of temporary loss which will be restored following construction. In addition, parts of the crane pads will be re-vegetated but it is not thought that the vegetation on these areas will necessary return to the same vegetation type as was there previously so have been counted as total loss. The vegetation on the re-vegetated areas will however, provide some habitat and will be an improvement on bare gravel.

5.18.5 In addition, losses could be reduced by an ecological clerk of works walking the site with engineers before construction commences, pointing out all areas of sensitive habitat and identifying which areas can be completely avoided by minor movement of infrastructure within the 50m micro-siting where possible. The ecological clerk of works would also ensure that any micro-siting does not lead to movements into more sensitive habitats. Agreement on an Ecological Clerk of Works (ECoW) would be undertaken with Powys County Council and statutory bodies subsequent to any approval.

5.18.6 The main area of impact is Turbines R26 and R38 with associated infrastructure on blanket bog. Whilst 3 turbines were removed from the north, 1 from an area of heather rich (M19) bog and 2 from an area of mixed cotton grass / heather bog (M19/20) and changes were made in the region of turbine R27 to avoid crossing a pocket of deeper peat with richer vegetation the track across the south of this area had to be retained as a main access to the site and RES felt that the two associated turbines should also therefore be retained. This is an area of mixed habitats with generally lower heather cover and higher cover of rushes and moor grass (M6, M19 and M25).

5.18.7 As well as the direct impact from infrastructure there is likely to be some impact on adjacent vegetation caused by changes in the hydrology of the peat. The exact distance from permanent infrastructure, within which influence occurs is unknown, there have been many different opinions and it will vary a lot in differing hydrological conditions. Impact is likely to be higher where tracks cut across slopes interrupting water flow and least on flatter areas of wet bog. The carbon loss calculation provided in Appendix 2.2 uses figures identified from on-site assessment with a drainage extent of 4.10 metres and dewatering is discussed in Chapter 8. However dewatering may not necessarily lead to vegetation changes. After reviewing opinions and drawing on extensive personal experience Dargie (2008) considered a 10 metre zone of potential influence to be a reasonable precautionary distance, and this probably exaggerates the actual distance of effect by two to five fold. For example, in one study Stewart and Lance (1991) observed a low level of drainage at Moorhouse (Cumbria) with a lowering of the water table laterally observed 2m downslope of a drain (2.3m on steeper slope) and only 1m upslope (0.3m steeper ground). Dargie (2008) reports that monitoring work at Farr wind farm in the Scottish highlands showed that most

observed effects were confined to 2 – 5 metres from infrastructure. Blanket peat has a very low hydraulic conductivity and drying effects are likely to be confined to a narrow zone usually no more than 2 metres from a ditch (Stewart & Lance, 1991) with most impact downslope of the drain. The water level is lowered nearest to the ditches and quickly rises further from the source of drainage. Vegetation will not necessarily be lost, unless drainage is very severe, but there will be subtle changes to drier upland species (Rydin and Jeglu 2006). Stewart and Lance (1991) found that Calluna cover peaked after 8 years but declined thereafter and declines in sphagnum cover were highly localised.

5.18.8 It is planned to fell 149ha of conifers which were mainly planted on peat. Clearance of conifers will allow re-instatement of bog habitat (see section 5.15).

5.18.9 Overall the Proposal will lead to a loss of 10.2ha of important habitat – this is considered a significant impact – a total of 1.3% of the resource within the site. In addition 4.6ha of peatland under existing forestry will be lost for future restoration. However, the development will also involve positive impacts including the clearance of forestry from 149ha of peatland. In addition, the existing area of peatland habitats 200ha will be subject to favourable habitat management (See section 5.20).

Effects on Water Courses (Including Otters and Fisheries)

5.18.10 There are 21 watercrossings proposed. These are detailed in Chapter 8; Table 8.9. The proposed crossings are on small water courses high in the catchment. There were no sign of otter or water vole in any of these streams, although otters may occasionally forage along such streams, or use them as foraging routes across catchments. The streams and proposed crossings are fairly small; therefore the proposed construction will not be a barrier to otter movement. As long as the pollution control measures outlined in Appendix 3.4 are followed then there should be no effect on otter habitat or fisheries. Flow will not be restricted, there should be no increase in sediment load and the overall streamside habitat will not be altered.

5.18.11 There will be upgraded water crossings along the access route on the existing minor road. These may well be used by otters. These water crossings should be assessed before construction by an ecological clerk of works. Any new bridges or culverts should include otter passes if considered necessary.

Effects on Designated Sites

5.18.12 There are no designated sites within the development area. Gweunydd Dolwen SSSI, designated for its acid and neutral dry grassland to the immediate south of the site. There is some road widening proposed adjacent to this site (See Chapter 10) but it is on the opposite side of the stream to the designated site, does not impose on the site and will not affect the designated features of the SSSI.

Effects of the Decommissioning Phase

5.18.13 Given that decommissioning activity is unlikely to take place within the timeframe considered by this Chapter 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.

5.18.14 The effects of the decommissioning phase are likely to be comparable to those considered during the construction phase, although of lesser magnitude, as decommissioning would take less time. Decommissioning works would be planned with care so as to minimise the potential for ecological effects.

5.18.15 Ecological effects of decommissioning may be less significant than those during construction due to 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.

5.18.16 Further habitat restoration will be possible during the decommissioning and should be included in any programme.

5.19 Mitigation

5.19.1 If sufficient consideration of ecological constraints in the initial planning of the layout is undertaken there is often limited mitigation of the remaining identified effects. On this site many sensitive habitats have been avoided but some effects remain. It is considered there is potential for some of the significant effects of the proposed development on the ecology of the area identified above to be mitigated by construction method and practice. In addition, best practice, and associated guidance from statutory consultees, would be followed throughout all of the proposed works. Mitigation for the effects of the proposed works is given below.

Mitigation of the Construction Phase: General

5.19.2 Most mitigation during the construction phase involves good practice and would be secured through agreement on a Construction Method Statement and Construction Environmental Management Plan. Contractors will be informed which areas are especially sensitive and that care must be taken not to damage sensitive habitats. Construction vehicles must remain within designated routes and not stray across habitats. An ecological clerk of works would be present when decisions are taken on issues such as micro-siting of turbines and could advise on the detail of the mitigation proposed below on a day to day basis. This person, who would be suitably qualified and independent, would also make regular checks that mitigation proposals and good practice are being followed.

5.19.3 Topsoil removed during the construction works on less sensitive habitats would be retained and reinstated on completion of the construction phase over the cable trenches, track shoulders and turbine foundation areas as far as reasonably possible. This will reduce the amount of temporary and permanent habitat loss. If more topsoil is displaced than can be replaced, then any remaining soil would be spread onto land as close to the point of origin as possible, though it would not be spread on identified habitats such as marshy grassland or acid flush. Soil would only be spread on improved or semi-improved habitats. Some soil would be used to landscape the borrow pits.

5.19.4 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.

5.19.5 Tracks and areas of hardstanding would be constructed of compacted stone, which would not result in significant increased run-off following rainfall that might increase soil erosion or result in localised changes to hydrology (see Chapter 8). The imported stone would be sourced from on-site borrow pits, as far as possible, so as to match the existing ground conditions.

5.19.6 As detailed in Chapter 8, Hydrology, RES would implement various pollution prevention measures. Appendix 3.4 outlines the emergency preparedness and response and spillage procedures and the environmental requirements to subcontractors respectively.

5.19.7 Prior to any work commencing a badger survey will be conducted for all areas within 30m of infrastructure and at all proposed sites of works along the access route. If badgers are found to have moved into the areas then NRW will be consulted and suitable action undertaken and / or licensing procedures will be followed.

5.19.8 Prior to construction a repeat otter survey will be undertaken at all proposed water crossings and for 50 metres up and down stream. If signs of otters are found, especially any sign of holts or lying up areas, NRW will be consulted and suitable action undertaken and/or licensing procedures followed.

Mitigation of the Construction Phase: Peat Habitats

5.19.9 As the peat habitats (including blanket bog, mire and heath) were identified as the most important and sensitive a detailed construction method for work across peatlands and mitigation plan has been developed. This should be read in conjunction with the Habitat

Management Plan (HMP) which appears in Appendix 5.2. Details of post-construction management and enhancement of many peat areas can be found in the plan.

5.19.10 During the surveys and discussions detailed in this section it became clear that the Site in many areas comprises a detailed mosaic with some sensitive pockets of habitat within wider areas of less sensitive habitat. In walking the site it became clear that the scale of mapping available and the differences between accuracy of individual GPS systems meant it was not always possible to clearly identify these pockets. Therefore an ecological clerk of works would walk the site with engineers before construction commences, pointing out all areas of sensitive habitat and seeing which areas can be completely avoided by minor movement of infrastructure within the micro-siting available. These areas will be clearly marked with post and tape to ensure they are avoided. The ecological clerk of works would also ensure that any micro-siting does not lead to movements into sensitive habitats.

5.19.11 A full Peat Management Plan has been prepared and is at Appendix 8.9. It is summarised in the following paragraphs.

Peat Management Plan: Summary

5.19.12 On the areas identified as blanket bog, prior to construction, the top layer of vegetation on areas to be destroyed or used temporarily will be stripped off as turf by an experienced specialist contractor. These turves will be stored adjacent to the construction area in a way that ensures they remain moist and viable. Peat will then be removed and stored separately and kept damp. Extra care must be taken when working within peat areas to keep all activities within a narrow construction envelope where possible.

5.19.13 Immediately following construction some turves will be replaced along the road edges to allow quicker re-vegetation and soften the road edges. Peat will be replaced around the turbine base excavations, and re-turfed. Peat will be spread over the parts of the crane pads, rotor assembly pads and other areas used in the construction and re-turfed.

5.19.14 Remaining peat will be stored appropriately and used for drain blocking. Any surplus peat will spread in areas identified by an ecological clerk of works as suitable (generally areas of existing peat with poorer quality vegetation). These areas will be stripped of turves beforehand, and vegetation replaced on the bare peat, or if surplus turves are available, these will be used if of appropriate vegetation. A detailed calculation of volumes and areas where peat will be used is given in the Peat Management Plan (Appendix 8.9).

5.19.15 Any edges of cut peat that may remain exposed, or areas of peat excavation on steep slopes, will be covered with hessian textile to stabilise the peat. This will be held in place with biodegradable pegs. This will allow re-turfing and re-vegetation without erosion risks.

5.19.16 Sensitive habitat will be fenced and stock excluded for up to two years to allow full and proper recovery of vegetation.

5.19.17 The re-vegetated areas will be monitored. Any areas of bare peat, where vegetation is not re-growing, will be seeded with a seed mixture obtained from the existing habitats on site. Stock exclusion in these areas will continue until vegetation is properly established.

Mitigation of the Operational Phase

5.19.18 There is only limited scope for mitigation during the operational phase and residual ecological effects that may persist through the operational phase of the wind farm are perhaps better addressed through enhancement measures (see below) rather than mitigation.

5.20 Enhancement of Wildlife Value

5.20.1 Where reasonable opportunities exist for enhancing the wildlife value of the Site then these should be taken. IEEM (2006) have noted that 'there is a growing body of opinion that new developments should deliver net ecological gain rather than simply being designed to achieve mere damage limitation'. In Planning Policy Wales: Technical Advice Note 8 –

Renewable Energy – also states (Para 2.10) that opportunities to enhance, extend or re-create habitats 'should be grasped'. Additionally, Planning Policy Wales 2002, section 5.2.7, states that:

> *'The planning system has an important part to play in meeting biodiversity objectives by promoting approaches to development which create new opportunities to enhance biodiversity, prevent biodiversity losses, or compensate for losses where damage is unavoidable'.*

5.20.2 Following further discussions with interested parties, a habitat management plan has been developed for the Site. The detailed HMP is presented at Appendix 5.2. This will cover the life of the development. Key points in the plan include (where appropriate):

- Top the rushes outside of nesting season / areas.
- Leave rushes long in wet corners and provide wet flushes were possible providing habitat for invertebrates and newts, which in turn will become a food source for waders [especially young] and bats.
- Streamside planting of elder / alder will create streamside habitat and encourage bat feeding and create otter lying up areas.
- Install artificial otter holts at appropriate locations in the lower catchment.

5.20.3 Specific management sites will include:

- Continuation and expansion of existing black grouse management area.
- Drain blocking and grazing management on blanket bog areas.
- Felling of forestry and restoration of bog/heath habitat under turbines.

5.20.4 All habitat management will be monitored and prescriptions changed as necessary to ensure the work delivers the enhanced biodiversity envisaged.

5.20.5 It is envisaged that a total 200 ha of blanket bog and mire habitat will be restored and maintained along with 149 ha of forestry on previous peat habitat removed and habitat restored.

5.20.6 The habitats at this site, especially blanket bog, have previously been severely damaged by forestry and, to a lesser extent, agricultural improvement. The current proposal provides an opportunity to reverse some of the previous damage and restore a significant area of bog habitat.

5.21 Monitoring

5.21.1 Monitoring of the non-avian ecology is proposed to cover the vegetation to ensure that the habitat management plan is effective and that no unforeseen detrimental effects occur. A full outline monitoring programme is given within the Habitat Management Plan (Appendix 5.2).

5.21.2 Vegetation around construction on the peat habitats and across the area of the HMP will be monitored in years 0(immediately prior to construction) 1, 2, 5, 10, 15, 20 and 25 of the development.

5.21.3 Results will be used to alter the HMP prescriptions if considered necessary to achieve the proposed outputs.

5.21.4 Monitoring will include the artificial otter holts detailed in the HMP.

5.22 Residual Effects

5.22.1 Following mitigation the residual effects of the development on the non-avian ecology are calculated to be as follows:

5.22.2 14.8 ha of peatland habitat will be directly lost to tracks, turbines and other infrastructure.

5.22.3 There will be an additional loss of approximately 17.5ha, which includes some semi-natural habitat. It is not considered this loss will affect the overall integrity of the site.

5.22.4 There will be an area of a total of 200 ha of blanket bog and mire habitat restored and maintained along with 149ha of forestry on previous peat habitat removed and habitat restored.

5.22.5 It is considered that the restoration of habitats, and wider habitat management measures across the site, represents a net gain on the ecological value of the Site from the habitat enhancement measures.

5.23 Conclusions

5.23.1 Ecological surveys of mammals and habitats were undertaken at Llanbrynmair wind farm development site by Ecology Matters Ltd between 2006 and 2013.

5.23.2 These revealed a relatively sparse mammal population, as is found in many such upland sites. No potential impacts on these mammals were identified including for protected species such as otter and badger.

5.23.3 There are no designated sites within the wind farm site boundary and no impacts have been identified on sites outwith the wind farm.

5.23.4 There were large areas of habitat that are BAP priorities. The layout of the Site has been designed to avoid these as far as possible, but there will be a loss of 14.8 ha hectares of peatland habitat. Construction methods have been developed to minimise impact and ensure restoration of surrounding vegetation following construction. Much of the site is heavily modified by farming and forestry activity over the years.

5.23.5 A Habitat Management Plan (HMP), including the restoration of priority bog areas has been produced (Appendix 5.2) and there should be a net conservation gain from the proposed habitat enhancement measures. The HMP has been designed to be able to be used as a planning condition if consent is given. The implementation of the plan will be overseen by an independent Habitat Management Group.

5.23.6 A peat management plan has also been produced to minimise loss of peat. These conclusions should be read in conjunction with the Hydrology Chapter 8 and the Peat Management Plan (Appendix 8.9) and Habitat Management Plan (Appendix 5.2).

5.23.7 Whilst the construction of a wind farm at this site cannot completely avoid impacting habitats, it is considered that the impacts on habitats have been minimised as far as possible within other constraints and therefore it is considered that the proposed development will comply with the policies set out in Section 5.4. With the implementation of all mitigation and the HMP there will be an overall net ecological gain over the site during the life of the wind farm.

5.24 References

5.24.1 Averis A, Averis B, Birks J, Horsfield D, Thompson D and Yeo M. 2004 An illustrated guide to British upland vegetation. JNCC.

5.24.2 EU 1992.Habitats Directive:

http://eur-lex.europa.eu/LexUriServ/site/en/consleg/1992/L/01992L0043-20070101-en.pdf

5.24.3 IEEM 2006 Guidelines for Ecological Impact Assessment in the United Kingdomwww.ieem.net

5.24.4 JNCC 2003 Handbook for Phase 1 habitat survey - a technique for environmental audit. Joint Nature Conservation Committee Natural England 2007. Draft Climate Change Policy.

5.24.5 Rodwell J.S. (Ed.) 1991 - 2000. British Plant Communities. Vols. 1 to 5. (JNCC).Cambridge University Press.

5.24.6 UK BAP 2006 Biodiversity Action Plans for UK, Wales and Powyswww.ukbap.org.uk

5.24.7 WAG 2003 Going Wild in Wales. Welsh Assembly Government.

5.24.8 WAG 2007. List of Species and Habitats of Principal Importance for Conservation of Biological Diversity in Wales, December 2007. www.wales.gov.uk

6 ORNITHOLOGICAL ASSESSMENT

6.1 Introduction

6.1.1 This chapter has been undertaken to determine the likely significant effects of the proposed Llanbrynmair Wind farm on the Ornithology of the study area. The assessment considers the effect on the ornithological resource.

6.1.2 This Chapter has been written by Dr Steve Percival of Ecology Consulting and assesses the potential ornithological effects of the proposed wind farm development at Llanbrynmair, also referred to as 'the Proposal'. It updates and supersedes the ES Ornithology chapter in the original ES, integrating all of the Supplementary Environmental Information (SEI) relating to ornithology and updating the assessment for the current proposed development.

6.1.3 The assessment provides baseline information, identifies potential impacts on ornithology, 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 Chapter also discusses ongoing management and monitoring measures. Such assessments are considered for the construction, operation and decommissioning phases of the project.

6.1.4 The proposed development site (the 'Site') is shown in Figure 3.6 (all Figures are in Volume III) and is situated 13km west from Welshpool in mid-Wales.

6.1.5 The bird survey Study Areas have been defined as per SNH guidance (Whitfield *et al*. 2010), to give a minimum 500m buffer around the proposed wind turbine locations for the main surveys (hereafter defined in the chapter as the 'Study Area') and up to a 2km buffer for key species where access/viewing was possible and where potentially suitable breeding habitat existed. The Study Area covered an area of approximately 29.3km^2, as shown in Figure 6.1.

6.1.6 The Proposal will include 30 wind turbines with micro-siting of up to 50m, associated transformers, crane hardstandings, rotor assembly pads, temporary and permanent anemometer masts, access tracks, watercourse crossings, on-site underground cabling, substation compound and welfare buildings; borrow pits, temporary construction compounds and a batching plant (See Chapter 3 for details).

6.2 Legal and Policy Context

6.2.1 The following documents have been taken into account in this assessment:

- National Planning Policy Framework, which includes guidance on how government policies for conservation and enhancement of flora and fauna should be reflected in land use planning;
- Overarching National Policy Statement for Energy (EN-1)
- National Policy Statement for Renewable Energy Infrastructure (EN-3);
- EU Council Directive 79/409/EEC on the conservation of wild birds (the 'Birds Directive');
- Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (codified version);
- The Conservation of Habitats and Species Regulations 2010 which now constitutes the "Habitats Regulations." This supersedes the Conservation (Natural Habitats, etc.) Regulations 1994 and translates the Birds and Habitats Directives into UK Law;
- 'Managing Natura 2000 Sites' (European Communities 2000), which gives guidance on the implementation of the Birds and Habitats Directives;

- European Commission (2010) guidance on wind energy development in accordance with the EU nature legislation;
- The Wildlife and Countryside Act 1981, as amended;
- The Countryside and Rights of Way Act 2000;
- The Natural Environment and Rural Communities Act 2007;

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

- Technical Advice Note 5 Nature Conservation;
- Powys Structure Plan 1996;
- Powys UDP Deposit Draft 2004;
- Montgomeryshire Adopted Local Plan;
- UK Biodiversity Action Plan;
- Wales Biodiversity Action Plan;
- Powys Local Biodiversity Action Plan.

6.2.3 TAN 5 sets out policies on different aspects of planning in Wales regarding nature conservation that planning bodies should adhere to. The document mainly concerns protected areas but it also states that:

> *"Statutory and non-statutory sites, together with features which provide wildlife corridors, links or stepping stones from one habitat to another, all contribute to the network necessary to ensure the maintenance of the current range and diversity of our flora, fauna, geological and landform features and the survival of important species. Sensitive landscaping and planting, the creation, maintenance and management of landscape features important to wildlife and the skilled adaptation of derelict areas can provide extended habitats* (Para 28)"

6.2.4 This has been taken into account in this assessment.

6.2.5 The following Powys Structure Plan Policies have been considered in this ornithological assessment:

- Policy EC4 – Environmental Impact;
- Policy EC5 – Protection of Habitats and Conservation Management;
- Policies EC8 & 9 – Nature Conservation Areas;
- Policy EC10 – Conservation of River Valleys;
- Policy EC12 – Broadleaved and Coniferous Woodlands;
- Policy EC20 – Renewable Energy Sources.

6.2.6 The following Powys County Council Unitary Development Plan policies have also been considered:

- Policy SP3 – Natural, Historic and Built Heritage;
- Policy E3 – Wind Power;
- Policy ENV3 – Safeguarding Biodiversity and Natural Habitats;
- Policy ENV4, 5 & 6 – International and national and local/regional sites for nature conservation;
- Policy ENV 7 – Protected Species;
- Policy ENV9 – Woodland Planting.

6.2.7 The following Montgomeryshire Local Plan policies have also been considered:

- Policy ENV6 - Tree felling;
- Policy ENV8 – Nature Conservation;
- Policy ENV9 – Wildlife Habitats;
- Policy ENV10 – Habitat Creation.

6.2.8 All relevant policies are further considered in Chapter 2 of this SEI.

6.3 Ornithological Impact Assessment (OIA) Principles & Methodology

6.3.1 This assessment has been carried out using the methodology developed by SNH and the British Wind Energy Association [BWEA] and updated by Percival (2007). The assessment first identifies the sensitivity (conservation importance; as defined in Table 6.1) of the receptors present in the study area, then determines the magnitude of the possible effect on those receptors (as described in Table 6.2).

6.3.2 The evaluation of sensitivity of the bird populations includes the criteria adopted by CCW in the Guidelines for Selection of Biological Sites of Special Scientific Interest (SSSI) (Joint Nature Conservation Committee 1995), using 1% of the resource to define national and regional importance. A further category of 'local importance' was used for species that did not reach regional importance but were still of some ecological value. For bird species this included all species on the red or amber lists of the RSPB *et al*.'s (Eaton *et al*. 2009) 'Birds of Conservation Concern' that did not reach national or regional importance at the site. In addition listing on Annex 1 of the EU Birds Directive, Schedule 1 of the Wildlife and Countryside and UK Biodiversity Action Plan [BAP] priority species were all considered in the evaluation process.

6.3.3 The value of the overall breeding bird assemblage was evaluated using the standard JNCC (1995) scheme, for the two main semi-natural habitats in the Study Area, upland moorland/grassland (with water bodies) and woodland. Each species listed for each habitat was scored according to the order of magnitude of its British population and these scores were summed to give totals for the site. These overall scores were then compared with the thresholds for consideration as a SSSI for these habitat categories, as a reference for judging their importance. If they reached the SSSI threshold, then they were deemed to be nationally important, if they reached 50% of that threshold then they were be deemed to be regionally important.

Table 6.1 Definition of terms relating to the sensitivity of the ornithological components of the site.

Sensitivity	Definition
VERY HIGH	Cited interest of SPAs, Ramsar sites, SACs and SSSIs. Cited means mentioned in the citation text for the site as a species for which the site is designated (SPAs/SACs/Ramsars) or notified (SSSIs).
HIGH	Other species that contribute to the integrity of an SPA or SSSI. A local population of more than 1% of the national population of a species. EU Birds Directive Annex 1, EU Habitats Directive priority habitat/species and/or W&C Act Schedule 1 species. Other ecologically sensitive species, e.g. large birds of prey or rare birds (<300 breeding pairs in the UK).
MEDIUM	Regionally important population of a species, either because of population size or distributional context. UK BAP priority species.

Sensitivity	Definition
LOW	Any other species of conservation interest, e.g. species listed on the Birds of Conservation Concern not covered above.

Table 6.2 Definition of terms relating to the magnitude of ornithological effects.

Magnitude	Definition
VERY HIGH	Total loss or very major alteration to key elements/ features of the baseline conditions such that post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether. Guide: >80% of population/habitat lost
HIGH	Major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed. Guide: 20-80% of population/habitat lost
MEDIUM	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/ composition/ attributes of baseline will be partially changed. Guide: 5-20% of population/habitat lost
LOW	Minor shift away from baseline conditions. Change arising from the loss/ alteration will be discernible but underlying character/ composition/ attributes of baseline condition will be similar to pre-development circumstances/patterns. Guide: 1-5% of population/habitat lost
NEGLIGIBLE	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation. Guide: <1% of population/habitat lost

6.3.4 The combined assessment of the magnitude of an effect and the sensitivity of the receptor has been used to determine whether or not an adverse effect is significant. These two criteria have been cross-tabulated to assess the overall significance of that effect (Table 6.3).

Table 6.3 Matrix of magnitude of effect and sensitivity used to test the significance of effects (the significance category of each combination is shown in each cell. Shaded cells indicate potentially significant effects).

MAGNITUDE	SENSITIVITY				
		Very high	**High**	**Medium**	**Low**
	Very high	Very high	Very high	High	Medium
	High	Very high	Very high	Medium	Low
	Medium	Very high	High	Low	Very low
	Low	Medium	Low	Low	Very low
	Negligible	Low	Very low	Very low	Very low

6.3.5 The interpretation of these significance categories is as follows:

- Very low and low are not normally of concern, though normal design care should be exercised to minimise adverse effects;
- Very high and high represent adverse effects on bird populations which are regarded as significant for the purposes of EIA;

- Medium represents a potentially significant adverse effect on which professional judgment has to be made.

6.4 Site Surveys Overview

6.4.1 The main baseline field surveys were undertaken to establish a baseline and identify potentially sensitive species during 2005 and 2006. Standard survey techniques were employed to:

- Evaluate the breeding bird community.
- Evaluate the bird community outside the breeding season.
- Quantify the number of overflying birds of conservation concern and their potential collision risk.

6.4.2 As with all time limited ecological surveys, the results outlined below give a snapshot of conditions at the time of survey. They are not necessarily an indication of every species on the Site but recognised sampling techniques were used to give sufficient information to assess the overall possible ornithological impact of the Proposal.

6.4.3 Subsequent to the main 2005 and 2006 surveys, further survey work has been undertaken in 2011 and 2012 on the main ornithological issue at the site, curlew. This species has declined markedly by about 50% in Wales in the last 15 years (Johnstone *et al*. 2011) and these surveys were carried out to determine if the population within the Study Area had also declined, and if the areas important to it had changed.

6.5 Information Gaps

6.5.1 No significant information gaps have been identified. Inevitably with any ecological survey it cannot be guaranteed to detect all target species/individuals and surveys cannot be fully representative of all conditions (e.g. severely reduced visibility). However in this case it was concluded that the baseline surveys provide a robust data set on which to carry out the assessment. None of the limitations are considered likely to have significantly affected the conclusions of this assessment.

6.6 Methodology

6.6.1 The determination and appraisal of the baseline conditions present at the Site were undertaken through a combination of desk study and field surveys.

6.6.2 A desk study was carried out to collate existing records from the Site and surrounding area and to inform the necessary field surveys. CCW, RSPB, the Montgomeryshire Wildlife Trust, the Montgomeryshire Barn Owl Group (MBOG) and the Biological Information Service for Powys were approached for background records of statutory designated sites within 5 km of the Site, and non-statutory designated sites, habitats and notable species within 2 km of the Site. Additional information was also obtained from the baseline surveys carried out for the proposed Carnedd Wen wind farm site adjacent.

6.6.3 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 automatically mean that they do not occur in the study area. Likewise, the presence of records for protected species does not automatically mean that these species still occur within the area of interest, only that conditions were once suitable. This is particularly true with older records.

6.6.4 The field survey work undertaken comprised the following elements:

- General breeding bird surveys
- Specific breeding surveys for key target species
- Bird surveys during autumn and winter

- Year-round vantage point surveys for overflying birds
- Targeted surveys to provide further information on the current status and areas of importance for breeding curlew.

Breeding Bird Survey

6.6.5 The main breeding bird surveys within the Study Area were carried out using the standard upland survey method (Brown and Shepherd 1993). Two survey visits were made in 2005, the first during 28 April-2 May and the second during 6-10 June 2005, with two observers during each visit. This was extended to three visits in 2006, in line with current SNH guidance (Whitfield *et al*. 2010). The first of these visits were made during 17-20 April, the second during 30 May - 2 June and the third during 26-29 June 2006, with three observers during each visit. All species were recorded and all bird locations and behaviour were mapped to 1:10,000 scale using the standard Common Birds Census notation. Supplementary behavioural observations and notes were made to determine breeding locations as accurately as possible. The area was subdivided into half-kilometre square (25 hectare) areas. Birds were recorded systematically for 20-25 minutes in each of these areas, standardising the search effort per unit area. The surveys were carried out avoiding strong winds, heavy rain, fog and low cloud. Birds were located by walking, listening and scanning by eye and with binoculars. Birds were considered to be breeding if singing, displaying, carrying nest material, nests or young found, repetitively alarmed adults, disturbance displaying, carrying food or in territorial dispute.

6.6.6 The Brown and Shepherd method has been shown to give reliable population estimates for most upland breeding birds. It may, however, under-estimate some of the more cryptic species. Of the species found in the Study Area this may particularly apply to snipe, red grouse and black grouse (though additional dawn/dusk visits were undertaken to obtain more information on these species and RSPB carried out specific black grouse surveys – see below). The population estimates for these species particularly should therefore be treated as a minimum figure.

Breeding Raptor Surveys

6.6.7 The desk study and the results of the preliminary surveys in 2005 indicated that the Study Area was used by a range of scarce raptor species, including hen harrier, merlin, peregrine, goshawk and red kite, so a programme of species-specific surveys (following Evans, 2001, for goshawk and Gilbert *et al*. 1998 for the other species) was undertaken in 2006.

Black Grouse Surveys

6.6.8 Again as a result of the finding of the desk study, consultations and the 2005 preliminary surveys, a specific survey for black grouse was undertaken in 2006. This work was carried out by RSPB using their standard black grouse survey technique (Gilbert *et al*. 1998). This survey covered all of the 1km squares in which RSPB considered this species may be present and relevant to the Proposal; SH 9507, 9509, 9510, 9607, 9608 and 9609.

6.6.9 Additional back grouse information was obtained from the baseline surveys carried out for the Carnedd Wen proposed wind farm, through to 2012 (RWE 2012).

Autumn and Winter Bird Surveys

6.6.10 The autumn and winter bird surveys comprised regular counts of the birds within the Study Area. A total of six surveys were carried out at approximately monthly intervals during October 2005 - March 2006. The counts were carried out as instantaneous counts, recording a snapshot of the birds present in each field/sector of the Study Area at the time it was surveyed. One such count of each field/sector was made each survey visit, recording the numbers of all the key species present. Any additional records made outside this time were noted as supplementary records. These snapshot counts were organised to ensure that the full range of times of day were covered in each part of the Study Area. The survey focussed

on key target species, as defined in SNH guidance (Whitfield *et al*. 2010). As well as counting each species, the behaviour of each flock was also recorded, e.g. feeding/roosting. Birds in flight over-flying the field during the snapshot were also recorded, together with an estimate of their height and direction.

Vantage Point Surveys

6.6.11 Preliminary observations of bird flight activity were made during the 2005 breeding season to make an initial identification of areas of higher importance to key species.

6.6.12 A full programme of systematic vantage point surveys was carried out through the autumn/winter 2005-06 and through the 2006 breeding season. This survey was undertaken to quantify the possible collision risk to birds overflying the Proposal. Seven main vantage points overlooking the potential collision risk zone (taken as per SNH guidance as the proposed wind farm plus a 200m buffer, Whitfield *et al*. 2010) and its surrounds. The SNH-recommended survey method (Madders, in Whitfield *et al*. 2010) was followed, though refined to record flight height estimates as accurately as possible rather than just summarising them to height classes. The main focus of this work was the potential collision risk zone (see 6.8.5), though flights seen outside this area were also recorded. During each vantage point (VP) survey all of the key species (target species, as defined in SNH guidance) were mapped and the flight height of each flock recorded (estimated as accurately as possible using reference structures such as power lines). The activity during each flight (e.g. flying to roost, foraging) was also recorded. Observations were carried out at each point throughout the survey period, with the timing of these observations made to cover dawn/dusk roost flights as well as general daytime movements. Surveys during the breeding season were undertaken during April-July 2006, and outside the breeding season during October 2005 – March 2006, with approximately 36 hours of observation from each VP during each period, giving a total of 495 hours' observations. Visibility from each VP at rotor height shown in Figure 6.2. These represent the actual visibility taking forestry into account and were ground-truthed at each vantage point location.

Supplementary Curlew Surveys

6.6.13 Following consultation with CCW and RSPB, further surveys were carried out during 2011, 2012 and 2013 on the key bird issue at this site, curlew. These surveys sought to provide further information on the current breeding status of this species in the area.

6.6.14 These surveys comprised walkover (Brown and Shepherd 1993) surveys of the lower part of the site that had been used by curlew during the previous surveys, with three visits during April-June to determine current numbers and distribution. They followed the same survey methodology as the Breeding bird survey described above.

6.6.15 In addition a mini-vantage point survey was also undertaken, between mid-March and June, and involved a series of mini-vantage point watches from strategic points across the curlew breeding area to observe their behaviour and habitat use. During each watch all curlews observed were mapped and their behaviour recorded, together with a record of the habitat they were using. A total observation time of 36 hours was achieved in each year.

6.7 Desk Study Results

6.7.1 The results of the desk study are summarised in Table 6.4. Distributions of key species are shown later in the chapter in conjunction with the information obtained from the baseline field surveys.

Table 6.4 Results of desk study.

Organisation	Response Obtained
CCW	Confirmation that no statutory designated sites (Sites of Special Scientific Interest, Special Protection Areas, Special Areas of Conservation) occur within the application Site.
RSPB	Details of black grouse lek locations in the area.
Biodiversity Information Service for Powys	All species and designated site details held for this Site.
Montgomery Barn Owl Group	Breeding locations of barn owls within and around the survey area obtained for last 5 years.

6.7.2 There are no statutory ecological designations within the Llanbrynmair Site. There are five statutory protected nature conservation sites within 5km of the Site. Distance are given to the nearest proposed wind turbine location;

- Gweunydd Dolwen SSSI – 1.4km SE – acid and dry neutral grassland notified for its botanical interest;
- Corsydd Llanbrynmair (Llanbrynmair Moors) SSSI – 1.9km NW – three remnant areas of blanket bog, notified for its botanical and invertebrate interest;
- Gweunydd Llechwedd-Newydd – 3.4km north – acid-neutral grassland notified for its botanical interest;
- Gwaun Llan (Llan Pastures) – 4.6km SW – small unimproved damp pasture notified for its botanical interest;
- Gwaun Hafod-Wen – 3.8km S – upland acid pasture notified for its botanical interest.

6.7.3 Additionally the Berwyn SSSI, SPA and SAC lies 5.3km north from the nearest proposed turbine, an area of blanket mire and heath, with acid grassland and bracken. Its main ornithological (SPA/SSSI) interest includes breeding populations of hen harrier, merlin and peregrine. Its main SAC interest is its blanket bog habitat. There are no other SPAs within 20km.

6.7.4 Most of the records from the desk study relate to breeding locations of species specially protected from disturbance under Schedule 1 of the 1981 Wildlife and Countryside Act. In order to avoid possible persecution/infringement of the Act, it is important that these be kept confidential. As a result they are discussed in detail in a separate Confidential Appendix.

6.8 Bird Survey Results

Breeding Bird Populations

6.8.1 A total of 79 species were recorded as breeding across the Study Area in at least one of the two baseline survey years, with a further 3 species recorded in the Study Area or overflying but with no evidence of breeding (peregrine, lesser black-backed gull and swift). A full list of breeding birds recorded is given in Table 6.5.

Table 6.5. Breeding bird population estimates in the Llanbrynmair Study Area in 2005 and 2006.

Species	Number of pairs in 2005	Number of pairs in 2006	Density (pairs per km^2) 2005	Density (pairs per km^2) 2006
Great Crested Grebe	0	1	0	<0.1
Mallard	0	10	0	0.3
Tufted Duck	0	2	0	0.1
Red Kite	1	0	<0.1	0
Hen Harrier	1	2	<0.1	0.1
Goshawk	1	3	<0.1	0.1

Species	Number of pairs in 2005	Number of pairs in 2006	Density (pairs per km^2) 2005	Density (pairs per km^2) 2006
Sparrowhawk	2	0	0.1	<0.1
Buzzard	14	8	0.5	0.3
Merlin	0	1	0	<0.1
Kestrel	2	2	0.1	0.1
Red Grouse	3	2	0.1	0.1
Black Grouse	1	1	<0.1	<0.1
Pheasant	13	24	0.4	0.8
Coot	1	2	<0.1	0.1
Snipe	2	4	0.1	0.1
Woodcock	1	0	<0.1	
Curlew	1	10	<0.1	0.3
Common Sandpiper	0	1	0	<0.1
Stock Dove	1	0	<0.1	
Woodpigeon	59	61	2.0	2.1
Cuckoo	5	8	0.2	0.3
Barn Owl	0	2	0	0.1
Tawny Owl	0	1	0	<0.1
Great Spotted Woodpecker	0	2	0	0.1
Skylark	115	209	3.9	7.1
Sand Martin	0	7	0	0.2
Swallow	3	13	0.1	0.4
House Martin	0	9	0	0.3
Tree Pipit	7	11	0.2	0.4
Meadow Pipit	408	636	13.9	21.7
Grey Wagtail	6	14	0.2	0.5
Pied Wagtail	17	42	0.6	1.4
Wren	111	192	3.8	6.6
Dunnock	11	32	0.4	1.1
Robin	62	167	2.1	5.7
Redstart	4	28	0.1	1.0
Whinchat	5	15	0.2	0.5
Stonechat	12	15	0.4	0.5
Wheatear	15	21	0.5	0.7
Blackbird	28	93	1.0	3.2
Song Thrush	40	69	1.4	2.4
Mistle Thrush	26	33	0.9	1.1
Grasshopper Warbler	7	10	0.2	0.3
Sedge Warbler	0	1	0	<0.1
Whitethroat	0	1	0	<0.1
Garden Warbler	0	9	0	0.3
Blackcap	0	7	0	0.2
Wood Warbler	0	3	0	0.1
Chiffchaff	3	5	0.1	0.2
Willow Warbler	143	185	4.9	6.3
Goldcrest	73	58	2.5	2.0
Spotted Flycatcher	0	3	0	0.1
Pied Flycatcher	1	7	<0.1	0.2
Long-tailed Tit	0	3	0	0.1
Coal Tit	27	24	0.9	0.8
Blue Tit	5	30	0.2	1.0

Species	Number of pairs in 2005	Number of pairs in 2006	Density (pairs per km^2) 2005	Density (pairs per km^2) 2006
Great Tit	0	19	0	0.6
Nuthatch	0	4	0	0.1
Treecreeper	0	1	0	<0.1
Jay	5	2	0.2	0.1
Magpie	19	16	0.6	0.5
Jackdaw	1	8	<0.1	0.3
Rook	0	10	0	0.3
Carrion Crow	43	47	1.5	1.6
Raven	4	4	0.1	0.1
Starling	1	3	<0.1	0.1
House Sparrow	0	10	0	0.3
Chaffinch	184	345	6.3	11.8
Greenfinch	0	2	0	0.1
Goldfinch	0	13	0	0.4
Siskin	7	25	0.2	0.9
Linnet	10	16	0.3	0.5
Redpoll	63	77	2.2	2.6
Crossbill	0	5	0	0.2
Bullfinch	6	8	0.2	0.3
Reed Bunting	11	37	0.4	1.3

Autumn and Winter Bird Populations

6.8.2 The numbers of all of the key target species recorded during the autumn / winter surveys is given in Table 6.6 (mean, peak and frequency of occurrence) and Table 6.7 (count totals for each survey). Bird numbers seen generally during this period were low.

Table 6.6. Autumn/wintering bird target species populations recorded in the Llanbrynmair wintering bird Study Area during the field counts October 2005-March 2006 (n=6 surveys).

Species	Mean count	Peak count	Frequency of occurrence
Grey Heron	0.2	1	17%
Teal	0.5	3	17%
Mallard	0.3	2	17%
Goldeneye	0.7	3	33%
Red Kite	0.5	2	33%
Hen Harrier	0.3	1	33%
Sparrowhawk	1.0	2	83%
Buzzard	1.2	3	50%
Kestrel	1.3	3	83%
Peregrine	0.2	1	17%
Red Grouse	1.2	7	17%
Black Grouse	1.3	3	67%
Golden Plover	10.5	63	17%
Snipe	4.2	25	17%
Woodcock	1.0	3	67%
Barn Owl *	0.2	1	17%
Tawny Owl	0.2	1	17%

** only record was of a bird recently killed, probably by a goshawk.*

Table 6.7. Autumn/wintering bird populations in the Llanbrynmair wintering bird Study Area, 2005-06: field count totals for each visit. Note: the table includes all target species (waterfowl, grouse and birds of prey).

Species	22-25 /10/05	29/11 - 3/12/05	27-29 /12/05	20-23 /01/06	19-22 /02/06	17-21 /03/06
Grey Heron	1	0	0	0	0	0
Teal	0	3	0	0	0	0
Mallard	0	2	0	0	0	0
Goldeneye	0	0	1	3	0	0
Red Kite	0	2	1	0	0	0
Hen Harrier	0	0	0	1	0	1
Sparrowhawk	1	2	1	0	1	1
Buzzard	2	3	0	0	2	0
Kestrel	3	1	2	1	0	1
Peregrine	0	0	0	0	0	1
Red Grouse	0	7	0	0	0	0
Black Grouse	2	3	2	0	0	1
Golden Plover	63	0	0	0	0	0
Snipe	25	0	0	0	0	0
Woodcock	0	0	1	1	1	3
Barn Owl	0	0	0	0	1	0
Tawny Owl	0	0	1	0	0	0

Vantage Point Survey Results: Breeding Season

6.8.3 The observed bird flight rates over the Study Area are summarised in Table 6.8, which gives the mean over-flying rate per hour over the April-July 2006 study period. Table 6.9 gives the same data separately for each VP. This includes all the observations of birds (of the key target species in SNH guidance, Whitfield *et al*. 2010) flying over the proposed wind farm site and its surrounds.

6.8.4 No species was observed regularly over-flying in important numbers and no important regular flight lines were noted. The main species of interest seen over-flying during the vantage point surveys included red kite, hen harrier, goshawk, peregrine, merlin, black grouse and golden plover.

6.8.5 Table 6.8 also gives the percentage of flights of each species that were recorded at rotor height which is considered to be the collision risk zone (taken conservatively as 21-150m above ground level to allow for errors in flight height estimation; on an 80m tower the actual rotor height would be likely to be about 33.5-126.5m). As black grouse can be vulnerable to collision with towers, any flights of this species below rotor height were also considered to be at risk.

Table 6.8. Bird flight rates recorded over the Llanbrynmair Study Area during April-July 2006 vantage point surveys. N = 250.5 hours observation.

Species	Overall flight rate (bird-minutes/hr)	Total bird-minutes flight time recorded	% at rotor height
Grey Heron	0.01	1	0%
Canada Goose	0.02	4	64%
Mallard	0.02	6	43%
Goosander	<0.01	1	100%
Red Kite	1.56	390	90%
Hen Harrier	0.40	101	35%
Goshawk	0.55	139	91%
Sparrowhawk	0.04	10	72%
Buzzard	9.39	2353	89%
Kestrel	0.13	33	39%
Merlin	0.01	1	0%
Hobby	0.02	5	100%
Peregrine	0.02	6	73%
Golden Plover	0.42	105	0%
Snipe	<0.01	1	100%
Curlew	0.14	35	46%
Black-headed Gull	0.06	16	100%
Lesser Black-backed Gull	0.36	90	88%
Herring Gull	0.09	23	100%
Raven	3.69	924	50%

Table 6.9. Bird flight activity in the Llanbrynmair Study Area, April-July 2006: number of bird-minutes observed per hour observation for each of the main VPs.

Species	VP 1	VP 2	VP 3	VP 4	VP 5	VP 6	VP 7
Grey Heron				0.02			0.02
Canada Goose			0.04				0.07
Mallard		0.07	0.09				
Goosander		0.03					
Red Kite	0.22	0.69	2.42	3.46	1.33	0.54	2.30
Hen Harrier	0.94	0.32	0.63	0.19	0.05	0.33	0.34
Goshawk	1.38	0.29	0.34		0.11	0.53	1.21
Sparrowhawk	0.14		0.02		0.01		0.12
Buzzard	6.67	6.11	12.64	11.43	8.35	12.30	8.34
Kestrel	0.08	0.25	0.37	0.04		0.07	0.11
Merlin				0.01			0.02
Hobby	0.14						
Peregrine			0.06			0.04	0.05
Golden Plover						2.92	
Snipe				0.03			
Curlew			0.28	0.50	0.13	0.09	
Black-headed Gull			0.01				0.42
Lesser Black-backed Gull			0.61	0.51	0.12	0.11	1.19
Herring Gull	0.11	0.06		0.18	0.21		0.09
Raven	2.49	3.92	4.04	3.49	6.06	3.02	2.76

Note: blank cells indicate that species not recorded from that vantage point

Autumn / Winter Vantage Point Survey Results

6.8.6 The observed bird flight rates recorded outside the breeding season are summarised in Table 6.10, which gives the mean over-flying rate per hour over the October 2005 – March 2006 study period. Table 6.11 gives the same data separately for each VP.

6.8.7 No species was observed regularly over-flying in important numbers and no important regular flight lines were noted. The main species of interest seen over-flying during the vantage point surveys included red kite, hen harrier, goshawk, peregrine, merlin, black grouse and golden plover.

6.8.8 Table 6.10 also gives the percentage of flights of each species that were recorded at rotor height (taken conservatively as 21-150m above ground level to allow for errors in flight height estimation; on an 80m tower the actual rotor height would be likely to be about 33.5-126.5m).

Table 6.10. Bird flight rates recorded over the Llanbrynmair Study Area during October 2005 – March 2006 vantage point surveys. N = 243.5 hours observation.

Species	Overall flight rate (no/hr)	Total bird-minutes flight time recorded	% at rotor height
Cormorant	0.09	22	100%
Grey Heron	0.001	0.3	0%
Mallard	0.01	2	50%
Goosander	0.001	0.3	0%
Red Kite	0.96	234	41%
Hen Harrier	0.53	130	3%
Goshawk	0.19	45	90%
Sparrowhawk	0.02	6	53%
Buzzard	1.55	378	75%
Kestrel	0.67	163	12%
Merlin	0.01	2	0%
Peregrine	0.03	8	89%
Black Grouse	0.01	2	0%
Golden Plover	5.89	1434	65%
Lapwing	0.68	165	100%
Snipe	0.08	20	86%
Raven	4.07	992	51%

Table 6.11. Bird flight activity in the Llanbrynmair Study Area, 2005-06: number of bird-minutes observed per hour observation for each of the main VPs.

Species	VP 1	VP 2	VP 3	VP 4	VP 5	VP 6	VP 7
Cormorant	0.09	0.17	0	0	0	0	0
Grey Heron	0	0	0	0	<0.01	0	0
Mallard	0.01	0	0.01	0	0	0	0
Goosander	0	0	0	0	0	0	0
Red Kite	0.96	0.27	0.02	0.04	0.30	2.23	1.10
Hen Harrier	0.53	0.17	0.09	0.48	0	0.40	0.43
Goshawk	0.19	0.39	0.01	0.18	0	0.02	0
Sparrowhawk	0.02	0	0.02	0.03	0	0	0.01
Buzzard	1.55	0.50	0.87	0.59	0.76	0.77	1.04
Kestrel	0.67	0.01	0.21	0.06	0.03	0.90	1.38
Merlin	0.01	0.01	0	0.01	0	0	0.01
Peregrine	0.03	0	0	0	0	0.02	0
Black Grouse	0.01	0.03	0	0	0	0	0
Golden Plover	5.89	0	0	0.54	26.47	5.71	3.58
Lapwing	0.68	0	0	0	0	1.37	1.27
Snipe	0.08	0	0	0.16	0	0.03	0.01
Raven	4.07	2.90	2.34	1.42	0.23	2.19	1.26

Curlew Surveys 2011 and 2012

6.8.9 The curlew surveys in 2011 and 2012 indicated that there has been a considerable decline in curlew activity within the survey area in comparison with the 2005 and 2006 surveys that were used as the baseline for the original ES. Only two curlew territories were identified in the surveys in both years (Figure 6.3). The birds' behaviour indicated that neither of these

pairs was actually breeding within the survey area in either year: most were either feeding or roosting, with both members of each pair frequently being seen together rather than attending a nest/chicks (60% of records were of pairs together). This would suggest that neither pair bred successfully, if at all. Most of the birds were using the improved grassland within the survey area, with 64% of records within that habitat in 2011 and 58% in 2012. The other records were on marshy grassland (rush pasture).

6.9 Nature Conservation Value of the Identified Resources

Breeding Birds

6.9.1 An analysis of the nature conservation value of the resources identified for the Study Area, in the desk and field surveys, has been undertaken and the results are presented in Table 6.12 (below). This assessment has been carried out using the methodology developed by SNH and the British Wind Energy Association [BWEA] and updated by Percival (2007). Table 6.12 includes all the species noted during the surveys that have low or greater sensitivity. Additional species that were only observed over-flying the Study Area, or using it but not showing any indication of breeding there, have also been included.

Table 6.12. Conservation evaluation of the breeding bird populations at Llanbrynmair.

Species	Breeding pairs within Study Area (peak 2005 and 2006)	Import-ance on basis of numbers (Wales)	EU Birds Directive Annex 1	W and C Act Schedule 1	Red List	Amber List	BAP priority species (UK BAP/ Welsh S42/ Powys LBAP)	Sensitivity
Breeding species:								
Red Kite [5]	1	Regional	✓	✓		✓	P	High
Hen harrier [4]	2	National	✓	✓	✓		W	High
Goshawk [5]	3	National		✓				High
Buzzard [3] [3]	29							
Merlin [4]	1	Regional	✓	✓		✓		High
Kestrel	2					✓	W	Medium
Red Grouse [1]	3					✓	UK	Medium
Black Grouse [3] [3]	1	Regional			✓		UK, W	High *
Snipe [2]	4					✓		Low
Woodcock [2]	1					✓		Low
Curlew [2]	11	National				✓	UK, W, P	High
Common sandpiper [2]	2							
Stock Dove [1]	3					✓		Low
Cuckoo [2]	8				✓		UK, W	Medium
Barn Owl	3	Regional		✓		✓		High
Great Spotted Woodpecker [2]	2							
Skylark	209				✓		UK, W	Medium
Sand Martin	11					✓		Low
Swallow	63					✓		Low
House Martin	28					✓		Low
Tree Pipit [1.5]	13				✓		UK, W	Medium
Meadow Pipit	636					✓		Low
Grey wagtail [2]	14					✓		Low
Dunnock	32					✓	UK, W	Medium

Species	Breeding pairs within Study Area (peak 2005 and 2006)	Import-ance on basis of numbers (Wales)	EU Birds Directive Annex 1	W and C Act Schedule 1	Red List	Amber List	BAP priority species (UK BAP/ Welsh S42/ Powys LBAP)	Sensitivity
Redstart [1]	31					✓		Low
Whinchat [2]	15					✓		Low
Stonechat [2]	22							
Wheatear [2]	25					✓		Low
Song Thrush	75				✓		UK, W	Medium
Mistle Thrush	42					✓		Low
Grasshopper Warbler	10				✓		UK, W	Medium
Garden Warbler [1]	9							
Blackcap [1]	10							
Wood Warbler [2]	3				✓		UK, W	Medium
Chiffchaff [1]	7							
Willow Warbler	255					✓		Low
Goldcrest	119							
Spotted Flycatcher [1]	3				✓		UK, W	Medium
Pied Flycatcher [2]	10					✓	W	Medium
Coal Tit [1]	46							
Nuthatch [2]	4							
Treecreeper [1]	4							
Jay [1]	7							
Raven [3] [3]	6							
Starling	3				✓		UK, W	Medium
House Sparrow	26				✓		UK, W	Medium
Siskin [2]	25							
Linnet	24				✓		UK, W	Medium
Lesser Redpoll [1]	79				✓		UK, W	Medium
Common Crossbill [3]	5			✓				High
Bullfinch [1]	19				✓		UK, W	Medium
Reed Bunting	37				✓		UK, W	Medium

Note: Table includes all species of low or higher sensitivity and all those that contribute to breeding bird assemblage scores.
Superscript numbers refer to each species' contribution to the upland moorland breeding bird assemblage score, with woodland score in square brackets.
Blank sensitivity column indicates no particular conservation value for that species.
** Though black grouse numbers within the study area are currently low, they have still been classed as high sensitivity as a precautionary measure as they form part of a nationally important (in a Welsh context) population that is found to the north of the wind farm site.*

6.9.2 The breeding bird community within the Study Area included eight high sensitivity species: hen harrier, red kite, goshawk, peregrine, black grouse, curlew, barn owl and common crossbill. All other than curlew and black grouse are specially protected from disturbance during breeding under Schedule One of the Wildlife and Countryside Act. Hen harrier, red kite and peregrine are additionally listed on Annex 1 of the EU Birds Directive. A single pair of hen harrier would be nationally important in a Welsh context, as would the three pairs of

goshawk: the most recently published population estimate for hen harrier in Wales is 43 territories (Sim *et al*. 2007). The 10 pairs of curlew found in the 2005 and 2006 surveys are sufficient to be considered to be of nationally important in a Welsh context (though only locally important in a UK context), though recent surveys in 2011 and 2012 have shown that population to be reduced to only two pairs. The black grouse formed part of a nationally important population (again in a Welsh context). Black grouse is of particular importance in a Welsh context as a priority species at risk of extinction in Wales that has been targeted for specific conservation action. More recent surveys undertaken by RWE (RWE 2012), however, did not locate any evidence that this species is still present in the area, with no confirmed records since 2008. Crossbill numbers were only locally important in a Welsh context. The others of these species were present in regionally important numbers (Lovegrove *et al*. 1994).

6.9.3 Seventeen species were classed as medium sensitivity: red grouse, kestrel, cuckoo, skylark, tree pipit, dunnock, song thrush, grasshopper warbler, wood warbler, spotted flycatcher, pied flycatcher, starling, house sparrow, linnet, lesser redpoll, bullfinch and reed bunting. All are UK and/or Welsh BAP priority species. A further 13 breeding species were determined to be low sensitivity.

6.9.4 In addition to these species breeding within the Study Area, one high sensitivity (peregrine) and one low sensitivity species (lesser black-backed gull) were also seen during the surveys, but showed no signs of breeding within the Study Area.

6.9.5 The overall conservation value of the Study Area upland breeding bird community, measured from the 2005 and 2006 survey data as the breeding bird assemblage score, was 32 (JNCC 1995). The contribution from each species is shown in Table 6.13 above. This value is below the threshold for national importance (34; JNCC 1995) but is above the threshold for regional importance (17) for this habitat, upland moorland and grassland with water bodies. The Study Area is therefore regionally important in terms of its overall upland breeding bird community in a UK and Welsh context. The score for the woodland habitat was 48, well in excess of the threshold for national importance (39). Hence this community was of sufficient quality to be classed as nationally important. This was largely on the basis of a diverse deciduous woodland breeding bird community in the woodland on the western edge of the Study Area (500m-1km from the nearest proposed wind turbine) rather than the areas of coniferous afforestation. Overall, given the range of species present and their status in Wales, the Study Area as a whole has been considered as nationally important in a UK and Welsh context for its breeding bird community.

Non-Breeding Birds

6.9.6 The conservation value of the non-breeding bird populations observed in the Study Area has been summarised in Table 6.13. No very high sensitivity species were noted. Of the main target species, eight high sensitivity species were observed (red kite, hen harrier, goshawk, merlin, peregrine, golden plover and barn owl; through their listing on Annex 1 of the Birds Directive and/or Schedule 1 of the Wildlife and Countryside Act, and black grouse; present in regionally important numbers, part of a nationally important population in a Welsh context and a UK BAP priority species), three medium sensitivity (kestrel, red grouse and lapwing; UK/Welsh BAP priority species) and five low sensitivity target species were recorded during the wintering bird surveys.

6.9.7 Several other incidental records of other species of conservation importance were obtained during the winter surveys. These included one high sensitivity species, crossbill (a Schedule 1 species) and 5 medium sensitivity UK BAP priority species (skylark, song thrush, starling, lesser redpoll and bullfinch).

Table 6.13. Conservation evaluation of the non-breeding bird populations at Llanbrynmair.

Species	Peak count	>1% regional popul-ation	EU Birds Directive Annex 1	W&C Act Sch1 species	Red [R]/ Amber [A] List	BAP priority species (UK BAP/ Welsh S42/ Powys LBAP)	Sensitivity
Cormorant	1						
Teal	3				A		Low
Goldeneye	3				A		Low
Red Kite	2	✓	✓	✓	A	P	High
Hen harrier	2	✓	✓	✓	R	W	High
Goshawk	2	✓		✓			High
Kestrel	3				A	W	Medium
Merlin	1	✓	✓	✓	A		High
Peregrine	1	✓	✓	✓	A		High
Red grouse	7				A	UK	Medium
Black grouse	3	✓			R	UK, W	High *
Golden plover	63		✓			W	High
Lapwing	120				A	UK, W	Medium
Snipe	25				A		Low
Woodcock	3				A		Low
Lesser black-backed gull	+				A		Low
Barn owl	1	✓		✓	A		High
Skylark	+				R	UK, W	Medium
Fieldfare	+				A		Low
Song thrush	+				R	UK, W	Medium
Redwing	+				A		Low
Mistle thrush	+				A		Low
Starling	+				R	UK, W	Medium
Redpoll	+				R	UK, W	Medium
Crossbill	+			✓			High
Bullfinch	+				R	UK, W	Medium

Note: Table includes all species of low or higher sensitivity.
+ = present but not quantitatively surveyed (non-target species)
** Although black grouse numbers within the study area are currently low, they have still been classed as high sensitivity as a precautionary measure as they form part of a nationally important (in a Welsh context) population that is found to the north of the wind farm site.*

6.10 Sensitivity of the Valued Resources

6.10.1 Consultations with CCW and RSPB following the baseline surveys indicated that they had most concern over two bird species, curlew and black grouse.

6.10.2 **Curlew** – the main area used by the curlew in 2005 and 2006 was in the south-eastern part of the Study Area, on the lower ground. This area was a mosaic of improved grassland

(which provides this species with an attractive food resource; invertebrates are more readily available on the short grassland) and rushy pasture (which provides them with nesting cover and additional feeding habitat). Flight activity was also largely noted in over this lower ground in 2005 and 2006 (Figure 6.3a: all records and flight lines 2005 and 2006). This same area was used in 2011, 2012 and 2013, though with only two pairs present (Figure 6.3b-d).

6.10.3 **Black Grouse** – the distribution of black grouse records from the current baseline surveys (including the four records of over-flying birds made during the vantage point surveys) and from available desk study records is summarised in Figure 6.4. All of the records were from the northern part of the Study Area, with the large majority of the recent lekking activity over 500m to the north of the Proposal. As noted above there are no records of this species using the area since 2008, with RWE surveys indicating that it may have become locally extinct.

6.10.4 Six further high sensitivity species were noted during the baseline surveys that are specially protected from disturbance under Schedule 1 of the 1981 Wildlife and Countryside Act: **red kite, hen harrier, goshawk, merlin, peregrine and barn owl**. In order to avoid possible persecution/infringement of the Act, it is important that information relating to nesting locations of these be kept confidential. As a result they are discussed in detail in a separate Confidential Appendix.

6.10.5 Two further high sensitivity species were also recorded, golden plover and crossbill:

6.10.6 **Golden plover** – this species was not recorded breeding within the Study Area but there were several records of non-breeding birds made during the baseline surveys. These were mostly from the southern part of the Study Area, and this was the only location in which a flock was recorded on the ground (a single flock of 63 on one date). Small numbers were recorded over-flying (Figure 6.5). The Study Area was not important for this species.

6.10.7 **Crossbill** – this species, though protected under Schedule 1 of the 1981 Wildlife and Countryside Act, is widespread though much of the coniferous forestry in Wales and is not a species considered vulnerable to wind farm developments (Whitfield *et al*. 2005). The records from the baseline surveys were scattered over the conifer forest within the Study Area but with most in the northern part (Figure 6.6). The main potential impact on this species is felling of their forest habitat. Their populations can be highly variable between years, so it will be important that pre-construction surveys be carried out to inform the need for mitigation during construction.

6.10.8 Sixteen other UK/Wales BAP priority species were recorded breeding in the Study Area during the baseline surveys: red grouse, kestrel, cuckoo, skylark, tree pipit, dunnock, song thrush, grasshopper warbler, wood warbler, spotted flycatcher, pied flycatcher, starling, house sparrow, linnet, lesser redpoll, bullfinch and reed bunting. Their distributions are shown in Figure 6.7 (skylark), Figure 6.8 (dunnock) and Figure 6.9 (other species). All are species that that have been identified as not being potentially vulnerable to wind farm development (Whitfield *et al*. 2010). Skylarks were widely distributed over the open ground in much of the Study Area. The other species were scattered over mostly the lower ground.

6.10.9 One further UK BAP species was recorded, lapwing. The only records were of four small flocks (up to 120 birds) seen over-flying during the winter vantage point surveys.

6.11 Future Baseline Conditions

6.11.1 Foreseeable changes in the baseline conditions without the construction of the scheme would likely be limited if the present farming regime continues. If the farming regime altered, especially grazing levels, then grassland habitats would be expected to change. It is possible that the landowners may introduce more drainage, cut rush areas and re-sow with ryegrass to improve yields in the near future: this could negatively affect the habitat for nesting curlew in particular. Reduced or abandonment of grazing may lead to an improvement in the structure of the grassland habitats but complete abandonment over time is likely to lead to scrub encroachment in the long-term. Harvesting of commercial conifer forestry may create a temporary increase in open upland habitat though this would

be likely to be replaced as new generation forestry (likely to be replacement planting of spruce) becomes established.

6.11.2 Future changes owing to climate change cannot be predicted with any certainty here, but it is likely that drought conditions in summer combined with harsher winters may affect the species composition found at the Site.

6.12 Constraints

6.12.1 The following constraints were identified following the ornithological surveys and are illustrated in Figure 3.3. These were used to inform the final layout of the development to minimise its ornithological impact.

- Black grouse – the approach taken was to establish a caution area, minimising the number of turbines within 1.5km of recent lek sites. The 1.5km reflects the usual range size of birds around the lek and would be relevant primarily where there is potential black grouse nesting habitat within this range (moorland/forest edge). The Study Area supported only a very small population of this species in 2005 and 2006, and more recent evidence suggests that it is no longer present in this area at all (RWE 2012). Only a single lek (of a single male) was recorded within 1.5km of the Proposal in the 2006 survey undertaken by RSPB, and only three others (again single records of single male leks) in the previous 5 years (using the standard survey methodology, though this may still under-estimate actual numbers). Recent research on this species in Austria (Zeiler and Veronica Grünschachner-Berger 2007) has suggested that there may be a displacement effect to 300m. The only black grouse records within 300m of the proposed turbine locations are listed in Table 6.14.

Table 6.14. Black grouse records within 300m of current RES turbines.

Source	Date	Easting	Northing	Males	Females	Note	Distance from turbine (m)
RES breeding 2005 surveys	28/04/05	295740	309240	0	1	Female flushed	277
RES winter 05-06 surveys	20/03/06	295500	308300	1	0	male	212
RWE breeding survey	2007	295178	308590	1	0	Lek	263
RWE breeding survey	2008	294532	307945	1	0	Lek	237

- Though the precise locations of these leks are unlikely to remain the same if this species does recolonize this area, given the changes in the forest habitat, they do indicate that there was only a low level of black grouse activity in proximity to the wind turbines.
- **Curlew** - following consultation with CCW and RSPB, a constraint with regard to curlew was implemented, given the local population's national importance in a Welsh context. The core area of importance to this species was identified using an adaptive kernel (50%) range analysis (Borger *et al*. 2006) of all the curlew records from the breeding surveys, and no turbines were located within this zone. Its location is shown in Figure 6.3. This zone included 65% of all the curlew records made during the baseline breeding bird surveys in 2005 and 2006, and 72% in the more recent 2011, 2012 and 2013 surveys. There were no curlew nesting within 600m of the proposed turbine locations in either 2011, 2012 or 2013, and none likely to have been nesting within 300m of any in 2005 or 2006.
- **Hen harrier** habitat – this is discussed in the Confidential Appendix as it involves nest site locations of Schedule 1 species. No turbines have been located within potentially suitable hen harrier breeding habitat and there are no known hen harrier nest sites within 500m of any proposed turbine.

6.13 Ornithological Impact Assessment

Structure of the Impact Assessment

6.13.1 Direct and indirect environmental effects of the wind farm's construction and operational and decommissioning phases, based on the project description in Chapter 3, are evaluated for each aspect of the ornithological studies in the following paragraphs.

6.13.2 Mitigation for identified negative effects is presented below, along with proposals to enhance the wildlife value of the Site.

Proposed Site Layout

6.13.3 Following an analysis of ornithological constraints, a final layout minimising potential environmental impacts has been produced as shown in Figure 3.6, Volume III.

6.13.4 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 land lost to grazing.

6.13.5 The track network has been designed so that where it is possible to upgrade existing tracks, rather than construct new tracks, these opportunities have been taken.

Effects on Birds

6.13.6 The main potential effects of wind farms on birds are considered to be direct loss of breeding or feeding habitat, potential collision risk and indirect loss of habitat from disturbance (either temporary during construction or permanent from operating turbines) (Percival 2005). Each of these is considered in turn in the following sections.

Direct Effects (1): Loss of Habitat

6.13.7 This would be an effect of low/negligible magnitude, with only a very small area taken up by the turbine bases and access tracks (see Chapter 5). It would take place only during the construction phase of the Proposal. Careful selection of routes for the access tracks and turbine locations and use of proven construction techniques would ensure that such effects on birds would be of at most of low significance, and would not be considered significant under the EIA Regulations.

6.13.8 Loss of habitat through forest felling associated with the development would affect woodland species including two high sensitivity (goshawk and crossbill), two medium sensitivity species (song thrush and bullfinch) and four low sensitivity species (dunnock, mistle thrush, willow warbler, goldcrest and redpoll). In even a local context, however, the magnitude of this loss would be at most low, and therefore not significant. Any such effects would also be outweighed by the nature conservation gain that would result from the restoration of open habitats and peatland in that area.

Direct Effects (2): Collision Risk

6.13.9 There have been a number of wind farms that have caused bird mortalities through collision but their characteristics are very different to those at the proposed Llanbrynmair site. Most notably, at Altamont Pass in California and Tarifa in southern Spain, large numbers of raptors have been killed (Orloff and Flannery 1996, Janss 2000, Thelander *et al*. 2003). Such problems have occurred where large numbers of sensitive species occur in close proximity to very large numbers (hundreds/thousands) of turbines, and usually also where the wind farm area provides a particularly attractive feeding resource. In wind farm sites in the UK, with similar bird densities to Llanbrynmair, collision rates have generally been very low and are not considered to be significant (Meek *et al*. 1993, Tyler 1995, Dulas 1995, EAS 1997, Bioscan 2001, Percival *et al*. 2008, Percival *et al*. 2009). The risk is from operational turbines so would only apply to the operational phase of the Proposal.

Indirect Effects: Disturbance

6.13.10 Disturbance could potentially affect a rather greater area than direct habitat loss. The maximum distance that wind turbines have been shown to affect breeding birds is 800m (Percival 2005; Pearce-Higgins *et al*. 2009), though most reliable studies have not reported effects further than 600m from turbines (Drewitt and Langston 2006) and displacement is usually partial rather than complete (i.e. a reduction in use not complete exclusion). Displacement has generally been more widely reported and over a greater distance outside the breeding season.

Construction Phase

6.13.11 Disturbance is likely to be highest during construction owing to the activities being carried out. Pearce-Higgins *et al*. (2012) found that red grouse, snipe and curlew densities all declined on wind farms during construction, though also that densities of skylark and stonechat increased. Construction also involves the presence of work personnel on site which itself can be an important source of potential disturbance. Even at this time displacement from a zone around the wind turbines is likely to only be partial. Pearce-Higgins *et al*. (2012) for example reported decreases in curlew density during construction of 40% and snipe by 53%. A worst-case approach has been adopted in this assessment for the construction disturbance assessment, that all breeding birds within 500m of the wind turbines could potentially be at risk of displacement, and a slightly wider zone (600m) for wintering birds (Percival 2005; Drewitt and Langston 2006).

Operational Phase

6.13.12 Experience from existing UK wind farms have shown that many species are tolerant of the presence of operational wind turbines and not unduly disturbed by them. A recent study of wintering golden plover, lapwing and pink-footed geese, found no evidence of displacement of any of these species (Percival *et al*. 2008). All three species were observed feeding within 300m of wind turbines in years when their preferred crop was present in that zone.

6.13.13 Some short-term displacement during wind farm operation of species such as curlew may occur following construction but populations have subsequently re-established themselves (Bullen Consultants 2002). Most species that have been studied have not been significantly affected (Meek *et al*. 1993, Phillips 1994, Dulas 1995, Thomas 1999, Gill 2004, Percival 2005, Percival *et al*. 2008, Devereux *et al*. 2009). Scarcer species such as hen harrier have been less studied, however, so a cautious approach has been taken with these. However there are an increasing number of records of such species breeding successfully in close proximity to operational wind turbines, e.g. hen harriers in Scotland 400m from a turbine (M. Madders, pers. comm.) and only 200 m from a turbine in Northern Ireland (Steele 2005). A recent RSPB study has reported partial displacement of breeding upland birds around wind turbines up to 800m (Pearce-Higgins *et al*. 2009). This scale and pattern of displacement is similar to that reported for breeding waders in general by Hotker *et al*. (2004), with most studies reporting only small scale (0-200m) displacement distances and a smaller number over a greater distance. For the purposes of this assessment it has been assumed that all breeding birds within 300m of the wind turbines could be at risk of disturbance during operation, with consideration also given to the breeding populations within a 500m buffer as well, and a 600m buffer outside the breeding season.

6.13.14 A further potential operational disturbance effect could be disruption to important flight lines (barrier effect). Birds may see the wind farm and change their route to fly around (rather than through) it. This would reduce the risk of collision but could possibly have other effects, for example potentially making important feeding areas less attractive (by acting as a barrier to the birds reaching them) and (if diversions were of a sufficient scale) resulting in increased energy consumption.

6.13.15 The distance needed to divert around the Llanbrynmair Development would be relatively small and would not be expected to act as a major barrier to movements. Accordingly, the

ecological consequences of any such changes in flight lines would be of negligible magnitude and not significant.

Ornithological Impact Assessment Results

6.13.16 The first stage in the assessment has been to determine the numbers of each of the key species in the potential 'risk zones' for each of the two main possible impacts, collision and disturbance. For disturbance the numbers within 300 m and 500 m have been determined (see Table 6.15). For collision, this risk zone has been taken as the wind farm plus a 200m buffer (as recommended in current SNH guidance, Whitfield *et al*. 2010).

Table 6.15. Conservation importance of the breeding birds at Llanbrynmair within 300m and 500m of the proposed turbine locations (peak count during all baseline surveys).

Species	*Total breeding pairs (peak) within:*		*Importance of population in zone of possible disturbance effect*
	300m	*500m*	
Red Grouse [1]	0	1	Local
Black Grouse [3] [3]	1	1	Regional
Kestrel	1	1	Local
Snipe [2]	2	3	Local
Curlew [2]	2	3	Regional
Cuckoo [2]	5	5	Local
Skylark	103	153	Local
Swallow	1	1	Local
Tree Pipit [1.5]	2	3	Local
Meadow Pipit	251	366	Local
Grey Wagtail [2]	3	4	Local
Dunnock	8	11	Local
Redstart [1]	1	2	Local
Whinchat [2]	6	7	Local
Stonechat [2]	5	7	Local
Wheatear [2]	7	12	Local
Song Thrush	18	28	Local
Mistle Thrush	10	19	Local
Grasshopper Warbler	5	7	Local
Willow Warbler	53	96	Local
Raven [3] [3]	2	3	Local
Starling	1	1	Local
Linnet	4	6	Local
Redpoll [1]	28	41	Local
Crossbill [3]	4	5	Local
Bullfinch [1]	2	6	Local
Reed Bunting	14	19	Local

Note: Table includes all species of low or higher sensitivity and all those that contribute to breeding bird assemblage scores.
Superscript numbers refer to each species' contribution to the upland moorland breeding bird assemblage score, with woodland score in square brackets.
Species specially protected under Schedule 1 of the Wildlife and Countryside Act are not included here but are discussed in a separate confidential appendix.

6.13.17 The breeding bird assemblage score for the upland breeding bird community (upland moorland and grassland with water bodies) was 19.5 for the 300m buffer zone and 20.5 for the 500m zone. This value was below the threshold for national but above that for regional importance, hence in these zones the breeding bird community are of regional importance on the basis of their overall assemblage. That for the woodland breeding bird assemblage was 14 (for both the 300m and 500m zones), which falls just below the threshold for regional importance.

6.13.18 The over-flying rates of high and medium sensitivity target species within the potential collision risk zone is shown in Table 6.16. The flight occupancy rate is expressed as the proportion of the total survey time in which the birds were in the collision zone. Movement rates across this zone were generally low, with no regular flight lines or important foraging activity observed. The collision risk zone was split into zones according to the coverage from the VPs, and the overall effective observation time over the whole collision risk zone calculated (50.9 and 52.6 hours respectively for the winter and breeding season periods, both well in excess of the SNH-recommended 36 hours). The relatively high occupancy for golden plover resulted from a small number of larger flocks occasionally being observed.

Table 6.16. Over-flying rates of target species within the potential collision risk zone (wind farm plus 200 m buffer).

Species	Non-breeding season: Flight occupancy rate (% observation time seen)	Total bird-time observed (bird-mins)	Breeding season: Flight occupancy (% observation time seen)	Total bird-time observed (bird-mins)
Black grouse	0.004%	0.2	0%	0
Red kite	0.82%	38.2	1.22%	58.8
Goshawk	0.19%	9.0	0.67%	32.4
Hen harrier	1.09%	51.0	0.86%	41.7
Merlin	0.02%	0.7	0.01%	0.3
Peregrine	0.08%	3.6	0.02%	1.1
Golden plover	26.1%	1219.2	0%	0
Curlew	0%	0	0.22%	10.6

Collision Risk Modelling

6.13.19 In order to further inform the determination of the likelihood of potential adverse effects occurring, collision modelling has been carried out for all the high sensitivity species recorded over-flying the site at rotor height in non-trivial numbers (i.e. all the species listed in Table 6.16 above, apart from merlin, which were not recorded flying at rotor height). Black grouse was also considered, as a UK and Welsh BAP species of high conservation importance, but their flight occupancy of the collision risk zone was so low that it was clear that the collision risk would be negligible (and no flights were observed at rotor height). The other high sensitivity species, barn owl, was not recorded during the vantage point surveys flying through this zone at all. Curlew were only included for the breeding season and golden plover for the non-breeding season as there were not any records of those species flying through this zone at rotor height during the vantage point surveys outside those periods.

6.13.20 The collision risk model used in this assessment is the one developed by SNH and BWEA (Percival *et al*. 1999, Band 2001, Band *et al*. 2007). Details of the model are given in these publications. The model runs as a two-stage process. Firstly the risk is calculated making the assumption that flight patterns are unaffected by the presence of the wind turbines, i.e. that no avoidance action is taken. This is essentially a mechanistic calculation, with the collision risk calculated as the product of (i) the probability of a bird flying through the rotor swept area, and (ii) the probability of a bird colliding if it does so. This probability is then multiplied by the estimated numbers of bird movements through the wind farm rotors at the risk height (i.e. the height of the rotating rotor blades) in order to estimate the theoretical numbers at risk of collision if they take no avoiding action.

6.13.21 The second stage then incorporates the probability that the birds, rather than flying blindly into the turbines, will actually take a degree of avoiding action, as has been shown to occur in all studies of birds at existing wind farms. SNH has recommended a precautionary approach, using a value of 99% as an avoidance rate for geese and several birds of prey (including hen harrier) and 98% for most other species (Urquhart 2010), and that approach

has been adopted here. Actual avoidance rates measures at existing wind farms have typically been in excess of 99.9% (Fernley *et al*. 2006, Percival *et al*. 2008, Percival *et al*. 2009).

6.13.22 The collision model requires data on bird body size and flight speed. Body sizes were taken from Robinson (2005), flight speeds from Campbell and Lack (1985) and baseline mortality rates were taken from Balmer and Peach (1997), Cramp (1998), Kenward *et al*. 1999, Sandercock (2003) and Robinson (2005).

6.13.23 The model input data are summarised in Table 6.17. Bird collision zone occupancy data have been given in Table 6.16 above. Table 6.17 gives the % flying at rotor height, the estimated annual number of flights through the potential collision risk zone at rotor height, the background annual mortality rate, and an estimate of the baseline regional population size. The Welsh baseline populations have been estimated from Sim *et al*. (2007), Welsh Kite Trust (2012), Lovegrove *et al*. (1994) and RSPB (pers. comm.). Details of the collision risk calculations are given in Appendix 6.1.

6.13.24 Table 6.18 summarises the collision risk analysis for each of the high sensitivity species. The Table gives the additional annual mortality that would be required in order to give a potentially significant increase over this baseline (i.e. to exceed a low magnitude effect), the number of collisions predicted per year based on the precautionary avoidance rate (from the collision risk model), the percentage increase that this would represent over the baseline mortality and whether such an effect would be significant.

Table 6.17. Collision risk model input data for the proposed Llanbrynmair wind farm.

Species	Season	% flying at rotor height	Estimated no. of rotor passes/ year	Background annual mortality rate	Estimated Welsh population size
Red kite	Breeding	90%	294	18%	1,100 pairs
	Non- breeding	41%	89	18%	2,950
Hen harrier	Breeding	35%	81	28%	57 pairs
	Non-breeding	3%	9	28%	300
Goshawk	Breeding	91%	164	19%	100 pairs
	Non- breeding	90%	45	19%	420
Peregrine	Breeding	73%	4	15%	300 pairs
	Non- breeding	89%	19	15%	930
Golden plover	Non- breeding	65%	4,503	27%	20,000
Curlew	Breeding	46%	31	26%	1,000 pairs

Table 6.18 Collision risk modelling predictions for the proposed Llanbrynmair wind farm.

Species	No of collisions required to give significant increase over baseline mortality	Breeding season pre-cautionary predicted number of collisions per year (99% avoidance rate)	Non-breeding season pre-cautionary predicted number of collisions per year (99% avoidance rate)	Annual pre-cautionary predicted number of collisions per year (99% avoidance rate)	Percentage increase in baseline mortality at 99% avoidance rate	Likely significant effect?
Red kite	24	0.26	0.08	0.34	0.07	×
Hen harrier	4	0.06	0.007	0.07	0.09	×
Goshawk	4	0.132	0.037	0.17	0.21	×
Peregrine	7	0.003	0.014	0.02	0.01	×
Golden plover	270	0	2.8	2.8	0.05	×
Curlew	39	0.02	0	0.02	0.003	×

High Sensitivity Species

6.13.25 **Red kite** - this species was recorded over-flying the Study Area but its activity within the Site was rather less than in other parts of the Study Area. There is some information on red kites at existing wind farms that suggests that they are not particularly vulnerable to collision and that they will forage in proximity to wind turbines (Green 1995, Tyler 1995, Whitfield and Madders 2006). There have been at least three records of kite deaths by collision at one mid Wales wind farm (Welsh Kite Trust pers. comm.), and four collisions documented in Scotland (Natural Research 2010). Although formal monitoring has not taken place at many wind farms, it would be expected that more deaths would have been recorded if it were a widespread problem. In general, it is considered that kite are not particularly vulnerable and with the relatively low amount of time spent by kites feeding over the proposal site it is considered unlikely that collision risk is significant or would affect the conservation status of the local kite population. The results of the collision risk modelling supported this conclusion, with a precautionary prediction of 0.3 collisions per year, a value that would constitute only a 0.07% over the current baseline mortality of the Welsh population, for a population that is increasing steadily year on year (Welsh Kite Trust 2013[20]). This would be an effect of negligible magnitude and not significant.

6.13.26 Disturbance could potentially displace foraging kites from a zone around the wind turbines, though the evidence from existing wind farms suggests that kites do use wind farm sites. They may still be discouraged to a degree, and it is uncertain as to the precise extent of any potential disturbance zone. In terms of quantifying the magnitude of any potential impact, the key issue is the ecological consequence of any disturbance that may occur. That magnitude will be primarily dependent on the availability of alternative feeding areas to which birds may move should they be displaced from the wind farm site. At Llanbrynmair, there are two points that demonstrate that the magnitude should be of at most low magnitude, (i) the birds currently make only limited use of the proposed wind farm site, and (ii) there is ample alternative foraging habitat available in the vicinity, as the wind farm site does not support any particularly important or scarce kite habitat. A low magnitude effect would be of low significance and not considered significant. In addition, precautionary mitigation measures described below would be implemented to ensure compliance with the 1981 Wildlife and Countryside Act in that no active nest would be disturbed.

[20] www.welshkitetrust.org. Accessed 22/4/13.

6.13.27 **Hen harrier** – as for red kite, this species was recorded over-flying the Study Area but the numbers flying through the Site at rotor height were low. The information available on collision risk to hen harriers at existing wind farms is not yet comprehensive but that which has been published suggests that they are not particularly vulnerable to collision and that they will forage and even nest in proximity to wind turbines in some circumstances (Green 1995, Thelander *et al*. 2003, Steele 2005, Whitfield and Madders 2006). Very few harrier collisions have been reported and harrier collision rates are considerably lower than that recorded for raptors in general (Erickson *et al*. 2001; Hotker *et al*. 2004; Illner 2011), though there have been two recent hen harrier collisions documented at the Griffin wind farm in Perthshire. The precautionary predicted collision risk at Llanbrynmair was small, at 0.07 birds per year. This would constitute only a 0.09% increase over the existing baseline mortality, an effect of negligible magnitude that would not be significant.

6.13.28 In terms of potential disturbance effects on hen harrier, the wind farm has been designed to avoid areas of potentially suitable habitat and historic nesting sites. There were no recorded hen harrier nest sites within 500m of the proposed ES wind farm layout. There were three recorded nest sites within 2km of the wind farm, at distances of 1.2km, 670m and 730m from the nearest proposed wind turbine locations. Mitigation would also be put in place to ensure that there is not any disturbance to nesting birds during construction. There may be a small loss of foraging habitat around the wind turbines if this species were to be displaced, but any such adverse effects would be of negligible magnitude and not significant. Rather this species would receive a net benefit from scheme through the habitat enhancement plan (see Appendix 5.2), particularly through increased foraging habitat provided by forest felling.

6.13.29 CCW requested additional information on the potential loss of foraging habitat for hen harriers. Whitfield and Madders (2006) concluded that displacement of foraging harriers was unlikely to occur at distances greater than 100m from wind turbines, so this distance has been used for this assessment update. Hen harrier is described in that report as a species with low sensitivity to disturbance at operational wind farms. The total amount of habitat within the 100m zone around each wind turbine is shown in Table 6.19. The total land within this zone is 92ha. With a typical hen harrier range extending over about 1,250 ha (Picozzi 1978, Martin *et al*. 1987, Arroyo *et al*. 2006), this would approximate to about 7% of the home range, though the vantage point survey would suggest that actual use of that zone is less than that. The key point in relation to the assessment is that this small potential loss will be more than offset by the proposed Habitat Management Plan (see following section).

Table 6.19 Habitats within 100m of the proposed Llanbrynmair wind turbines.

Habitat	Area within 100m of wind turbines (ha.)
Blanket Bog	9
Improved grassland	22
Marshy grassland (rush pasture)	34
Coniferous woodland	28

6.13.30 **Goshawk** – this was another raptor species seen over-flying the Study Area, but only infrequently. The precautionary collision risk was estimated at 0.2 collisions per year, equivalent to a 0.2% increase over the existing baseline mortality. This would be an effect of negligible magnitude that would not be significant.

6.13.31 The main adverse effects on this species would be habitat loss through forest felling and disturbance during construction. Mitigation would also be put in place to ensure that there is not any disturbance to nesting birds during construction, following Forestry Commission guidance (Petty 1996) establishing a 400m protection zone around any active nests. The loss

of forest habitat resulting from the scheme would be at most low magnitude and not significant.

6.13.32 **Peregrine** – there was only a very low level of flight activity of this species recorded, and consequently there would be a negligible collision risk (0.02 collisions per year), equivalent to an increase of only 0.01% over the existing baseline mortality. This would be an effect of negligible magnitude and not significant.

6.13.33 Disturbance to peregrine would be of negligible magnitude and not significant. There are not any known nesting sites within 2km of the proposed turbine locations and the Study Area was not important to this species.

6.13.34 **Merlin** – there was only a very low level of flight activity of this species recorded through the collision risk zone and no flights at all observed at rotor height (all below). As a result the collision risk would be of negligible magnitude and not significant.

6.13.35 In terms of potential disturbance effects to merlin, the wind farm has been designed to avoid areas of potentially suitable habitat and historic nesting sites. Mitigation would also be put in place to ensure that there is not any disturbance to nesting birds during construction. There may be a small loss of foraging habitat around the wind turbines if this species were to be displaced, but any such adverse effects would be of negligible magnitude and not significant. Rather this species would receive a net benefit from scheme through the habitat enhancement plan, particularly through increased foraging habitat provided by forest felling.

6.13.36 **Black grouse** – there was only a very low level of flight activity of this species recorded through the collision risk zone and no flights were observed at rotor height (all were below). This would suggest that the collision risk would be negligible and not significant. There is a likelihood of a low level of collision with the turbine towers (grouse have been reported colliding with towers at existing wind farms, e.g. red grouse at Novar, Bioscan 2001) though this should be at most a low magnitude effect and not significant (particularly as the wind farm has been located outside the main area used by this species). This conclusion is reinforced by the fact that there have been no records of this species in the area since 2008 (RWE 2012).

6.13.37 Black grouse has been shown to be adversely affected by wind turbines in Austria (Zeiler and Grünschachner-Berger 2007), with reduced recruitment to lek sites within 300m of turbines. There have been only four single black grouse records within 300m of the proposed turbine locations (Table 6.14), two lekking birds and two incidental records. The two 'leks' were only recorded used by single males on single dates. If they were displaced such displacement would not be significant and would be far outweighed by the benefits to this species from the habitat enhancement plan. As for collision risk, this conclusion is reinforced by the fact that there have been no records of this species in the area since 2008 (RWE 2012).

6.13.38 As a result of the layout changes, there are now no turbines within 500m of the core proposed black grouse refuge and no site tracks (or any other associated infrastructure) relating to the RES scheme that will pass through the main black grouse area, so there would not be expected to be any effects of the tracks or any other infrastructure of the RES scheme on black grouse. The only possible effects would be as a result of any measures to implement the Habitat Management Plan that could require new fencing to be erected. If this were the case all new fencing would be appropriately fitted with markers to reduce the possibility of any black grouse collisions occurring.

6.13.39 **Golden plover** – occasional flocks of this species were recorded over-flying during the winter period and one flock was observed on the ground. The collision risk (2.8 birds per year using a precautionary 99% avoidance rate) would be negligible magnitude (less than 0.1% of the existing baseline mortality) and not significant (particularly when it is considered that the actual collision risk would be likely to be much lower given the very low numbers of collisions recorded for this species at existing wind farms (Hotker *et al*. 2004) and the recognition by RSPB/BirdLife that waders as a group are not particularly vulnerable to collision (Langston and Pullan 2003).

6.13.40 Disturbance to golden plover would be of negligible magnitude and not significant given that no important flight routes were noted and that only a single flock was recorded on the ground during the baseline surveys.

6.13.41 **Curlew** – collision risk to curlew would be of negligible magnitude both in the number of collisions predicted (0.02 per year) and in the context of the population baseline mortality (0.003%), even applying a precautionary 99% avoidance rate.

6.13.42 Studies of curlew at existing wind farms have shown that they will nest in close proximity to wind turbines (e.g. 20m in Gotland, Sweden, Percival and Percival 1998; 75m at Ovenden Moor, Thomas 1999) and that populations within wind farm sites have generally been sustained following construction of wind farms (e.g. at Dun Law, ESS 2003, and at Ovenden Moor, Bullen Consultants 2002). At one wind farm site in Wales (Carno), however, some displacement from within the wind farm site has been reported (Williams and Young 1997) and a temporary drop in numbers occurred at Ovenden Moor before numbers recorded to pre-construction levels (Bullen Consultants 2002). Pearce-Higgins *et al*. (2009) reported partial displacement of this species up to 800m from wind turbines. That study was based on a gradient analysis of the curlew numbers at increasing distance from 12 existing wind farms, without any before/after comparison pre/post construction, and claimed a reduced density to as much as 800m from wind turbines. Studies that have been carried out comparing curlew numbers and distribution before/after construction of a wind farm have all found that any displacement has been restricted to a much smaller zone around the turbines and in most cases have demonstrated no significant effect of the wind turbines at all (Whitfield *et al*. 2010), and in some cases have even documented increases in numbers in proximity to the wind farm after construction (at Causeymire, N. Redgate pers. comm. and at Knabb's Ridge; Percival and Percival 2010). It is possible therefore that some displacement around the wind turbines at Llanbrynmair may occur, though the balance of evidence from currently available studies would suggest that such displacement, if it did occur, would be only small-scale relocation. However to ensure that this is the case and that suitable habitat exists outside the wind farm to accommodate any displaced birds, specific management for this species would be implemented as part of the habitat enhancement plan. As any major routine maintenance would be scheduled outside the breeding season, this would not contribute any further disturbance to breeding curlew.

6.13.43 The main core area used by breeding curlew has been avoided in the site design process, reducing the potential for disturbance effects. It is clear from the results of the 2011 and 2012 surveys that the numbers of curlew in the vicinity of the proposed wind farm site has declined markedly since 2006, down from 10-11 pairs to only 2, and of those 2 neither appeared to be actually nesting within the survey area in either 2011 or 2012. The distribution of curlew in 200m bands from the current proposed layout is summarised in Table 6.20. In all years there have been only very few records in proximity to the proposed wind turbine locations.

Table 6.20 Curlew distribution in relation to distance from proposed wind turbine locations.

Distance from turbines (m)	Total number of curlew records (%)				No pairs curlew				
	2005 and 2006	2011	2012	2013	2005[21]	2006	2011[22]	2012[23]	2013[24]
0-200	3 (9%)	1 (2%)	2 (3%)	6 (13%)	0	2	0	0	0
201-400	2 (6%)	1 (2%)	3 (4%)	5 (11%)	0	1	0	0	0
401-600	2 (6%)	9 (22%)	3 (4%)	9 (19%)	2	1	0	0	0
601-800	9 (26%)	9 (22%)	20 (27%)	5 (11%)	1	2	(2)	(1)	0
>800m	18 (53%)	21 (51%)	47 (63%)	22 (47%)	8	4	0	(1)	1 (+1)

6.13.44 It was concluded in the previous ES that there could be displacement of the 1-3 pairs as a result of the Llanbrynmair wind farm. Applying a precautionary approach, adopting the Pearce-Higgins *et al*. (2009) displacement model, a population decrease of 2-3 pairs would be predicted from the 10-11 pairs that had been recorded during the baseline surveys in 2005 and 2006. The reduced layout since the original ES reduces the potential displacement slightly and results in a greater area further from the turbines into which displaced birds could move. The more recent 2011, 2012 and 2013 surveys have shown there to have already been a major decline in curlew numbers at this site, such that only two pairs would be possibly affected, and with the surveys indicating that the only use these two pairs made of the site was as a feeding and roosting area rather than a nesting site, apart from one confirmed (but unsuccessful) nesting attempt in 2013, 1.5km from the nearest proposed wind turbine and outside the development site boundary.

6.13.45 There is also considerable availability of alternative habitat should any displacement of curlew occur. A breeding pair of curlew would require about 30 hectares for a viable territory (J. Byrne, RSPB, pers. comm., at meeting of 9/2/11). Of the area used by the curlew, 3.7km^2 lies further than 800m from any of the proposed wind turbine locations. On this basis, that area would have the potential capacity to support about 12 pairs of curlew, more than has been recorded in the whole survey area, even in the peak year (2005). This area clearly has the capacity to accommodate displaced birds should any occur, particularly given that the population has now declined to only two pairs in the survey area as a whole.

6.13.46 Curlew could also be affected by the site tracks, including the effects of traffic using those roads during construction and maintenance and the potential for increased access leading to agricultural improvement. In relation to the latter CCW stated in consultation that "*Increased road access often leads to agricultural improvement or changes in grazing use of the site. These changes would have a substantial impact on curlew and other bird species*." The proposed Habitat Management Plan would specifically ensure that such changes did not take place within any of its areas, in relation to curlew, black grouse and hen harrier. It sets specific prescriptions for grazing and a commitment for grazing to be managed to deliver benefits to all of these species. Increased access through the construction of the site tracks would not therefore result in any reduction in suitable habitat for curlew.

6.13.47 In relation to use of the site access tracks during construction and operational maintenance, as outlined in the ES, vehicular access would be restricted to designated routes throughout

[21] Note: values of number of pairs in each zone in 2005 and 2006 differ from the previous SEI due to a typo in that report (though numbers reported in main text relating to impacts were correct).
[22] 2011 pairs bracketed as behaviour indicated unlikely to be nesting within survey area.
[23] 2012 pairs bracketed as behaviour indicated unlikely to be nesting within survey area.
[24] 2013 1 pair confirmed 1.5km from nearest turbine, 2nd pair behaviour indicated unlikely to be nesting within survey area

construction and operation as far as reasonably practicable, to minimise potential disturbance of birds. The access tracks do pass through the main curlew area, but given the frequency of use of the tracks (vehicle movements to/from the site would be capped at 80 vehicles (160 trips) per day through the breeding season) and that there would not be any sudden increase in vehicle activity through the curlew breeding season, this would not be expected to result in any additional disturbance to curlew or any other bird species that could be potentially significant (particularly given the recent decline in the number of curlew present in the area). Construction of the tracks would take place outside the curlew breeding season (i.e. during August-February). Vehicle activity along those tracks would be at a relatively constant level, with no sudden increase through the breeding season, to give the birds the opportunity to habituate to the presence of the vehicles.

6.13.48 It has been concluded that on the balance of evidence from currently available studies, and given the availability of alternative habitat in the vicinity to which displaced birds could move, as well as the benefits that would accrue from the proposed Habitat Management Plan, that if such displacement did occur it would be only small-scale relocation and not significant. The reduced baseline population found in 2011, 2012 and 2013 reinforces this conclusion.

6.13.49 **Barn owl** – no flight activity was observed through the collision risk zone and none at rotor height, so collision risk to this species would be of negligible magnitude and not significant.

6.13.50 The current and historic barn owl nest locations were avoided in the site design process, such that no turbines are located within 500m of any recently used nest site (the closest is 550m from a proposed turbine location). Continued breeding of barn owls in close proximity to existing wind farms has been reported at numerous sites including Stag's Holt and Red Tile Farm in Cambridgeshire (Percival *et al*. 2009a, 2010), Deeping St Nicholas in Lincolnshire (Percival *et al*. 2009b). There would be likely to be a small loss of foraging habitat but this would be outweighed by benefits from the habitat enhancement plan. As a result adverse effects on this species would be of negligible magnitude and not significant.

6.13.51 Mitigation would be put in place to ensure that there is not any disturbance to nesting barn owls during construction. A proposed temporary construction compound lies adjacent to one historic barn owl nest site, which could be a problem if it were occupied by the owls during construction as this species is protected under Schedule 1 of the Wildlife and Countryside Act (so any disturbance to nesting birds would be illegal). From data supplied by the Montgomery Barn Owl Group (C. Griffiths), this breeding location has been a long-standing barn owl nest site in the barn at that location, with occupancy recorded up to 40 years ago. Barn owls were breeding naturally on a wall plate at this site for many years before MBOG installed a box to prevent the pulli from falling to the ground. Four chicks were successfully fledged from the site in 2007, 3 in 2008 and 2 in 2009. However, following the two hard winters of 2009 and 2010 it has not been used, and no evidence was noted of any recent activity during an inspection in February 2013 (Mick Green, pers. comm.). This decline following these winters was widespread over the region, with numbers of breeding barn owls in Montgomeryshire falling from 75 pairs down to 20 pairs after the 2 hard winters, then returning to 40 pairs in 2012. It is likely therefore that barn owls will breed at this site again in the near future. As a result a Barn owl Protection Plan will be developed and agreed with CCW to ensure that any breeding barn owls, should they occur at this site during breeding, are not disturbed by any construction activity (by closing or moving that nest site and providing alternative sites in areas adjacent (further from potential disturbance). Additional measures to benefit this species are included in the Habitat Management Plan.

Medium Sensitivity Species

6.13.52 The medium sensitivity species are priority species under the UK/Wales BAP. None would be likely to be particularly affected by such a development, given experience from other wind farms (Meek *et al*. 1993, Phillips 1994, Thomas 1999, Percival 2005) and their relatively large UK population sizes. Effects would be of at most low magnitude (more likely negligible) and not significant.

Low Sensitivity Species

6.13.53 The low sensitivity species are of lesser concern, as a high magnitude impact would be necessary in order for a significant effect to occur. As these species are generally at low density within the Study Area, such a magnitude impact would be very unlikely.

Effects on Designated Sites

6.13.54 Given the distances of the proposed wind farm site from the statutory designated areas and their designated/notified interest features, no effects on any of their ornithological interest features are likely to occur.

6.13.55 CCW has advised DECC[25] that it considers that the Llanbrynmair wind farm would not be likely to have a significant effect on the Berwyn SPA either alone or in combination, provided its suggested conditions (to which the developer has agreed) are implemented relating to an Ecological Steering Group, a Habitat Management Plan, an Ecological Clerk of Works and provisions to ensure that Wildlife and Countryside Act, Schedule 1 breeding birds are protected during felling and construction.

Effects of the Decommissioning Phase

6.13.56 The ornithological effects that will occur during decommissioning will be similar to those during construction, though given the reduced time required and the presence of existing infrastructure they would be of a lower magnitude. These effects are likely to include possible disturbance to Schedule 1 breeding species, black grouse, other breeding species and wintering birds. Significant effects are not likely but precautionary mitigation measures will be implemented to ensure this.

6.14 Mitigation and Enhancement

6.14.1 The Proposal is not likely to result in any significant ornithological effects, primarily as a result of the primary mitigation measures that were incorporated into the design process discussed above. However, best practice and associated guidance from statutory consultees would be secured through agreement on a Construction Method Statement and Construction Environmental Management Plan. Mitigation for timing and the effects of the proposed works is given below.

Mitigation of the Construction Phase

6.14.2 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 birds.

6.14.3 Initial site work that involves habitat clearance would take place outside of the bird breeding season as far as reasonably practicable, or a survey undertaken immediately prior to work starting to avoid destruction of any nests in habitat to be cleared. All birds and their nests are protected under the Wildlife and Countryside Act 1981, therefore work that could destroy nests must be avoided.

6.14.4 All species listed on Schedule 1 of the 1981 Wildlife and Countryside Act are protected from disturbance during the breeding season. It would be important to ensure that no Schedule 1 species are disturbed during the breeding season, particularly during the construction phase of the wind farm. A further survey would therefore be undertaken immediately prior to construction, if construction were planned for the bird breeding season (April-July). If any were found then potentially disturbing activities would be suspended where possible for the

[25] CCW letter of 12/10/12 to DECC.

breeding season within an appropriate zone (dependent on the location of the birds and the species involved). Appendix 5.2 contains further details of this regarding curlew.

6.14.5 The Habitat Management Plan would be implemented prior to the commencement of construction, so that the benefits that it would provide would be able to accommodate any birds displaced during construction, particularly curlew.

6.14.6 As discussed in para 7.14.51 above, a Barn Owl Protection Plan will be developed to ensure that this species is not disturbed during breeding by any construction activities.

Mitigation of the Operational Phase

6.14.7 As stated at Section 4.5, major routine maintenance would be scheduled to occur outwith the bird breeding season to further minimise any potential disturbance effects.

6.14.8 No mitigation during the operational phase is considered necessary, given the design mitigation that has been implemented to reduce the potential effects on key birds species discussed above.

Mitigation of the Decommissioning Phase

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

6.15 Residual Effects

6.15.1 Following mitigation the residual effects of the Proposal will be a loss of open habitat to turbine bases and tracks. The development has been designed so that higher value habitat loss has been avoided where possible and that any loss will be mainly on habitats currently of low conservation value.

6.15.2 Using evidence from existing wind farms it is considered unlikely that this will have any long term impact on the integrity of the Site's ornithological features or the conservation status of the species found here.

6.15.3 There will be a net gain on the conservation value of the Site from the habitat enhancement measures.

6.16 Cumulative Assessment

6.16.1 CCW advised that that the cumulative assessment should consider all wind farms in SSA B with regard to curlew. These sites are listed in Table 6.21. It should be noted though that a key aim of the Llanbrynmair scheme will be to deliver a net gain to curlew through the Habitat Management Plan, such that the site's contribution to any cumulative effects would be a positive one.

6.16.2 The main potential for a cumulative effect on curlew is in combination with the Carnedd Wen wind farm, though the recent updated SEI layout for that scheme does not result in any potential disturbance into the area used by the curlew additional to that resulting from the Llanbrynmair scheme (having also deleted turbines in proximity to breeding curlew). Overall, the Llanbrynmair scheme would not be expected to make any significant contribution to a significant adverse cumulative impact on curlew.

Table 6.21 Wind farms in Strategic Search Area (SSA) B and their baseline curlew populations.

Site Name	Developer	Installed Capacity (MW)	No. of Turbines	Status	Curlew
Llanbrynmair	RES UK Ltd	90	30	Application Lodged	11 pairs (2005-06), 2 pairs (2011-13).
Carnedd Wen	Npower	130	65	Application lodged	5 pairs (same birds as Llanbrynmair)
Carno Extension	Carno Amegni	15.6	12	Operational	3-4 pairs
Cemmaes	First Wind farm Holdings Ltd	15.3	18	Operational pre-2005	None
Mynydd Clogau	RES UK Ltd	14.45	17	Operational pre-2005	None
Carno	Npower	33.6	56	Operational pre-2005	Decline following construction
Tirgwynt	West Coast Energy	24	12	Consented	5-6 pairs
Mynydd Waun Fawr, Llanerfyl	Vattenfall	40	16	Application lodged	5-6 pairs
Esgair Cwmowen	Pennant Walters	47.5	19	Application lodged	2 pairs
Rhyd Ddu, Llanerfyl	Vattenfall	50	Not Known	Pre-application scoping	?
Pen Coed, Llangadfan	Gamesa Energy	20	10	Pre-application scoping	?
Dyfnant Forest	SPREL	120	40-50	IPC Pre-application scoping	?

6.17 Enhancement of Wildlife Value

6.17.1 Where reasonable opportunities exist for enhancing the wildlife value of the Site then these should be taken. IEEM (2006) have noted that 'there is a growing body of opinion that new developments should deliver net ecological gain rather than simply being designed to achieve mere damage limitation'.

6.17.2 A draft Habitat Management Plan has been produced to deliver such a nature conservation gain. This is an outline document that will be refined following further discussions with interested parties, including CCW and RSPB, a finalised plan agreed. This will cover the life of the Proposal. Details are provided in Appendix 5.2. As described in the Plan, it will deliver a range of ornithological and other wildlife benefits.

6.17.3 The current agricultural management appears to have supported high numbers of curlew within the study area up until recently, though there has clearly been a major decline since the main ES baseline surveys. The management plan for curlew would seek to maintain (and where possible enhance) the mosaic of habitats available to the curlew, including rushy patches for nesting and providing cover for chicks, and agriculturally-improved grassland for foraging, together with reducing mortality through predator control.

6.17.4 The principle of the management for the key bird species, curlew, would be to adopt management prescriptions for this species developed through the Tir Gofal scheme and as recommended by RSPB[26]. This would involve:

- Unimproved pastures:
  - Unimproved pastures would be managed with no, or very limited, use of fertiliser.
  - Light stocking levels would be used from April to mid-June to maintain the nesting cover and minimise the loss of nests through trampling.
  - Grazing by cattle from late summer onwards would provide a suitable sward for nesting and feeding in the following spring.
- Silage Fields:
  - If curlews are nesting within silage fields, these fields would be cut from the middle of the field outwards and no cutting would take place after dark.
- Wet Areas:
  - Wet flushes, boggy areas and damp, rough grassland would be retained by avoiding new drainage and by blocking drains where feasible. These are important invertebrate-rich feeding areas, particularly for chicks.
- Hay Meadows:
  - Some unimproved hay meadows would be retained/restored, rather than harvesting all grass as silage.
- Predator Control:
  - Control of potential curlew predators would be enhanced through the employment of a ranger. These measures would include control of crows, foxes, weasels and stoats.

6.17.5 The principle of the Black Grouse management is to add value and secure for the longer term (the lifetime of the wind farm) the management instigated under the Welsh Black Grouse Recovery Project, through continuation and extension of the previous management. The plan would also deliver an increased level of predator control (focussing particularly on crows and foxes).

6.17.6 The benefits to hen harriers resulting from the Habitat Management Plan would comprise:

- Maintenance of current low stocking level on moorland habitats and moorland edge within the site, to sustain and enhance heather cover (to provide harriers with enhanced foraging and nesting habitat).
- Heather management through rotational cutting to provide a mosaic of heather age and structure (which would again enhance harrier foraging and nesting habitat).

6.17.7 In addition there would also be a very considerable increase in hen harrier foraging habitat following forest felling for the Carnedd Wen scheme, resulting in a cumulative benefit to this species for the two schemes in combination.

6.18 Monitoring

6.18.1 An ornithological monitoring programme will be implemented to provide detailed information about the effects of the wind farm on the local bird populations and on the habitat enhancement programme. The surveys carried out during 2005-06, 2011 and 2012 will provide a baseline for a post-construction monitoring programme. This work will continue when the wind farm has been commissioned, to determine the effects that the wind farm does (or does not) have on the local bird populations (though this will need to be

[26] RSPB Advice Note on Farming for Wildlife in Wales: Curlew.

analysed and interpreted in combination with the proposed mitigation measures), and to inform the habitat management plan. The following will be undertaken for the bird monitoring programme:

- a standard Brown and Shepherd (1993) method breeding bird survey, with an additional third visit per season. The Study Area for this survey will include the same area as that covered during the baseline studies. The survey would be undertaken immediately prior to construction and then annually for the first three years after commissioning, then at 5, 10 and 15 years;
- the same area will be surveyed for breeding raptors and black grouse on the same time schedule, using the techniques recommended in Gilbert *et al*. (1998);
- flight observations will be carried out following the same methodology as the baseline studies to quantify rates of bird movement through the wind farm; and
- the data from each year's vantage point surveys would be used to update the collision risk modelling. If this indicated that the predicted collision risk in this ES may be exceeded for the two main species of concern at risk, red kite and hen harrier, then a programme of collision monitoring will be undertaken in the following year (breeding season or year-round as appropriate), following the methodology developed in the USA for bird collision monitoring at wind farms (Morrison 1998). Searches within 70m of each turbine would be undertaken initially at weekly intervals, though this interval will be reviewed in light of the findings of a scavenger activity survey (to determine how long corpses remained on the ground).

6.18.2 The flight observations and collision monitoring would be carried out for the first three years after commencement of operation of the wind farm, and the results reviewed. If no collisions of any key species had been recorded during this time this part of the monitoring programme would stop, otherwise it would be continued to the same time schedule as the other bird monitoring.

6.18.3 No other bird monitoring is considered necessary.

6.19 Conclusions and Statement of Significance

6.19.1 The assessment of the potential effects of the proposed wind farm on the features of ornithological interest is summarised in Table 6.22.

6.19.2 The Proposal does not involve significant land take and, with habitat management, no significant effects on habitats are predicted and there should be a net conservation gain from the proposed habitat enhancement measures.

6.19.3 It is concluded that the Proposal would comply with relevant planning policies to ornithology. Overall, no ornithological impacts are likely to occur as a result of the Proposal that would be considered significant under the EIA Regulations, nor would it result in any breach of the Habitats Regulations.

Table 6.22. Summary of effects of the Llanbrynmair wind farm on birds.

Project Phase	Summary of Effect	Value	Nature of Effect			Mitigation Measure	Residual significance
			Positive / Negative	***Permanent / Temporary***	***Reversible / Irreversible***		
Construction	Habitat loss: construction of turbine bases and access tracks	Up to medium	Negative	Temporary	Reversible	Avoidance of more sensitive habitats in design process	Not significant
	Disturbance to Schedule 1 breeding species	High	Negative	Temporary	Reversible	Only Barn Owl breeding in potential impact zone. Check again pre-construction; if present avoid disturbing activity in proximity. Implementation of Barn Owl Protection Plan.	Not significant
	Disturbance to black grouse	High	Negative	Temporary	Reversible	Avoid lek sites as much as possible in design process, improve surrounding habitat in Habitat Management Plan.	Not significant
	Disturbance to curlew	High	Negative	Temporary	Reversible	Avoid core area for this species in design process, improve habitat in HMP.	Not significant

Project Phase	Summary of Effect	Value	Nature of Effect			Mitigation Measure	Residual significance
			Positive / Negative	***Permanent / Temporary***	***Reversible / Irreversible***		
	Disturbance to other breeding species	Up to medium	Negative	Temporary	Reversible	Pre-construction survey and active nests avoided.	Not significant
	Disturbance to wintering birds	Up to high	Negative	Temporary	Reversible	Avoid areas higher ornithological importance in design process	Not significant
Operation	Mortality through bird collision with wind turbines	Up to high	Negative	Temporary	Reversible	Avoid areas of higher ornithological importance in design process	Not significant
	Displacement of birds from zone around wind turbines	Up to high	Negative	Temporary	Reversible	Avoid areas with higher ornithological importance in design process	Not significant
	Habitat Management Plan	Up to high	Positive	Temporary	Reversible		Not significant
Decommissioning	Disturbance to Schedule 1 breeding species	High	Negative	Temporary	Reversible	Check again pre-decommissioning; if present avoid disturbing activity in proximity.	Not significant
	Disturbance to black grouse	High	Negative	Temporary	Reversible	Check again pre-decommissioning; if present avoid disturbing activity	Not significant

Project Phase	Summary of Effect	Value	Nature of Effect			Mitigation Measure	Residual significance
			Positive / Negative	***Permanent / Temporary***	***Reversible / Irreversible***		
						in proximity.	
	Disturbance to other breeding species	Up to medium	Negative	Temporary	Reversible	Pre-de-commissioning survey and active nests avoided.	Not significant
	Disturbance to wintering birds	Up to high	Negative	Temporary	Reversible	Avoid areas with important bird populations in design process	Not significant
	Restoration works	Up to medium	Positive	Permanent	Reversible		Not significant

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7 CULTURAL HERITAGE

7.1 Topic Glossary

Conservation Area - 'An area of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance', designated under The Planning (Listed Buildings and Conservation Areas) Act 1990.

Heritage, cultural - Inherited assets which people identify and value as a reflection and expression of their evolving knowledge, beliefs and traditions, and of their understanding of the beliefs and traditions of others.

Historic asset - An identifiable component of the historic environment. It may consist of or be a combination of an archaeological site, an historic building, or a parcel of historic landscape. Nationally important historic assets will normally be designated.

Historic Environment Record - A public, map-based data set, primarily intended to inform the management of the historic environment. In Wales these are maintained by the four Welsh Archaeological Trusts.

Listed Building - A building that has been placed on the Statutory List of Buildings of Special Architectural or Historic Interest, designated under The Planning (Listed Buildings and Conservation Areas) Act 1990.

Registered Historic Landscape - An area of land included on The Register of Landscapes of Outstanding Historic Interest in Wales (CCW, Cadw & ICOMOS UK 1998) or Register of Landscapes of Special Historic Interest in Wales (CCW, Cadw & ICOMOS UK 2001).

Registered Historic Park or Garden - Historic parks and gardens included on the Register of Parks and Gardens of Special Historic Interest in Wales (Cadw/ICOMOS 2002).

Scheduled Monument - An archaeological site that is recognised as being of national importance, designated and legally protected under the Ancient Monuments and Archaeological Areas Act 1979.

Setting - The surroundings in which an historic asset is experienced, its local context, embracing present and past relationships to the adjacent landscape.

7.2 Introduction

7.2.1 This chapter describes the likely significant effects of the proposed Llanbrynmair Wind farm on the cultural heritage resource of the study area.

7.2.2 The construction and decommissioning phases of the proposed development have the potential to adversely affect the significance of historic assets through physical damage to their fabric, but may also lead to their protection and enhancement. The effects may be direct, for instance where an asset is disturbed during ground-breaking works, or indirect, perhaps when changes in hydrology may lead to waterlogged archaeological deposits becoming desiccated and degraded.

7.2.3 During its operational phase, the proposed development may affect the significance of historic assets through visual change in their setting.

7.2.4 The objectives of this assessment are to:

- Describe the location, nature and extent of any known historic assets or areas of archaeological potential which may be affected by the proposed development;
- Provide an assessment of the importance of these assets;

- Assess the likely scale of any effects on the heritage resource posed by the development;
- Outline suitable mitigation measures to avoid, reduce or offset significant adverse effects; and
- Provide an assessment of any residual effects remaining after mitigation.

7.2.5 This chapter represents a compilation of information on the topic already presented in the original Environmental Statement and in the five SEI packages prepared after the application was submitted in March 2009. Some of the information already presented has been superseded, due to modifications to the application, and only information still current has been included in the present chapter. This chapter therefore entirely replaces any cultural heritage information previously submitted and removes the need to refer back to any previously submitted documents with respect to this topic.

7.2.6 A detailed account of the evolution of the wind farm design is presented in Section 3.3 of Chapter 3. The information provided for the cultural heritage topic in response to these design changes and requests for further information from consultees may be summarised as follows:

- ES (2008): Baseline studies and assessment of predicted effects for 43 turbine layout (Chapter 8);
- SEI Package 1 (2010): ASIDOHL undertaken at request of CPAT (Chapter 4), and clarifications on methodology adopted in ES (Chapter 5);
- SEI Package 2 (2011): Assessment of access route from Llanerfyl carried out (Chapter 4), updating of assessment of effects to take account of reduction in turbine numbers from 43 to 34 and changes to site layout (Chapter 12);
- SEI Package 3 (2012): Note on implications for cultural heritage topic resulting from reduction of turbine numbers from 34 to 30 (para 3.2.4);
- SEI Package 4 (2012): Updating of assessment for access route from Llanerfyl in response to changes in specifiation of highways works (Chapter 4); and
- SEI Package 5 (2012): No cultural heritage information.

7.2.7 Preparation of the present SEI Package has involved a final series of amendments and updates to the cultural heritage information:

- Revision of assessment of operational effects to address concerns raised by Powys County Council regarding potential effects on Listed Buildings, and to address recent changes in guidance on assessment of the setting of historic assets;
- Updating and revision of the assessment of cumulative effects to reflect the current status of wind farms in TAN8 SSA B;
- Updating of assessment of construction phase effects resulting from further changes in wind farm site layout (re-positioning of electricity sub-station and concrete batching plant);
- Updating of assessment of offsite highway works to reflect changes in proposed route from Llanerfyl and addition of second route from Talerddig; and
- Collation of all current information into a single chapter with figures and appendices as required.

7.2.8 This chapter therefore completes and updates the original cultural heritage section relevant to the final design. A full description of the project, as it is now designed, will be found in Chapter 3.

7.2.9 The cultural heritage assessment is structured as follows:

- Relevant Legislation and Policy
- Approach and methods
- Baseline Conditions
- Design Evolution and mitigation
- Potential effects
- Mitigation
- Residual effects
- Cumulative effects
- Statement of Significance

7.2.10 This chapter is accompanied by Figures 7.1 to 7.7 and two appendices in Volume II. Appendix 7.1 contains a full listing of historic assets within the study area for the offsite highway works. Appendix 7.2 contains the full report on the ASIDOHL.

7.3 Relevant Legislation and Policy

7.3.1 Legislation regarding Listed Buildings and Conservation Areas is contained in the Planning (Listed Buildings and Conservation Areas) Act 1990. There is one Listed Building within the proposed wind farm site but this will not be directly affected by development. Potential effects are therefore limited to harm resulting from change in setting. With respect to 'setting', Section 66 of the Act states (in part):

> *"In considering whether to grant planning permission for development which affects a listed building or its setting, the local planning authority or, as the case may be, the Secretary of State shall have special regard to the desirability of preserving the building or its setting".*

7.3.2 The setting of Conservation Areas is not protected in statute.

7.3.3 Legislation relating to archaeological monuments is contained in the Ancient Monuments and Archaeological Areas Act 1979. There is one Scheduled Monument within the proposed wind farm site but this will not be directly affected by the development; potential effects on significance are therefore limited to harm resulting from change in setting. The Act makes no reference to the setting of Scheduled Monuments and therefore has no direct bearing on the issues raised in the present assessment.

7.3.4 No other types of historic asset are protected or controlled by statute.

7.3.5 The NPS for Energy (EN-1) sets out the national policy for energy infrastructure, which encompasses onshore wind farms generating more than 50 MW. Section 5.8 addresses the Historic Environment. The necessary scope of the assessment is defined in NPS EN-1 as follows:

> *"...the applicant should provide a description of the significance of the heritage assets affected by the proposed development and the contribution of their setting to that significance. The level of detail should be proportionate to the importance of the heritage assets and no more than is sufficient to understand the potential impact of the proposal on the significance of the heritage asset." (s5.8.8)*
>
> *"Where proposed development will affect the setting of a heritage asset, representative visualisations may be necessary to explain the impact." (s5.8.9)*

> *"The applicant should ensure that the extent of the impact of the proposed development on the significance of any heritage assets affected can be adequately understood from the application and supporting documents."* (s5.8.10)

7.3.6 The NPS for Renewable Energy Infrastructure (EN-3) contains policies specifically relating to renewable energy infrastructure and it is designed to be read in conjunction with EN-1. EN-3 contains information on the assessment requirements for renewable energy infrastructure including onshore wind and a range of technology specific information. EN-3 reiterates the considerations set out by EN-1 in relation to cultural heritage (paras 2.7.41 – 2.7.45). It raises the issue of the reversibility of setting effects and notes that micro-siting is an option for the avoidance of known archaeology.

7.3.7 Planning Policy Wales (5th Edition, November 2012) contains current land use planning policy for Wales. It provides the policy framework for the effective preparation of local planning authorities' development plans. Chapter 6 (Conserving the Historic Environment) sets out the Welsh Government's objectives in respect of cultural heritage, and encompasses archaeological remains, Listed Buildings, Conservation Areas, historic landscapes, and the 'historic environment' as an holistic entity.

7.3.8 Technical Advice Note 8: Renewable Energy (Annex C, Para 2.22 Archaeology) stipulates that relevant procedures be followed in preparing planning submissions, with specific reference to Welsh Office Circular 60/96 (Planning and the Historic Environment – Archaeology). Circular 60/96 is the key policy document of Welsh Government providing detailed guidance on the handling of archaeology in the legal land-use planning system in Wales.

7.3.9 The following policies within the Powys County Council UDP 2001-2016 are noted as being of particular relevance to cultural heritage and archaeological issues:

- Policy UDPSP3 – Natural, Historic & Built Heritage;
- Policy ENV2 - Safeguarding the Landscape;
- Policy ENV14 - Listed Buildings;
- Policy ENV16 - Landscapes, Parks and Gardens of Special Historic Interest;
- Policy ENV17 - Ancient Monuments and Archaeological Sites;
- Policy ENV18 - Development Proposals Affecting Archaeological Sites.

7.4 Approach and Methods

7.4.1 The original ES data gathering and analysis was undertaken by Dyfed Archaeological Trust Ltd (DAT). DAT was also responsible for contributions on cultural heritage in the five SEI Packages leading up to the present package. Headland Archaeology Ltd has compiled this updated chapter and also prepared the final SEI Package.

7.4.2 Original baseline data collected by DAT has been reviewed by Headland Archaeology to ensure that it is still current and additional data has been collected where study areas have been enlarged for this final SEI package.

7.4.3 Headland Archaeology has adopted the methodologies, analysis and conclusions of DAT regarding construction and decommissioning effects except where recent modifications to the layout (in 2013) have justified changes. These include the re-location of the electricity substation and concrete batching plant within the wind farm site as well as the changes to the offsite highway works, including promotion of the second access route from Talerddig.

7.4.4 It should be noted that the presentation and vocabulary of the assessment criteria used for construction and decommissioning effects has been modified to bring it

into line with that used for operational effects (see below) but this has not changed the actual assessment of effects.

7.4.5 Headland Archaeology has adopted a different approach to the assessment of operational effects, reflecting guidance on the setting of historic assets issued since the preparation of the original ES and the consequent development of professional practice in this area. As a result, the methods used by DAT in the original ES have been replaced and a new assessment of operational effects carried out. The new approach adopted assessment criteria that are shared with the assessment of construction and decommissioning effects, as noted above.

7.4.6 Revision of the assessment of operational effects has also necessitated the preparation of a new assessment of cumulative effects as this also relates to the setting of historic assets. This revision also provided the opportunity for the assessment to take account of the current situation regarding wind farm applications in TAN8 SSA B.

7.4.7 The assessment of effects on the historic landscape (ASIDOHL) was not updated and the final SEI package relies on the original assessment undertaken by DAT.

Consultation

7.4.8 A scoping opinion was received from Cadw in May 2005 which informed the scope of the cultural heritage assessment. Cadw provided details of the Scheduled Monuments in and around the proposed wind farm site and recommended consultation of the records held by Clwyd Powys Archaeological Trust (CPAT). Cadw also confirmed that there were no historic parks or gardens that might be directly affected by the proposal. Reference was made to Planning Policy Wales (2002), and CCW's Guide to Good Practice on Using the Register of Landscapes of Historic Interest in Wales in the Planning and Development Process.

7.4.9 Submission of the ES in 2009 led to a further round of consultation, documented in SEI(1) Chapter 5. CPAT recommended that an 'Assessment of the Significance of the Impact of Development on the Historic Landscape' (ASIDOHL) be carried out, based on the Historic Landscape Characterisation prepared for TAN8 SSA B by CPAT in 2006. An ASIDOHL was completed and submitted as part of SEI(1).

7.4.10 CPAT sought and received clarification from DAT regarding the fieldwork methodology, as described in the ES. The need for protective avoidance zones around two Bronze Age barrows (PRN 720 and 4288) on the wind farm site was discussed with CPAT. It was agreed that a 100m stand-off was sufficient to protect the asset and its setting. Finally, CPAT raised the issue of peat deposits and the need to consider its palaeoenvironmental potential. It was agreed that any impact on peat will be very localised and affect only a small portion of the total resource.

7.4.11 Further revision of the wind farm layout led to consultation with CPAT in 2011 regarding the appropriate width of avoidance zones, reported in SEI(2) Chapter 12. It was agreed that a minimum width of 50m was acceptable to avoid damage in cases involving access tracks on the wind farm site, with fencing to be used during construction to ensure protection of the historic asset.

7.4.12 Powys County Council was consulted in 2013 in advance of work on this final package of SEI regarding the scope of the proposed cultural heritage SEI and the methodology to be adopted for the revised assessment of operational effects.

Guidance

7.4.13 The following sources of guidance were referred to in undertaking the cultural heritage assessment:

- Cadw (2007) Guide to Good Practice on Using the Register of Landscapes of Historic Interest in Wales in the Planning and Development Process (2nd Edition).
- Cadw (2011) Conservation Principles.
- English Heritage (2005) Wind Energy and the Historic Environment.
- English Heritage (2011) The Setting of Heritage Assets.
- NAW 2002 Welsh Office Circular 60/96, Planning and the Historic Environment: Archaeology; Planning Policy Wales.

Scope of Works

7.4.14 For the cultural heritage impact assessment a distinction was made between assessing the effect of the wind farm on historic assets within the application site and assets in the wider landscape (up to 5 or 10km from the wind turbines).

7.4.15 The scope and purpose of the study was different in these two areas. In the application site, all historic assets (designated and undesignated) were included in the study and the purpose was to understand the heritage potential of the application site and to identify significant direct physical effects on historic assets that might occur during construction phase works.

7.4.16 In the wider study area, all designated assets were included in the study and the purpose was to identify significant effects resulting from change in the setting of historic assets for the duration of the operational period of the wind farm. Consideration was also given to the potential for undesignated assets to experience significant setting effects. However, designated assets receive a higher level of protection in planning policy (both local and national) and are therefore more likely to experience significant effects.

7.4.17 At the request of Powys County Council, all designated assets were included in the study up to 5km from the wind turbines and selected types of designated asset were considered up to 10 km away. The two categories are as follows:

- 10km: Registered Landscapes of Historic Interest, Grade I and II* Registered Parks and Gardens of Historic Interest, Scheduled Monuments, Grade I and II* Listed Buildings
- 5km: Conservation Areas, Grade II Registered Parks and Gardens of Special Historic Interest, Grade II Listed Buildings

7.4.18 Assessment of any potential cumulative effects was based on consideration of any operational, consented or proposed wind farms within 10km of the Llanbrynmair turbines.

7.4.19 It may be noted here that there are no examples of Registered Landscapes or Parks and Gardens within the study areas as defined above and therefore these types of designation did not actually feature in the assessment.

The Assessment Process

7.4.20 The cultural heritage assessment was carried out in the following stages:

- Desk-based study of existing records leading to the identification of historic assets potentially affected by the development;
- Field surveys to supplement baseline information and identify previously unrecorded historic assets;
- Definition of baseline conditions, based on results of the desk-based study and field survey;

- Identification of predicted effects on historic assets (informed by baseline information, site visits, Zone of Theoretical Visibility (ZTV) figures, wirelines and photomontages);
- Assessment of the magnitude of identified effects;
- Assessment of the importance of historic assets affected by the development;
- Assessment of the EIA significance of effects, broadly a product of the asset's importance and the magnitude of the effect;
- Proposal of appropriate mitigation measures; and
- Recognition of residual effects.

7.4.21 Standard sources for cultural heritage assessments were consulted during the baseline stage of the assessment, and were reviewed in the assessment stage. These included cartographic and documentary resources held at the Regional Historic Environment Record, held at the Clwyd Powys Archaeological Trust (CPAT) offices; The National Monuments Record (NMR), including aerial photographs, held at the Royal Commission for Ancient and Historic Monuments in Wales (RCAHMW); The National Library of Wales (NLW) and the Montgomeryshire Records Office at Llandrindod Wells. Databases of Scheduled Monuments and Listed Buildings compiled by Cadw were also searched.

7.4.22 A field visit was undertaken in June 2006 to evaluate the condition and vulnerability of known features on the wind farm site, to identify new ones and to assess issues of intervisibility and setting. This visit was confined to land within the area identified as suitable for turbines – the turbine envelope (Fig. 8.1).

7.4.23 A second field visit was made in June 2008 after the provisional turbine locations and infrastructure layout had been made. The locations of proposed turbines were visited and the lines of proposed new tracks walked. The survey took account of the possibility for up to 75m micrositing for all infrastructure. All historic assets within the Site were considered, but only those features that might be affected by the Proposal were visited. Owing to the dense tree cover it was not possible to visit turbine locations or walk proposed new tracks within coniferous forestry plantations. There were no known historic assets within forestry within the Site.

7.4.24 Further field visits were made during the preparation of SEI in 2011 and 2013 to consider the effect of modifications to the wind farm layout.

7.4.25 The wider study area around the wind farm was visited in 2013 as part of the revision of the assessment of operational effects. Selected designated historic assets were visited, concentrating on areas where visual change was predicted.

Assessment Criteria

Definition of 'Significance' and 'Setting'

7.4.26 The starting point for an assessment is an analysis of what constitutes the significance of an asset. Significance, as defined in Conservation Principles (Cadw 2011, Definitions), is the sum of the cultural heritage values we attach to an historic asset (aesthetic, communal, evidential and historical).

7.4.27 It includes the portion of the values that derive from the setting of the asset. 'Setting' is defined as the surroundings in which an historic asset is experienced, its local context, embracing present and past relationships to the adjacent landscape (Cadw 2011, Definitions).

7.4.28 Heritage significance should not be confused with EIA significance; it is unfortunate that the same word has two closely related but different meanings.

7.4.29 The actual assessment of effects involves consideration of the magnitude of the predicted impacts (positive or adverse) on the heritage significance of the asset and the importance of the asset to arrive at a conclusion regarding the significance of the effects (using significance here in the context of EIA).

Magnitude of Effect

7.4.30 Magnitude of effect is a measure of the degree to which the overall significance of a historic asset will be increased or diminished by the proposed development. In determining the magnitude of effect, the asset's heritage significance is defined. This allows the identification of key features and provides the baseline against which the magnitude of change can be assessed; the magnitude of effect being proportional to the degree of change in the asset's baseline significance.

7.4.31 The criteria used to assign a value to magnitude of effect are set out in Table 7.1. These criteria should be treated as an aid to professional judgement and cannot offer exact descriptions of what will occur in all cases.

7.4.32 In cases where the only potential impact is on the setting of a historic asset, only that part of the significance derived from setting can be affected. This portion must be identified and the assessment of magnitude weighted proportionately to account for the unaffected portion residing in the fabric of the asset.

7.4.33 English Heritage has published general guidance on the factors that should be considered when assessing impacts on the setting of heritage assets ("The Setting of Heritage Assets", 2011, Section 4). It has also published more specific guidance on factors relevant to onshore wind energy developments ("Wind Energy and the Historic Environment", 2005). Both of these documents can be usefully applied in the context of wind farm development in Wales in the absence of detailed Welsh guidance. Their guidance has been followed in the present assessment.

Table 7.1 Criteria for determining the magnitude of effect on the significance of a historic asset.

Magnitude of impact	Criteria	
Major positive	1.9	Alteration of the asset or change in its setting leads to major increase in the significance of the asset OR the significance of the asset is preserved where it would be lost if the 'do nothing' scenario was played out.

Magnitude of impact	Criteria
1.10 Moderate positive	1.11 Alteration of the asset or change in its setting leads to a considerable increase in the significance of the asset OR the asset is preserved by record, where it would be lost if the 'do nothing' scenario was played out.
1.12 Slight positive	1.13 Alteration of the asset or change in its setting leads to a slight increase in the significance of the asset OR the asset is preserved by record where it would otherwise continue to degrade if the 'do nothing' scenario was played out.
1.14 Negligible	1.15 Very slight loss or alteration of the asset or change in its setting, not materially affecting the significance of the asset.
1.16 Slight adverse	1.17 Alteration of the asset not affecting key elements, or change in its setting, leading to a slight reduction in the significance of the asset.
1.18 Moderate adverse	1.19 Loss or alteration of one or more key elements of the asset, or change in its setting, leading to a considerable reduction in the significance of the asset.
1.20 Major adverse	1.21 Total loss or major alteration of the asset, or change in its setting, leading to the total loss or major reduction in the significance of the asset.

Asset Importance

7.4.34 The sensitivity of an asset to adverse effects on its heritage significance is determined by its heritage importance and therefore the degree of protection it is afforded in statute or policy. Table 7.2 sets out the criteria for assigning assets to one of three levels of importance. These criteria are intended to guide the assessor and individual assets may merit classification at a higher or lower level of importance. These cases should be explained and justified.

7.4.35 Designated assets are assigned to one of the two higher levels of importance, reflecting the treatment of these assets in national policy (PPW4 Chapter 6). Grade II Listed Buildings and Grade II Registered Parks & Gardens are assigned to an intermediate level of importance, reflecting the lower level of policy protection provided by PPW4 (6.5.12 and 6.5.25).

7.4.36 Conservation Areas cannot be assigned to either level of importance using PPW4 but their status as locally designated assets is used to justify their classification here as assets of medium importance.

7.4.37 Most historic assets are not formally designated; undesignated historic assets are assigned to the appropriate category according to the professional judgment of the assessor.

Table 7.2 Criteria for determining the importance of historic assets.

1.22 Importance of the asset	Criteria
High	1.23 Registered Landscapes of Historic Interest, Grade I and

			II* Registered Parks and Gardens of Historic Interest, Scheduled Monuments, Grade I and II* Listed Buildings, and other historic assets of equal importance
1.24	Medium	1.25	Conservation Areas, Grade II Registered Parks and Gardens of Special Historic Interest, Grade II Listed Buildings and other historic assets of equal importance
1.26	Low	1.27	Undesignated historic assets of lesser importance. Assets of local importance but generally common features at a national or regional level
1.28	Negligible	1.29	Minor sites or sites so badly damaged that too little now remains to justify their inclusion in a higher grade
1.30	Unknown	1.31	Features about which insufficient is known to attribute them to a higher rank, or which cannot be sufficiently accurately located to justify their consideration

Significance of Effects

7.4.38 The significance of an effect on the significance of a historic asset is the product of the magnitude of the effect and the importance of the asset. The matrix in Table 7.3 provides a guide to decision-making regarding levels of significance but is not a substitute for professional judgement and interpretation, particularly where the importance of the asset or impact magnitude levels are not clear or are borderline between categories. It should be noted that in each case these effects can be either adverse or positive.

7.4.39 Effects of major and moderate significance are considered to be 'significant effects' in terms of the EIA Regulations

7.4.40 The impacts of wind turbines on the setting of historic assets are distinctive because the effects are usually fully reversed on decommissioning of the development. The mitigating value of full reversibility is recognised in relevant policy and guidance (for example NPS EN-3, para 2.7.43 and Wind Energy and the Historic Environment). It is recognised in this present assessment methodology as a factor that can reduce the predicted significance of effects when compared to similar permanent or irreversible effects.

Table 7.3 Matrix for determining the significance of effects.

Level of Importance	**Magnitude of effect**			
	Major	***Moderate***	***Slight***	***Negligible***
High	Major	Major	Moderate	Negligible

Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Offsite Highway Works

7.4.41 Assessment of the potential for offsite highway works to adversely affect the significance of historic assets was undertaken through a programme of desk-based research and field assessment of the proposed route.

7.4.42 Information on recorded historic assets was collated for a corridor 500m on either side of the proposed routes, extending to 1km for designated assets. This covered on-line data and other readily available computer based information from the regional historic environment record (HER), National Monument Record (NMR), and Cadw. LANDMAP and Historic Landscape Character descriptions were also consulted.

7.4.43 A field assessment of the route was also undertaken to identify any obvious features that might be affected by the proposal but which had not been previously recorded.

7.4.44 Initial results of the desk-based and field assessments were fed back into the highway design process to ensure that any potential adverse effects could be avoided, if possible.

7.4.45 The assessment was originally undertaken in 2010 and covered the section of road approaching the wind farm site from Llanerfyl, to the northeast. The field assessment was repeated in 2012 to take account of modifications to the proposals for this route. In 2013, the proposals were changed again, with a second route added from the south at Talerddig and related modifications to the Llanerfyl route. The desk-based study was extended to take account of the Talerddig route and the field assessment repeated for both the Llanerfyl and Talerddig routes.

7.4.46 The assessment of potential effects for the offsite highway works considered both the direct physical effects of construction works and the consequent effects on the setting of designated historic assets. Assessment criteria followed those used for the main wind farm site.

Assumptions and Limitations

7.4.47 Baseline information on the cultural heritage resource of the application site and its surroundings has been collated from existing records; it is therefore dependant on the quality of existing records. It has proved possible, where necessary, to check these records during site visits and conclude that the overall level of information for individual historic assets is sufficient and proportionate to its relevance in the study.

7.4.48 New information has been collected for this study to address two relevant information gaps that were apparent in the existing records. Firstly, field survey has been used to enhance understanding of the on-site archaeological potential. There inevitably remains a degree of uncertainty regarding the potential for currently unrecorded sub-surface archaeological features. However, the risk of unexpected major adverse effects during construction works is considered to be very low.

7.4.49 Assets considered to be at risk of significant setting effects were visited to better-understand the contribution that setting makes to their heritage significance.

Photomontages, wirelines and ZTVs were also produced to illustrate the predicted visual change affecting key assets.

7.4.50 Both of these areas of research are considered to have generated sufficient information to permit an informed assessment of impacts on the cultural heritage resource.

7.5 Baseline Conditions

7.5.1 This section of the chapter describes the cultural heritage resource of the wind farm site and surrounding area. It begins with a general description of the historic landscape character of the wind farm site before summarising information about individually recorded historic assets within the wind farm site (from existing records and field work undertaken for this assessment).

7.5.2 It then summarises information about the various categories of designated historic asset in the area surrounding the proposed wind farm, based on the 5 and 10km study areas already defined.

7.5.3 Finally, there is a separate description of historic assets in the areas potentially affected by the offsite highway works.

Landscape Character

7.5.4 This is an area of upland, now mostly enclosed, farmland. The core of the area is now unpopulated and only limited evidence of former settlement is present on the periphery of the core area, although farms and other settlements are present at lower levels on the fringes of the Site. The core area in which most of the turbines will be located can be considered in two parts. Much of the pasture in the southern portion is now, or has previously been, improved pasture, but with significant areas of marshy ground and rough, unimproved pasture. The northern area consists of large areas of unimproved heath/moor, with smaller areas of improved grassland pasture. A significant proportion of both areas is forested.

7.5.5 There are numerous forestry and farm access tracks providing access to much of the area and the Glyndwr's Way national trail traverses the area. Although the peripheral slopes were already enclosed, the tithe map and 1st edition Ordnance Survey maps of the area indicate that the core was still largely open common in 1891.

7.5.6 Field boundaries in the core of the northern area consist mainly of post and wire (generally stockproof) fencing. On the eastern periphery of the area on hill slopes and valley sides, where agricultural enclosure has been established for longer, denuded hedgebanks and drystone walling are present, now topped with post and wire fencing. The field boundaries are similar in the southern area, but also present here are substantial denuded banks and dry-stone walls.

7.5.7 The study area has recently been included in a 'landscape characterisation' project CPAT Report no. 821, October 2006). The Site lies within seven Landscape Character Areas (LCAs): 6 Carnedd Wen; 8 Llyn Gwyddior; 9 Cerrig y Tan; 10 Penylan Gwynion; 11 Bryn Gwyn; 12 Pen Coed and 13 Fridd Fawr. Summary descriptions of these below have been taken from CPAT's report:

- LCA 6 Carnedd Wen, in the north-east part of the study area: Extensive 20th-century conifer plantation on undulating upland plateau and more steeply-sloping hill edge superimposed upon an area of largely unenclosed moorland with some areas of residual ancient broadleaved woodland and scrub on some of the hillslopes.
- LCA 8 Llyn Gwyddior, the central part of the study area: Enclosed moorland on upland plateau and hill edge with little recorded archaeology but containing

deposits of potential significance to the environmental and land use history of the area.

- LCA 9 Cerrig y Tan, most of the southern part of the study area: Fieldscape of large irregular fields probably of medieval and early post-medieval origin.
- LCA 10 Penylan Gwynion, most of the central section of the study area: 20th-century conifer plantation superimposed upon an area of former unenclosed moorland with little recorded archaeology but containing deposits of potential significance to the environmental and land use history of the area.
- LCA 11 Bryn Gwyn, includes part of the southern end of the study area: Compact area of post-medieval enclosed moorland and small modern conifer plantations around the headwaters of a stream valley with some areas of small fields suggesting medieval to early post-medieval upland encroachment with abandoned farmsteads and relict field systems in some plantations.
- LCA 12 Pen Coed, includes part of the northern part of the study area: Extensive area of enclosed moorland including substantial areas of registered Common Land, with evidence of encroachments and relict settlement evidence of medieval to post-medieval date.
- LCA 13 Fridd Fawr, part of the extreme western edge of the study area: Fieldscapes of large and small irregular fields on lower hillslopes with a small number of widely dispersed existing farms but with numerous relict farmsteads, house sites and elements of field systems of possibly later medieval and early post-medieval origin abandoned in the later 19th and 20th centuries.

Historic Assets within the Wind farm Site

7.5.8 Table 7.4 includes all historic assets previously recorded within the wind farm site boundary (see Figure 7.1 for locations).

Table 7.4 All Previously Recorded Historic Assets in the wind farm site.

1.32	Name	Type	Period	Importance
719	1.33 Ffridd Cwm y Ffynnon	1.34 Round Barrow	1.35 Prehistoric	1.36 SM (MG314)

1.32	Name	Type	Period	Importance
1.37	1.38 Esgair Priciau	1.39 Round Barrow	1.40 Prehistoric	1.41 Low
1.42	1.43 Dol y Garreg Wen	1.44 Non Antiquity	1.45 Unknown	1.46 Unknown
1.47	1.48 Nant Graig y Fran	1.49 Hafod	1.50 Post-Medieval	1.51 Low
1.52	1.53 Ffridd Pwll y Warthol	1.54 Round Barrow	1.55 Prehistoric	1.56 Low
1.57	1.58 Ffridd Cwm Ffynnon	1.59 Clearance Cairn	1.60 Post-Medieval	1.61 Unknown
1.62	1.63 Rhaiadr Du	1.64 House	1.65 Post-Medieval	1.66 Low
1.67	1.68 Traws Nant	1.69 House	1.70 Post-Medieval	1.71 Unknown
1.72	1.73 Pant y Gareg	1.74 House	1.75 Post-Medieval	1.76 Unknown
1.77	1.78 Prys Gwyn Gyll	1.79 Barn	1.80 Post-Medieval	1.81 Low
1.82	1.83 Prys Gwyn Gyll	1.84 House	1.85 Post-Medi	1.86 Unknown

1.32	Name	Type	Period	Importance
			eval	
1.87	1.88 Beulah Chapel	1.89 Chapel	1.90 Post-Medieval	1.91 Low
1.92	1.93 Cannon Valley	1.94 House	1.95 Post-Medieval	1.96 LBII (17942)
1.97	1.98 Hen Ffridd	1.99 Ford	1.100 Post-Medieval	1.101 Negligible
1.102	1.103 Cannon Farm	1.104 Ford	1.105 Modern	1.106 Unknown
1.107	1.108 Cannon Farm	1.109 Ford	1.110 Post-Medieval	1.111 Unknown
1.112	1.113 Cannon Farm	1.114 Ford	1.115 Post-Medieval	1.116 Unknown
1.117	1.118 Cannon Farm	1.119 Wall	1.120 Post-Medieval	1.121 Unknown

1.32	Name	Type	Period	Importance
1.122	1.123 Cannon Farm	1.124 Trackway	1.125 Post-Medieval	1.126 Unknown
1.127	1.128 Cannon Farm	1.129 Farm	1.130 Post-Medieval	1.131 Unknown
1.132	1.133 Rhaiadr Du	1.134 Barn	1.135 Post-Medieval	1.136 Low
1.137	1.138 Afon Cannon	1.139 Sheep Fold	1.140 Post-Medieval	1.141 Low
1.142	1.143 Afon Cannon	1.144 Sheep Fold	1.145 Post-Medieval	1.146 Low
1.147	1.148 Afon Cannon	1.149 Sheep Fold	1.150 Post-Medieval	1.151 Unknown
1.152	1.153 Afon Cannon	1.154 Sheep Fold	1.155 Post-Medieval	1.156 Unknown
1.157	1.158 Rhosydd clearance	1.159 Clearance Cairn	1.160 Post-Medi	1.161 Unknown

1.32	Name	Type	Period	Importance
			eval	
1.162	1.163 Cannon Farm	1.164 Stable	1.165 Modern	1.166 Unknown
1.167	1.168 Cannon Farm	1.169 Barn	1.170 Modern	1.171 Unknown
1.172	1.173 Cannon Farm	1.174 Mill	1.175 Modern	1.176 Unknown
1.177	1.178 Cannon Farm	1.179 Kennels	1.180 Post-Medieval	1.181 Unknown
1.182	1.183 Cannon Farm	1.184 House	1.185 Modern	1.186 Unknown
1.187	1.188 Cannon Farmhouse	1.189 House	1.190 Modern	1.191 Unknown
1.192	1.193 Afon Cannon	1.194 Field System	1.195 Post-Medieval	1.196 Unknown

1.32	Name	Type	Period	Importance
1.197	1.198 Cannon Farm	1.199 Barn	1.200 Post-Medieval	1.201 Unknown
1.202	1.203 Cannon Farm	1.204 Boundary Bank	1.205 Post-Medieval	1.206 Low
1.207	1.208 Cannon Farm	1.209 Field System	1.210 Post-Medieval	1.211 Low
1.212	1.213 Afon Cannon	1.214 House	1.215 Post-Medieval	1.216 Unknown
1.217	1.218 Afon Cannon	1.219 House	1.220 Post-Medieval	1.221 Unknown
1.222	1.223 Afon Cannon	1.224 Sheep Fold	1.225 Post-Medieval	1.226 Low
1.227	1.228 Goruwch	1.229 Farmstead	1.230 Post-Medieval	1.231 Unknown

1.32	Name	Type	Period	Importance
1.232	1.233 Bron-Ddolwen	1.234 Field System	1.235 Post-Medieval	1.236 Unknown
1.237	1.238 Rhosydd	1.239 Enclosure	1.240 Unknown	1.241 Unknown
1.242	1.243 Rhos, Y	1.244 Earthwork	1.245 Unknown	1.246 Unknown
1.247	1.248 Rhos, Y	1.249 Earthwork	1.250 Unknown	1.251 Unknown
1.252	1.253 Esgair, Yr,	1.254 Earthwork	1.255 Unknown	1.256 Unknown
1.257	1.258 Esgair, Yr	1.259 Earthwork	1.260 Unknown	1.261 Unknown
1.262	1.263 Traws Nant	1.264 Earthwor	1.265 Post-	1.266 Unkn

1.32	Name	Type	Period	Importance
		k	Medieval	own
1.267	1.268 Rhos, Y	1.269 Earthwork	1.270 Unknown	1.271 Unknown
1.272	1.273 Rhos, Y	1.274 Building	1.275 Unknown	1.276 Unknown
1.277	1.278 Rhos, Y	1.279 Building	1.280 Unknown	1.281 Unknown

Information from Field Visits

7.5.9 Field visits to the Site identified a number of previously unidentified historic assets; these are listed in Table 7.5 and their locations are shown in Figure 7.1.

Table 7.5 Historic Assets in the wind farm site identified from field visits.

1.282	Grid Ref	Type	Period	Importance
N1	1.283 SH94440048 10	1.284 Enclosure/building?	1.285 Post-Medieval?	1.286 Low
N2	1.287 SH942	1.288 Peat cutting?	1.289 Post-	1.290 Neg

1.282	Grid Ref	Type	Period	Importance
	8004810		Medieval?	ligible
N3	1.291 SH93940049 20	1.292 Modern quarry	1.293 Modern	1.294 Negligible
N4	1.295 SH94180053 80	1.296 Modern quarry	1.297 Modern	1.298 Negligible
N5	1.299 SH93210044 00	1.300 Possible barrow?	1.301 Unknown	1.302 Unknown
N6	1.303 SH93300044 00	1.304 Cairn?	1.305 Unknown	1.306 Unknown
N7	1.307 SH92900047 70	1.308 Barrow?	1.309 Unknown	1.310 Unknown
N8	1.311 SH92780046 00	1.312 Barrow	1.313 Prehistoric	1.314 Low
N9	1.315 SH92780046 00	1.316 Modern quarry	1.317 Modern	1.318 Negligible
N10	1.319 SH93200380	1.320 Clearance cairns?	1.321 Unknown	1.322 Negligible
N11	1.323 SH92870037 10	1.324 Possible ditch?	1.325 Unknown	1.326 Unknown
N12	1.327 SH92950037 40	1.328 Barrow/cairn?	1.329 Unknown	1.330 Unknown
N13	1.331 SH93040383	1.332 Clearance cairns?	1.333 Unknown	1.334 Negligible
N14	1.335 SH92810389	1.336 Modern quarry	1.337 Modern	1.338 Negligi

1.282	Grid Ref	Type	Period	Importance
	0			ble
N15	1.339 SH91870046 00	1.340 Possible barrow?	1.341 Unknown	1.342 Unknown
N16	1.343 SH91910047 20	1.344 Modern quarry	1.345 Modern	1.346 Negligible
N17	1.347 SH94360059 90	1.348 Modern clearance cairns	1.349 Modern	1.350 Negligible
N18	1.351 SH94100058 70	1.352 Barrow?	1.353 Unknown	1.354 Unknown
N19	1.355 SH94710059 20	1.356 Hafod	1.357 Post-Medieval?	1.358 Low
N20	1.359 SH94480063 90	1.360 Clearance cairn/barrow?	1.361 Unknown	1.362 Unknown
N21	1.363 SH94590065 50	1.364 Clearance cairn?	1.365 Unknown	1.366 Negligible
N22	1.367 SH94400066 30	1.368 Clearance cairn?	1.369 Unknown	1.370 Negligible
N23	1.371 SH95040069 20	1.372 Barrow/clearance cairn?	1.373 Unknown	1.374 Unknown
N24	1.375 SH95170068 80	1.376 Peat cutting	1.377 Post-Medieval?	1.378 Negligible
N25	1.379 SH95190081 40	1.380 Quarries and cairns?	1.381 Unknown	1.382 Negligible
N26	1.383 SH95970081 20	1.384 Possible ring cairn?	1.385 Unknown	1.386 Unknown

1.282	Grid Ref	Type	Period	Importance
N27	1.387 SH91950051 00	1.388 Clearance cairn	1.389 Unknown	1.390 Negligible
N28	1.391 SH91810305 43	1.392 Barrow?	1.393 Unknown	1.394 Unknown
N29	1.395 SH91880056 00	1.396 Quarrying?	1.397 Post-Medieval?	1.398 Negligible
N30	1.399 SH91880057 00	1.400 Trackway	1.401 Unknown	1.402 Low
N31	1.403 SH92230057 30	1.404 Clearance cairn?	1.405 Unknown	1.406 Negligible
N32	1.407 SH92340057 80	1.408 Quarry	1.409 Unknown	1.410 Negligible
N33	1.411 SH92320057 50	1.412 Barrow?	1.413 Unknown	1.414 Unknown
N34	1.415 SH91820053 00	1.416 Drystone wall	1.417 Post-Medieval?	1.418 Low
N35	1.419 SH93016044 48	1.420 Clearance cairn	1.421 Unknown	1.422 Negligible
N36	1.423 SH93497040 25	1.424 Clearance cairn	1.425 Unknown	1.426 Negligible
N37	1.427 SH 95480 912	1.428 Lancaster Bomber Crash site	1.429 Modern	1.430 Medium
N38	1.431 SH95191081 41	1.432 Memorial stone	1.433 Modern	1.434 Negligible

Description of Historic Asset Types within the Wind farm Site

Hafodau, Farmsteads, Farm Buildings, Other Buildings and Other Settlement Sites

7.5.10 Several farms lie within the Site boundary, as does a chapel. Other settlements are often still visible as ruins. Isolated dwellings or 'hafodau' can also occur as visible remains in upland areas. These do not normally have an associated field system.

Field Boundaries, Sheepfolds and Clearance Cairns

7.5.11 Boundaries can be extensive linear features that divide up the landscape and help to define its character and antiquity. They can take many forms including stone walls, banks and ditches, or post and wire fences. They can also survive in varying degrees of completeness and viability. Sheepfolds are usually stone-built features. Piles of stones, termed clearance cairns, occur in large numbers in upland landscapes, and can be of virtually any date, although it is likely that most belong to the recent or post-medieval period. It is often not possible to distinguish larger examples from prehistoric burial cairns (round barrows).

Footpaths, Access Tracks and Roads

7.5.12 There are numerous paths and access tracks of varying character and antiquity across the Site. Some of these are public access ways, others are farm tracks.

Round Barrows and Barrow Cemeteries

7.5.13 Barrows can occur singly or in groups, and are often (but not exclusively) situated in prominent locations such as hilltops or along ridges. There are several examples of single barrows within the perimeter of the Proposal. It is possible that ploughing activity has denuded other barrows to the extent that they are no longer visible as surface features. Some remains of them, however, may survive below ground. There may also be other associated features of archaeological significance preserved below ground in the vicinity of known barrows.

Quarries and Peat Cutting

7.5.14 There are several small quarries and areas of peat cutting recorded within the Site. Such features are of limited landscape and archaeological value but are nevertheless testament to past human activity in the area.

Peat Deposits

7.5.15 Peat deposits, although not considered historic assets in their own right, may have considerable cultural heritage significance for either of two reasons. As permanently waterlogged sediments, peat deposits can preserve ancient organic objects such as wooden artefacts or woolen clothing. Peat deposits can also be important sources of well-date palaeoenvironmental information, including vegetation records from plant macro-fossils and pollen.

7.5.16 Site surveys reported in Chapter 8 have recorded the extent and depth of peat deposits within the wind farm site. These confirm that the areas of the site affected by development generally have little or no peat. 75% of the footprint of the development is on land with less than 0.5m of peat and 95% has less than 1.0m of peat. There are occasional small pockets over 1.5m in depth but no extensive areas of deep blanket peat.

7.5.17 There are no records for organic artefacts being discovered within the wind farm site but the potential cannot be entirely ruled out. Relatively shallow deposits of blanket peat, like those recorded at Llanbrynmair are likely to have accumulated slowly and are unlikely to offer long or high-resolution palaeoenvironmental records. Peat cutting in the past (noted above) will also reduce the potential value of the deposits. Overall the importance of the peat deposits at Llanbrynmair is considered to be low.

Scheduled Monuments within 10km of the Wind farm

7.5.18 In addition to the historic assets within the wind farm site, 50 Scheduled Monuments are located within 10km of the wind farm; these are listed in Table 7.6. Only one Scheduled Monument, a Bronze Age round barrow (MG314) lies within the Proposal boundary (see Figure 7.1). The location of all other assets is shown in Figures 7.2 and 7.3.

7.5.19 35 of the 50 Scheduled Monuments listed in Table 7.6 are prehistoric ritual and funerary sites of Neolithic and Bronze Age date, reflecting the widespread survival of these types of site in uncultivated areas of higher ground. There are numerous examples of individual round cairns or barrows but also three short stone rows (MG134, MG276 and MG291) and three stone circles (MG066, MG068 and MG179).

7.5.20 Prehistoric settlement, spanning the Bronze Age and Iron Age, is represented by five examples of hillforts and other substantial enclosures, and three examples of unenclosed hut circles. A short section of scheduled Roman road on Mynydd Waun Fawr (MG320) is probably contemporary with at least some of the Iron Age settlement sites.

7.5.21 The medieval and later periods are represented by the remaining six sites. There are two examples of an earthwork castle (motte and bailey castles at Llanerfyl, MG072, and Llanbrynmair, MG065). A third site, Caer Noddfa in Carno (MG052) may be an defensive enclosure of medieval date but Roman origins have also been suggested. A cross-incised stone of early-medieval date is also in Carno (MG146). Pillow mounds at Llanfihangel (MG250), the remains of a rabbit warren, are probably of medieval date. The final and most recent Scheduled Monument is an underground store for root vegetables (MG218) on the site of an abandoned post-medieval farm.

Table 7.6 Scheduled Monuments within 10km of the Wind farm.

Cadw Ref. No.	Name	Location	Type	Period
ME217	Ffridd Braich Llwyd Bronze Age Ritual Complex	Mawddwy	Ring cairn	Prehistoric
MG052	Caer Noddfa	Carno	Enclosure	Medieval
MG065	Domen Fawr Castle Mound Tafolwern	Llanbrynmair	Motte	Medieval
MG066	Ceffig Caerau Stone Circle	Llanbrynmair	Stone circle	Prehistoric
MG068	Lled Croen-yr-Ych Stone Circle	Llanbrynmair	Stone circle	Prehistoric
MG070	Gardden Camp & Barrows	Llanerfyl	Hillfort	Prehistoric
MG072	Llysun Motte and Bailey	Llanerfyl	Motte & Bailey	Medieval
MG074	Gogerddan Camp	Banwy	Hillfort	Prehistoric
MG075	Maes Llymystyn Camp	Banwy	Enclosure	Prehistoric
MG128	Cae'r-Mynach Round Cairn	Banwy	Round cairn	Prehistoric
MG133	Maes Dyfnant Round Cairn	Llanwddyn	Round cairn	Prehistoric
MG134	Mynydd Dyfnant Stone Alignment	Banwy	Stone alignment	Prehistoric
MG146	Cross-Incised Stone (Now in Carno Church)	Carno	Cross-marked stone	Early Medieval
MG149	Moel Ddolwen Camp	Llanerfyl	Hillfort	Prehistoric
MG164	Pencad Cymru Cairn	Banwy	Round cairn	Prehistoric
MG179	Y Capel Stone Circle	Dwyriw	Stone circle	Prehistoric
MG180	Ring Cairn 540m SW of Llyn y Tarw	Caersws	Ring cairn	Prehistoric
MG205	Castell Carno	Carno	Hillfort	Prehistoric
MG209	Yr Allor Cairn	Llanbrynmair	Ring cairn	Prehistoric
MG218	Root Store at Bon-y-Maen 800m NW of Blaen y Cwm	Llanerfyl	Root store	Post-Medieval/Modern
MG250	Soldiers' Graves Pillow Mounds	Llanfihangel	Pillow mound	Medieval
MG265	Ffridd yr Ystrad Cairns	Llanbrynmair	Round cairn	Prehistoric
MG268	Boncyn y Llwyn round cairn	Banwy	Round cairn	Prehistoric
MG269	Tryfel Cairns and Stone Setting	Banwy	Round cairn	Prehistoric
MG270	Llechwedd Du Round Cairn	Banwy	Round cairn	Prehistoric
MG272	Gelli Gethin Round Cairn	Llanfair Caereinion	Round cairn	Prehistoric
MG273	Cae'r Lloi Round Barrow	Banwy	Round barrow	Prehistoric
MG276	Lluest Uchaf Cairns and Stone Row	Caersws	Stone Row	Prehistoric
MG277	Craig y Llyn Mawr Round Cairn	Caersws	Round cairn	Prehistoric
MG278	Nant Cwm Gerwyn Cairns	Caersws	Kerb cairn	Prehistoric
MG279	Blaen y Cwm Ring Cairn	Carno	Ring cairn	Prehistoric
MG291	Carreg Lwyd Ritual Complex	Carno	Stone Row	Prehistoric
MG292	Twr Gwyn Mawr Round Cairn	Llanbrynmair	Round cairn	Prehistoric
MG293	Blaen y Cwm Round Cairns	Carno	Round cairn	Prehistoric
MG294	Esgair Draenllwyn Round Cairn I	Carno	Round cairn	Prehistoric
MG295	Esgair Draenllwyn Round Cairn II	Carno	Round cairn	Prehistoric
MG296	Bryn yr Aran Stone Setting	Carno	Stone setting	Prehistoric
MG297	Esgair Draenllwyn Stone Setting	Carno	Stone setting	Prehistoric
MG304	Bryn yr Aran Ring Cairn and Ritual Platform	Carno	Ring cairn	Prehistoric
MG311	Moelfre round barrow	Glantwymyn	Round barrow	Prehistoric
MG312	Moel Eiddew platform cairn	Glantwymyn	Platform Cairn	Prehistoric
MG313	Mynydd Lluest Fach barrow cemetery	Llanbrynmair	Ring cairn	Prehistoric
MG314	Ffridd Cwm y Ffynnon round barrow	Llanbrynmair	Round barrow	Prehistoric

Cadw Ref. No.	Name	Location	Type	Period
MG320	Mynydd Waun Fawr Roman Road	Llanfair Caereinion	Road	Roman
MG325	Bryn Du hut circle	Aberhafesp	Hut circle settlement	Prehistoric
MG327	Mynydd y Gribin kerb cairn	Dwyriw	Kerb cairn	Prehistoric
MG328	Craig y Llyn Mawr platform cairn and standing stone	Caersws	Platform Cairn	Prehistoric
MG331	Bryn y Gadair Round Cairn	Carno	Round cairn	Prehistoric
MG338	Round Hut 700m NNE of Garreg Hir	Caersws	Hut circle settlement	Prehistoric
MG339	Round Hut 400m NE of Garreg Hir	Caersws	Hut circle settlement	Prehistoric

Listed Buildings

7.5.22 This assessment has adopted a study area for all grades of Listed Building extending up to 5km from the proposed wind farm. This study area has been extended to 10km for higher grade assets (Grade I and II*) reflecting their importance and therefore greater sensitivity to adverse effects on their significance.

Grade I and II* assets within 10km of the wind farm

7.5.23 There are five Grade II* Listed Buildings within 10km of the proposed wind farm; these are listed in Table 7.7 and their locations are shown in Figures 7.2 and 7.3. There are no examples of Grade I Listed Buildings within 10km of the proposed wind farm.

7.5.24 The Grade II* assets comprise two examples of medieval churches (St Mary, Llan, 7605; and St Tydecho, Mawddwy, 4756) and three 'gentry' houses of particular architectural interest. Pwlliwrch (7607) is a rare survival of a late 15th century hall house with later modifications; Cemmaes Bychan (now split into two properties which are separately listed: 7595 and 83044 under Tan y ffordd) is an early example for this area of a renaissance house, built in 1632; Plasnewydd (7583) is another slightly later example, probably built in the later 17th century.

Table 7.7 Grade II* Listed Buildings within 10km of the Wind farm.

Cadw ref. no.	Name	Location	Type
4756	Church of St Tydecho	Mallwyd	Church
7583	Plasnewydd	Plasnewydd	Gentry House
7597	Cemmaes Bychan	Cemmaes	Gentry House
7605	Church of St Mary	Llan	Church
7607	Pwlliwrch	Darowen	Gentry House
83044	Tan y ffordd	Cemmaes	Gentry House

Grade II Assets within 5km of the Wind farm

7.5.25 There are 43 Grade II Listed Buildings within 5km of the proposed wind farm; these are summarised in Table 7.8 and their locations are shown in Figure 7.2.

7.5.26 The assets are concentrated in two clusters in valleys to the north and south of the proposed wind farm where most of the settlement is located. There are 27 Listed Buildings at least 3km to the northeast of the proposed wind farm, in the valleys of the Afon Banwy and its tributary the Afon Gam, which runs northeast from the wind farm site. The second cluster of 13 Listed Buildings is at least 2km to the southwest of the wind farm, centred on Llanbrynmair, at the confluence of the Afon Twymyn

and its tributaries the Afon Rhiwseason and Afon Laen. This leaves three isolated farmhouses located on the margins of the upland area occupied by the wind farm site: Cwm Pen Llydan (84408), 1.5km to the west; Abercannon (17942), 1km to the east and actually within the application area; and Cwm-carnedd-uchaf (18132), 1km to the southwest.

7.5.27 The list of Grade II buildings is dominated by houses and outbuildings, mostly on farms, that have been listed as good examples of local vernacular architecture. Most are stone buildings dating from the 18th and 19th century; Bryn-Coch uchaf (17946) stands out in this group as a rare survival of a 17th century timber framed building retaining much of its original fabric. In poor condition when listed in 1996, it has recently been restored and extended.

7.5.28 The next most numerous category of asset is milestones; there are seven examples shared between the two late 18th century turnpike roads to the north and south of the wind farm (now the A458 and A470). Accommodation was needed for the traffic generated by these turnpike roads and there are designated examples of early inns on both roads: the Wynnstay Arms (7598) in Llanbrynmair on the A470 and the Cann Office Hotel (80781) in Llangadfan on the A458. Communication was also improved by the provision of bridges and there are three listed examples of early stone bridges in the vicinity of Llangadfan crossing the Afon Banwy and its tributaries. The Pont-y-clochydd (80801) is a rare survival of a medieval bridge; the other two examples are of 19th century date (80797, 80800).

7.5.29 There are three places of worship: the medieval churches of St Cadfan, Llangadfan (7632), and St Tydecho, Foel (80796) and a 19th century chapel, with its minister's house (Yr Hen Gapel, 18131) in Dolfach. The Church of St Cadfan also has a separately listed Lych Gate (80788) and a holy well, also dedicated to St Cadfan (80804).

7.5.30 Finally there are three other assets that do not fit into the groups described above. These are the 19th century railway station buildings in Llanbrynmair (18118), a late-19th century shooting lodge at Belan Hall (17943) built in the style of a New England timber-framed and clapboarded house, and a mid-18th century sundial in the churchyard at St Mary, Llan (18133).

Table 7.8 Grade II Listed Buildings within 5km of the Wind farm.

Cadw ref. no.	Name	Location	Type
7598	Wynnstay Arms	Llanbrynmair	Inn
7632	Church of St Cadfan	Llangadfan	Church
17579	Milestone	Glanhanog	Milestone
17942	Abercannon	Cannon Valley	Farmhouse
17943	Belan Hall	Cefn-llys Isaf	Shooting Lodge
17946	Bryn-Coch Uchaf	Nant Menial	Farmhouse
18114	Milestone at Llanbrynmair Bridge	Llanbrynmair	Milestone
18115	Coed Cae	Llanbrynmair	Farmhouse
18116	Bryn llys	Llanbrynmair	Farmhouse
18118	Llanbrynmair Railway Station and house	Llanbrynmair	Railway Station
18129	Diosg	Dolfach	Farmhouse
18130	Milestone at the N end of Dol-fach	Dolfach	Milestone
18131	Yr Hen Gapel, forecourt railings, and Minister's house	Dolfach	Chapel and House
18132	Cwm-carnedd-uchaf	Dolfach	Farmhouse
18134	Hafod y Llan, also known as the Old Rectory	Llan	House
18136	Cwm gwyn	Rhiwsaeson	Farmhouse
18137	Plas rhiw-saeson	Rhiwsaeson	Farmhouse

Cadw ref. no.	Name	Location	Type
80780	Cae'n-y-coed	Cae'n-y-coed	Farmhouse
80781	Cann Office Hotel	Llangadfan	Inn
80782	Detached Outbuildings Range at Rhiwlas (former Rectory)	Llangadfan	Farm building
80783	Dol-Hywel	Dol-Hywel	Farmhouse
80784	East Range of Farmyard Buildings at Maesllymystyn	Maesllymystyn	Farm building
80785	Farm Outbuilding at Cae'n-y-coed	Cae'n-y-coed	Farm building
80786	Hay Barn at Maesllymystyn Farm	Maesllymystyn	Farm building
80787	Lletypiod and Tynewydd	Foel	House
80788	Lychgate of St Cadfan's Church	Llangadfan	Lych Gate
80789	Maesllymystyn farmhouse	Maesllymystyn	Farmhouse
80791	Milestone near Dyffryn Restaurant	Foel	Milestone
80792	Milestone near Foel-fach	Foel-fach	Milestone
80793	Milestone near Wern Farmyard	Wern	Milestone
80794	Milestone on B4395 near Glanaber	Llangadfan	Milestone
80795	North Range of Farmyard Buildings at Maesllymystyn	Maesllymystyn	Farm building
80796	Parish Church of St Tydecho, Foel	Foel	Church
80797	Pont Llangadfan	Llangadfan	Bridge
80800	Pont Rhyd-yr-efail (partly in the community of Llanerfyl)	Llangadfan	Bridge
80801	Pont-y-clochydd	Foel	Bridge
80802	Rhiwlas (former Rectory) with open-sided Coach-shed to north-west	Llangadfan	House
80803	South Range of Farmyard Buildings at Maesllymystyn	Maesllymystyn	Farm building
80804	St Cadfan's Well	Llangadfan	Holy Well
80805	Ty'n-y-llan	Foel	House
80806	West Range of Farmyard Buildings at Maesllymystyn with Coach-house, Stable, Haybarn and Granary	Maesllymystyn	Farm building
84408	Cwm Pen Llydan	Pandy	Farmhouse

Conservation Areas

7.5.31 There are two Conservation Areas with the 5km study area adopted for this assessment. They are located in the historic cores of the adjacent settlements of Llan and Bont Dolgadfan, in the valley of the Afon Twymyn, at the southwestern limit of the study area 5km from the proposed wind farm (see Figure 7.2).

Landscapes of Historic Interest

7.5.32 There are no examples of land areas including in the Register of Landscapes of Historic Interest within the 10km study area adopted for this assessment. The closest registered area is the Clywedog Valley, a Landscape of Special Historic Interest (HLW P6), 10-19km to the south. This lies almost entirely outside the ZTV for the proposed wind farm and there is no reason to predict adverse effects on its historic interest due to the operation of the wind farm. Registered Landscapes of Historic Interest will not be considered further in this assessment.

Parks and Gardens of Historic Interest

7.5.33 There are no examples of parks or gardens in the Register of Parks and Gardens of Historic Interest within the 10km study area adopted for this assessment. The closest registered asset is the park at Gregynog Hall (Grade I, PGW PO33), 15km to the southeast. This lies entirely outside the ZTV for the proposed wind farm and

there is no reason to predict adverse effects on its historic interest due to the operation of the wind farm. Registered Parks and Gardens of Historic Interest will not be considered further in this assessment.

Offsite Highway Works

7.5.34 The location of historic assets close to the proposed offsite highway works is shown in Figures 7.7a and 7.7b. A full listing of undesignated assets within 0.5km of the works, which comprises almost 136 records, will be found in Appendix 7.1. Table 7.9 (below) lists undesignated assets immediately adjacent to the minor roads that would be subject to the highway works; it excludes records such as place names where there is no physical asset recorded. The potential for direct physical effects is limited to these 14 assets.

7.5.35 Most of the assets in this list comprise a variety of relatively recent road-side structures that survive in the present-day landscape or are recorded on 19th century mapping. All are post-medieval in date, probably 18th or 19th century, and are a typical sub-set of the much longer list of assets in the study area provided in Appendix 7.1.

7.5.36 The record of a medieval asset is the manor at Tirymynach in Talerddig (17923). This is a documentary reference only; its precise location is not known and there may not be any surviving remains.

7.5.37 The settlement of Llanerfyl (15714) presumably originates in the Early Christian period judging by the dedication of the church and the survival of an early grave marker. Map evidence demonstrates that there were very few other buildings around the medieval church of St Erfyl in the early 18th century; the village appears to have only developed as a nucleated settlement after the creation of the Welshpool to Machynlleth turnpike road later that century. Map evidence again demonstrates that the current road to Talerddig, where offsite highway works would take place, was created by 1850 to bypass the old road to Talerddig that began in the centre of the village opposite the church.

Table 7.9 Historic Assets located adjacent to proposed offsite highway works.

ID No.	Name	Type	Period	Importance
8529	Ty Newydd House Site	House	Post-Medieval	Low
11326	Beulah Welsh Independent Chapel, Cwm Nant-Yr-Eira	Chapel	Post Medieval	Low
11328	Gosen Chapel, Llanerfyl	Chapel	Post Medieval	Low
15714	Llanerfyl	Settlement	Multiperiod	Medium
17923	Tirymynach Manor	Manor	Medieval	Unknown
48251	Ffridd Fawr, farmstead	Farmstead	Post-Medieval	Low
65503	Dolwen bridge (site of)	Bridge	Post-Medieval	Negligible
65506	Hafod Ford	Ford	Post-medieval	Negligible
65604	Ffridd Fawr cow shed	Cow house	Post-Medieval	Low
66430	Ty mawr sheepfold	Sheep fold	Post-Medieval	Negligible
67177	Bryn-coch-uchaf quarry	Quarry	Post-Medieval	Negligible
67181	Glyn well	Well	Post-Medieval	Negligible
67900	Capel-yr-aber trackway	Trackway	Post-Medieval	Negligible
97163	Ty Newydd Methodist Chapel	Chapel	Post Medieval	Low

7.5.38 Table 7.10 lists all designated historic assets within 1km of the proposed highway works. All of these assets occur along the northern access route from Llanerfyl to the wind farm site.

7.5.39 The majority of the assets are Grade II Listed Buildings within the village of Llanerfyl. The medieval church of St Erfyl (17936) is surrounded by a cluster of 18th and 19th century houses; there is also an early cast iron fire hydrant on the roadside (17939) and a milestone for the Welshpool to Machynlleth turnpike road (17937), which is carried across the Afon Banwy here on a Grade II Listed Bridge (17938). The remains of a motte and bailey castle (MG072) are located immediately to the north of the village.

7.5.40 The route along the minor road to the wind farm site passes within 1km of four Grade II Listed farmhouses; there are also two Scheduled hillforts on higher ground above the route.

Table 7.10 Designated Historic Assets within 1km of proposed offsite highway works.

Cadw ref. no.	Name	Location	Type	Designation
17923	Bryn Erfyl and Tynllan	Llanerfyl	House	LB (II)
17933	Caerfynnon	Llanerfyl	House	LB (II)
17934	Railings and Gates to Caerfynnon	Llanerfyl	Railings	LB (II)
17935	Erfyl House	Llanerfyl	House	LB (II)
17936	Church of St. Erfyl	Llanerfyl	Church	LB (II)
17937	Milestone	Llanerfyl	Milestone	LB (II)
17938	Pont Llanerfyl	Llanerfyl	Bridge	LB (II)
17939	Water Standpost/Fire Hydrant	Llanerfyl	Fire hydrant	LB (II)
17942	Abercannon	Cannon Valley	Farmhouse	LB (II)
17943	Belan Hall	Cefn-llys Isaf	Shooting Lodge	LB (II)
17944	Maes-gwyn	Maes-gwyn	Farmhouse	LB (II)
17945	Cowhouse and Stable at Maes-gwyn	Maes-gwyn	Farm outbuildings	LB (II)
17946	Bryn-Coch Uchaf	Nant Menial	Farmhouse	LB (II)
80783	Dol-Hywel	Dol-Hywel	Farmhouse	LB (II)
MG072	Llysun Motte and Bailey	Llanerfyl	Motte & Bailey	SM
MG070	Gardden Camp & Barrows	Llanerfyl	Hillfort	SM
MG149	Moel Ddolwen Camp	Llanerfyl	Hillfort	SM

Future Baseline (Do-Nothing Scenario)

7.5.41 Historic assets are fragile and generally susceptible to irreversible damage. The longer-term preservation of archaeological assets in good condition is closely linked to future land use and land management and, in the case of the built heritage, continued investment in the maintenance of buildings.

7.5.42 The majority of assets, both designated and undesignated, are located on agricultural holdings. The continued maintenance of buildings will depend largely on the economic strength of the local farm economy and the continuation of sustainable uses for historic buildings. The preservation of archaeological sites in good condition will depend on avoidance of harm during agricultural operations, particularly cultivation or land improvement, and protection of assets during any change of land-use (for example afforestation).

7.6 Design Evolution and Mitigation

7.6.1 The original design has undergone several iterations to mitigate environmental effects. The following changes were adopted to mitigate cultural heritage effects.

Wind farm

7.6.2 Evolution of the wind farm design has allowed mitigation of adverse effects on historic assets to be achieved through increased avoidance of harm. This has reduced both direct physical effects and potentially harmful visual change in setting.

7.6.3 The principal focus for mitigation on the wind farm site has been the avoidance of direct physical impacts from construction through careful micrositing. The initial on-site archaeological survey produced a distribution map of known historic assets that was used to inform the original 43 turbine layout assessed in the Environmental Statement and all subsequent modifications to the onsite layout.

7.6.4 Adverse effects from the initial 43 turbine layout were reduced to six assets through micro-siting. This layout would have led to the destruction of three isolated clearance cairns, and damage to one area of clearance cairns and two areas of peat cutting.

7.6.5 Subsequent modifications to the layout, and the reduction in turbine numbers from 43 to 34 and finally 30, provided opportunities to further reduce direct physical effects. The current 30 turbine layout would directly harm only three assets: it would probably destroy one isolated clearance cairn, and damage one area of clearance cairns and one area of peat cutting.

7.6.6 Opportunities to reduce the operational impact of the wind farm on the setting of historic assets have arisen as a consequence of the reduction in turbine numbers. Two principal benefits were achieved, in both cases through the removal of turbines at the western edge of the wind farm (R1, R2, R3 , R28, R29 and R30).

7.6.7 Removal of these turbines increased the minimum distance of a turbine to round barrow MG314 from 250m up to 1km. This is the only Scheduled Monument within the wind farm site and the proximity of turbines R2 and R3 in the 43 turbine layout was raised as a concern by Cadw.

7.6.8 Removal of the same western turbines also considerably reduced the level of visual change for Listed Buildings in and around the village of Llanbrynmair, which was a matter of concern for Powys County Council's Conservation Officer. As a result all of the Listed Buildings close to the wind farm in this area would experience little or no visual change in their settings from the current 30 turbine layout.

Offsite Highway Works

7.6.9 Design of the offsite highway works was informed at all times by knowledge of the location of known historic assets. The limited extent of the works required has resulted in the development of a design that would have no direct physical effects on known historic assets or any adverse effects due to change in setting.

7.7 Potential Effects

7.7.1 This section of the chapter describes the potential effects of the development on the cultural heritage resource. The assessment of effects is presented in four main parts, each dealing with a separate aspect of the development, as follows:

- Wind farm Construction
- Wind farm Operation
- Wind farm Decommissioning
- Offsite Highway Works

7.7.2 Consideration of potential effects on historic landscape character, although strictly part of the operational effects of the wind farm, has been addressed separately

using an ASIDOHL-style assessment. A summary of the results of this assessment are presented at the end of this section of the chapter.

7.7.3 Potential effects of the proposed development on the cultural heritage resource can be described in three categories:

- Direct physical effects;
- Indirect physical effects; and
- Effects on setting.

Direct Physical Effects

7.7.4 Direct physical effects describe those development activities that directly cause damage to the fabric of a historic asset. Typically, these activities are related to construction works. In the present case they could include excavation of a foundation for the turbine, creation of the access track and the excavation of service trenches for example. The offsite highway works could also give rise to direct physical effects. It follows that effects of this type can only occur within the construction footprint of the development

7.7.5 Further direct physical effects are unlikely to be experienced during the operational life of the wind farm. Similarly, the decommissioning of the wind farm would not lead to further direct physical effects, assuming that the works are carefully managed and restricted to areas already disturbed during construction.

Indirect Physical Effects

7.7.6 Indirect physical effects describe those processes, triggered by development activity, that lead to the degradation of historic assets. A typical example of a process is the lowering of a groundwater table as a result of construction of a site access track through a peat deposit leading to the drying out of formerly waterlogged archaeological deposits in the area adjacent to the track. The result can be total loss of organic materials in these deposits and therefore most of their cultural value.

Effects on Setting

7.7.7 Effects on setting of historic assets describes how the presence of a development changes the surroundings of a historic asset in such a way that it affects (beneficially or adversely) the heritage significance of that asset. Visual effects are most commonly encountered but other environmental factors such as noise, light or air quality can be relevant in some cases. Effects may be encountered at all stages in the life cycle of a development from construction to decommissioning but they are only likely to be considered significant during the prolonged operational life of the development.

7.7.8 In the case of the Proposal, the height of the wind turbine results in a structure that would be visible from some distance. This visibility would be enhanced by the rotation of the blades when the turbine is operating. The Proposal therefore has the potential to generate significant effects on the significance of historic assets through visual change in setting, but only for assets where the wider landscape makes a substantive contribution to their heritage significance.

7.7.9 Other environmental impacts of the Proposal have been considered as potential causes of effects on setting but have then been discounted. These include night-time illumination and increase in noise (neither being of sufficient magnitude to affect the experience of a visitor to any of the historic assets in the study area).

Wind farm Construction

7.7.10 Construction works within the application site have the potential to affect known historic assets and other, currently unrecorded sub-surface archaeological features. These effects could be direct or indirect physical effects.

7.7.11 Predicted direct physical effects of the construction of the wind farm on historic assets are summarised in Table 7.11 and assets listed in this table are also labelled in Figure 7.4.

7.7.12 The layout of the wind farm has been designed where possible to avoid any adverse effect on known historic assets; as a result only three recorded assets would experience direct physical damage. These are an area of clearance cairns (N10), a single clearance cairn (N36) and one area of probable peat cutting (N24). The area of clearance cairns (N10) and the area of peat cutting (N24) would be affected by turbine access tracks which would disturb a 7.5m-wide swath through the assets. The other clearance cairn N36 lies on the north side of the area allocated to the concrete batching plant and would probably be totally destroyed.

7.7.13 All three of these assets are considered to be of Negligible Importance. The predicted level of damage to N10 and N24 could reach as high as Medium Magnitude, depending on the proportion of each site actually affected. This is judged to be an effect of Negligible Significance. The probable destruction of the single clearance cairn N36 is judged to be an effect of Major Magnitude and Minor Significance.

7.7.14 The wind farm has also been designed to avoid areas of deep peat where possible; 95% of the footprint of the development would affect peat less than 1m deep with extensive deposits over 1.5m in depth only encountered around Turbine R35 (see Vol. 3 Figure 8c). As a result only a very small fraction of the peat resource in the local landscape would be disturbed. This level of disturbance is not considered to materially affect the value of the local peat resource as a source of palaeoenvironmental information.

7.7.15 In addition to the adverse effects on known historic assets, there would be potential for adverse effects to currently unrecorded assets within the construction footprint of the wind farm. Inevitably, the nature and importance of any such assets is not known; however it is considered unlikely that any would be of greater than Low Importance. There would be potential for effects of High Magnitude, if an asset experienced complete or substantial damage. There is therefore potential for adverse effects of up to Moderate Significance.

Table 7.11 Potential direct physical effects of wind farm construction on historic assets.

ID no	Type	Importance	Magnitude of effect	Significance of effect
N10	Clearance Cairns?	Negligible	Moderate	Negligible
N24	Peat cutting	Negligible	Moderate	Negligible
N36	Clearance Cairn	Negligible	Major	Minor
-	Unrecorded assets	Up to Low	Up to Major	Up to Moderate

7.7.16 Avoidance of known assets through design modifications to the wind farm has led to a number of assets still being located close to proposed construction works (within 50m). These assets would be at risk from accidental damage during construction works. The following assets, all labelled on Figure 7.4, would be at risk:

- Round barrow (720)
- Round barrow (4288)
- House (8791)
- Possible barrow (N7)
- Quarry (N14)
- Hafod (N19)
- Clearance cairns (N22)
- Possible ring cairn (N26)
- Clearance Cairn (N35)

7.7.17 In all cases, the risk would arise from proximity to access tracks.

7.7.18 Indirect physical effects on historic assets could arise through the disturbance of peat deposits, leading to de-watering and oxidation of the peat or any organic artefacts within it. Detailed information on the predicted extent of de-watering is provided in Chapter 8. As noted above, the wind farm layout has been designed to avoid areas of deep peat where possible so the extent of indirect damage has also been kept to a minimum. The level of indirect disturbance is not considered to materially affect the value of the local peat resource as a source of palaeoenvironmental information.

Wind farm Operation

The Assessment Process

7.7.19 Operation of the wind farm has the potential to affect the heritage significance of assets through change in their settings. As noted above, only visual change is considered to have potential to cause significant effects in the present case.

7.7.20 The approach to assessment of setting effects adopted for this study follows the advice provided in Section 4 of English Heritage's guidance on "The Setting of Heritage Assets" (2011). English Heritage promotes a five-step assessment process of which the first three steps are relevant to the present study. This assessment therefore proceeded in the following three stages:

- Identification of historic assets likely to be affected by the development;
- Analysis of the contribution made by setting to the heritage significance of these selected assets;
- Assessment of the effect of the development on the heritage significance of these assets based on an understanding of the visual change in their settings.

7.7.21 All designated assets included in the baseline study were considered for the potential for impact on their heritage significance. A sub-set of assets with potential to be affected were then taken forward into a detailed assessment and all other assets excluded from further assessment. This filtering process was based on asset type and the predicted level of visual change for individual assets in each type; selections were checked in the field and then justified in this assessment.

7.7.22 The potential for undesignated assets to be affected by change in their setting was also considered as part of the assessment. In this case it was concluded that there was no potential for EIA significant adverse effects and all undesignated assets were excluded from the detailed assessment.

7.7.23 The heritage significance of assets selected for assessment was then described and the contribution made by setting to that heritage significance was analysed.

Analysis was based on written descriptions of the assets and site visits, focussing on those aspects of heritage significance that were likely to be affected by the development.

7.7.24 The visual relationship between each asset and the proposed wind turbines was studied in the field, informed by visibility mapping and photomontages. These include mapped ZTV for turbine blade tips and at hub-height covering the entire study area (Figures 4.11 and 4.12). There were photomontages from selected viewpoints (Figures 4.13 to 4.36). Designated historic assets have been plotted on the blade-tip ZTV in Figures 7.5 and 7.6 to assist with the assessment.

7.7.25 The effect of the visual change on the heritage significance of the asset was then assessed. The assessment employed standard criteria for impact magnitude, asset importance and EIA significance of effect; as described in Section 7.4

Selection of Assets that Merit Detailed Assessment

Scheduled Monuments

7.7.26 The majority of Scheduled Monuments are located on the higher ridges and plateau areas that occupy most of the land within the 10km study area. This reflects the elevated and open sites apparently favoured by the builders of the many prehistoric ritual and funerary monuments. As a result, most Scheduled Monuments within the study area will be intervisible with the operational wind farm according to the prediction of the bare-ground blade-tip ZTV (Figures 7.5 and 7.6). Only 15 out of the 50 assets are predicted to experience little or no intervisibility (defined here as no more than 3 blade-tips visible). These are:

- Ffridd Braich Llywd Bronze Age Ritual Complex (ME217)
- Caer Noddfa (MG052)
- Maes Llymystyn Camp (MG075)
- Cae'r-Mynach Round Cairn (MG128)
- Maes Dyfnant Round Cairn (MG133)
- Mynydd Dyfnant Stone Alignment (MG134)
- Cross-incised Stone (now in Carno Church) (MG146)
- Y Capel Stone Circle (MG179)
- Ring Cairn 540m SW of Llyn y Tarw (MG180)
- Root Store at Bon y Maen (MG218)
- Gelli Gethin Round Cairn (MG272)
- Cae'r Lloi Round Barrow (MG273)
- Mynydd lluest Fach barrow cemetery (MG313)
- Mynydd Waun Fawr Roman Road (MG320)
- Craig y Llyn Mawr platform ciarn and standing stone (MG328)

7.7.27 The lack of visual change for the cross-incised stone within the church at Carno is self-explanatory. The 14 other assets are all located off hill tops in locations that are therefore screened from the wind farm by intervening ridges. In addition to the lack of visual change at the asset itself, it is considered that none of these assets is appreciated from remote viewpoints that would themselves be affected by visibility of the wind farm; all are experienced only at close-range. It is therefore concluded that none of these 15 Scheduled Monuments merits detailed assessment.

7.7.28 For most of the other 35 Scheduled Monuments there would be an open view of all or most of the Llanbrynmair turbines viewed from adjacent areas of high ground across intervening valleys. This type of visual change is illustrated by VP1 (Glyndwr's Way, Brynaere, Figure 4.22), 3.5km from the nearest turbine, and VP14 (Bryn y Gadair, Figure 4.26), 9.5km from the nearest turbine, at the outer edge of the 10km study area. The only Scheduled Monuments in valley-floor locations predicted to experience some visual change are the two earthwork castles in Llanbrynmair (MG065) and Llanerfyl (MG072)

7.7.29 The extent to which this predicted visual change would affect the significance of these 35 Scheduled Monuments depends on contribution that setting makes to the significance of these particular assets. They can be divided into six asset types for the purpose of discussion:

- Prehistoric funerary cairns (19)
- Prehistoric ritual sites (6)
- Prehistoric hillforts (4)
- Prehistoric houses (3)
- Medieval earthwork castles (2)
- Medieval pillow mounds (1)

7.7.30 Prehistoric funerary cairns (or barrows) are the most common asset type and sites include examples of a range of morphologies, predominantly round cairns but also examples of ring and platform cairns. All are broadly contemporary, Bronze Age in date, and are widely encountered in upland parts of Wales. Typically they occur singly or in groups on local high-points, sometimes occupying prominent ridge lines or hillcrests. As a result, most command long-range and often panoramic views out and it is considered that this was an important factor in site selection by the builders of the cairns. In some cases it is possible to see distinctive high hills in these views which may have held particular significance in prehistoric society. This is hard to demonstrate as such views tend to be readily obtained from any open hilltop but in the present study area the relevance of views west towards Cader Idris has been proposed for cairns that possess this view.

7.7.31 The importance of views in, towards the cairns, is harder to judge because most sites are no longer readily seen from a distance. However it is apparent that most of the cairns could never have been seen from lower ground because they were located back from the valley crests on the flatter tops to the hills. This would suggest that views of this type were not valued. Intervisibility between adjacent cairns is encountered and it may be assumed that cairns were more visible when first built. It is impossible to confirm whether this was an important consideration to the builders of these monuments or simply an accident of demand for the limited supply of suitable sites for the cairns.

7.7.32 Given this analysis, the setting of these cairns makes a positive contribution to their significance in a variety of ways. Appreciation of their place in the landscape is the key point: open hilltop locations where the cairn in the focal point in its local landscape. Views are also relevant: extensive open long-range views out from the cairn and views toward the cairn, but generally from less than 1km. In some cases, intervisibility between cairns can be appreciated but again, over relatively short distances, and usually involving adjacent cairns on the same hill.

7.7.33 The presence of wind turbines will not physically block views from cairns due to the high 'visual permeability' of wind farms but a large number of turbines at close range could be a very distracting feature in the view, diminishing the sense of openness. Close proximity of turbines to a cairn, sharing the same hilltop, could also challenge the much smaller cairn for visual dominance in its local landscape, the cairn no longer being the focal point. It is considered that these types of effect

have the potential to affect the significance of a cairn at relatively close range and are only likely to occur within 2km of the wind farm. The effect is also likely to be greater if the wind farm and cairn share the same hill top and are therefore experienced in the same landscape feature.

7.7.34 There are only three cairns close enough to the proposed wind farm for these potentially adverse effects to arise. These are the Ffridd Cwm y Ffynnon round barrow (MG314), 1km to the west, Pencad Cymwu Cairn (MG164), 2.5km to the north-east and Boncyn y Llwyn Round Cairn (MG268), 2km to the north. All other cairns predicted to experience visual change would be at least 4km from the wind farm and it is considered that their significance would not be materially affected by the operation of the proposed wind farm.

7.7.35 The Ffridd Cwm y Ffynnon round barrow (MG314) would be located on a low ridge, part of the same upland area occupied by the wind farm with all 30 turbines in view and only 1km away from the closest. This assets merits detailed assessment.

7.7.36 The Pencad Cymwu Cairn (MG164) is located on a north facing spur of Pen Coed overlooking the valley of the Afon Banwy. The ZTV predicts it would be located on the edge of an area of turbine visibility with blade tips just appearing over the shoulder of Pen Coed. Given this limited level of visual change, not affecting the open views to the north, and the clear topographic separation provided by Pen Coed, it is considered that the significance of this cairn will not be materially affected. It does not merit detailed assessment.

7.7.37 The Boncyn y Llwyn Round Cairn (MG268) is located on a low hill above the Afon Banwy, and physically separated from the proposed wind farm by a ridge that rises 80m above the cairn, 1km to the south. The ZTV predicts visibility of 4-8 blade tips in views south from the cairn but this is based on a bare-ground model and the ridge above the cairn is forested. This suggests that there would be very limited turbine blade tip visibility and this would not affect the open views to the north. It is considered that the significance of this cairn will not be materially affected. It does not merit detailed assessment.

7.7.38 Turning to the prehistoric ritual sites, these comprise small groups of upright, set stones, arranged either in circles, short rows or less regular settings. The six examples are:

- Ceffig Stone Circle (MG066)
- Lled Croen-yr-Ych Stone Circle (MG068)
- Lluest Uchaf Cairns and Stone Row (MG276)
- Carreg Llwyd Ritual Complex (MG291)
- Bryn yr Aran Stone Setting (MG296)
- Esgair Draenllwyn Stone Setting (MG297)

7.7.39 They are termed ‘ritual’ sites because they do not have any obvious other function associated for example with habitation, subsistence or burial. The nature of the ritual is almost entirely obscure, but an association with celestial observations is widely accepted; this may be solar, lunar or stellar observation. Orientation of the stone rows is an obvious focus for speculation on the meaning of the chosen direction. The two stone rows within the ZTV for the proposed wind farm are both aligned north to south (Lluest Udraf, MG276 and Careg Lwyd, MG291) but there is no obvious explanation for this orientation in terms either of celestial events or local landmarks as foresights.

7.7.40 The contribution that setting makes to the significance of ritual sites of this type is closely related to this analysis and speculation regarding function. There is a recognition of a general potential for links to their surroundings with open views to the local horizon and the sky. This relationship can be very specific and important

if there is clear evidence for the relevance of a particular axial view or alignment with either celestial events, other prehistoric monuments or natural landmarks. In the present cases, no such relationships have been identified. As a result it is the general open hill-top setting that is valued.

7.7.41 All six of these assets are located in a relatively restricted area to the south and southeast of the proposed wind farm. The closest assets to the wind farm would be the two stone circles (MG066 and MG068), located only 200m apart and 4km to the south of the closest turbine. There is no reason to predict that the operation of the wind farm will adversely affect the significance of these two stone circles which would continue to be appreciated on an open hilltop, albeit with a wind farm visible 4km away.

7.7.42 The other four assets are at least 7km from the proposed wind farm and would not be affected by the very limited level of visual change at this range. It may be noted that three of these assets (MG291, 296 and 297) are located either within or immediately adjacent to the operational Carno wind farm.

7.7.43 It is concluded that none of the six prehistoric ritual assets merit detailed assessment. Their significance will not be affected by the operation of the proposed wind farm.

7.7.44 There are four examples of hillforts, presumably of Iron Age date, that lie within the ZTV for the proposed wind farm:

- Gardden Camp and barrows (MG070)
- Gogerddan Camp (MG074)
- Moel Ddolwen (MG149)
- Castell Carno (MG205)

7.7.45 Hillforts are hilltop enclosures, surrounded by single or multiple ramparts and ditches that are believed to have functioned as the power centres for local rulers in the Iron Age. Their apparently defensive locations on hilltops and strongly defended perimeters has suggested a primarily defensive purpose but these features may be as much about display of power and wealth as fear of attack.

7.7.46 As a result, hillforts are understood as sites that dominate their local landscapes, overlooking a territory that they control and creating an imposing central place in that territory for people to literally look up to. Their setting therefore contributes a clear topographic context that allows an appreciation of how the hillfort functioned, militarily and socially as the dominant place in the local landscape.

7.7.47 The presence of a wind farm would not affect the fundamental legibility of the topography but, if it is close-enough to effectively enter the territory of the hillfort, it could visually dominate the hillfort, thereby diminishing the status of the fort as the central place in its territory. Of the four hillforts under consideration, only one (Moel Ddolwen, MG149) is close enough to the proposed wind farm to be potentially affected in this manner. It is only 2km from the closest turbine and merits detailed assessment.

7.7.48 Gardeen and Gogerddan Camps (MG070 and MG074) both overlook the valley of the Afon Banwy, 4km and 6km from the proposed wind farm. Castell Carno is over 7km to the south, overlooking the valley of the Afon Carno. Operation of the proposed wind farm would not affect the legibility of these hillforts as power centres within their local territory.

7.7.49 The three examples of prehistoric houses (hut circles and round huts, MG325, 338 and 339) are all located over 8km to the southeast of the proposed wind farm. Prehistoric roundhouses, the dwelling places of subsistence farmers, are understood in a local setting that illustrates to the practicalities day to day life including of shelter, water supply and workable agricultural land. There is no reason to predict

that visibility of wind turbines at a range of 8km will affect this setting in a way that diminishes the significance of these three assets. They do not merit detailed assessment.

7.7.50 Turning to the three medieval assets, the pillow mounds at Llanfihangel (MG250) are evidence for a former rabbit warren, the mounds used to create well-drained burrows for the rabbits. This asset would be almost 10km from the proposed wind farm and its significance would be entirely unrelated to the long-distance views to wind turbines. It does not merit detailed assessment.

7.7.51 The two medieval earthwork castles both comprise a motte and bailey: an earth mound (the motte) with an attached defended enclosure (the bailey). Both probably date from the 12th century although only Domen Fawr in Llanbrynmair (MG065) is recorded in contemporary documents. Both this site and the second castle at Llanerfyl (Llysun Castle, MG072) are military strongholds for local lords and their setting contributes to their significance at two scales. At the very local scale, both castles are built on defensive sites making use of local topography and rivers as barriers. On a larger scale, the castles can be seen as occupying strategic positions on important routes through mid-Wales allowing their owners to observe and control the movement of people and goods.

7.7.52 Visibility of wind turbines at a range of over 3km from Domen Fawr and over 6km from Llysun would not adversely affect the legibility of either the local topographic setting or the wider strategic location of these two castles. The significance of these assets would not be affected by operation of the wind farm and they do not merit detailed assessment.

7.7.53 To summarise: two Scheduled Monuments are considered to merit detailed assessment; these are the Moel Ddolwen Hillfort (MG149) and the Ffridd Cwm y Ffynnon round barrow (MG314). The significance of all other Scheduled Monuments, considered as part of this assessment, would not be materially affected by the operation of the wind farm.

Listed Buildings

7.7.54 The distribution of Listed Buildings, in contrast to that just described for Scheduled Monuments, is concentrated in the valleys where most settlement is located. As a result the majority of assets are in areas where little or no visual change is predicted (Blade-tip ZTV, Figures 7.5 and 7.6). The local topography comprises a dissected plateau with relatively level areas of upland separated by deep, narrow valleys. The proposed wind farm is located on a plateau and because turbines are not placed on the edge of the plateau, the immediately adjacent valleys are extensively screened. It is therefore logical to first identify the few assets where more than minimal visual change is predicted.

7.7.55 Using the blade-tip ZTV (Figures 7.5 and 7.6), which is based on a worst-case bare-ground model, the following 11 Listed Buildings are predicted to experience visual change of more than 1-3 blade tips:

- Church of St Mary, Llan (7605)
- Abercannon (17942) Farmhouse
- Belan Hall (17943) Shooting Lodge
- Bryn-Coch Uchaf (17946) Farmhouse
- Diosg (18129) Farmhouse
- Milestone (18130)
- Yr Hen Gapel (18131) Chapel
- Sundial in churchyard (18133)

- Hafod y Llan (18134) House
- Cann Office Hotel (80781) Inn
- Pont-y-clochydd (80801) Bridge

7.7.56 The 37 assets missing from this list include most of the Grade II Listed Buildings in Banwy and Llanbrynmair and all four Grade II* Listed Buildings in the extended study area (5-10km from the proposed wind farm). For these 37 assets, it is considered that the limited degree of visual change at the asset (no turbine visible at hub height and no more than 3 blade tips) is not sufficient to lead to adverse effects on significance. An example of this level of visual change are provided by the photomontage from VP8 in Llanbrynmair village (Figure 4.20), 2.8km from the nearest turbine.

7.7.57 This assessment reflects, in part, a view that none of these assets are highly sensitive to visual change in their wider landscape settings and therefore the minimal visual change is not relevant. It is also considered that none of these assets is appreciated from remote viewpoints that would themselves be affected by visibility of the wind farm; all are experienced at close-range.

7.7.58 It may be noted that two of the three medieval parish churches are included among the 37 assets: St Tydecho, Foel (80796) and St Cadfan, Llangadfan (7632). In some areas, medieval churches can be prominent, landmark buildings that might be considered highly sensitive to visual competition. Some further comment is therefore required on the decision to exclude these two particular examples from detailed assessment. Both are buildings of modest scale, located within small churchyards that are well-screened by trees. They are experienced only at close-range and longer-range views make no contribution to their significance. In both cases, screening by trees would filter views towards the wind farm and visual change in the immediate vicinity of the churches would be very limited. These are not sensitive 'landmark' churches and do not merit further consideration.

7.7.59 It is therefore concluded that none of these 37 Listed Buildings merits detailed assessment. The remaining 11 assets can now be considered individually.

7.7.60 There are three Listed Buildings in Llan. The Church of St Mary (7605) is located in an open position at the top of a low knoll within the village making it the focal point of the village and a landmark in the surrounding area. The wind farm would be visible in views to the northeast and there is potential for the significance of the church to be affected by the operation of the wind farm. It is considered to merit detailed assessment.

7.7.61 Hafod y Llan (18134) is the old rectory and is located immediately to the north-west of the church. The positive contribution that setting makes to this asset is limited to its local surroundings and its relationship to the adjacent church; it is unrelated to the wind farm site or views to the northeast. The significance of this asset would not be affected by operation of the wind farm and does not merit detailed assessment.

7.7.62 The sundial (18133) is in the churchyard close to the church; views towards the wind farm would be available but the contribution setting makes to this asset is considered to be limited to the churchyard in which it is located. The significance of this asset would not be affected by operation of the wind farm and does not merit detailed assessment.

7.7.63 The three farmhouses can be dealt with in a group. All three are examples of local vernacular architecture, illustrating the evolution of farmhouse architecture from the 17th to the 19th centuries. Bryn-Coch Uchaf (17946) is a rare survival of a 17th century timber-framed building, recently restored and extended. Abercannon (17942) is a traditional longhouse style stone building probably of 18th century date; Diosg (18129) is a more substantial late 18th century house with a wing added in 1830.

7.7.64 The heritage significance of all three farmhouses resides primarily in their fabric, the reason for their listing. Setting makes a positive contribution to the significance of these farmhouses by providing an immediate setting of farm buildings (demolished at Bryn-Coch Uchaf) and a local farming landscape that relates closely to the origins, development and continued use of these houses. This is not an unchanging setting: farm buildings are modernised and new sheds built, and the farming landscape has evolved since the 17/18th centuries as farming practice has changed. The presence of wind turbines in the wider rural landscape is not considered to adversely affect the significance of these buildings; aesthetic considerations around wind turbines are not considered to be relevant for this type of building. Wind turbines are part of the evolving upland farming landscape, they do not displace farming, and the farmhouses would continue to be experienced and appreciated in this evolving landscape.

7.7.65 The significance of these three assets would not be affected by operation of the wind farm and they do not merit detailed assessment.

7.7.66 Belan Hall (17943) is a late-19th century shooting lodge, listed on account of its unusual architectural style. It would be located 4km to the east of the wind farm and, although the bare-ground ZTV (Figure 7.5) predicts turbine visibility, the house is surrounded by mature woodland except to the southeast. The architecture of the lodge can only be appreciated at close range and there would be no visual change in the vicinity of the lodge. The significance of this asset would not be affected by operation of the wind farm and does not merit detailed assessment.

7.7.67 The Milestone (18130) is located on the A470 at Dolfach. In common with all milestones, it is appreciated as part of the roadside furniture, and it is the road itself and views along it that are relevant to its setting. The presence of wind turbines 2km to the north would not affect its significance and it does not merit detailed assessment.

7.7.68 Yr Hen Gapel (18131) is located close to the milestone, just discussed, but to the north of the A470 and railway on the valley side. The bare-ground ZTV predicts 4-8 blade-tips will be visible around the chapel (Figure 7.5) but a field visit and a photomontage from a point 250m to the south on the A470 (Dolfach VP07, Figure 4.19) revealed that these bare-ground predictions would overstate the actual level of visual change. The chapel can only be appreciated at close range, after crossing the railway bridge from the A470. From here, close under the hill, views to the north upslope to the wind farm would be screened by trees and the rising ground. Turbine visibility in combination with the chapel, if any, would be very limited and insufficient to affect its significance. This asset does not merit detailed assessment.

7.7.69 The Cann Office Hotel (80781) is an 18th century coaching inn in Llangadfan, built to serve the new turnpike road, now the A456. The bare-ground ZTV predicts 4-8 blade tips would be visible at a range of almost 5km (Figure 7.5). The Cann Office Hotel is appreciated as a roadside inn in its immediate village context in Llangadfan. Longer range views to or from the building do not contribute to its significance and the presence of the wind farm would not affect its significance. This asset does not merit detailed assessment.

7.7.70 The Pont-y-clochydd (80801) is a medieval stone bridge over a tributary of the Afan Banwy in Foel. The contribution that setting makes to its significance is limited to an understanding of the immediate surroundings of the bridge: local topography, the river and the historic route finding a suitable crossing point. The visibility of turbine blades 4km to the southwest would not affect the legibility of this setting or an appreciation of the bridge as an historic structure. The significance of this asset would not be affected by operation of the wind farm and does not merit detailed assessment.

7.7.71 To summarise: one Listed Building is considered to merit detailed assessment; this is the Church of St Mary, Llan (7605, Grade II*). The significance of all other Listed

Buildings, considered as part of this assessment, would not be materially affected by the operation of the wind farm.

Conservation Areas

7.7.72 There are two Conservation Areas within the study area, closely adjacent in the villages of Llan and Bont Dolgadfan, both 5km southwest of the proposed wind farm. Operation of the wind farm would have the potential to affect the significance of these Conservation Areas by changing views out from the designated area, affecting its character.

7.7.73 Llan, as noted above in the discussion of the Church of St Mary, occupies a prominent position on a low hill within the valley of the Afon Twymyn. The Conservation Area covers the church, churchyard and buildings immediately surrounding it. This area offers views in all directions, including to the northeast and there would be potential for the presence of the wind farm to affect the character of the Conservation Area. This asset merits detailed assessment.

7.7.74 In contrast, Bont Dolgadfan Conservation Area is a small area centred on the bridge over the Afon Twymyn (the Bont Dolgadfan) and has no longer-range views in or out of the designated area. The presence of the wind farm 5km to the northeast would not affect its significance and no further assessment is merited.

7.7.75 To summarise: one Conservation Area is considered to merit detailed assessment, this is Llan. The significance of the one other Conservation Area, considered as part of this assessment, would not be affected by the operation of the wind farm.

Assessment of Individual Assets

7.7.76 Four designated historic assets have been identified where there was considered to be potential for the operation of the wind farm to lead to visual change that might adversely affect the significance of the assets.

Moel Ddolwen Hillfort (Scheduled Monument, MG149)

7.7.77 The rampart and ditch of Moel Ddolwen Hillfort enclose an area measuring c.120x50m on the top of Moel Ddolwen, a small but prominent hill overlooking the valley of the Afon Gan in the community of Llanerfyl.

7.7.78 The rampart and ditch are considerably reduced by ploughing and only survive as prominent features on the north side of the hill but an entrance at the west end can still be recognised. There are no surface features in the interior of the hillfort which has been entirely smoothed by ploughing.

7.7.79 The significance of the hillfort resides primarily in the evidential value of the archaeological deposits that are believed to survive below the present ground surface. The setting of the hillfort adds historical value to this significance by illustrating the way in which the hillfort functioned in the past as an important local power centre. As noted above, hillforts are understood as sites that dominate their local landscapes, overlooking a territory that they control and creating an imposing central place in that territory for people to literally look up to. Their setting therefore contributes a clear topographic context that allows an appreciation of how the hillfort functioned, militarily and socially as the dominant place in the local landscape

7.7.80 Moel Ddolwen Hillfort fits well into this model. It is sited on the top of a small but distinct hill, overlooking the valley of the Afon Gan to the south, from which it rises steeply over 100m. There is higher ground close to the north and the territory that it appears to dominate comprises the lower ground along the Afon Gan, extending for a few kilometres up and downstream to the west and east. This is readily appreciated by anyone standing on the hill top and these open views out from the hillfort contribute to its significance.

7.7.81 Moel Ddolwen is a distinctive hill when viewed from the Talerddig to Llanerfyl road, particularly from around Dolwen in the west and Tynewydd Gosen in the east. However, the hillfort itself is not visible as the surviving rampart is on the screened northern side of the hill. This reduces the value of these views towards the hillfort but a person who knows the fort is there (the site is recorded on OS maps) can still understand the prominent location.

7.7.82 The wind farm would be visible to the west of the hillfort with the closest turbine (R43) 2km away. Viewed from the western end of the hillfort, the entire wind farm will be visible on the horizon but across intervening lower ground and the ridge of Moel Ffridd-ddolwen. This topographic separation would allow a visitor to continue to appreciate the hillfort as the dominant place in the local landscape with the wind farm dominating an adjacent but separate area. Two photomontages from nearby viewpoints illustrate this relationship (VP6, Figure 4.18 and VP24, Figure 4.36)

7.7.83 Viewed from the east, around Tynewydd Gosen, Moel Ddolwen would appear on the skyline against a backdrop of turbine blades, which would challenge the visual dominance of the hill and distract any viewer that was aware of the existence of the hillfort. These in-combination views would persist as far west as Hafod at which point there would be considerable visual separation between the hill and wind farm. Approaching Moel Ddolwen from the west, for example along Glyndwr's Way, the wind farm would always be behind and the hill would remain dominant.

7.7.84 It is concluded that the presence of the wind farm would diminish the value of views towards the hillfort from the east although the value of views from the west and views out from the hillfort would experience no loss of value. Overall, the setting of the hillfort would remain legible to an informed visitor. This is considered to be an adverse effect of Slight Magnitude on the significance of the hillfort; it would persist for the operational life of the wind farm and then be entirely reversed on decommissioning. Given the High Importance of this Scheduled Monument, this is judged to be an effect of Minor Significance.

Ffridd Cwm y Ffynnon round barrow (Scheduled Monument, MG314)

7.7.85 This round barrow is the only Scheduled Monument located within the wind farm site. The barrow is located on a local high point on the ridge that forms the western edge of the plateau where the wind farm would be sited. The ridge runs north-south; slopes to the east on to the plateau are gentle but to the west the land falls 250m, steeply into the valley of the Afon Rhiwsaeson.

7.7.86 The barrow, like many other similar funerary cairns, is not located on the valley crest itself. As a result it probably would not have been seen on the skyline from the valley below and views out from the cairn tend to emphasise the more distant valley to the south-west and the surrounding hilltops.

7.7.87 The designation of the barrow as a Scheduled Monument reflects its evidential value as a well-preserved Bronze Age funerary cairn, although the presence of a centrally placed hollow suggests any burial may have been disturbed by excavation. This significance is enhanced by its setting which adds historical value to the asset, placing it in a landscape where at least some aspects of its original setting can be appreciated and analysed. The open hill-top location is typical of funerary cairns and it still commands 360º views, only very slightly restricted by forestry to the north-east. This appears to be a barrow where general 'views out' are relevant to its siting; there is no evidence for visual links to other contemporary cairns or barrows, nor is there any viewpoint from which the barrow can be appreciated at longer range. The presence of the barrow can only be appreciated within 200m. The ability to explore, if not entirely understand these visual relationships, adds to our knowledge of the builders of the barrow and therefore the significance of the asset.

7.7.88 The wind farm would be located to the east and north-east of the barrow with the closest turbine (R4) 1km to the south-east. None of the turbines would occupy the actual ridge of which the barrow is located with R4 and R31 on lower ground to the south-east and R7 on the adjacent ridge to the east. Turbines would be visible in 110º of the view from the barrow from north-east round to south-east; this is the area occupied by the higher plateau land. Views north and west out to adjacent hills over the valley of the Afan Rhiwsaeson would not be changed.

7.7.89 Relevant views towards the barrow will be less affected than views out. Viewpoints to the west of the barrow where turbines would appear in the background are limited because the ground falls away, losing site of the barrow and wind turbines. The barrow is more likely to be viewed from the south or east from the public bridleway and from here the turbines would be behind the viewer.

7.7.90 The presence of the wind farm would change views out from the barrow but, at a range of at least 1km, turbines would not obstruct views or diminish the overall sense of openness that can currently be experienced at the barrow. The barrow will remain isolated on its local ridge of higher ground and it will remain possible to examine and interpret the possible reasons behind the siting of this funerary cairn.

7.7.91 It is concluded that the operation of the wind farm would not adversely affect the significance of this Scheduled Monument.

Church of St Mary, Llan (Listed Building Grade II, 7605)*

7.7.92 The Church of St Mary in the village of Llan is located in a prominent position at the centre of the village, occupying the top of a low knoll and isolated from other buildings in the village by its graveyard. The church is believed to have been founded in the 6th century but the present building is of 14/15th century date, enlarged in the 17th century by the addition of a large north transept and low bell tower.

7.7.93 The status as one of the few Grade II* listed Buildings in the area reflects the evidential value of its medieval fabric, largely unaffected by recent restoration or rebuilding. The setting of the church adds aesthetic value to its significance. The surrounding graveyard creates the perfect setting for the church where it can be appreciated as an attractive and rare example of medieval architecture in the area. The collection of headstones in the graveyard as well as the Grade II Listed sundial all add to the interest in the setting and its aesthetic value.

7.7.94 The relative elevation and isolation of the church makes it a local landmark, signalling the traditional focus of the parish prior to the development of Llanbrynmair as a village on the Newtown to Machynlleth turnpike in the 19th century. The church is visible from a variety of viewpoints, roads and footpaths, generally within 1km of the village. These views contribute historical as well as aesthetic value to the significance of the church.

7.7.95 The wind farm would be visible to the north-east of the church at a range of at least 5km. This visual relationship is illustrated by a photomontage from VP11 (Figure 4.23) which is located down a road level and therefore more screened than views would be from the graveyard to the north of the church. The wind farm would also be seen in combination with the church in views from footpaths to the south-west of the church.

7.7.96 Views of turbines from within the graveyard, close to the church would add a discordant element to what are currently attractive views, slightly degrading the aesthetic value of the church. Similarly, the presence of turbines in views of the church would slightly degrade its status as a modest but important visual focal point in the local landscape, again diminishing its aesthetic values.

7.7.97 It is concluded that the presence of the wind farm in views of and from the church at a range of 5km would adversely affect the significance of the church, an effect of Slight Magnitude. This adverse effect would persist for the operational life of the

wind farm and then be entirely reversed on decommissioning. Given the High Importance of this asset, this is considered to be an effect of Minor Significance.

Llan Conservation Area

7.7.98 The Conservation Area in Llan extends to cover the church, its graveyard and the houses that immediately surround it. The character of the area is dominated by the church: it provides the focal point for the Conservation Area with views from most directions looking inwards and up to the church on the high point in its graveyard. The graveyard also provides the ideal viewpoint to look out over the houses and out into the surrounding countryside. This elevated viewpoint makes outward facing views an important component of the character of the Conservation Area.

7.7.99 Given the role that the church plays in the character of the Conservation Area, the views and visual relationships with the wider landscape that contribute to the significance of the church also apply to the Conservation Area. However, the Conservation Area also includes areas on lower ground where views in and out are much less relevant than they are for the church.

7.7.100 The wind farm would be visible from the Conservation Area, particularly from the more elevated viewpoints at its centre around the church and the northern edge of the Conservation Area; again VP11 (Figure 4.23) is relevant, showing the southern end of the wind farm visible at a range of 5km. However, there will be no visual change in other parts of the Conservation Area and views of the church from outside the graveyard, for example, would be unaffected.

7.7.101 It is concluded that the presence of the wind farm would adversely affect the significance of the Conservation Area, an effect of Slight Magnitude. This adverse effect would persist for the operational life of the wind farm and then be entirely reversed on decommissioning. Given the Medium Importance of this asset, this is considered to be an effect of Minor Significance.

Table 7.12 Potential effects of wind farm operation on historic assets due to visual change in setting.

Cadw ref. no.	Name	Importance	Magnitude of effect	Significance of effect
MG149	Moel Ddolwen hillfort	High	Slight	Minor
MG314	Ffridd Cwm y Ffynnon round barrow	High	None	-
7605	Church of St Mary, Llan	High	Slight	Minor
-	Llan Conservation Area	Medium	Slight	Minor

ASIDOHL

7.7.102 In response to a consultation on the proposed Llanbrynmair Wind farm Development, the archaeological advisors to Powys County Council recommended that an Assessment of the Significance of the Impact of Development on the Historic Landscape (ASIDOHL) be undertaken to assess the potential effects of the Proposal upon the historic landscape of the development area and its surroundings.

7.7.103 Although the area is not included within the Register of Landscapes of Special Historic Interest in Wales, landscape characterisation of TAN 8 areas has been undertaken in order to enable assessment of the effects of such developments upon the historic landscape (CPAT 2006).

7.7.104 Full details of this ASIDOHL are presented in Appendix 7.2. The assessment concluded that the proposed wind farm development would have:

- A slight direct physical impact on the historic landscape;
- Very slight (if any) indirect physical impact on the historic landscape; and,
- Moderate indirect (non-physical) visual impact on the historic landscape.

7.7.105 The assessment also concluded that the relative importance of the affected Historic Landscape Character Areas (HLCAs) varies from Low to High. The overall impact of the development is rated as Moderate.

7.7.106 It should be noted that the ASIDOHL was undertaken in 2010 and assessed the potential effect of the original 43 turbine application on the historic landscape. The assessment has not been repeated for the current 30 turbine layout because it is considered that the changes in turbine numbers and distribution do not materially affect the overall conclusions of the ASIDOHL, reported above.

Wind Farm Decommissioning

7.7.107 When the wind farm is decommissioned, it is expected that all surface elements of the wind farm development would be removed and the ground reinstated. This would include the crane pads and hardstandings, with the wind turbine foundations broken back to below ground level before the ground is revegetated and reinstated. It is generally accepted that removal of cables and electrical infrastructure is more damaging than leaving them in situ so this is the current preferred option. Site access tracks could remain in situ if required by the landowners or be reinstated. The control building and external equipment would be removed and the land reinstated.

7.7.108 All of this work would take place in parts of the site already disturbed during construction. A carefully controlled programme of decommissioning and reinstatement should not lead to any further adverse impacts on those historic assets already affected by the construction works.

7.7.109 There is potential for further accidental damage because archaeological deposits are known to exist close to elements of the site infrastructure. Any adverse effect is unlikely to exceed Negligible Magnitude and this would not be significant.

Offsite Highway Works

7.7.110 The construction phase of the offsite highway works has the potential to affect known historic assets and other, currently unrecorded sub-surface archaeological features. Details of the location and nature of the proposed works are most-readily understood in a series of detailed drawings presented in Appendix 10.1 A: Transport Drawings. These drawings are divided into three Sections (1-3) numbered from Llanerfyl to Talerddig with an index plan at the start of the appendix showing the location of the detailed drawings. Chainage is measured along the route starting at Llanerfyl.

7.7.111 There are numerous locations where there will be relatively minor works for the creation of overruns or passing places but for the purposes of assessment of potential effects on heritage assets during construction there are five principle locations where more substantial ground disturbance will occur. These are:

- Llanerfyl (Chainage 0-50 m, Section 1, Sheet 1 of 14). 100 m of new off-road track.
- Gosen Bridge (Chainage 4440-4540 m, Section 1, Sheet 8 of 14). Road widening and new section of bridge.
- Gosen Access Track (Chainage 4620-4970 m, Section 1, Sheet 9 of 14). 350 m of off-road track.

- Dolwen Isaf Bridge (Chainage 7330-7530 m, Section 1, Sheet 12 of 14). 170 m of off-road track.
- Neinthirion bypass (Chainage 8950-9550 m, Section 2). 900 m of off-road track

7.7.112 Careful design of the offsite highway works has ensured that no known historic asset would be directly affected during construction works, including the five areas specifically referenced above.

7.7.113 No works would take place close to any of the assets listed in Table 7.9 that are located immediately adjacent to the road (with the exception of the settlement of Llanerfyl, discussed below). It should be noted that the bridge noted as asset 65503 in this table is a now-removed footbridge and not the existing road bridge at Dolwen Isaf that would form part of the offsite highway works.

7.7.114 There remains potential for construction works to disturb currently unrecorded historic assets. In most areas, the highway works affect numerous small areas closely linked to the existing road and its verges. There is considered to be only a very low potential for the discovery of historic assets in these locations.

7.7.115 The potential for unrecorded assets is considered to be higher in two areas: the 900 m of new off-road track at Neinthirion and the 100 m of off-road track at the village of Llanerfyl.

7.7.116 At Neinthirion, the elevated potential solely reflects the relatively large area of land that would be disturbed by the works off the line of the existing road. In Llanerfyl, it reflects a combination of off-line working at the junction of the C20131 Talerddig Road with the A456 and proximity to the early medieval centre of Llanerfyl. Off-line road works would be to the east of the existing road junction which itself is at the eastern edge of the 19th century settlement. It is concluded that the potential for currently unrecorded features in both of these areas is low.

7.7.117 In addition to the potential for direct damage due to construction works, the offsite highway works could adversely affect historic assets through permanent change in their settings. Undesignated assets close to the proposed works are not considered to be of sufficient importance to experience significant adverse effects but there is some potential with the designated historic assets.

7.7.118 There are two locations where there would be more than negligible change in the immediate setting of a designated asset: at Llanerfyl and adjacent to Abercannon Farm (a Grade II Listed Building).

7.7.119 There is a cluster of Grade II Listed Buildings in Llanerfyl but only one house would be sufficiently close to the highway works to experience any change in its setting. This is Caer Ffynnon (17933), a former farmhouse and inn, now a private house, facing the existing T junction where the Talerddig road joins the A456. The cast iron railings around the front garden and garden gate for this house are separately listed (17934).

7.7.120 The existing setting of Caer Ffynnon includes buildings on the edge of the village, the main road and road junction (which is dominated by two mature Wellingtonias, one each side of the Talerddig road) and views beyond into farmland beyond the village.

7.7.121 The offsite highway works would not alter the junction in front of the house but, because Abnormal Indivisible Load (AIL) vehicles would not be able to pass between the Wellingtonias, a bypass road is needed to the east. This would allow traffic to turn off the A456 further to the east and re-join the existing Talerddig road just to the south of the trees.

7.7.122 Details of the proposed works are shown in Appendix 10.1 A: Transport Drawings, Drawing 60283248-P-041. The new junction would comprise 100 m of grass reinforcement track; this would be used for AIL vehicles during construction works and then retained but not normally used during the operation of the wind farm

unless an AIL vehicle was required (for example if a replacement turbine blade was required. Temporary fences along the track would be removed and wooden post and rail fences built at both ends of the track. The track would be allowed to grass-over, blending in with the adjacent pasture.

7.7.123 The new track would only be used by AIL vehicles and the existing Talerddig road junction would remain in use for all other traffic. The only visible change in the setting of Caer Ffynnon, after the end of the construction works, would be the replacement of two short sections of hedge by post and rail fences. This would not constitute an adverse change in its setting and the significance of this Listed Buildings would be unaffected.

7.7.124 The Grade II listed farmhouse of Abercannon (17942) would be located adjacent to the section of off-road track that bypasses Neinthirion (Appendix 10.1 A: Transport Drawings, Drawing 60283248-D-045). This road would pass 100m to the south of the farmhouse. Like the new section of track just described in Llanerfyl, this road would only be used by wind farm construction vehicles and other traffic would continue to use the public road at least 200m from the farm. It is not considered that the temporary use of this road by construction traffic would affect the significance of the farmhouse. This would be a grass reinforcement track and for the operational life of the wind farm it would be allowed to grass-over. The continued existence of the bypass road, and its occasional use by large vehicles accessing the wind farm would not materially affect the contribution that setting makes to the significance of this Listed Building.

7.8 Mitigation

Construction

7.8.1 Where the exact location, extent and character of a historic asset was known, the turbine and infrastructure layout for the wind farm has avoided foreseeable effects upon the majority of assets. This may be considered embedded, or primary, mitigation.

7.8.2 Not all assets can be avoided and the construction phase of the proposed development would lead to the disturbance of clearance cairns and an area of former peat cutting. It is also possible that other undetected archaeological features may be present within the construction footprint.

7.8.3 Mitigation of any adverse impact on these archaeological features (known or unknown) would be achieved through an appropriate programme of archaeological works which would offset the adverse effect.

7.8.4 A specification for a suitable programme of archaeological works would be prepared and submitted to Clwyd Powys Archaeological Trust (as archaeological advisors to Powys County Council) for approval prior to the commencement of construction works. This would make provision, prior to the commencement of construction works, for the protection of assets at risk from accidental damage by appropriate fencing. It would also make provision for the excavation and recording of any known feature of interest prior to the commencement of construction works in a manner proportionate to its importance. Finally, it would make provision for monitoring of groundworks and the excavation and recording of any features of archaeological interest that are revealed.

Operation

7.8.5 The assessment has shown that operation of the wind farm would adversely affect the heritage significance of three historic assets through visual change in their settings for the duration of the operational life. These visual effects would be fully

reversed when the wind farm is decommissioned and none of the effects would be significant in EIA terms.

7.8.6 In the context of wind farm development, harm to the significance of an asset due to change in its setting can generally only be mitigated through modifications to the design of a development. As a result, all of the mitigation achieved here is already embedded in the design of the development.

Decommissioning

7.8.7 Groundworks during decommissioning have the potential to damage archaeological features in previously undisturbed areas of land. The decommissioning phase should be designed so as to avoid further disturbance of known archaeological features encountered during construction works.

7.8.8 All site works should be carefully controlled to minimise the potential for accidental damage. A decommissioning management plan would be prepared in advance, in line with relevant legislation, guidance and policy at the time.

Offsite Highway Works

7.8.9 Careful design of the offsite highway works has ensured that no known historic asset will be affected by the works. However, it is possible that other undetected archaeological features may be present within the construction footprint.

7.8.10 Mitigation of any adverse impact on these archaeological features (if present) would be achieved through an appropriate programme of archaeological works which would offset the adverse effect.

7.8.11 A specification for a suitable programme of archaeological works would be prepared and submitted to Clwyd Powys Archaeological Trust (as archaeological advisors to Powys County Council) for approval prior to the commencement of construction works. This would make provision for monitoring of groundworks and the excavation and recording of any features of archaeological interest that are revealed.

7.9 Residual Effects

Construction

7.9.1 Successful implementation of an approved programme of archaeological works would fully mitigate the adverse effect of the construction works and, potentially, lead to an enhancement in our knowledge of the archaeology of this part of Powys. It is concluded that there would be no residual construction effects.

Operation

7.9.2 The effects on the setting of historic assets would occur for the duration of the operational life and would then be fully reversed on decommissioning. All mitigation measures are embedded in the design of the wind farm and therefore residual effects remain as summarised in Table 7.12.

Decommissioning

7.9.3 Careful management of the decommissioning process would ensure that there is no accidental adverse impact on the heritage resource of the application site. There would be no adverse impacts and therefore no residual effects.

Offsite Highway Works

7.9.4 Successful implementation of an approved programme of archaeological works would fully mitigate any adverse effect of the offsite highway works and, potentially, leading to an enhancement in our knowledge of the archaeology of this part of Powys. It is concluded that there would be no residual construction effects.

7.10 Cumulative Effects

Scope and Approach to the Assessment

7.10.1 The simultaneous operation of two or more wind farms within the setting of a historic asset has the potential to generate adverse cumulative effects on the contribution that setting makes to the significance of that asset.

7.10.2 In the present case, there is potential for cumulative effects to arise from the operation of the proposed Llanbrynmair wind farm in combination with a number of other wind farms with TAN8 SSA B and the area immediately surrounding it, including operational and consented developments and those still in the planning system.

7.10.3 This can only occur if a historic asset is predicted to be adversely affected by the operation of Llanbrynmair alone, that is to say the assessment is not concerned with the potential for cumulative effects resulting from the operation of two or more wind farms other than Llanbrynmair. It follows that only the three historic assets with predicted operational effects for Llanbrynmair alone (listed in Table 7.12) have been assessed for possible cumulative effects on their significance.

7.10.4 The scope of the cultural heritage cumulative assessment adopted here follows that defined for TAN 8 SSA B in the LVIA for Llanbrynmair (Chapter 4) and also used by the landscape consultant for RWE Npower Renewables with respect to its Carnedd Wen proposal.

7.10.5 All existing and proposed wind farms (for which planning applications have been submitted as of 1/6/13) within, or on the boundary of, SSA B (as defined in TAN 8, rather than the refined boundary) have been included in the assessment. In addition Carno III, although outside the SSA, has been included because it forms a continuation of the Carno cluster. The proposed Dyfnant Forest Wind farm has also been included because, although a planning application has not yet been submitted, the project is well developed.

7.10.6 Two cumulative scenarios have been assessed. Scenario A comprised Llanbrynmair in combination with all operational or consented wind farms. These are

- Carno I (Operational);
- Carno II (Operational);
- Cemmaes II (Operational);
- Mynydd Clogau (Operational); and
- Tirgwynt (Consented).

7.10.7 The location of these wind farms and a cumulative ZTV for them is shown in Figure 4.38b.

7.10.8 Scenario B comprised Llanbrynmair in combination with the operational and consented developments in Scenario A plus wind farms with applications submitted and Dyfnant Forest Wind farm (pre-application):

- Carno I (Operational);
- Carno II (Operational);

- Cemmaes II (Operational);
- Mynydd Clogau (Operational);
- Tirgwynt (Consented);
- Carnedd Wen (Application);
- Carno III (Application);
- Cemmaes III (Application);
- Esgair Cwmowen (Application);
- Mynydd Waun Fawr (Application); and
- Dyfnant Forest (Pre-application).

7.10.9 The location of these wind farms and proposed wind farms and a cumulative ZTV for them is shown in Figure 4.39b.

7.10.10 The three historic assets for which operational effects have been predicted for Llanbrynmair alone have each been assessed against both of the cumulative scenarios, using the methods and assessment criteria set out in Section 7.4 of this chapter.

7.10.11 The significance of each of these four assets and the contribution that setting makes to that significance remains the same as that already described in Section 7.7 of this Chapter. This assessment therefore addresses the predicted cumulative visual change for the two scenarios and the degree to which this would adversely affect the significance of the assets.

Assessment of Individual Assets

Moel Ddolwen Hillfort (Scheduled Monument, MG149)

7.10.12 The hillfort is located on the top of Moel Ddolwen, a small but prominent hill overlooking the valley of the Afon Gan in the community of Llanerfyl.

7.10.13 The significance of the hillfort resides primarily in the evidential value of the archaeological deposits that are believed to survive below the present ground surface. The setting of the hillfort adds historical value to this significance by illustrating the way in which the hillfort functioned in the past as an important local power centre.

7.10.14 There is higher ground close to the north of the hillfort and the territory that it appears to dominate comprises the lower ground along the Afon Gan, extending for a few kilometres up and downstream to the west and east. This is readily appreciated by anyone standing on the hill top and these open views out from the hillfort contribute to its significance.

7.10.15 Moel Ddolwen is a distinctive hill when viewed from the Talerddig to Llanerfyl road, particularly from around Dolwen in the west and Tynewydd Gosen in the east. However, the hillfort itself is not visible as the surviving rampart is on the screened northern side of the hill. This reduces the value of these views towards the hillfort but a person who knows the fort is there can still understand the prominent location.

Scenario A

7.10.16 The cumulative ZTV (Figure 4.38b) predicts that Llanbrynmair and two other wind farms would be visible from the hillfort. The other two wind farms are Carno I and II, already operational and visible at least 12km to the south-west of Moel Ddolwen (see Viewpoint 6, Figure 4.18). They are visible from the hill top but cannot be seen

in any of the views of the hillfort from the lower ground that surrounds the hill (demonstrated by the cumulative ZTV).

7.10.17 It is concluded that the presence of Carno I and II, at a range of over 12km, do not affect the significance of the hillfort and no cumulative effects would result from Scenario A.

Scenario B

7.10.18 The cumulative ZTV (Figure 4.39b) predicts that Llanbrynmair and either six or seven other wind farms would be visible from the hillfort. Carnedd Wen would be visible at least 3km to the west, occupying the same sector of the horizon as Llanbrynmair and appearing to be one wind farm. Mynydd Waun Fawr would be a similar distance to the south-east, across the valley of the Afon Gan, with all turbines visible on the ridge line. Dyfnant Forest would be partially visible behind Pen Coed, over 6km to the north. The three Carno schemes would appear as single cluster of turbines, at least 12km to the south-west of Moel Ddolwen.

7.10.19 It is considered that Dyfnant Forest and the three Carno schemes would be too far from the Moel Ddolwen and the level of visual change too low to affect the setting of the hillfort.

7.10.20 The visual relationship of the hillfort with Mynydd Waun Fawr and Carnedd Wen is similar to that of Llanbrynmair although the turbines would be slightly be further from the hillfort. Both would be visible on the horizon in views out from the hillfort but across intervening lower ground. This topographic separation would allow a visitor to continue to appreciate the hillfort as the dominant place in the local landscape with the wind farms dominating adjacent but separate areas.

7.10.21 The presence of Mynydd Waun Fawr would increase the number of viewpoints in which in-combination views of hillfort and turbines would be experienced, challenging the visual dominance of the hill and distracting any viewer that was aware of the existence of the hillfort. The affected views would be to the south-east from Glyndwr's Way. Carnedd Wen would largely be seen as part of Llanbrynmair and not increase the number of in-combination views over and above those already identified for Llanbrynmair alone.

7.10.22 It is concluded that the presence of Mynydd Waun Fawr and Carnedd Wen would increase the level of adverse effect but the in-combination effect of Scenario B would still result in an adverse effect of Slight Magnitude on the significance of the hillfort (i.e. not sufficient to score more highly than the effect of Llanbrynmair alone). This adverse effect would persist for the operational lives of the wind farms and then be entirely reversed on decommissioning. Given the High Importance of the Scheduled Monument, this is judged to be an effect of Minor Significance.

Church of St Mary, Llan (Listed Building Grade II*, 7605)

7.10.23 The Church of St Mary in the village of Llan is located in a prominent position at the centre of the village, occupying the top of a low knoll and isolated from other buildings in the village by its graveyard.

7.10.24 The status as one of the few Grade II* listed Buildings in the area reflects the evidential value of its medieval fabric, largely unaffected by recent restoration or rebuilding. The setting of the church adds aesthetic value to its significance. The surrounding graveyard creates the perfect setting for the church where it can be appreciated as an attractive and rare example of medieval architecture in the area. The collection of headstones in the graveyard as well as the Grade II Listed sundial all add to the interest in the setting and its aesthetic value.

7.10.25 The relative elevation and isolation of the church makes it a local landmark, signalling the traditional focus of the parish prior to the development of Llanbrynmair as a village on the Newtown to Machynlleth turnpike in the 19th

century. The church is visible from a variety of viewpoints, roads and footpaths, generally within 1km of the village. These views contribute historical as well as aesthetic value to the significance of the church.

Scenario A

7.10.26 The cumulative ZTV (Figure 38b) predicts that only Llanbrynmair Wind farm would be visible from Llan or any viewpoints around it in which the church might be appreciated. As a result no cumulative effects could occur.

Scenario B

7.10.27 The cumulative ZTV (figure 39b) predicts that Llanbrynmair and one to three other wind farms would be visible; however it is clear from site visits that only Carnedd Wen would be visible in addition to Llanbrynmair wind farm from Llan and its surroundings.

7.10.28 Carnedd Wen would appear as a western extension to the cluster of Llanbrynmair turbines on the skyline at least 6km north-east of Llan. Views of turbines from within the graveyard, close to the church would add a discordant element to what are currently attractive views, slightly degrading the aesthetic value of the church. Similarly, the presence of turbines in views of the church would slightly degrade its status as a modest but important visual focal point in the local landscape, again diminishing its aesthetic values.

7.10.29 It is concluded that the presence of Carnedd Wen would increase the level of adverse effect but the in-combination effect of Scenario B would still result in an adverse effect of Slight Magnitude on the significance of the church (i.e. not sufficient to score more highly than the effect of Llanbrynmair alone). This adverse effect would persist for the operational lives of the wind farms and then be entirely reversed on decommissioning. Given the High Importance of this asset, this is considered to be an effect of Minor Significance.

Llan Conservation Area

7.10.30 The Conservation Area in Llan extends to cover the church, its graveyard and the houses that immediately surround it. The character of the this area is dominated by the church: it provides the focal point for the Conservation Area with views from most directions looking inwards and up to the church on the high point in its graveyard. The graveyard also provides the ideal viewpoint to look out over the houses and out into the surrounding countryside. This elevated viewpoint makes outward facing views an important component of the character of the Conservation Area.

7.10.31 Given the role that the church plays in the character of the Conservation Area, the views and visual relationships with the wider landscape that contribute to the significance of the church also apply to the Conservation Area. However, the Conservation Area also includes areas on lower ground where views in and out are much less relevant than they are for the church.

Scenario A

7.10.32 The cumulative ZTV (Figure 38b) predicts that only Llanbrynmair Wind farm would be visible from Llan or any viewpoints around it in which the Conservation Area might be appreciated. As a result no cumulative effects could occur.

Scenario B

7.10.33 The cumulative ZTV (figure 39b) predicts that Llanbrynmair and one to three other wind farms would be visible; however it is clear from site visits that only Carnedd Wen would be visible in addition to Llanbrynmair wind farm from Llan and its surroundings.

7.10.34 Carnedd Wen would appear as a western extension to the cluster of Llanbrynmair turbines on the skyline at least 6km north-east of Llan. The wind farms would be visible from the Conservation Area, particularly from the more elevated viewpoints at its centre around the church and the northern edge of the Conservation Area. However, there would be no visual change in other parts of the Conservation Area and views of the church from outside the graveyard, for example, would be unaffected.

7.10.35 It is concluded that the presence of Carnedd Wen would increase the level of adverse effect but the in-combination effect of Scenario B would still result in an adverse effect of Slight Magnitude on the significance of the Conservation Area (i.e. not sufficient to score more highly than the effect of Llanbrynmair alone). This adverse effect would persist for the operational life of the wind farm and then be entirely reversed on decommissioning. Given the Medium Importance of this asset, this is considered to be an effect of Minor Significance.

Summary of Cumulative Effects

7.10.36 The potential for cumulative effects resulting from the operation of Llanbrynmair Wind farm in combination with other wind farms in TAN 8 SSA B was assessed using two different scenarios.

7.10.37 Scenario A considered Llanbrynmair in combination with five other operational or consented wind farms. No cumulative effects were identified from combinations of Llanbrynmair and any of these five wind farms.

7.10.38 Scenario B considered Llanbrynmair in combination with the five wind farms from Scenario A and an additional six developments at the application or (in one case) pre-application stage. For all three historic assets considered in the assessment cumulative effects were identified due to the presence of Carnedd Wen (in three cases) and Mynydd Waun Fawr (in one case). No other wind farms were predicted to harm the significance of the historic assets adversely affected by Llanbrynmair

7.10.39 The additional adverse effect on the significance of all three assets still resulted in an assessment of Slight Magnitude i.e. it was not substantively greater than the effect due to Llanbrynmair alone.

7.11 Statement of Significance

7.11.1 This assessment has identified that the proposed development would result in adverse effects on historic assets during the construction phase and operational period. None of the resulting residual effects would be EIA significant. Careful management of the decommissioning phase would ensure that no further adverse impacts occur on assets already damaged by construction works.

7.11.2 Construction works within the wind farm site would damage three undesignated assets: an area of peat cutting, an area of clearance cairns and a single clearance cairn. These are considered to be adverse effects of no more than Minor Significance. No adverse effects have been identified due to proposed off-site highway works.

7.11.3 Construction works could also damage currently unrecorded sub-surface archaeological features; this is considered to be an adverse effect of no more than Moderate Significance. All adverse effects due to construction works would be fully mitigated by an appropriate programme of archaeological excavation and recording.

7.11.4 Operation of the wind farm would affect the heritage significance of three historic assets through visual change in their settings. There would be adverse effects of Minor Significance on a hillfort at Moel Ddolwen (Scheduled Monument), the Church of St Mary, Llan (Listed Building Grade II*) and Llan Conservation Area. Operation of

the wind farm would also affect the character of the historic landscape surrounding the wind farm, leading to a moderate visual impact on the historic landscape.

7.11.5 Operation of the wind farm in combination with proposed wind farms at Carnedd Wen and Mynydd Waun Fawr would lead to cumulative adverse effects on the significance of the same three assets affected by Llanbrynmair alone. The hillfort at Moel Ddolwen would be adversely affected by both Carnedd Wen and Mynydd Waun Fawr, the Church of St Mary, Llan and Llan Conservation Area would be adversely affected by the operation of Carnedd Wen. In all cases the magnitude and significance of effect would not be substantively greater than the effect due to Llanbrynmair alone.

7.11.6 Any effects on the historic landscape or the setting of historic assets would occur for the duration of the operational life of the wind farm and then be fully reversed on decommissioning. Mitigation has been achieved, where possible, through design of the wind farm and minimises the level of harm to the historic assets.

7.12 References

7.12.1 Britnell W J 2006 Tan 8 Strategic Search Areas in Powys, Historic Landscape characterization (CPAT Report no. 821).

7.12.2 Caseldine A, 1990, Environmental Archaeology in Wales

7.12.3 DoE 1995, The Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide. Appendix 10

7.12.4 Clwyd-Powys Archaeological Trust Historic Environment Record digital modern and historic mapping and monument records

Historic Mapping

- 1st Edition 1891 Ordnance Survey 6" Map Montgomeryshire Sheet 27 NE
- 1st Edition 1891 Ordnance Survey 6" Map Montgomeryshire Sheet 20 SE
- 1st Edition 1891 Ordnance Survey 6" Map Montgomeryshire Sheet 20 NE
- 1st Edition 1891 Ordnance Survey 6" Map Montgomeryshire Sheet 21 NW
- 1st Edition 1891 Ordnance Survey 6" Map Montgomeryshire Sheet 20 SW
- 2nd Edition 1903 Ordnance Survey 6" Map Montgomeryshire Sheet 27 NE
- 2nd Edition 1903 Ordnance Survey 6" Map Montgomeryshire Sheet 20 SE
- 2nd Edition 1903 Ordnance Survey 6" Map Montgomeryshire Sheet 20 NE
- Llanbrynmair Parish Tithe Map and apportionment 1839

Aerial Photographs

Vertical

- 106G/UK/1468 1148-1150 4 April 1946
- 106G/UK/1468 3063-3068 4 April 1946
- 106G/UK/1468 6060-6068 4 April 1946
- 106G/UK/1468 2059-2066 4 April 1946
- 106G/UK/1468 4059-4061 4 April 1946

Oblique

- 945003-61, 62, 63, 64, 65, 66, 67 and 68
- 975044-47
- 94-cs-0034, 0035, 0036, 0037, 0038, 0039, 0040
- 97-cs-0328 and 0329

8 GEOLOGY, HYDROLOGY AND HYDROGEOLOGY ASSESSMENT

8.1 Introduction and Scope

8.1.1 This chapter has been undertaken by Fluid Environmental Consulting Ltd (Fluidec) and SKM and supersedes Chapter 9 of the original ES submitted in 2009 which assessed the potential geological, hydrogeological and hydrological effects of the previous layout of the proposed wind farm development at Llanbrynmair, north of Llanbrynmair Village, Powys in Wales.

8.1.2 Since the original ES (2009) a significant number of turbines have been removed and the location of access tracks and some infrastructure have changed due to additional information on a variety of environmental constraints and taking into account advice from consultees. Many of these changes have been detailed within five subsequent SEIs and are summarised within Chapter 3 of this document. These changes have altered the potential geological, hydrogeological and hydrological effects of the proposed wind farm which were presented in the first ES (2009). The original assessment has therefore been updated to consider the potential geological, hydrogeological and hydrological effects subsequent to the final revised scheme layout provided in Figure 3.6. The potential cumulative impacts with the adjacent Carnedd Wen wind farm proposal have also been considered due to its proximity to the site including some infrastructure in shared surface water catchments.

8.1.3 The assessment provides baseline information and consultee responses. It identifies potential effects of the revised scheme and assesses the significance of these effects based on the magnitude of the effect and the sensitivity of the receptor(s). Impacts are assessed based on the risk of: sedimentation and erosion; pollution; alteration of natural drainage patterns, runoff volumes and rates; flood risk and alteration of the geological environment through the dewatering and excavation of peat. Mitigation, management and monitoring measures are then discussed and the residual effects relevant to geology, hydrology and hydrogeology have been determined.

8.1.4 From 1 April 2013, the principal consultee on hydrological and hydrogeological issues, Natural Resources Wales (NRW) took over the functions formally carried out by the Countryside Council for Wales (CCW) and Forestry Commission Wales, along with the devolved functions of Environment Agency Wales and some functions that are currently carried out within the Welsh Government.

8.1.5 In response to concerns raised by NRW over the impact of the proposed development on the peatland habitats of the site, substantial additional work has been undertaken to better define their extent and characteristics. The volumes of peat to be excavated have been calculated and the dewatering influence on peat of site infrastructure reassessed following liaison on methodology with NRW and acquisition of a wide spatial coverage of site specific data on peat depth. An assessment of the net balance of peat and the development of a peat balance table has been undertaken leading to a revision and enhancement of the Peat Management Plan (Appendix 8.9). As hydrological and hydrogeological effects may create secondary effects on ecology and peatland habitats reference should be made to Chapter 5.

8.1.6 The potential geological, hydrogeological and hydrological effects of the transport access routes are assessed within Chapter 10.

8.2 Methodology

8.2.1 The assessment has been undertaken partly using a qualitative assessment based on professional judgement and statutory and general guidance, but also using a quantitative assessment using analytical equations and site specific data in

particular to evaluate effects on peat. It has been updated since the original ES was submitted in 2009 and additional site visits undertaken to assess the changes to the layout and their impact on the hydrological, hydrogeological and geological environments as well as to obtain greater understanding of the peat on site including its characteristics, depth, structure and hydrology. It incorporates:

- a review of the relevant legislation, guidelines and policy;
- consultation with both statutory consultees and private water supply users;
- a desk study to identify existing information;
- site visits to determine baseline conditions;
- the prediction of likely effects on hydrology, geology and hydrogeology from the proposal; and
- the assessment of the likely significance (as described in the EIA regulations) of those effects having regard to the predicted magnitudes of effects and the sensitivities of receiving environments.

Assessment Criteria

8.2.2 The significance of any potential effects of the proposed wind farm on baseline conditions is assessed as part of the effect assessment. The combination of the magnitude of potential effect and the sensitivity of the receptor combine to determine the potential significance of that effect.

8.2.3 The magnitude, sensitivity and significance criteria described in this section were considered appropriate for the conditions and environments prevailing at the site. Magnitude criteria are presented in Table 8.1.

Table 8.1 Magnitude of Effect Criteria.

Magnitude of Potential Effects	Definition
High	Fundamental change to hydrological conditions (including deterioration in water quality) resulting in temporary or permanent consequential changes.
Medium	Detectable change to hydrological conditions resulting in non-fundamental temporary or permanent consequential changes. Some deterioration in water quality likely to temporarily effect most sensitive receptor
Low	Detectable but minor change to hydrological conditions. Drinking water or environmental water quality standards are not exceeded and level of change is unlikely to affect the most sensitive receptor
Negligible	Unquantifiable or unqualifiable change in hydrological conditions (including water quality)

8.2.4 Sensitivity criteria can be based both on the vulnerability of a receptor to a particular pressure (degree of environmental response to any particular effect), as well as the 'value' of the receptor (e.g. an area of international significance should be considered more sensitive to effect than an area of little or no conservation value). The sensitivity criteria used for this site include ecological habitats and are presented in Table 8.2.

Table 8.2 Sensitivity Criteria.

Sensitivity of Environment	Definition
High	Environment is generally highly sensitive to change and responds in a major way to effects. Sites containing viable areas of threatened habitats listed in a Regional Biodiversity Action Plan. Nationally designated sites such as Sites of Special Scientific Interest (SSSIs), or non-designated sites meeting SSSI selection criteria, National Nature Reserves (NNRs), Marine Nature Reserves, Nature Conservation Review Grade 1 sites (Ratcliffe 1977). Internationally designated or proposed sites, such as Ramsar Sites, Special Protection Areas, Biosphere Reserves, Special Areas of Conservation, or otherwise meeting criteria for international designation. Sites supporting populations of internationally important species. Private water supplies for human or stock consumption.
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. Sites containing viable areas of threatened habitats listed in a Regional Biodiversity Action Plan and/or habitats covered within a Natural Heritage Zone or SSSI Area of Search used by Scottish Natural Heritage, comfortably exceeding Site of Importance for Nature Conservation (SINC) criteria, but not meeting SSSI selection criteria (Regional value)
Low	Environment responds in minimal way to effect such that only minor change(s) are detectable Designated SINC or undesignated sites of varied quality containing habitat types of local interest, including amenity and educational functions (Local value)
Negligible	Environment is insensitive to effect, no discernible changes Low grade and widespread habitats

8.2.5 The combination of magnitude and sensitivity logically combine to provide a matrix categorisation of significance. These are presented in Table 8.3.

Table 8.3 Significance Matrix.

Magnitude of Potential Effect	Sensitivity			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor/Moderate	Moderate	Moderate/Major
Low	Negligible	Minor	Minor	Minor/Moderate
Negligible	Negligible	Negligible	Negligible	Negligible

8.2.6 The assessment of likely effects of the proposal, both within and outside the site and the potential cumulative effects of the proposal with the Carnedd Wen wind farm, is based on an assumption that best practice methods are used in the development of the wind farm. Levels of significance which are Major, Moderate/Major or Moderate are considered significant for the purpose of the EIA regulations and will require mitigation or management to reduce the level of significance of effect if possible.

8.2.7 It should be recognised that the matrices are a guide to the determination of effects and professional judgement is also used to ensure the significance of the effect is appropriate.

Legislation, Guidelines and Policy

Legislation

8.2.8 In regard to hydrology, management of water-borne pollution and protection of natural heritage areas, the Environment Agency Wales (now NRW since April 2013) have statutory obligations in terms of the management and control of pollution into water resources, including water dependent Natura 2000 Protected Areas. Accordingly, it would be reasonable to assume that the adoption of the EA's Best Practice Guidelines will prevent pollution to acceptable standards and make any 'significant' effects unlikely.

8.2.9 There is a range of environmental legislation that any development must adhere to throughout the development life cycle. Key legislative drivers relating to the water environment which have been considered within this assessment are listed below:

- EC Freshwater Fish Directive (2006/44/EC) (to be repealed in 2013 by EC Water Framework Directive);
- Water Framework Directive 2000/60/EC;
- Groundwater Directive 80/68/EEC
- Groundwater Daughter Directive 2006/118/EC
- Water Act 2003;
- The Environment Act 1995;
- Land Drainage Act 1991 and 1994 Amendment;
- Pollution Prevention and Control Act 1999;
- The Pollution Prevention and Control (England and Wales) Regulations 2010
- Private Water Supplies (Wales) Regulations 2010

- The Water Supply (Water Quality) Regulations 2010 (Wales);
- Groundwater (England and Wales) Regulations 2009; and
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2003

8.2.10 The development activities associated with the construction of the proposal will need to conform to existing water legislation in Wales, and with any relevant changes regarding the abstraction of water, discharges to water and any engineering works or impoundments. These include the following requirements:

- Consent for the erection of any mill dam, weir or other like obstruction to the flow of an ordinary watercourse or to raise or otherwise alter such an obstruction (EA);
- Consent for the erection of any culvert that would be likely to affect the flow of any watercourse or alter any culvert in a manner that would be likely to affect any such flow (EA and Local Authority);
- An Impounding Licence for the impounding of any watercourse, ditch or stream (EA);
- An Abstraction Licence for the abstraction of more than 20m3 /day of water from any inland water or underground strata (EA);
- Any works in, under or over a watercourse will require a land drainage consent (EA);
- Any access tracks requiring a bridge crossing will require individual land drainage consent for each structure (EA);
- Any bridge widening will require consent for the permanent works and possibly consent for the temporary works (EA); and
- Assurance that riparian owners common law rights to receive water is undiminished in quantity or quality.

Guidelines

8.2.11 The Pollution Prevention Guidelines (PPGs), published by the EA and CIRIA, include the documents referred to below, which are the principal documents used for guidance on preventing contamination of surface water from construction activities. These relevant to this wind farm development include:

- Control of water pollution from constructions sites. Guidance for consultants and contractors C532 (CIRIA, 2001);
- Environmental good practice on site C650 (CIRIA, 2005);
- Culvert Design and Operation Guide C689 (CIRIA, 2010);
- Control of water pollution from linear construction projects: technical guidance C648 (CIRIA, 2006);
- The SUDS manual C697 (CIRIA 2007);
- PPG1: General guide to the prevention of pollution (EA, SEPA & EHSNI);
- PPG2: Above ground oil storage tanks (EA, SEPA & EHSNI, 2004);
- PPG4: Treatment and disposal of sewage where no foul sewer is available (EA, SEPA & EHSNI, 2006);
- PPG5: Works and maintenance in or near water (EA, SEPA & EHSNI, 2007);
- PPG6: Working at construction and demolition sites(EA, SEPA & EHSNI);

- PPG8: Safe storage and disposal of used oils (EA, SEPA & EHSNI, 2004);
- PPG21: Pollution incidence response planning (EA, SEPA & EHSNI, 2004); and
- PPG26: Storage and handling of drums and intermediate bulk containers (EA, SEPA & EHSNI, 2006).

8.2.12 Other relevant guidance includes:

- Guidance on Road Construction and Maintenance (Forests and Water Guidelines Fifth Edition 2011, Forestry Commission)[27];
- DEFRA Good Practice Guide for Handling Soils (MAFF 2000); and
- Technical Advice Note 15: Development and Flood Risk (TAN 15[28]) and the corresponding Development Advice Map from the Welsh Assembly (2009).

Development Plan Policy

8.2.13 The Powys County Council Unitary Development Plan (UDP) (2001 – 2016) was adopted on 1st March 2010. It replaces the former structure and local plans and is the basis for determining planning applications and guiding development for Powys County Council up until 2016.The following policies within the UDP which relate to this chapter are:

- SP 3: Natural, Historic and Built Heritage;
- SP 12: Energy Conservation and Generation
- ENV 3: Safeguarding Biodiversity and Natural Habitats;
- ENV 4: Internationally Important Sites;
- ENV 5: Nationally Important Sites;
- ENV 6: Sites of Regional and Local Importance;
- ENV 7: Protected Species;
- E 3: Wind Power
- E 4: Removal of Redundant Wind Turbines
- MW 6: Borrow Pits
- MW 9: Peat Extraction
- MW 18: Geomorphology, Archaeology and History;
- DC 9: Protection of Water Resources
- DC 13: Surface Water Drainage; and
- DC 14: Flood Prevention.

Consultation and SEI

8.2.14 In February 2005, RES consulted with Countryside Council for Wales (CCW) and the Environment Agency Wales (EA) in order to gain initial comments on the proposal in

[27] Forestry Commission (2003) *Forests and Water Guidelines.* Fourth Edition. Forestry Commission: Edinburgh.
[28] Welsh Assembly Government (2004) *Technical Advice Note 15: Development and Flood Risk.* Planning Policy Wales.

line with EA scoping guidance[29]. These organisations provided specific comments in relation to geology, hydrogeology and hydrology as listed below in Table 8.4.

8.2.15 A formal scoping request was submitted to Powys County Council (PCC) in February 2006 however no response was provided. RES therefore sent scoping requests directly to the relevant consultees in the absence of a formal scoping opinion response.

8.2.16 Following submission of the Planning Application (accompanied by the Environmental Statement) to PCC in March 2009, a number of requests for further information have been made by PCC and CCW (and subsequently NRW). The requests for information relevant to this chapter are summarised in Table 8.4. Five Supplementary Environmental Information documents have been submitted since the Planning Application submission in 2009. Please note this SEI supersedes the original ES and five subsequent SEI packages.

Table 8.4 Summary of Consultation Reponses Relevant to Hydrology Chapter.

Consultee	Summary of Comments
Countryside Council for Wales (31st March 2005)	• The potential impact of the wind farm on the nearby Gweunydd Dolwen SSSI will need to be considered. This site is approximately 200m from the consultation boundary and considerably further from the plateau area where the turbines are likely to be constructed. An impact on this SSSI is improbable but it should be duly considered. • The higher ground within the study area is unimproved wet heath, blanket mire, marshy grassland and acid grassland. • A peat depth map should be provided where appropriate.
Environment Agency Wales (15th June 2005)	• Restoration of habitats such as upland moor and blanket bog, and removal of artificial forestry and agricultural drainage will help reduce acidification of the watercourses and reduce peak run-off and help attenuate flows. • Removal of plantations shading watercourses and within the valley floor will benefit both the water quality and habitat of the watercourses that feed the important salmonid habitats of the Afon Gam and Afon Cannon. • New infrastructure such as “improved drainage” should not be used to improve agricultural productivity. • Watercourse crossings and impacts on the natural hydrology will need to be minimised and avoided wherever possible to ensure no adverse impact on protected species such as otter and salmon and the ecology of wetland habitats. • Opportunities should be taken to create marsh, wetland and open water communities. • Prior consent of the EA is required for the erection of any mill dam, weir or other like obstruction to the flow of an ordinary watercourse or to raise or otherwise alter such an obstruction. Consent is also required for the erection of any culvert that would be likely to affect the flow of any watercourse or alter any culvert in a manner that would be likely to affect any such flow. The EA resists culverting and consents will not normally be granted except for access crossings. • Culverting of watercourses also requires the prior written approval of the Local Authority. • The developer must ensure that the operations do not interfere with riparian owners common law rights to receive water undiminished in quantity or quality. • Any material should not be tipped within 7m of a watercourse, ditch or spring.

[29] Environment Agency, 2004. *Scoping guidelines on the Environmental Impact Assessment (EIA) of projects: I7 Wind farms (on-shore and off-shore).* Environment Agency, Bristol.

Consultee	Summary of Comments
	• The EA will require method statements that describe the site controls and pollution prevention measures to be agreed. • An Impounding Licence may be required from the EA for the impounding of any watercourse, ditch or stream. • An Abstraction Licence may be required from the EA for the abstraction of water from any inland water or underground strata. • Site specific weather conditions should be covered within the ES. • The EA would like to be involved in a site visit to look at access routes, identify any land drainage issues, proximity to watercourses, low points on haulage roads and pollution prevention measures.
Countryside Council For Wales (11th November 2010)	• CCW objects to the development in its current form due to impacts on peatland habitats. • The proposal needs to be modified to avoid significant impacts on peatland habitats from wind farm infrastructure, particularly turbines and access roads. • The evaluation of the impact of the proposal on the peat habitats and determination of mitigation is difficult due to deficiencies in data. • No rationale for the choice of probing locations is given in the ES. The ES should demonstrate that the impacts of the scheme have been minimised by avoiding the siting of infrastructure on peat. The design of the wind farm should be informed by reliable and accurate peat depth mapping. The peat depth mapping is almost exclusively taken from around infrastructure positions with no available data for large areas of the site. • Additional peat depth data for the site is required to inform the re-siting of infrastructure and to demonstrate that impacts on peat and its associated habitats have been avoided and minimised. Peat depth data will be needed for all infrastructure positions. Data is also required for the wider site and on transects perpendicular to road positions to demonstrate that the overlap between infrastructure and deep peat (>0.5m) has been minimised. • Further hydrological assessment of the impact of infrastructure on habitats is required. We consider that the use by the ES of a generic 2m maximum extent for assessing hydrological effects is problematic. A more specific assessment is required for individual road alignments and other infrastructure. • The ES assesses impacts on peatland habitats as resulting mainly from permanent habitat loss as a result of the infrastructure footprint. There is no consideration of impacts resulting from hydrological impacts, fragmentation or dust settlement. • The hydrological impacts of the proposal are inadequately considered by the ES. Further consideration is required of losses of sensitive mire habitats as a result of hydrological degradation in the longer term and any necessary mitigation identified to prevent these losses. The ES suggests that any hydrological impacts within the peat as a result of infrastructure will be limited to a zone of 2m. Further justification and evidence needs to be provided to support this stance using examples which are directly comparable to Llanbrynmair Moors. The generic 2m zone of impact also takes no account of variation in topographically position or local variations in the hydrological conditions of peat such as the presence of peat pipes. • The calculation of habitat loss as a result of permanent and temporary infrastructure does not assess impacts from a number of types of infrastructure which are also likely to be required for the proposal. This includes turning circles, soil/peat storage mounds, wood stacking and loading areas and water settlement bays and collection ditches for the control of sediments. The location of this additional infrastructure needs to avoid deep peat, blanket bog, flush and fen. • The ES contains no assessment on the impact of cable strips on peat hydrology and hence no suitable avoidance or mitigation measures are provided.

Consultee	Summary of Comments
Countryside Council For Wales (22nd June 2012)	• The potential impact of turbines R7 and R8 and associated infrastructure on ground water flows and hydrology feeding into two areas of raised bog and a large soligenous fen needs to be considered • Whilst the fen is likely to be predominantly surface water fed, it may also be receiving some groundwater inflow via fracture flow. Given the catchment is small and the development impact quite close to the site, the impact of the excavation and subsequent turbine completion on groundwater flow and consequently the fen needs to be further investigated. • The possible introduction of preferential groundwater flow paths in bedrock shattered by excavation should be investigated in the area around R7 and R8. • Surface water impacts in relation to turbines and tracks could also potentially impact on the fen and should be investigated further. .
Countryside Council for Wales (12th October 2012)	• The area of peatland habitat to be affected as a result of drainage around the infrastructure needs to be considered. • Despite the amendments to the scheme, 24 of the 30 remaining turbines are located on deep peat. Further information on peat distribution and depth across the application site is required. Without such information CCW cannot advise if the scheme has been designed to avoid and minimise impacts on deep peat. • The carbon calculator has a number of deficiencies and does not give an accurate assessment of pay back periods and carbon losses from disturbance to peat.
Natural Resources Wales (25 April 2013)	**Calculation of peat volumes to be excavated** • It is accepted that the use of peat probing measurements of peat thickness, which could include thicknesses of soft materials underlying the peat, is a conservative approach in this context. • No mention is made of the use of additional peat probing data to inform decisions on the relocation of road alignments, turbines and other infrastructure and to enable the developer to demonstrate impacts have been minimised through choice of routes. It would be useful to include in the proposal the locations of the 'specific areas' where additional probing will be undertaken. • Reference is made to use of average peat depths; we suggest it would be helpful for the applicant to prescribe a minimum or standard sampling density (i.e. probe locations per ha or length of track). It is recommended that an estimate of variance around the average peat thickness used for each area specific calculation is provided. **Re-assessment of dewatering influence on peat of site infrastructure and assessment of potential impact from drainage** • It is noted that a programme of groundwater level (water table) monitoring to support hydrological characterisation of, and impact assessment for, the site has not been proposed; this is maybe surprising given the scale of the project and the supporting impact assessment works. Such a programme would provide water level data to verify the important assumptions on water table levels within dry wet and dry habitats, and to verify hydrological impact calculations pre- (background), during- and post-construction. It would also allow actual water levels to be used as the starting condition for the application of analytical drawdown equations. • It would be useful to know which vegetation communities were being allotted to the 'wet' and 'dry' habitat categories. The calculation of the lateral extent and magnitude of water table drawdown resulting from the construction of wind farm infrastructure should explore fully the sensitivity of the results to known uncertainties and sensitivities, relating both to the conceptual model and to values used for key variables. These latter should include:

Consultee	Summary of Comments
	• The sensitivity of impact predictions to slope angle (see Baird, 2013). • Uncertainty relating to the effective thickness of the acrotelm in blanket mire. It is worth noting here that an acrotelm thickness of 20 cm is likely to be excessive for blanket mire in general, and for the more Sphagnum-poor examples at Llanbrynmair in particular. • Uncertainty in the value for hydraulic conductivity/transmissivity of the peat. The literature review for values for the hydraulic conductivity of peat should recognise that different types of peat (fen, raised bog, blanket mire) can have very different conductivities. It should also be noted that hydraulic conductivity can vary appreciably in space, even when peat is of the same type. • Uncertainty in the presence and hydraulic role of peat pipes. Related to the above; the presence of peat pipes can increase transmissivity by orders of magnitude. The difficulties in treating the possible presence of peat pipes in this type of impact assessment study are recognised. A survey for peat pipes of locations where the peat mass is exposed, e.g. cuttings and erosion faces, is strongly recommended in order to inform the impact assessment. • The method for applying analytical drawdown equations in 'two layers' would need to be explained in more detail before NRW can provide comments; further detail would be welcomed. • It is recognised that positioning the upper limit of a seepage face at the base of the peat for the analytical drawdown calculations is a conservative approach in this context. However, it will need to be demonstrated, by observation rather than hydraulic testing, that the hydraulic conductivity of the mineral ground underlying the peat is much lower than that of the peat, and therefore that it will not act as an under-drain to the peat. It should be noted that the assumption that the underlying mineral ground will support a seepage face to its upper surface at the side of an excavation implies a very low hydraulic conductivity. • Worst-case transient drawdown impacts during dry periods should be assessed. It is possible that short episodes of enhanced drawdown during these periods, during which oxygen could penetrate further into the peat mass than is predicted by studying an 'average' drawdown condition, can have a disproportionately large effect on carbon dynamics and peat loss. • The final analytical drawdown model(s) should be conservative in terms of construction and parameter values. Any deviations from such a conservative condition should be supported fully by field evidence or other information. **Assessment of potential link between turbines 7 and 8 and soligenous fen** • Assuming that it is the soligenous fen on the saddle to the west of Esgair Ffordd which is referred to here (viewed during the field visit on 12 March), NRW have no particular concerns about hydrological impacts, given that the currently proposed access road to Turbines 7 and 8 passes well to the other side of the watershed. • Further detail would be welcomed however on how the access road will be sited to avoid the linear ridge line/flank mires to the north of the area of soligenous fen.

Desk Study

8.2.17 The assessment was predominantly based on a desk study with site visits for verification. The desk study involved collating and assessing the relevant information from the following sources.

- Ordnance Survey (OS) Landranger Maps at 1:50,000 scale: No.125 Bala and Lake Vyrnwy and No.136 Newtown and Llanidloes;
- OS Explorer Map at 1:25,000 scale: No. 215 Newtown and Machynlleth;
- British Geological Survey (BGS) Hydrogeology Map No. 1 England and Wales at 1:625,000 scale 1977;
- British Geological Survey (BGS) and Environment Agency (EA) Aquifer Designation Map at 1:75,000 scale (2012).
- British Geological Survey (BGS) and Environment Agency (EA) Groundwater Vulnerability Map at 1:75,000 scale (2012).
- British Geological Survey (BGS) and Environment Agency (EA) Groundwater Source Protection Zone Map at 1:75,000 scale (2012).
- British Geological Survey (BGS) Geological Survey Ten Mile Map at 1:625,000. South Sheet (Quaternary) 1977;
- British Geological Survey (BGS) Geological Survey Ten Mile Map at 1:625,000. South Sheet (Solid) 1979;
- British Geological Survey (BGS) Bedrock and Superficial Deposits Sheet 150 Dinas Mawddwy (2012)
- Leslie, Alick, Dinas Mawddwy, Geological Survey of the Area North of Talerddig, mapped May-August 2007; and
- Bassett, Douglas Anthony, 1955. The Silurian Rocks of the Talerddig District, Montgomeryshire. Quarterly Journal of the Geological Society.

8.2.18 The EA was able to provide information on river flows, surface water and groundwater abstractions and discharges and surface water quality. The Meteorological Office website provides information on average regional rainfall.

8.2.19 A flood risk assessment was conducted for the area for the original ES (2009) and included a desk study based on the size, land use, topography and geology of the Afon Gam catchment and EA Flood Maps that show the area and routing of flood events. This information was then collated and rainfall runoff modelling undertaken to determine the potential effects from flooding at a number of watercourse crossings and infrastructure locations. The flood risk assessment has been updated to take into account the new watercourse crossings of the revised scheme.

Site Visits and Field work

8.2.20 Initial site visits for the 2009 ES submission were undertaken in May 2006 followed by a more detailed inspection in July 2008 by hydrogeological consultants of Enviros Consulting including Duncan Saunders now of Fluidec.

8.2.21 Further site visits have taken place to improve understanding, examine changes to the site layout and their interaction with the hydrological, hydrogeological and geological environment and for definition of the peatland habitats of the site. These have included:

- Ecology Matters have carried out extensive depth penetration probing on site between 2010 and 2013. Following revisions to the site layout and access routes, all new areas of track were probed. They also carried out some

additional coring to obtain actual soil, peat and other mineral soil samples for comparison with depth penetration results.

- A site visit was undertaken by RES, John Ferry (SKM) and Mick Green (Ecology Matters) in February 2013 during which coring was carried out to enable a better understanding of the thickness of the upper layer of the peat (acrotelm). During this site visit examination of the soligenous fen and the potential impact from the section of track in the area of turbines R7 and R8 was also undertaken. The final transport route was also reviewed on this visit.
- Duncan Saunders (Fluidec) undertook a site visit in March 2013 to examine the final infrastructure and transport route layout to assess the interaction with the water environment.
- In March 2013 a meeting took place on site with Carol Fielding, Peter Jones, Dave Reed of CCW and Rob Low of Rigare Ltd their hydrological advisor with Duncan Saunders, John Ferry and Mick Green to examine particular areas of the site and to discuss the outstanding peat issues.
- A site visit was undertaken by Duncan Saunders in April 2013 to further examine the final transport route and carry out some further depth penetration probing and coring to examine areas classified as deep peat to compare the true depth of the peat identified from the coring tool.
- A site visit to assess the forested areas for restoration and peat volume calculation was undertaken by Duncan Saunders in May 2013.
- A site visit was undertaken by Duncan Saunders and Mick Green in June 2013 to carry out further depth penetration probing and coring to examine a number of additional areas classified as being located on peat greater than 0.5m depth.

8.3 Existing Environment

8.3.1 This section describes the existing hydrological and hydrogeological baseline conditions at the proposed site and within its immediate surroundings. Figure 8.1 shows the catchments and the locations of the rivers within and around the site along with designated sites, private water supplies and watercourse crossings.

Topography

8.3.2 The proposed site is located within an undulating upland area and some incised valleys. A ridge runs from approximately north to south west, with a steep slope running along the western edge from approximately 400 m to 450m AOD to a low of 220m AOD over a distance of approximately 500m. The site generally slopes to the east from approximately 430m AOD over a gentler gradient to approximately 240m AOD forming a valley where the Afon Gam flows in a north easterly direction. This is intersected by several incised valleys. The southern extreme of the site forms a steep slope falling to the south with high points at Ffridd Hafodowen, Moel Caetwpa and Banc y Gorlan.

Meteorological Summary

8.3.3 The site is subject to high annual average precipitation from rainfall and snowfall. Average annual rainfall in Trawscoed, about 43 miles to the south is 1,213.9 mm (Meteorological Office 1971-2000).

Land Cover and Land Use

8.3.4 As discussed in Chapter 5 (Ecology), and as confirmed by NRW, the land cover at the site mainly consists of acid grassland with some heath and marshy grassland, together with improved grassland and conifer plantation.

8.3.5 The site is mainly used for grazing of sheep and cattle and a number of farm houses are located near the site boundary.

8.3.6 The higher ground at the site is dominated by grassland and forestry, with some discontinuous areas of blanket bog present.

8.3.7 The vegetation assessment completed by Ecology Matters in 2008 shows that within the site boundary conservation interest habitats include areas of mire which are composed of a mosaic of blanket bog, acid flush, acid grassland, heath and marshy grassland. These are discussed more thoroughly in Chapter 5 (Ecology).

Peat

8.3.8 Situated at the southern end of Llanbrynmair moors, a large proportion of the wind farm site is underlain by a relatively thin and discontinuous layer of peat, with areas of blanket bog. Whilst some of this blanket bog has artificial drainage, there are still areas that are wet and boggy and that support good quality blanket bog vegetation. Afforestation and grazing has resulted in both modification and damage to some of the peat habitats on the site.

8.3.9 The detailed spatial occurrence and depth distribution of peat across the site has been examined extensively based on feedback from consultees in order to design the most optimal infrastructure layout and to minimise and define impacts.

8.3.10 To achieve a detailed understanding of the spatial and depth distribution of peat and its properties, a series of tasks have been completed in conjunction with the ecological consultants (Ecology Matters) which include:

- Peatland habitat mapping (Ecology Matters and detailed within the Ecology Chapter);
- Depth penetration probing at all infrastructure and track locations at appropriate spacing (Ecology Matters);
- Depth penetration probing in a 100m grid at other areas on site where there are not already constraints to development (Ecology Matters). These include steep gradients, noise constraints, ornithological constraints, watercourse buffers, landscape constraints etc;
- Development of a maximum depth of peat contour map to indicate the deepest areas of potential peat based on the depth penetration probing results and also on coring in some areas where sufficient coring has been completed;
- Examination of the variability of the depth of the acrotelm;
- Calculation of maximum potential peat volumes that will be removed due to excavation for infrastructure based on the depth penetration probing results;
- Calculation of dewatering volumes associated with the drainage induced by the various excavations based on the depth penetration probing results and estimation of the hydrogeological properties of the acrotelm and the catotelm; and
- Examination of areas where peat will be reused (peat restoration areas and infrastructure) to allow calculation of reuse volumes.

8.3.11 Peat habitat mapping has been completed by Ecology Matters and is detailed fully within Chapter 5 (Ecology).

Peat Depth Assessment

8.3.12 Penetration depth probing was originally only carried out in areas where infrastructure was proposed or where peat or soft deposits were evident. Where there was no evidence on the surface to suggest peat / soft deposits, probing was not attempted.

8.3.13 A significant amount of work has subsequently been undertaken since submission of the original ES in 2009 and in response to consultee comments to improve spatial understanding of peat on the site and the extent of the peat land habitats across the site. Extensive depth penetration surveys covering the areas of interest identified by NRW where there are no other absolute constraints have now been carried out with almost 5,000 probes being completed. This probing has allowed a conservative peat depth contour map to be developed as coring has indicated that in the majority of cases the probe penetration depth is deeper than the actual peat depth. This map also shows the extent of the probing undertaken (Figure 8.2 a, b and c).

8.3.14 Peat depth (based almost entirely on probe penetration depth) across the area of infrastructure ranges from a complete absence, where topsoil over mineral soil is present, to over 3 metres. Based on an assumption that a probe penetration depth of 0.1m signifies no peat then 244,150 m^2 of the infrastructure (65%) is on peat. The total area of the infrastructure footprint is 377,850 m^2.

8.3.15 Across the majority of the area of infrastructure, 95%, the peat depth is less than one metre (this includes the 35% that is not located on peat), with areas of deeper peat (>1.5m) being found in small pockets rather than large areas of blanket bog. The peat depths tend to be greatest under mire vegetation or within forestry (where it was planted on peat), with shallower areas of peat found on the steeper slopes of the site.

Table 8.5 Maximum Potential Peat Depth across the Site.

Depth range (m)	Peat depth distribution (m^2)	Peat depth distribution (%)
0 – 0.1 (no peat)	133,700	35%
0.1 - 0.5	150,750	40%
>0.5 – 1	75,900	20%
>1 – 1.5	12,800	3.4%
>1.5 – 2	3,600	1%
>2	1,100	0.3%
Total	**377,850**	

8.3.16 As a result of modification and degradation of the peat habitats, the depth of the peat does not always relate to the quality of the overlying habitat. Most of the deepest depth penetration probes were within afforested areas (near Turbine R18 and R35), with some also located in heavily grazed areas (near Turbines R5 and around Turbine R15).

8.3.17 Coring of a total of 117 locations across the site identified that the peat was found to be regularly underlain (on a total of 104 occasions, 89%) by soft glacial clay (photos 6 and 7, Appendix 8.3) which has the same penetration characteristics as peat, often leading to an overestimation of peat depth.

8.3.18 Table 1 in Appendix 8.3 presents the data obtained from peat probing and coring and is summarized below in Table 8.6 (probe penetration depths were not recorded at three locations therefore 114 locations are presented).

Table 8.6 Comparison of penetration depth probing and coring.

Probe penetration depth range (m)	No of locations (from 117)	Depth of Peat from Coring (m)				
		0 - 0.5	>0.5 - 1	>1 - 1.5	>1.5 - 2	>2
0 - 0.5	16	16	-	-	-	-
>0.5 - 1	69	56	13	-	-	-
>1 - 1.5	23	9	3	11	-	-
>1.5 - 2	2	-	-	1	1	-
>2	4	-	-	-	2	2

8.3.19 A total of 117 locations around the site have been cored with a focus on areas that have been indicated as being on deep peat based on probe results.

8.3.20 Of the 117 locations a total of 33 actually encountered peat greater than 0.5m depth based on the coring. This is compared to 95 probes which were greater than 0.5m depth (probing was not taken at the time of the other 22 cores or was less than 0.5m depth). It should be noted that the large majority of these cores were focused on areas determined to be deep peat by probing.

8.3.21 There is significant variability in the probe penetration depth and the peat depth obtained from coring.

- A total of 69 probe penetration depths between >0.5m and up to 1.0m were compared with coring. Only 13 cores (19%) encountered peat >0.5m, whereas 56 (81%) cores identified peat <0.5m;
- Of the 117 locations cored 104 (89%) encountered clay beneath the peat, 5 encountered bedrock and 8 did not encounter the base of the peat; and
- Of the 29 probe penetration locations that were >1.0m a total of 20 (69%) were confirmed with the corer to have peat depths >1.0m.

8.3.22 Based on this data it is apparent that the maximum peat depth contour plan produced is an overestimate of peat depth on the site and is therefore has led to very conservative estimates of excavated peat and peat dewatering volumes.

8.3.23 The depth of peat at a number of turbine bases was cored to establish the actual peat depth. Based on the overall findings (Appendix 8.3) the peat occurrence at the 30 turbine bases demonstrates that:

- 16 bases (R5, R6, R8, R9, R12, R13, R14, R16, R23, R24, R25, R32, R37, R39, R41 and R43) did not encounter peat >0.5m within 25m of the centre of the turbine base;
- minor micrositing can avoid the possible peat >0.5m at a single location within 25m the centre of each of 7 turbine bases (R4, R7, R17, R19, R27, R40 and R42). These locations have not been cored and given other results it is likely that the depth of peat is <0.5m and the minor micrositing may not be necessary;
- minor micrositing can avoid the peat that has been verified to be slightly in excess of 0.5m through coring at 3 turbine bases (R15, R26 and R38); and
- There are only 4 turbines that will therefore be located on areas of peat of depth >0.5m and will require additional probing, coring and refinement of micrositing post felling. These are the 4 turbines at R18, R31, R35 and R36, all

of these are located on degraded peat that has been afforested and which will be felled and the peatland habitat restored.

Acrotelm Thickness

8.3.24 Generally, the physical properties of peat enable the peat to be divided into two distinct layers: an upper active layer of roots and recently decomposing plant material termed the "acrotelm", and a lower layer of denser and more decomposed (humified) peat called the "catotelm". The peat survey work found evidence of these two distinct layers within the peat across the site (Photos 4, 5 and 7 Appendix 8.3). The acrotelm was recorded in 56 cores and was observed at depths ranging from 0.05m – 0.4m with an average depth of about 0.18m, therefore a value of 0.2m has been used for calculation purposes to be conservative. The depth of the boundary between the catotelm and the underlying mineral soil ranged from 0.15m to over 3m in the area of the soligenous fen (Section 8.3.60 and Figure 8.3).

Peat Excavation Volumes

8.3.25 The total calculated excavation volumes of peat are based on almost 5,000 locations where a probe has been used to ascertain the depth of penetration to 0.1m accuracy. As stated the probe depth is generally an overestimation of actual peat depth due to the presence of clay of similar penetration resistance across almost the whole of the site and therefore the volumes calculated are conservative.

8.3.26 The detailed calculations are presented in Appendix 8.1 and the volumes are:

- Total volume of peat which will be excavated = 120,900m^3
- Total volume of acrotelm which will be excavated = 50,400 m^3
- Total volume of catotelm which will be excavated = 70,500 m^3

8.3.27 These values are estimates based on the available data and a number of assumptions regarding peat distribution.

Peat Dewatering Volumes

8.3.28 Excavations in peatlands can lead to a change in peat hydrology including temporary and permanent dewatering of the peat. The peat on site is a generally saturated and relatively thin layer overlying bedrock and also usually clay of glacial origin. Where sections of peat and underlying material are removed for the installation of turbine bases, tracks or other infrastructure there is the potential for the groundwater within the adjacent peat to drain to these excavations potentially resulting in a drying out of some of that adjacent peat and deterioration in its quality.

8.3.29 To estimate the potential impact on peat hydrology a dewatering assessment (Appendix 8.2) has been completed based on the requirements of Environment Agency guidance: Hydrogeological Impact Appraisal for Dewatering Abstractions April 2007.

8.3.30 It is not feasible or assessed to be appropriate to obtain certain site specific data across the whole of this linear site such as groundwater levels and permeability values due to the likely high variability and the need for a very large number of wells and tests. Therefore the following assumptions have been made (and are explained further in Appendix 8.2):

- The peat depth for each infrastructure is an average of those recorded by the depth of penetration probe using the GIS software ArcGIS. This is likely an

overestimate in most cases based on the results demonstrated by coring however it is a conservative approach;

- The peat depth for each 50m section of track is that recorded by the penetration probe adjacent to the line of the track;
- The peat depth is used as the depth of the seepage face;
- The acrotelm is assumed to be 0.2m deep based on site observations;
- The peat saturation state is dependent on the surface habitats as mapped by the ecologists. A saturated habitat indicates that groundwater level is at surface. A non saturated habitat indicates that the groundwater level is at the base of the acrotelm i.e. 0.2m below ground surface;
- Based on the literature review the permeability of the acrotelm peat is estimated to be 3m/day and the catotelm peat 0.003m/day;
- A recharge rate of 0.0017m/day (607mm/yr) to the acrotelm has been used which assumes that 50% of rainfall is effective. (From met office website, Trawscoed 1971-2000 average 1213.9 mm/yr);
- It is assumed that all infrastructure will be excavated to below the base of the peat and therefore will always drain. This is the worst case scenario;
- The distance to zero drawdown is calculated using the Niccoli *et al*. (1998) equation as provided by the Tier 1 Groundwater Analytical Equation Tool (EA, 2007) which estimates the radius of influence in an unconfined aquifer from an open pit;
- A linear drawdown with distance from the base of the peat to the distance to zero drawdown is assumed. This is an overestimate and very conservative; and
- The distance to zero drawdown is the maximum extent of the peat that could be impacted either permanently by the tracks, or temporarily by the turbine bases or other infrastructure.

8.3.31 Based on these assumptions the total volume of peat calculated to be impacted by all wind farm infrastructure is predicted to be about 53,600 m^3. Of this, the impact to 18,900 m^3 will be temporary and to 34,700 m^3 the impact will be permanent.

8.3.32 As with the calculated excavation volumes of peat, these values are likely to be maximum values as coring has demonstrated that the actual peat depth is generally substantially less than the probe penetration depths utilised.

8.3.33 If the linear drawdown assumption is used for the two separate layers of peat as would be more accurate rather than across them (as required by the carbon calculator) both the volume of peat calculated to be impacted by all wind farm infrastructure is predicted to be about 24,600 m^3. Of this 8,900 m^3 will be temporary and 15,700 m^3 will be permanent. These values are not being used to be conservative and to comply with the calculations within the carbon calculator.

Geology

8.3.34 The geology of the proposed site is taken from British Geological Survey (BGS) Bedrock and Superficial Deposits Sheet 150 Dinas Mawddwy (2012). The site is located on a broad syncline orientated NNE-SSW, comprising sedimentary depositions from the Silurian period.

8.3.35 The upland areas are underlain by the Penstrowed Grits, comprising interbeds of sandstone turbidites, high matrix sandstone, subordinate conglomerate and interbedded turbiditic mudstone up to 1,750m in depth. This is further underlain by the Nant-ysgollon Mudstones, which outcrop or sub-crop along the face of the Afon Gam Valley. These are pale grey sandstones and darker grey or maroon mudstones

up to 150m thick. Nearing the valley base the Dolgau Mudstones predominate, composed of grey mudstone with thicknesses between 100 m and 150m. Directly below the Afon Gam are dark blue shales of the Glanyrafon Formation. The site is also intersected by the Llanerfyl Fault.

8.3.36 The area is also characterised by extensive soliflucted till deposits over the undulating moorland (blue clay observed in the cores) and patchy peat deposits with occasional blanket peat.

8.3.37 On the higher and steeper ground drift deposits are generally absent with bedrock at surface or underlying a thin soil and weathered rock layer.

Hydrogeology

8.3.38 The site as classified by the Environment Agency Aquifer Map, Bedrock designation has areas of secondary B aquifer and Secondary Undifferentiated Aquifer. These aquifers are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. Such minor aquifers will seldom produce large quantities of water for abstraction, although they are important both for local supplies and in supplying base flows to rivers. The secondary undifferentiated aquifer has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type. (www.environment-agency.gov.uk)

8.3.39 The underlying solid geology formations are not major aquifers and groundwater flow would largely be via occasional fissures or flow in near surface weathering zones. Nonetheless they are significant in local private water supplies and it should be presumed that there will be some shallow groundwater flow.

8.3.40 In effect the low permeability of the peat will act to store water and release it slowly over time, with the exception of the thin layer of acrotelm where flows can be more rapid. The underlying clay across much of the site will prevent infiltration and result in more rapid runoff and in some areas the development of flushes and other wetland habitats in areas of shallow gradient. Springs and discharge zones are present at breaks of slope, in areas of shallow gradient close to watercourses and where the glacial clay is at surface. In general groundwater occurrence is generally very local and flow is shallow.

8.3.41 A number of physical and hydrological properties of the peat such as hydraulic conductivity and groundwater level, were required to enable assessment of dewatering effects to be calculated.

Hydraulic Conductivity of Peat

8.3.42 To date, (as noted by Lewis *et al.* 2011), efforts at estimating hydraulic conductivity in peatlands using different field and laboratory methods have resulted in a wide range of hydraulic conductivity values as low as 10^{-8} ms^{-1} (Hogg and Price 1995) to as high as 10^{-2} ms^{-1} (Hogan *et al.* 2006) (Appendix 8.2 – literature review). Water movement in peat is complex and has been found to vary significantly between sampling sites. Holden and Burt (2003) found hillslope and catchment scale variability may be more important than plot scale variability and that depth and individual peat layers are not always significant controls on hydraulic conductivity. Although peat pipes can be significant on a local scale for groundwater flow they are unlikely to play an important role in a linear site such as this unless very frequent. No evidence of peat pipes has been observed in the numerous field visits by either the ecologists or hydrologists/hydrogeologists.

8.3.43 Given the reported variable nature of peatland hydraulic conductivity (Lewis *et al*. 2011)) and the large area of the site, it was not deemed practical to base the hydraulic conductivity on site specific data as a very large volume of samples would have been required which would have likely given a large range of values for the hydraulic conductivity.

8.3.44 As noted by the Environment Agency's Science Report "Hydrogeological impact appraisal for dewatering abstractions" (EA 2007), environmental uncertainty cannot be reduced, and knowledge uncertainty can only be reduced by scientific investigation. However, model, sample and data uncertainty can be reduced by the conceptual modelling process. For the purposes of a robust estimation of dewatering volumes, it was decided to reflect the differences in the hydraulic conductivity between the acrotelm and the catotelm, and to base these figures on an extensive literature review (Appendix 8.2).

8.3.45 The literature review determined that permeability values of 3 m/day (3.5×10^{-5} ms^{-1}) for the acrotelm and 0.003 m/day (3.5×10^{-8} ms^{-1}) for the catotelm were reasonable.

Groundwater Level Variation

8.3.46 While it is appreciated that there is no recognised direct link between NVC habitat classifications and groundwater level, it is considered that habitat types offer a reasonable indication of groundwater level. Therefore groundwater level across the site has been based on the NVC habitat classifications. The base of the acrotelm, 0.2m, (as defined in section 8.3.22) is assumed to be the minimum groundwater level in areas where peat is present.

8.3.47 The classification of whether each habitat is classified as wet or dry was undertaken by Ecology Matters and is presented in detail in Appendix 8.5. The code separation is as follows:

- **Wet habitats**: H12/M9, H12/M25, M15, M15/M23, M19, M19/H12, M19/M20, M19/M6, M20, M23, M23/M25, M25, M25/M6, M25/U5, M6, M6/M23, M6/M25, M6/U5, MG6/M23, NG7/M23, U20/M6, U4/M25
- **Dry habitats**: H12, H12/U5, H8, MG6, MG6/MG7, MG7, MG7/MG6, P, U20, U20/U4, U20/scrub, U4, U4/U20, U5

8.3.48 To calculate the average water table across the site for purposes of the carbon calculator an assessment was therefore undertaken of the area of infrastructure that coincided with wet or dry habitats and an average value taken. It should be noted that this is an approximation based on the range of water levels across this linear site and does not provide an understanding of the range or distribution of these levels.

8.3.49 The current average water level across the site is therefore estimated at:

- 0.10 m below ground level in the area of infrastructure that is located on peat; and
- 0.12 m below ground level for the whole of the infrastructure. (This has not been examined in detail as the concentration has been focused completely on peat).

8.3.50 This is based on the following assumptions:

- the wet habitats (as defined by the ecologist) have groundwater at surface;
- the dry habitats (as defined by the ecologist) have groundwater at the base of the acrotelm (0.2m);
- peat habitats are those defined by a probe depth of 0.1m or greater;

- the area of infrastructure on peat is 244,150 m^2 compared to a total area of infrastructure of 377,850 m^2;
- the area of infrastructure on peat and on wet habitats is 128,250 m^2 compared to 144,500 m^2 on all wet habitats; and
- the area of infrastructure on peat and on dry habitats is 116,100 m^2 compared to 198,100 m^2 on all dry habitats.

8.3.51 A programme of groundwater level monitoring to support hydrological characterisation of, and impact assessment for, the site has not been proposed as requested by NRW in April 2013. Given the large and effectively linear nature of the site which corresponds to numerous habitats, slopes and surface water catchments, the number of tube wells required and the duration of monitoring to ensure a sufficiently dry period was recorded would prove prohibitive.

Water Dependent Habitats

8.3.52 NRW has indicated the presence of a number of water sensitive habitats in much of the higher ground in the site. These are unimproved wet heath, blanket mire and marshy grassland. The habitat map completed by Ecology Matters has indicated blanket bog, acid flush and marshy grassland.

8.3.53 Assessment of the Groundwater Dependent Terrestrial Ecosystems (GWDTE) (Appendix 8.5) indicates the presence of 399 ha of High dependency GWDTE and 234.4 ha of Moderate dependency GWDTE in comparison to the 1695 ha that comprise the site.

8.3.54 The infrastructure excavations will comprise a total area of 37.8 ha which will result in a total loss of approximately 15 ha of peat mire habitat of which 9.6 ha are GWDTE with 5 ha (1.2%) of High dependency GWDTE and 4.6 ha (2%) of Moderate dependency GWDTE. This compares to peatland habitat enhancement of about 350 ha.

Soligenous Fen

8.3.55 The fen is located at an elevation of between 400m AOD and 410m AOD on a small plateau in an upland area called Esgair y Ffordd in the Afon Gam catchment (Figure 8.4). The plateau slopes gently for just over a kilometre south to the Afon Gam river valley at 250m AOD.

8.3.56 The fen occupies a series of hollows and is found in two separate parts or areas. These are elongated approximately WNW to ESE and follow the run of the slope. Each part is slightly less than 1 hectare. The western fen is to the west of the plantation and is separated by a strip of forest which forms part of a larger area of forestry plantation from the eastern fen. The eastern fen is entirely surrounded and encroached upon by plantation. The eastern fen gives rise to several minor watercourses in the south downslope.

8.3.57 Within the plantation there are also several raised bogs, now obscured by plantation, but can be seen on aerial photos where they are marked by lesser development of tree growth.

8.3.58 CCW stated (response presented in superseded SEI1) '*The fen is likely to be predominantly surface water fed; it may also be receiving some groundwater inflow via what would probably be considered as minor fracture flow from the bedrock.'*

Vegetation

8.3.59 The fen vegetation comprises a range of short to knee high bog and poor fen plant communities and mapped as M6/M25 mosaic. It is surrounded by grassland and marsh habitats (U5, U4) as well as forestry plantation. It is waterlogged and fully saturated to the surface upon the several visits. It is likely that the relict open mire habitat is now confined to a quarter or less of its original presumed area.

Geology

8.3.60 Cores taken in the fen show that there are upwards of 3m deep peat underlying the fen. These are amongst the deepest peat depths recorded in the whole wind farm site. The raised bog habitats being distant from any infrastructure were not probed or cored.

8.3.61 From the series of cores taken across the wind farm, it is very likely that the peat rests on relatively impermeable glacial boulder clay, although this was not seen within the cores taken as the peat was greater than 3m deep.

8.3.62 This likelihood is strengthened by earlier correspondence with the British Geological Society which revealed that the drift in the area comprises valley fill glacial sediment with patchy peat and glacial material on the plateau.

8.3.63 The solid geology beneath this area is comprised of sedimentary depositions from the Silurian period, specifically the Penstrowed Grits, comprising interbeds of sandstone and mudstone.

Hydrology

8.3.64 The fens are wetlands underlain by thick peat and clay and characterised by high soil water levels as evidenced by current conditions and the vegetation assemblage. Ground conditions both within and south of the main fens are waterlogged and marshy. It is only on the west and north scarp slopes and within the plantation that the soils are not water logged.

8.3.65 The bedrock is very likely to be separated by the clay from the peat and will not therefore be in hydraulic continuity with the fen, except to the north and west near the ridges where there are likely to be small narrow strips of unsaturated rock. These will have very small catchments. There is no evidence of springs in the area, but some evidence of seepage lines along the edge of the hollows where the more solid ground rises with grassland communities, again in very narrow strips. Thus groundwater is unlikely to be a significant provider of water to the fen although will be part of the mix. Shallow groundwater catchments are assumed to be similar to that of the surface water on the northern and the western scarp edges, but are likely to be more integrated in the south where there are large flatter areas.

8.3.66 It is likely that the forest plantation has significantly altered the mire and fen hydrology by dewatering and degrading peat both by tree roots, drying out and intercepting rainfall supply.

8.3.67 The fens as currently existing have very small limited surface water catchments, no more than twice the extent of the fens.

8.3.68 There is a small pool in the higher western fen and a historical waterlogged ditch aligned east- west and possibly several historic drains within the eastern mire. It is likely that these historical drains and the adjacent forest drains have lowered water levels although now the ditches are not flowing and are waterlogged with strong vegetation regrowth taking place.

8.3.69 In the lower eastern fen, several unnamed watercourses arise from the southern fen edge and flow south to the Afon Gam confirming the fen is a valley-head fen forming the source or headwaters of these streams.

8.3.70 Topographical controls – the combination of hollow and slope – and the geology and ecology assemblage suggest that the side of the fens are fed by lateral surface water, i.e. are soligenous, but that this is unlikely to extend into the centre of the fens other than in times of high saturated surface water flow. Direct input from rainfall must be considered an important component of water supply to the fens as the fens are small and it is difficult to make any distinction. There may be some limited groundwater input at the edges.

Designated Sites

8.3.71 There are no international designations located within the boundary of the proposed site, however the application site is located in the vicinity of the following designated sites (Table 8.7 and Figure 8.1).

Table 8.7 Designated Sites.

Designated Site	Grid Reference	Site Area (ha)	Approximate distance from proposed site boundary (m)	Approximate distance from nearest infrastructure (m)	Reason for designation	Catchment
Gweunydd Dolwen SSSI	SH 975071	2.3	200m	275m	Acid and neutral dry grassland	Afon Gam
Corsydd Llanbrynmair SSSI	SH 909102, SH 913117 & SH 940100	35.6	700m	1700m	Blanket bog.	Afon Cannon and Afon Banwy

8.3.72 The closest designated site to the proposed site is Gweunydd Dolwen SSSI which is 275m from the closest site infrastructure (one of the access tracks). This site consists of two enclosures on either side of the Afon Gam, however there is no potential hydrological link from site infrastructure to this grassland.

8.3.73 The Corsydd Llanbrynmair SSSI is a minimum of 1700m from site infrastructure and there is no hydrological link between proposed activities and this area of blanket bog.

8.3.74 Due to the lack of hydrological connectivity with site infrastructure neither of these designated sites are considered further.

Groundwater: Vulnerability to Pollution

8.3.75 The minor aquifers on site are of low to intermediate vulnerability to pollution as defined by the EA's Groundwater Vulnerability Zones.

8.3.76 The site is not within a Nitrate Vulnerable Zone nor is it within a groundwater source protection zone.

8.3.77 The overall chemical quality of the groundwater body on site as monitored by the Environment Agency is poor (deteriorating) and it is predicted to stay as poor quality in 2015. The quantitative quality of the groundwater which considers the degree to which the groundwater body is affected by direct and indirect abstractions is good and is predicted to remain as good by 2015.

8.3.78 The EA provide information on the pressures (point source pollution, diffuse source pollution and water abstraction and flow regulation) on the groundwater. These are

then assessed as risks to the groundwater failing the Water Framework Directive. The groundwater at the site is associated with the Severn River Basin District and has been assessed as being probably not at risk from the pressures outlined above.

Hydrology

8.3.79 The site lies within the Afon Gam catchment and the Afon Cannon sub-catchment and Afon Craigyfran sub-catchment. The Afon Banwy catchment lies outwith the site to the north and the Afon Rhiwsaeson sub-catchment outwith the site to the west. The Afon Gam is within the Severn River Basin District.

8.3.80 The Afon Gam flows in a north easterly direction and comprises the south eastern site boundary. The southern extent of this catchment is the headwaters of the Afon Gam and is comprised of a number of unnamed tributaries. The remaining area of the site predominantly flows eastwards through a number of tributaries (e.g. Nant y Graig, Nant Rhaeadr, Afon Cannon, Nant Craigyfrân and Nant Ffriddycastell) to discharge into the Afon Gam.

8.3.81 The Afon Banwy is located to the north of the site and flows from west to east. The Afon Gam discharges to the Afon Banwy at Llangadfan.

Catchment Response

8.3.82 Given the size, topography, land use and geology of the area it is likely that the catchments in the site will be very flashy. This means that flow in them will respond rapidly to rainfall and flood conditions could potentially occur with very little, or no, warning. Base flows in the watercourses are unlikely to dry up as the peatlands will sustain them due to steady seepage from these low permeability deposits. This is confirmed by local residents and the lack of any drinking troughs for livestock across the whole of the area suggests that there is a constant seepage of water from low permeability deposits.

Watercourse Crossings

8.3.83 A total of 22 watercourse crossings will be constructed on site. Of these 18 are new and 4 are existing and will be upgraded (Table 8.8)

Table 8.8 Inventory of watercourse crossings.

Number	Watercourse	Location	Grid Ref (SH)	Type of Crossing	Description	Photograph (Appendix 8.7)
1	Drain	East access track	97030 07130	Existing	Culverted drainage channel. Narrow, incised channel, eroded to base. Currently partly collapsed and in need of replacement.	Photos 12 and 13
2	Nant Craigyfrân tributary	Access track up to R35	96580 08070	New	Approx. 2m wide incised channel, eroded to a gravel, cobble and clay base. Moderate gradient with steep sided banks in places. Less than 50m upgradient of woodland.	Photos 14 and 15

Number	Watercourse	Location	Grid Ref (SH)	Type of Crossing	Description	Photograph (Appendix 8.7)
3	Nant Craigyfrân	Between R26 – R37	95540 09020	New	Incised small channel with more significant floodplain – approx. 5m wide cut into a terrace. The channel is generally incised down to the clay/mineral ground and has a shallow/moderate gradient.	Photos 16 and 17
4	Nant Craigyfrân tributary	Between R36 – R35	95630 08300	New	Narrow channel <1m width, generally incised to clay base. Shallow gradient with low flow.	Photo 18
5	Nant Gwyddior	Between R19 – R25	94725 07500	New	High bedload with bedrock exposed in places. About 1.5 m wide but flood width will be significantly greater, exceeding 3m. This site seems the optimal area to cross the watercourse as it has less steep banks and a lower (moderate) gradient	Photo 19
6	Afon Cannon tributary	Between R25– R17	95060 07000	New	Broad diffuse channel approx. 5m wide. No specific channel observed.	Photos 20 and 21
7	Afon Cannon tributary	Access track up to R17	95220 06920	New	Broad diffuse drain approx. 5m wide	Photos 22 and 23
8	Afon Cannon tributary	Between R25– R17	95150 06830	New	Broad diffuse channel approx. 5m wide. Very boggy with no specific channel observed.	Photos 24 and 25
9	Afon Cannon tributary	Between R17 – R42	95290 06620	New	Drain within discharge zone. Moderate gradient. 0.5m wide. Eroded to clay base.	Photos 26 and 27
10	Afon Gam tributary	Between R42 and R24	95335 06400	New	Very narrow, steep and incised with clay and gravel bed. Only 1m or less wide with a steep approach.	Photos 28 and 29
11	Afon Gam tributary	Between R14 and R15	94785 06370	New	Diffuse flow and discharge zone with various small channels. One main channel around crossing area with moderate gradient about 1m wide and shallow side slopes.	Photos 30 and 31

Number	Watercourse	Location	Grid Ref (SH)	Type of Crossing	Description	Photograph (Appendix 8.7)
12	Afon Gam tributary	Between R42 and R16	94420 06560	New	Diffuse flow with no clear channel until further down gradient. A drain runs along the fence line to the west.	Photos 32 and 33
13	Nant y Graig Lwyd tributary	Between R23 and second access point	94750 05830	Existing	Approx. 2m wide stream of shallow to moderate gradient. Bed is rocky and clay. Existing watercourse crossing is comprised of one 0.3m pipe culvert.	Photos 34 - 36
14	Nant y Graig Lwyd tributary	Between R23 and second access point	94630 05750	New	Narrow <1m incised stream cut into soil. Channel eroded to clay/gravel base and occasionally runs on soil/vegetation surface.	Photos 37 and 38
15	Nant y Graig Lwyd tributary	Between R23 and second access point	94670 05690	New	Narrow <1m incised stream cut into soil. Channel eroded to clay/gravel base and occasionally runs on soil/vegetation surface.	Photos 39 and 40
16	Afon Gam tributary	Access track up to R12	94380 05370	Existing	Newly constructed drains to clay with gravel base. Approx. 1m wide with 8" culvert.	Photos 41
17	Afon Gam tributary	Access track up to R12	94400 05500	Existing	Newly constructed drains to clay with gravel base. Approx. 1m wide with 8"culvert.	Photo 42 and 43
18	Afon Gam tributary	Between R12 and R13	94365 05580	New	Wide channel, diffuse flow. No clear channel as some multiple channels. Flow is over vegetation surface and occasionally incised into soils.	Photo 44
19	Afon Gam tributary	Between R12 and R13	94260 05720	New	Narrow channel with much vegetation (reeds). Eroded to clayey soil in places. Steep gradient by shallow banks.	Photos 45
20	Afon Gam tributary	Between R41 and R9	93080 03730	New	Narrow channel <1m wide.	Photo 46

Number	Watercourse	Location	Grid Ref (SH)	Type of Crossing	Description	Photograph (Appendix 8.7)
21	Afon Gam	Between R41 and R39	93050 03470	New	About 2m wide – moderate gradient, undercutting of bank evident with active erosion/deposition occurring, shale bedload, peat colouration and wide flood zone in places	Photos 47 and 48
22	Afon Gam	Between R31 – R5	92540 03810	New	About 1m wide – moderate gradient, undercutting of bank evident, peaty colouration, clay soil exposed in bank with rocky bedload	Photos 49 and 50

Water Quality

8.3.84 As part of the River Basin Management Planning process, the Environment Agency monitors the quality of surface water. Good status is a statement of 'overall status', and has an ecological and a chemical component. Ecological status is measured on the scale high, good, moderate, poor and bad. Chemical status is measured as good or fail. Good ecological status applies to natural water bodies, and is defined as a slight variation from undisturbed natural conditions. Specific standards and targets are measured as developed by the Water Framework Directive UK Technical Advisory Group (UKTAG) and the European Union to determine the overall status of each waterbody.

8.3.85 The Afon Gam from its source to its confluence with the Afon Cleden is classified as having good ecological status. The chemical quality for ammonia, dissolved oxygen, pH and phosphate is high with a high overall physico chemical quality. The overall hydro morphological quality is not high, with hydrology being classified as high and morphology as good. The overall specific pollutants quality is classified as high.

8.3.86 From the confluence of the Afon Gam with the Afon Cleden to its confluence with the Afon Banwy the overall ecological quality is classified as moderate, predicated to increase to good by 2015. Overall biological quality is good with good macro invertebrates. The chemical quality for ammonia, dissolved oxygen, pH and phosphate is high with a high overall physico chemical quality. The overall hydro morphological quality is not high, with hydrology being classified as high and morphology as good. The overall specific pollutants quality for this stretch is moderate with high quality for ammonia and moderate quality for copper and zinc.

8.3.87 None of the other surface waters within the site have been classified under WFD.

8.3.88 The EA also provide information on the pressures (point source pollution, diffuse source pollution, water abstraction and flow regulation, physical or morphological alteration and alien species) on the rivers under the Water Framework Directive (WFD). These pressures along a stretch of river are assessed in order to determine whether they pose a potential risk to the river failing to achieve good status under the WFD.

8.3.89 The Afon Gam has been assessed as probably at risk due to diffuse source pollution. Further downstream, from its confluence with the Afon Cledan (downstream of all site infrastructure), it becomes at risk due to diffuse source pollution.

River Flows

8.3.90 There is a river gauging station (number 64008) on the Afon Cwm in this area at NGR SH 916 083, however it is no longer in use.

Private Water Supplies and Abstractions

8.3.91 The EA advised (14th July 2006) that there are approximately six private groundwater abstractions within the Site, with further groundwater abstractions in close proximity to the site. The EA does not require a licence for abstractions that are 20m^3 or less per day, so not all abstractions may be identified. The EA have provided no indication of licensed groundwater or surface water abstractions in the vicinity of the Site.

8.3.92 During the initial Enviros site visit in May 2006, a number of local residents confirmed that they did use on-site springs and wells for private water supplies. This was then confirmed by letter.

8.3.93 Prior to the more detailed Enviros site visit in July 2008 properties that were within the site boundary, and in close proximity to it, were contacted with a questionnaire regarding their water supply (Appendix 8.6). These were then followed up with a visit on the 8th and 9th July 2008.

8.3.94 In February 2013, a review of landowner boundaries within the catchments of interest was undertaken to assess the potential for additional private water supplies.

8.3.95 The following table and data list gives further information on PWS (Table 8.9).

Table 8.9 Private Water Supplies in the vicinity of the Proposal.

PWS	Property	Information received	Visited	Photograph (Appendix 8.7)
PWS 1	Dolwen	Yes	Yes	Photo 1
PWS 2a and 2b	Cannon Farms	Yes	Yes	Photos 2 and 3
PWS 3	Abercannon	Yes	Yes	Photo 4
PWS 4a and 4b	Neinthirion	Yes	Yes	Photos 5 and 6
PWS 5	Dolau Ceimion	Yes	-	-
PWS 6a and 6b	Cwmderwen	Yes	Yes	Photo 7
PWS 7	Cwm Pen Llydan	Yes	Yes	Photo 8
PWS 8	Cwm Ffynnon	Yes	-	-
PWS 9	Ffridd Fawr	Yes	Yes	Photos 9 and 10
PWS 10	1 Glanllyn	Yes	-	-
PWS 11	Gilwern	Yes	-	-
PWS 12	Clegyrddwr	Yes	-	-
PWS 13	Cwmcarnedd Uchaf	Yes	Yes	Photo 11
PWS 14	Cwm-carnedd-isaf	-	Yes	-
PWS 15	Hafodowen	Yes	-	-

8.3.96 Additional properties were also identified in close proximity of the site, although no information on water supply was received from the properties Berth-lwyd, 2 Glanllyn, Pwll-melyn and Caeau-gleision. All of these are located within the Afon Rhiwsaeson catchment which has no proposal infrastructure within it and therefore can be scoped out of the assessment. Pentre-lludw was found to be an abandoned property and is also scoped out of the assessment.

8.3.97 **PWS 1 Dolwen** The PWS at Dolwen is a borehole which serves the two properties. The borehole (SH 9750 0756) was installed in 1993 and is used for drinking and household supply. Water is pumped to a tank in the house and does not undergo any form of treatment. There have not been any problems with the quality or clarity of the supply. This well is located within the Afon Gam catchment with a section of access track and a borrow pit upgradient, however there are a number of drainage ditches and small streams intersecting any runoff or shallow groundwater flow from the proposal. The likely associated groundwater catchment indicates there is unlikely to be a potential connection to the wind farm activities.

8.3.98 **PWS 2a and 2b Cannon Farms** This PWS serves two properties – Cannon and Yseubor Cannon. Cannon is occupied by four people permanently and Yseubor Cannon is currently a holiday home which may become permanently occupied. There are two springs (SH 95642 07767 PWS 2a) and SH 959 079 PWS 2b) which feed a large collection tank at SH 95690 07705. Five metres up gradient is a smaller concrete settlement chamber. There is also a cattle trough at SH 95674 07790 fed by the small stream. Water is then piped down to the properties. Water is treated through a filter and UV which get changed every 6 months and annually respectively. Every 3 years the water is tested and there have been no problems with quality or clarity. There are seasonal variations in the flow. The two springs and cattle trough are located within the Afon Cannon catchment. No proposal infrastructure is located upgradient.

8.3.99 **PWS 3 Abercannon** The PWS at Abercannon consists of a brick well (SH 95868 06699) and collection tank (SH 95882 06702). The well is about 1.5m deep and is located about 20m distant from the stream and at an elevation several metres above stream level. Water is piped via a plastic pipe underground to the storage tank in the house. Only one person lives in the house and water is used for domestic supply and drinking water. There is no treatment of the water and no records of any water quality testing. This abstraction is located within the Afon Canon catchment and down gradient of a number of proposed turbines, tracks and new water crossings, however the location of the PWS and likely associated shallow groundwater catchment indicate there is unlikely to be any connection to the proposal activities.

8.3.100 **PWS 4 Neinthirion** There are two PWS at this property – a borehole (unknown depth) supplying the property (PWS 4a) and a shallow well used for livestock (PWS 4b). Water is pumped from the borehole (SH 9641 0659) (installed June 1997) into a settlement and storage tank and then to a pressure vessel. The water undergoes treatment through filtration and UV for domestic use and drinking water. Five years ago the water was independently tested and post treatment showed Iron 205 µg/l, pH 7.2, Manganese 2 µg/l, Zinc 3 µg/l and Conductivity 375 µS/cm. These parameters are below the maximum concentrations prescribed within the Private Water Supplies Regulations 1991 for England and Wales, except for Iron which has a maximum prescribed concentration of 200 µg/l. The well (SH 9642 0663) is located alongside the stream and is a backup water source and used mainly for livestock supply. Yearly maintenance and inspection is carried out on both the supplies and water quality records are available. These abstractions are located close to the stream issuing from the southern part of the Afon Canon catchment where some proposal infrastructure is located upgradient, including two new watercourse crossings. Although the well is located close to the stream the proposed

watercourse crossings and turbines are more than 1km away and there is significant filtration occurring. Any connection with the proposal is therefore likely to be limited.

8.3.101 **PWS 5 Dolau Ceimion** The PWS at this property is a well at SH 967 054, on the opposite bank of the Afon Gam to the property. The water is treated through a filter and used for drinking, household supply and livestock. This well is located within the Afon Gam catchment, on the opposite side of the river to any proposal infrastructure. Therefore no infrastructure is located upgradient.

8.3.102 **PWS 6 Cwmderwen** The PWS at this property serves two properties (the main house and a bungalow – Delfryn – with 3 and 4 people respectively) and livestock. The upper water supply is a spring at SH 95055 05841 (PWS 6b) and a lower water supply is a borehole about SH 9517 0571 (PWS 6a) about 5m above the stream level. Over time the source used as the principal supply for these two properties has varied. The water supplies from the two sources are collected within a chamber and then gravity fed down to the properties. The water undergoes no treatment and was tested a few years ago by the Council, however no information on quality was available. There is variation on flow, but it does not dry up. The water can be peaty and cloudy during high flows. This borehole and spring supply are located close to the Nant y Graig Lwyd, a tributary of the Afon Gam. Some proposal infrastructure is located upgradient of the lower supply which includes the access track and a new watercourse crossing upstream, however there are no wind farm infrastructure located upstream of the upper supply.

8.3.103 **PWS 7 Cwm Pen Llydan** The PWS at this property is a spring collection tank (SH 9283 06281). The tank is fed from collector drains and about 1.5m deep and 2m in diameter. Water is then gravity fed to the property. The water is used for household use and undergoes no treatment. Two people live in the house. This supply is located within the Afon Rhiwsaeson catchment which has no proposal infrastructure within it.

8.3.104 **PWS 8 Cwm Ffynnon** This PWS is a 6 foot deep well fed by a spring which was installed in 1966. There is a storage tank (SH 913 053) by the well with pipes then leading down to the property. The water is filtered and the well is cleaned and flushed every two years. There have been no previous problems with the quality or clarity of the supply. The water is used for the household supply, drinking and the livestock. Greater volumes are required in the winter months when the livestock are housed. The supply drops during the dry summer months, but has never dried up. This supply is located within the Afon Rhiwsaeson catchment which has no proposal infrastructure within it.

8.3.105 **PWS 9 Ffridd Fawr** This PWS comprises a borehole and old well. The borehole (SH 9463 0391) was installed approximately 10 years ago and the water is pumped to a header tank in the property. The water undergoes no treatment. The old well (SH 9462 0394) is within a shed close to the Afon Gam and the pump has been removed. This supply is located within the Afon Gam catchment with a section of track upgradient of the borehole, however the location of the PWS and likely associated shallow groundwater catchment indicate there is unlikely to be any connection to the proposal activities.

8.3.106 **PWS 10 No 1 Glanllyn** This property is on mains supply but has rights of access to a well which is in the grounds of the adjoining house (assumed to be No 2 Glanllyn). No further information regarding this well is known. This well is located within the Afon Rhiwsaeson catchment which has no proposal infrastructure within it.

8.3.107 **PWS 11 Gilwern** This is a well (SH 908 038), installed in 1981, that is used for house supply. It is connected to an 800-gallon storage tank located approximately 100m downhill (SH 907 038). This supply is located within the Afon Rhiwsaeson catchment which has no proposal infrastructure within it.

8.3.108 **PWS 12 Clegyrddwr** There are three wells located at SH 9107, SH 9087 0382 and SH 9138 0415. One of the wells was installed in 2004, is 6 feet deep and connects to a 1000 gallon storage tank. It is used for drinking water, house supply and livestock watering. This supply is located within the Afon Rhiwsaeson catchment which has no proposal infrastructure within it.

8.3.109 **PWS 13 Cwm-carnedd Uchaf** This PWS is a spring and tank at SH 91651 03404. The supply serves the whole farm and undergoes no treatment or testing. This supply is located within the Afon Iaen catchment which has no proposal infrastructure within it.

8.3.110 **PWS 14 Cwm-carnedd-isaf** There is a spring PWS, in the field in-between two properties (SH 9191 0274), which has no treatment. This is not currently used as the property is empty. This supply is located within the Afon Iaen catchment which has no proposal infrastructure within it.

8.3.111 **PWS 15 Hafodowen** This PWS is a spring within the half acre of land the property stands in (SH 9276 0272). The spring feeds into a 1000 litre stainless steel tank and undergoes filtration. The water is used for drinking and household use, approximately 500 litres. The tank is cleaned annually. There are seasonal variations in flow and have been no problems with the quality or clarity of the supply. This supply is located within the Afon Iaen catchment which has no proposal infrastructure within it.

8.3.112 The majority of the private water supplies listed above are not within the catchments potentially affected by the proposal, or are not located down gradient of any proposal infrastructure. Table 8.10 below lists those PWS that could potentially be affected.

Table 8.10 Potentially affected PWS.

	Private water supplies	
Name of Property	**Source**	**Use**
Dolwen (PWS 1)	Groundwater	Domestic use and drinking water
Abercannon (PWS 3)	Groundwater	Domestic use and drinking water
Neinthirion (PWS 4)	Groundwater	Domestic use, drinking water and livestock
Cwmderwen (PWS 6a)	Lower spring	Domestic, drinking water and livestock
Ffridd Fawr (PWS 9)	Groundwater	Domestic use and drinking water.

Discharges

8.3.113 The Environment Agency (November 2006) provided information about effluent discharges within 6km of SH 9400 0600 which is a central point within the site. In addition the Environment Agency website was consulted in order to provide any further discharges that were of note (Table 8.11).

Table 8.11 Effluent discharges in the vicinity of the Proposal.

Site	Receiving water body	Effluent Description
Environment Agency November 2006		
Ffrid-Fewr (SH 94700 03900)	Underground strata	-
Cannon (SH 95890 07420)	Afon Cannon	Sewage effluent
Dolau (SH 96400 05840)	Afon Gam	Sewage effluent
Abercannon (SH 96280 06930)	Afon Cannon	Sewage effluent
Abercannon (SH 96280 06932)	Tributary of Afon Gam	Farm effluent
Dolau Ceimion (SH 96280 06931)	Afon Gam	Farm effluent
Llanbrynmair Estate (SH 97530 07620)	Tributary of Afon Gam	Sewage effluent
Environment Agency website		
Clegurnant Llanbrynmair	Afon Cwm	Sewage effluent
Llan Llanbrynmair PS	Afon Twymyn	Sewage effluent
Llan Llanbrynmair PS	Afon Twymyn	Sewage effluent
Llan Llanbrynmair STW	Afon Twymyn	Sewage effluent

Fisheries

8.3.114 Ecological survey data provided by the EA indicates that the Afon Gam and its tributaries have populations of brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), Bullhead (*Cottus gobio*), European minnow (*Phoxinus phoxinus*) and European stone loach (*Barbatula barbatula*). The most recent electrofishing survey, carried out in 2000, found good densities of juvenile salmonids in the upper reaches of the Afon Gam and as such indicate that this area supports significant spawning habitat. This area will therefore be very sensitive to changes in flow and/or water quality, particularly the generation of excessive suspended solids. More recent electrofishing data is not available. However, invertebrate surveys carried out in 2005 found good to excellent invertebrate numbers in the Afon Gam catchment, indicating no deterioration in ecological quality over the intervening years.

8.3.115 Discussion with local angling clubs and landowners has established that angling is a popular sport in this area particularly for brown trout. It is likely that all significant watercourses in the vicinity of the site are used recreationally for this activity.

Flooding

8.3.116 The Welsh Government has published the development advice map (DAM) for the entirety of Wales. This map classifies areas into flood zones A, B and C according to the assessed risk of flooding from tidal and major fluvial sources[30]. The maps are based on the Environment Agency's extreme flood outlines (zone c) and the British Geological Survey drift data (Zone B).

8.3.117 Within flood zone A it is considered that there is little or no risk of flooding, flood zone B relates to areas where drift deposits indicate flooding has historically occurred and flood zone C represents areas where there is believed to be a current

[30] It should be noted that small features and other types of flood sources will not be covered.

risk in excess of 0.1% annually. Flood zone C is then broken down into C1 and C2 representing defended and undefended area respectively.

8.3.118 The section of the DAM covering the Llanbrynmair wind farm site shows that virtually the entire site is in flood zone A. The only element of the development that extends into flood zone C2 is one crossing of the Afon Gam watercourse at NGR SH 93100 03440 between turbines R39 and R41.

8.3.119 The flood extent shown on the DAM was generated as part of the Environment Agency's national flood mapping programme which only covers watercourses with catchment area of greater than 3 km^2. As such whilst flooding may occur along smaller features these would not be represented on the DAM.

8.3.120 A review of all watercourse crossings on the site identified an additional 3 watercourse crossings with catchment areas greater than 1 km^2 but less than 3 km^2 (and therefore not identified on the DAM).

8.3.121 The potential probability and significance of flooding associated with the development at each of the four crossing locations was considered. To assess the potential effect on these crossings and provide design flows form specific return periods an additional flood risk assessment with rainfall runoff modelling has been undertaken (Appendix 8.8).

8.4 Site Sensitivities and Possible Hydrological. Hydrogeological and Geological Effects

8.4.1 The assessment of significance of effects is based on the magnitude and sensitivity criteria described above. Sensitive receptors identified for the site are:

- Surface watercourses, including:
    - the Afon Gam and its tributaries (as spawning habitat);
- Groundwater;
- Private water supplies;
- Water dependent habitats; and
- Peat land habitats, including the soligenous fen (Esgair-y-ffordd)

8.4.2 Based on the assessment criteria defined in Table 8.3, a summary of the site sensitivities is presented in Table 8.12.

Table 8.12 Hydrologically Sensitive Receptors.

Hydrologically Sensitive Receptors		Sensitivity	Rationale / Designations
Terrestrial	Mire (inc Blanket Bog), groundwater dependent terrestrial ecosystems	High	UK BAP, Habitats Regs, Section 42
Groundwater	Deep groundwater	High	Used as PWS for Dolwen and Neinthirion
	Shallow groundwater	High	Maintains wet habitats and peat saturation Used as PWS for Abercannon, Cwmderwen, Neinthirion and Ffridd Fawr.
Watercourses	Afon Gam main stem and upper tributaries	High	Spawning habitat

	Afon Gam lower tributaries	Medium	Spawning habitat

8.4.3 This section describes the potential effects of the proposal based upon an assessment of the activities which will occur during the construction, operational and decommissioning phases of the wind farm development, in relation to the sensitive areas of the site, prior to mitigation and management. The purpose of this assessment is to identify key areas of concern where specific mitigation and management measures are required.

8.4.4 Possible hydrological, hydrogeological and geological effects resulting from the construction, operation and decommissioning of wind farms are related to five main factors:

- Erosion and Sediment Transport - Unmanaged erosion/sediment deposition and suspended solids generated from ground disturbance and new infrastructure could travel directly by surface run-off or cause modification to stream channel morphology, with resulting smothering of habitats/effect on both terrestrial and aquatic flora and fauna, especially fish. This could also result from slides of incorrectly stored excavated materials. Unacceptable levels of sediment could also affect water abstracted for drinking supply;
- Potential Polluting events affecting Groundwater and Surface Water Quality - Oil/Fuel/Chemical pollution (from for instance, accidental spillage or incorrect transport or storage during concrete preparation and refuelling procedures, or from leaching of concrete from turbine bases and installations) could effect both terrestrial and aquatic flora and fauna and also on human activities such as water abstracted for drinking supply. These could include:
    - Direct disturbance of the banks and bed of watercourses during watercourse crossing construction, repair and/or upgrade works or during cable installation within the watercourse bed;
    - Pumping of standing water required for dewatering of excavations such as turbine bases, borrow pits or as required for drainage management purposes;
    - Runoff from exposed ground, excavations and material stockpiles (aggregate and excavated/overburden peat and soil), cable trenches and tracks;
    - Runoff from tracks, bridges and culverts crossings at watercourse and drain crossings;
    - Runoff from recently reinstated areas (road verges, borrow pits etc);
    - Movement of stockpiled material;
    - Cement wash out areas, storage areas and other areas where cement grout or concrete is being applied;
    - Plant washing and vehicle wheel wash areas;
    - Fuel and chemical storage/refuelling areas;
    - Leaking/vandalised plant and equipment; and
    - Sewage and waste water from construction compound and permanent control building amenities.
- Alteration of Natural Drainage Patterns/Runoff Volumes and Rates - Any alteration of natural drainage could disturb natural surface and subsurface water flows to either water dependent habitats or to water supply abstraction

points, unless properly managed. Tracks and other hardstand areas could provide new preferential pathways and interfere with the retention of flows within catchments. Inappropriate water crossings could result in blockages and flooding, with the potential to exacerbate erosion. Storage of peat or other excavated material in inappropriate locations could result in an alteration to water flows and in an increase in peat slide risk in hazard prone areas;

- Increase in the Magnitude or Frequency of Flood Events – The construction of bridges or alteration of areas on floodplains may result in flood waters extending further or deeper elsewhere and/or increase the frequency of such events. This could result in risk to human life/health, damage to infrastructure, devaluing of land and change to ecological systems; and
- Alteration of the geological environment– The excavation of the subsoil is required to build the site infrastructure such as turbine bases and access roads and will result in an alteration of the geological environment, in particular any underlying peat may be removed and will need to be managed appropriately. Peat land habitats take 1,000s of years to develop and appropriate restoration plans are required to ensure the net balance is positive.

8.4.5 The potential effects of wind farm developments are summarised below in Table 8.13. It is noted that the effects listed in Table 8.13 are only potential and their inclusion does not necessarily indicate that they will occur.

8.4.6 Specific advice on the potential effects at the site as received from consultees is presented in Table 8.4. More detailed discussion on the specific effects which may arise within the site is presented further in Section 8.8 of this Chapter.

Table 8.13 Summary of potential effects on hydrology/hydrogeology and peatlands arising from wind farm developments (summarised from Environment Agency (2002) *Scoping Guidelines on the Environmental Impact Assessment (EIA) of Projects*. Environment Agency (EA), Bristol).

Potential Receptors	Activities and Potential Effects		
	Construction Phase	Operation Phase	Decommissioning Phase
Surface water hydrology and channel morphology	**Works next to or near watercourses** • change in flow velocities • increased erosion and subsequent changes in bed and bank stability • increased flood risk	**Use of vehicles and machinery** • increase in surface runoff from soil compaction • run off from access roads	**Use of vehicles and machinery to remove turbines and associated infrastructure** • temporary increase in surface runoff from soil compaction
	Use of vehicles and machinery • increase in surface runoff from soil compaction	**Site drainage** • rapid transfer of rainwater to watercourses via drains	
	Earthworks • increased sedimentation of watercourses		
Surface water quality	**Earthworks** • pollution from suspended material • disturbance of contaminated soil and subsequent pollution of water courses	**Materials management** • pollution from maintenance work spills or leaks of fuel or oil	**Use of vehicles and machinery to remove turbines and associated infrastructure** • contamination from spills or leaks of fuel or oil
	Materials management • pollution from spills or leaks of fuel, oil and construction material	**Use of machinery** • sediment-loading of watercourses	
Groundwater hydrology	**Earthworks and site drainage** • reduction in water table • changes to groundwater distribution and flow	**Physical presence of turbine foundations** • possible minimal alteration of groundwater flow	**Physical presence of turbine foundations** • possible minimal alteration of groundwater flow
Groundwater quality	**Earthworks and site drainage** • disturbance of contaminated soil and subsequent pollution of watercourses and/or groundwater potentially effecting dependent ecosystems	**Materials management** • contamination from spills or leaks of fuel and oil	**Use of vehicles and machinery to remove turbines and associated infrastructure** • contamination from spills or leaks of fuel or oil
	Materials management • Pollution from spills or leaks of fuel, oil and construction material		
Geological Environment	**Earthworks and site drainage** • reduction in water table resulting in the drying out of peat • excavation and removal of peat	**Site drainage** • Continued dewatering of peat	**Site drainage** • Continued dewatering of peat

8.4.7 During the development and lifetime of the wind farm there will be some activities which, if not properly managed, would have the potential to lead to significant effects on the surface and groundwater environment.

8.4.8 The main construction activities are described in Chapter 3 and the site layout is shown in Figure 3.6. Further details are given below.

8.5 Best Practice and Standard Mitigation Methods

8.5.1 There are many best practice techniques that will be employed at Llanbrynmair during the construction and operation of the wind farm. The most important aspects are summarised here. These techniques have been assumed when completing the risk assessment and are considered the standard that will be applied and are not considered as mitigation. This list is not exhaustive and guidance and best practice literature will be used. Mitigation measures are over and above these standards and will be specific to the source-pathway-receptor identified at risk.

8.5.2 A Construction Environmental Management Plan (CEMP) will be produced prior to commencement of any construction activities. This plan will include construction method statements, drainage management plans, watercourse and drain crossing details, pollution prevention methods, etc. Additionally an Environmental Incident and Emergency Response Plan will be developed.

8.5.3 Specific procedures will be required for activities such as:

- Fuel handling and storage, including the locations of both periodic and regular fuelling points and emergency spill response. These should be agreed with the ECoW;
- Management of concrete wash out areas, including pollution prevention measures and drainage controls;
- Responsibilities and details for monitoring and training in relation to pollution prevention and mitigation measures;
- Design, management and mitigation measures for surface water drainage; and
- Design, management and mitigation measures for watercourse crossings.

8.5.4 Other procedures such as various environmental inspection and water sampling plans will be developed to monitor and identify any potential leaks, spills or release of contaminants including sediment to the water environment.

Mitigation to Reduce Impact on Peat Hydrology

8.5.5 In order to reduce the impact on peat hydrology the following mitigation measures should be taken into account in the construction and operational period of the wind farm:

Tracks

- On slopes above tracks the cut off ditch should be positioned close to the track so that as much water as possible has the opportunity to infiltrate into the upgradient peat;
- Regular discharge of water from the track and from the upgradient diversion channel to the down gradient land would allow the water to infiltrate a short distance from the track and can help counter potential down gradient dewatering effects; and

- Dressing the cut slopes alongside the tracks with low permeability material can potentially help reduce flow rates from more permeable sections as it will act as a barrier to groundwater flow.

Turbine Bases and Other Infrastructure

- Dewatering of the turbine bases may be required depending on the permeability of the surrounding geology, however current understanding suggests this is low. This will be limited to as short duration as possible to keep the excavation dry until the concrete is poured, cured and the void space backfilled;
- Any water from dewatering excavations should be discharged to peat areas surrounding the turbine base excavation during this period to promote recharge and reduce the impact of dewatering. This is a recognised method of mitigating the environmental impact of an abstraction (EA, 2007). If there are no peat areas immediately surrounding the infrastructure but they are close by then the water should be discharged between the excavation and the peat to reduce the extent of drawdown in the other formations that may extend to the peat;
- Cut off ditches on upgradient slopes should also be close to the excavated areas as it practical to allow water to recharge the surrounding peat; and
- Excavations should be left open for as short duration as practical to reduce the impact of dewatering on the surrounding peat.

Peat Habitat and Deep Peat Avoidance

- The layout has been designed to avoid good quality peat habitats and areas of deep (>0.5 m as deemed by NRW) peat. This has been conducted through habitat mapping and through probing and coring to establish the spatial distribution of peat across the site (Figure 8.2).
- Additional micrositing of infrastructure will be undertaken in conjunction with the ECoW prior to construction for further avoidance as described in the Peat Management Plan (Appendix 8.9).
- Areas of disturbed peat will be reinstated as described in the Peat Management Plan (Appendix 8.9).

Mitigation Measures to Protect the Water Environment

8.5.6 Mitigation undertaken at the construction stage is critical and involves both management and monitoring. Given the significance of a number of nearby hydrological resources mitigation measures which at least meet those required within current Best Practice Guidelines will be applied (as per 8.2.11).

Site Induction

8.5.7 During the induction of contractors a specific session on good practice to control water pollution from construction activities would be included. The responsibility for protecting the water environment would be shared with all staff on the Site with an appropriate level of support from construction managers to achieve this. The site induction process would be based on the Pollution Prevention Guidance and best practice documents indicated above.

Construction Method Statement (CMS)

8.5.8 Construction phase Contractors, in consultation with the local authority, will prepare detailed Construction Method Statements providing specific mitigation measures to be employed.

8.5.9 Following the more detailed design of tracks and drainage, the CMS will define the construction planning and procedures to be applied. This document will be produced to function alongside the CEMP.

8.5.10 In all construction designs SUDS (Sustainable Urban Drainage Systems) shall be incorporated to minimise hydrological effects of the development and to maintain the current hydrological systems. See Appendix 3.6 for the SUDS Design Philosophy which will be employed in the detailed design of the proposal.

Micro-siting

8.5.11 During the construction phase micro-siting of up to 50m may be used in order to appropriately relocate infrastructure whilst on site for environmental reasons.

Watercourse Crossings

8.5.12 The layout of the turbines and on-site tracks and the access route was designed in line with best practice guidelines and the number of crossings of watercourses have been minimised. As a result, no new large water crossings are required and the number of new small crossings or upgrades was reduced to a maximum of 22.

8.5.13 Two of the crossings (across the upper Afon Gam; crossing number 11 and across the Afon Canon; crossing number 20) are indicated to be within areas prone to flooding. The design of these crossings will reflect this risk and have capacity for selected design level flooding.

8.5.14 Water crossings will be the subject of detailed design within a Construction Method Statement (CMS) to be submitted to the EA and the local authority (as appropriate) prior to commencement of construction. A monitoring programme for maintenance of crossings (to prevent blockages and flooding) will be provided and is anticipated to be a condition of planning.

8.5.15 Where it is necessary to cross watercourses or flowing drains, appropriately designed crossings and culverts will be installed, and licensed where appropriate, in consultation with EA if required (see Mitigation below);

Setback Distances

8.5.16 Another form of avoidance is location of turbines, tracks, borrow pits and other construction disturbance a minimum buffer distance from water features. A set-back distance of 50 m from watercourses is routinely recommended as a preliminary best practice measure for wind farm sites. This more than complies with the Forests and Water Guidelines, published by the Forestry Commission (2003) that require setback distances of between 5m and 20m. Forestry practices generally pose a much greater risk in terms of sediment loss than a wind farm site.

8.5.17 Infrastructure within the site has therefore been located in so far as possible over 50 m from watercourses, with the exception of where tracks they approach watercourse crossings, some sections of existing tracks that will be upgraded and some minor sections of track or infrastructure due to other overriding constraints.

Track and Cable Trenching Design

8.5.18 Tracks which are orientated at 90° to the slope contours may act to create rapid surface flows resulting in erosion of the tracks and provide a direct pathway for discharge to watercourses. Tracks have been designed to run with the contours where possible; however some sections of on-site access track are oriented at 90° to the slope.

8.5.19 Accordingly, these will require standard design features such as cut off drains, spoon drains or water bars etc. for tracks, and internal plugs for cables, to be installed such that water flow and sedimentation is minimised.

8.5.20 All tracks will be excavated and the material removed replaced in the same manner. This is especially important with peat and the topsoil layer.

Water Abstraction and Dewatering Activities

8.5.21 All dewatering activities will be managed through dewatering permits and method statements and the ECoW must be consulted and agree pumping and associated mitigation measures prior to commencement of works.

8.5.22 Suitable mitigation measures will be installed to minimise the volume of silt contained within pumped waters and to avoid or minimise the impact of the pumped water discharge on the water environment, including:

- Installation of upgradient cut off drains to reduce the volume of water entering excavations;
- In order to prevent disturbance from the base of excavations or from the bed of watercourses during abstraction, any pump intakes will be protected from sediment by raising the intake using a floating rose and a geotextile filter; and
- The discharge of abstracted water through sediment control structures and over natural vegetation to filter and infiltrate.

Management of Sedimentation

Management of Track Construction

8.5.23 Loose track material generated during the use of access tracks will be prevented from reaching watercourses by adequate maintenance of the track. In dry weather, dust suppression methods will be employed.

8.5.24 Standard erosion control techniques and sediment control structures are used across the site during the construction period.

8.5.25 Drainage will be installed on either side of tracks to enable appropriate management, capture and discharge of clean and potentially sediment laden runoff. Regular discharge of upgradient water to down gradient vegetation will be installed and appropriate sediment control structures to manage contact water.

8.5.26 Roadside drains likely to carry high sediment loads will not be allowed to discharge directly into watercourses but will discharge into sediment control structures or buffer areas of adequate width. A typical access track drainage design can be seen in Figures 3.9 and 3.18. The purpose of these drainage ditches is to collect track drainage, control run-off during intense rainfall events and mitigate erosion. These ditches will have filter check dams at intervals along their length to encourage infiltration and reduce velocity of flow within the channels. The drainage design will encourage run-off to leave access tracks quickly and prevent their acting as flow pathways and will also protect the site's soils from erosion. Sediment control structures will be located at the end of all cross drains and cut off drains.

Watercourse Crossings

8.5.27 The locations of water crossings are provided in Figure 8.1 and described in Table 8.8, the actual designs are illustrated in Figures 3.10 and 3.20.

8.5.28 Water crossings will be sized sufficiently to avoid overloading, blocking or washout, and will be protected and well bedded to avoid settlement.

8.5.29 Where reasonably practicable, any engineered water crossings would be designed to minimise erosion and to use soft engineering measures, rather than hard where erosion cannot be avoided (i.e. riprap rather than gabion baskets). All water crossings will aim to leave the watercourse in as natural a condition as possible.

8.5.30 Half moon culverts will be used in preference to pipe culverts where reasonably practicable to retain the natural stream bed.

Excavation of Turbine Foundations and Cable Trenches

8.5.31 Turbine bases are to be located at least 50m away from any mapped watercourse where reasonably practicable.

8.5.32 Soil movement will be undertaken with reference to best practice guidelines Good Practice Guide for Handling Soils (MAFF 2000). Subsoil from the foundation excavations would be primarily replaced around the foundations following pour and curing. Any remaining spoil would be used to fill borrow pits or spread in areas that are not environmentally sensitive as agreed by landowners and relevant consultees. Topsoil and turfs (if practicable, but particularly in peaty areas) will be stored so as to maintain their vitality and used to recover the foundation. This will help to maintain surface hydrological characteristics in terms of near surface infiltration and run-off regimes.

8.5.33 The installation of the electrical cables will be within small trenches. Where trenches are dug on steep slopes they will be dug in sections or plugs of soil may be left in place at intervals to prevent them acting as preferential drainage pathways and increasing soil erosion. As indicated above, best practice cable installation means that the trenches will not remain open for long periods of time and will be restored by replacing the subsoil and topsoil removed earlier.

8.5.34 Run-off and discharge water from the excavation sites will be discharged into sumps where sediment would be allowed to settle, and the drainage waters would be pumped out and discharged via vegetated soakaways to a vegetated area or infiltration trench down gradient of the excavation site. The exact method of site discharge will be confirmed prior to the commencement of construction. These measures are also designed to reduce soil erosion by controlling discharges from the excavations.

8.5.35 In the event of shuttering collapse during a concrete pour it is unlikely that material will escape as the excavation required to erect the shuttering will be below ground and of a larger volume than the shuttering capacity. However, in this unlikely event, actions as defined below would be put in place. When the concrete had solidified, it would be dug out and disposed of appropriately.

Borrow Pit Excavation

8.5.36 The proposed locations for the on-site borrow pits are shown on Figure 3.6. The locations have been chosen because they are: next to proposed access track to minimise the overall length of track required; away from dwellings to minimise disruption; on topography that lends itself to stone extraction and can be landscaped to blend in well after construction, and some are sited at existing borrow pit locations.

8.5.37 As shown in Figure 3.6, each borrow pit is proposed to be approximately 60 x 60m to a depth of 13m, and will yield stone to construct access tracks, crane hard-standings, car park, substation compound and the construction compounds on the Site. If suitable, the stone will also be used as aggregate for concrete to be batched on site.

8.5.38 A detailed design of the proposed borrow pits will be determined in consultation with the relevant authority once the application is determined.

8.5.39 As discussed above, all work will be undertaken in accordance with the guidance included in the relevant PPGs, CIRIA guidelines and PAN 50.

8.5.40 In terms of reinstatement, the working face of the borrow pits will be backfilled with on-site surplus material with the aim to reuse peat for the net positive creation of wetlands. Where possible, work areas will be progressively restored as the excavation proceeds in order to reduce exposure of surface soil. Material is likely to be available from the turbine foundation excavations for this purpose.

8.5.41 Erosion from the borrow pits will be controlled by re-vegetating the exposed areas as soon as possible when excavation is complete. Protecting the surfaces of soil mounds, either with vegetation or with a physical cover would reduce the effects of runoff during rainfall. Peat would be reused in all of the borrow pit with the aim to create wetland and maintain the integrity of the peat as a habitat and a carbon sink.

Management of Soil Stockpiles

8.5.42 Careful consideration will be given to the location of topsoil and subsoil storage areas for all facilities during construction, either by siting in a flat dry area away from watercourses or by the addition of cut-off drains above the storage, which will help to maintain a buffer from streams. The areas will be regularly inspected to ensure that erosion of the material is not taking place.

8.5.43 Settlement lagoons and silt traps will be inspected regularly especially after periods of heavy rainfall. Maintenance will be carried out in periods of dry weather where practicable.

Tree Felling

8.5.44 During the operation of tree felling there is the potential for an increase in the sediment load in nearby watercourses.

8.5.45 The areas of tree felling required will be kept to a minimum to minimise the disturbance to soils, except in those areas designated for peat habitat restoration purposes where all trees will be felled. A detailed methodology for tree felling will be prepared in accordance with best management practices detailed within the Forests & Water Guidelines published by the Forestry Commission (2003). Periodic inspection, and monitoring (detailed further in next section), of nearby watercourses will ensure any detrimental effects are identified at an early stage and appropriate action undertaken.

Management of Potential Oil, Fuel and Chemical Contamination

8.5.46 Fuel and oil spillages are potential sources of contaminants. Tracks, compounds and the car park where vehicles are re-fuelled or on stand-by, and areas where chemicals and fuel are stored, are potential sites of contamination. These areas are shown on Figure 8.1.

8.5.47 The construction compound shown in Figure 3.17 shows provision for the storage of fuel, oil and chemicals in designated areas, together with areas for vehicle compounds, refuelling sites, waste depots and on-site sewage systems.

8.5.48 Mitigation is to be demonstrated in accordance with PPG1, PPG2, PPG4, PPG6, PPG8 and PPG 26. Best practice will be adopted for handling potentially polluting substances (such as fuel, oil, cement and concrete additives) including:

- Designated facilities designed and used for storage and refuelling, located away from watercourses;
- Fuel, oils and chemicals will be stored on an impervious base within a bund able to contain at least 110% of the volume stored. Rainwater will not be allowed to accumulate within the bund and in any way compromise the required 110% volume capacity;
- Interceptor drip trays will be positioned under any stationary mobile plant to prevent oil contamination of the ground surface or water;
- A site oil, chemical and product inventory;
- A site drainage plan, including notations of areas of highest sensitivity;
- A list of emergency procedures, responsive to a risk assessment of areas of high sensitivity;
- Site induction of all personnel on emergency spillage procedures and staff trained in emergency procedures;
- A contact list for emergency services, the relevant environmental regulators, the local water supply and sewerage undertakers, the Health and Safety Executive and specialist clean up contractors, if required; and
- Emergency response equipment will be available at appropriate locations.

8.5.49 In the event of an accidental spillage, a predefined 'Procedure in the event of a contaminant spillage' will become effective. This procedure will be part of the Construction Environmental Management Plan and is audited to 14001 for RES construction works. The RES Emergency Preparedness and Response and Spillage Procedures are summarised in Appendix 3.4. The most pertinent construction activities are outlined below:

The Management and Movement of Liquid Concrete

8.5.50 Concrete foundations will adhere to a specific code of practice for concrete design to ensure that the concrete mix is designed to withstand chemical attack.

8.5.51 Where pollution is considered to be of an amount which may have an effect on the environment, a discharge license from EA is required. However, the level of risk associated with concrete use in wind farm projects is not considered sufficient to require licensing.

8.5.52 Concrete for the turbine bases may be batched on site. A stone crusher and grading equipment will be sited adjacent to the selected borrow pit and graded material taken to the batching plant located as shown in Figure 3.6. Stockpiled crushed stone will be transferred to dump trucks for delivery to the area where track construction is ongoing.

8.5.53 Within the emergency spillage procedure actions and contingency measures are described which would address major events such as a concrete spill. Machine operators would carry a supply of absorbent material in their cabs, and there would be a central stock of material stored within the construction compounds.

Disposal of Waste Materials

8.5.54 The cess-pit associated with the substation compound/ control buildings will be constructed and located in accordance with the relevant Building Standards and agreed with Powys County Council and the Natural Resources Wales prior to

construction (see Appendix 3.2 for further details). The EA have previously indicated that this type of proposed structure would be acceptable.

8.5.55 On site engine and hydraulic oil waste will be stored in an appropriately constructed compound and storage bund.

8.5.56 Waste oils will be stored in the construction compounds in an above ground tank within a concrete bunded area to prevent oil escaping to the environment in the event of leakage from the main tank. The bund will be 110% of the storage tank capacity. The bund will be emptied by a specialist company. Procedure for storage, removal and accidental spillage will be defined in the 'Pollution Incident Response Plan' with spill kits available adjacent to the bunded area.

8.5.57 The following additional measures will also be implemented:

- Drip trays will be provided for machinery;
- Machinery will be repaired and maintained, where practicable, in suitable designated locations;
- Facilities will be provided to ensure appropriate waste management;
- Wheel washing facilities where required will be located away from watercourses; and
- Should dewatering be required pumped water will be discharged via settlement ponds or filter strips prior to direct discharge into a watercourse.

Monitoring

Baseline Monitoring

8.5.58 In order to monitor for any changes during the construction and operational phases of the proposal, baseline information on the existing conditions may be required.

8.5.59 Prior to commencement of any invasive investigations or site works, a strategic set of water sampling locations will be identified. The locations of areas of tree felling and the PWS will be considered within the choice of sampling locations as well as any upgradient works on other developments. Any samples taken will be analysed for a suite of typical determinands used by NRW for their water quality assessments in freshwater rivers or for drinking water quality, and updated to include any requirements arising from the Water Framework Directive.

Monitoring during Construction

8.5.60 Should monitoring be required, as determined through consultation, water samples will be collected from the same locations as during baseline sampling and taken at intervals agreed with the NRW. Sampling locations will include some control points outside the influence of the construction and tree felling. These will be analysed for a suite of typical determinands used by NRW in order to ensure that there is no negative effect on surface water quality during the construction phase.

8.5.61 In addition, temporary drainage features, access track drainage channels, drainage crossings on tracks, silt traps, sediment lagoons etc. will be inspected on a regular basis to ensure they are clear and capable of performing their functions.

Monitoring during Operation

8.5.62 Periodic inspection of the river beds and banks will be undertaken during the operational phase of the works and culverts will be modified if required (for example by installing baffles within the culverts to reduce flow rates exiting the

culvert). Streams and drains will be inspected to ensure they are operating correctly and they will be cleaned of silt or vegetation if required.

Monitoring during Decommissioning

8.5.63 In the decommissioning phase, monitoring will be undertaken to a similar level and frequency as for the construction phase.

8.6 Assessment of Potential Effects

8.6.1 The following tables describe those elements of the proposal with the main potential for effects on hydrology, hydrogeology and geology, including hydrological/hydrogeological effects on peat. A magnitude of potential effect has been assigned to these based on their location and activity. This magnitude of potential effect takes into account the best practise and standard mitigation methods described in section 8.5.

Turbines and Crane pads

8.6.2 The relevant elements are:

- 30 wind turbines and associated crane pads (Table 8.14), which will have a maximum overall height to tip of up to 126.5m; and
- 30 temporary crane pads for construction of the turbines
- This area of this infrastructure is 4,700 m^2 for each turbine base and crane pad and will therefore require a total land take of 141,000 m^2;

Table 8.14 Inventory of turbine and crane pad locations and their associated magnitude of potential effect of causing sedimentation, pollution, alteration of natural water flows, excavation of peat and changes to peat hydrology.

Turbine	Location	Description	Magnitude
R4	SH 92584 04272	Gradient: On shallow slope adjacent to forestry Watercourse proximity: approx. 125m upgradient of tributary of Afon Gam. Average peat depth: 0.46m Estimated volume of peat dewatered: 35 m^3 Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
R5	SH 92925 04087	Gradient: On shallow slope Watercourse proximity: approx. 150m upgradient of tributary of Afon Gam. Average peat depth: 0.46m Estimated volume of peat dewatered: 840 m^3 Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low

Turbine	Location	Description	Magnitude
R6	SH 93298 04091	Gradient: On shallow slope Watercourse proximity: approx. 325m upgradient of tributary of Afon Gam. Average peat depth: 0.56m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 1,020 m^3 – coring has demonstrated this is an overestimate Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
R7	SH 92960 04910	Gradient: On ridge Watercourse proximity: approx. 375m upgradient of tributary of Afon Gam. Average peat depth: 0.28m Estimated volume of peat dewatered: 490 m^3 Sensitivities: On ridge now outside of soligenous fen surface water catchment. Watercourses are potential spawning grounds for designated species.	Low
R8	SH 93404 05090	Gradient: On ridge Watercourse proximity: approx. 125m upgradient of tributary of Afon Gam. Average peat depth: 0.55m Estimated volume of peat dewatered: 1,010 m^3 Sensitivities: On ridge now outside of soligenous fen surface water catchment. Watercourses are potential spawning grounds for designated species.	Low
R9	SH 93763 04052	Gradient: On shallow slope Watercourse proximity: approx. 50m upgradient of headwater of tributary of Afon Gam. Average peat depth: 0.46m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 840 m^3 – coring has demonstrated this is an overestimate Sensitivities: Watercourses are potential spawning grounds for designated species.	Low, due to proximity to watercourse but shallow gradient
R12	SH 94288 05267	Gradient: On shallow slope Watercourse proximity: approx. 100m upgradient of tributary of Afon Gam. Average peat depth: 0.60m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 1,100 m^3, coring has shown this is an overestimate Sensitivities: Watercourses are potential spawning grounds for designated species.	Low

Turbine	Location	Description	Magnitude
R13	SH 94242 05795	Gradient: On shallow slope Watercourse proximity: approx. 75m from tributary of Nant y Graig Lwyd. Average peat depth 0.28m Estimated volume of peat dewatered: 490 m^3 Sensitivities: Upgradient of Cwmderwen PWS. Watercourses are potential spawning grounds for designated species.	Low
R14	SH 94590 06305	Gradient: On moderate slope close to catchment divide Watercourse proximity: approx. 75m from tributary of Nant y Graig Lwyd. Average peat depth 0.24m Estimated volume of peat dewatered: 420 m^3 Sensitivities: Upgradient of Cwmderwen PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low, due to gradient and proximity to watercourse
R15	SH 94938 06501	Gradient: On shallow slope Watercourse proximity: approx. 125m upgradient of tributary of Afon Gam. Average peat depth: 0.55m Estimated volume of peat dewatered: 1,000 m^3 Sensitivities: Upgradient of Neinthirion PWS but no likely connection.	Low, for peat as areas of peat >50cm can be avoided by micrositing
R16	SH 94341 06803	Gradient: On plateau near catchment divide Watercourse proximity: approx. 125m from headwaters of Nant y Graig Lwyd. Average peat depth: 0.31m Estimated volume of peat dewatered: 550 m^3 Sensitivities: Upgradient of Cwmderwen PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
R17	SH 95230 06939	Gradient: On moderate slope Watercourse proximity: approx. 25m upgradient of tributary of Afon Cannon. Average peat depth: 0.56m Estimated volume of peat dewatered: 1,035 m^3 Sensitivities: Upgradient of Neinthirion PWS but no likely connection	Medium, due to proximity to watercourse and gradient. Low for peat as area >50cm can be avoided by micrositing

Turbine	Location	Description	Magnitude
R18	SH 93468 03641	Gradient: On shallow slope just inside forestry Watercourse proximity: approx. 75m from Afon Gam. Average peat depth: 1.27m Estimated volume of peat dewatered: 395 m^3 Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Medium, due to peat depth in forestry (although degraded) Low, due to proximity to watercourse and gradient
R19	SH 94486 07716	Gradient: On moderate slope Watercourse proximity: approx. 325m upgradient of tributary of Afon Cannon. Average peat depth: 0.42m Estimated volume of peat dewatered: 30 m^3	Low
R23	SH 94245 08191	Gradient: On moderate slope Watercourse proximity: approx. 250m upgradient of tributary of Afon Cannon. Average peat depth: 0.04m Estimated volume of peat dewatered: 0 m^3 Sensitivities: Upgradient of Cwmderwen PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
R24	SH 94991 06123	Gradient: On plateau – ridge of catchment divide Watercourse proximity: approx. 300m upgradient of tributary of Afon Gam. Average peat depth: 0.10m Estimated volume of peat dewatered: 0 m^3 Sensitivities: Upgradient of Neinthirion PWS but no likely connection	Negligible
R25	SH 95014 07341	Gradient: On moderate slope Watercourse proximity: approx. 300m upgradient of tributary of Afon Cannon. Average peat depth: 0.72m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 1,340 m^3 – coring has shown this is an overestimate	Low
R26	SH 95982 09095	Gradient: On shallow slope Watercourse proximity: approx. 250m upgradient of Nant Craigyfrân. Average peat depth: 0.63m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 1,160 m^3 – coring has shown this is an overestimate Sensitivities: Upgradient of Dolwen PWS but no likely connection	Low

Turbine	Location	Description	Magnitude
R27	SH 96419 09027	Gradient: On plateau Watercourse proximity: approx. 300m upgradient of Nant Ffriddycastell. Average peat depth: 0.30m Estimated volume of peat dewatered: 540 m^3 Sensitivities: Upgradient of Dolwen PWS	Negligible
R31	SH 92325 03976	Gradient: On moderate slope – although plateau in forestry Watercourse proximity: approx. 25m upgradient of tributary of Afon Gam within forestry. Average peat depth: 0.59m – coring has demonstrated this is an overestimate outside of forestry Estimated volume of peat dewatered: 1,080 m^3 – coring has demonstrated this is an overestimate outside of forestry Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Medium – due to peat depth in forestry Medium - due to proximity to watercourse and gradient
R32	SH 92523 03622	Gradient: On moderate slope Watercourse proximity: approx. 75m upgradient of tributary of Afon Gam. Average peat depth: 0.12m Estimated volume of peat dewatered: 0 m^3 Sensitivities: Upgradient of Ffridd Fawr PWS. Watercourses are potential spawning grounds for designated species.	Low, due to proximity to watercourse and gradient
R35	SH 95407 08489	Gradient: On shallow slope Watercourse proximity: approx. 225m upgradient of tributary of Nant Craigyfrân. Average peat depth: 1.52m Estimated volume of peat dewatered: 580 m^3 Sensitivities: Upgradient of Dolwen PWS but no likely connection	Medium, due to depth of peat, although it is degraded within forestry
R36	SH 95746 08372	Gradient: On shallow slope Watercourse proximity: approx. 100m upgradient of tributary of Nant Craigyfrân. Average peat depth: 0.88m Estimated volume of peat dewatered: 170 m^3 Sensitivities: Upgradient of Dolwen PWS but no likely connection	Medium, due to depth of peat, although it is degraded within forestry

Turbine	Location	Description	Magnitude
R37	SH 95669 08799	Gradient: On shallow slope Watercourse proximity: approx. 325m upgradient of Nant Craigyfrân. Average peat depth: 0.54m Estimated volume of peat dewatered: 55 m^3 Sensitivities: Upgradient of Dolwen PWS but no likely connection	Medium, due to depth of peat, although it is degraded within forestry
R38	SH 96007 08635	Gradient: On shallow slope Watercourse proximity: approx. 175m upgradient of Nant Craigyfrân. Average peat depth: 0.72m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 1,340 m^3 – coring has demonstrated this is an overestimate Sensitivities: Upgradient of Dolwen PWS but no likely connection	Low, as peat >50cm can be avoided by micrositing
R39	SH 93542 03198	Gradient: On shallow slope Watercourse proximity: approx. 100m upgradient of headwaters of tributary of Afon Gam. Average peat depth: 0.80m – coring has demonstrated this is an overestimate Estimated volume of peat dewatered: 1,510 m^3 – coring has demonstrated this is an overestimate Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
R40	SH 96788 08936	Gradient: On moderate slope Watercourse proximity: approx. 75m upgradient of Nant Ffriddycastell. Average peat depth: 0.39m Estimated volume of peat dewatered: 700 m^3 Sensitivities: Upgradient of Dolwen PWS but no likely connection	Low, due to proximity of watercourse and gradient
R41	SH 93019 03645	Gradient: On moderate slope Watercourse proximity: approx. 125m upgradient of Afon Gam. Average peat depth: 0.30m Estimated volume of peat dewatered: 530 m^3 Sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low, due to distance to watercourse

Turbine	Location	Description	Magnitude
R42	SH 95340 06551	Gradient: On moderate slope Watercourse proximity: approx. 150m upgradient of tributary of Afon Gam. Average peat depth: 0.36m Estimated volume of peat dewatered: 640 m^3 Sensitivities: Upgradient of the Neinthirion PWS but no likely connection.	Low
R43	SH 96818 08469	Gradient: On shallow slope Watercourse proximity: approx. 425m upgradient of Nant Craigyfrân. Average peat depth: 0.07m Estimated volume of peat dewatered: 0 m^3 Sensitivities: Upgradient of Dolwen PWS but no likely connection	Negligible

Access and Site Tracks

8.6.3 The relevant elements are:

- 25.3 km of access and site tracks (21.15 km will be new), with three access points from the existing road, resulting in 189,000 m^2 of land take; and
- on-site underground cabling and underground grid connection (Table 8.15).

Table 8.15 Inventory of track sections and their associated Magnitude of Potential Effect of causing sedimentation, pollution, alteration of natural water flows, excavation of peat and changes to peat hydrology.

Section of track	Description	Magnitude
Access Point 1 (SH 971 071)		
Access point 1 to track junction	Gradient: On shallow and moderate slopes Watercourse proximity: Approximately 50m from small tributaries of Afon Gam except at watercourse crossing Max peat depth: 0m Sensitivities: Upgrade of existing watercourse crossing required.	Low/Medium, due to proximity of watercourse and gradient

Section of track	Description	Magnitude
Track junction to R35 and R36	Gradient: On slope Watercourse proximity: Generally >100m except at two new watercourse crossings of tributaries of Nant Craigyfrân. Max peat depth: 2.10m Sensitivities: Part of this track is through existing forestry which will require felling. Some of the track is located on degraded blanket bog which will be restored. Upgradient of Dolwen PWS but no likely connection.	Medium, due to peat depth, however forestry prevents detailed understanding, therefore track will be microsited post felling
R36 to R37 and R38	Gradient: On shallow slopes Watercourse proximity: >100m from both the Nant Craigyfrân and its tributaries. Max peat depth: 1.6m Sensitivities: Some felling required. Upgradient of Dolwen PWS but no likely connection.	Medium, due to peat depth, however forestry prevents detailed understanding, therefore track will be microsited post felling
R37 to R26	Gradient: Shallow slopes Watercourse proximity: Generally >100m except at new watercourse crossing of the Nant Craigyfrân. Max peat depth: 1.9m Sensitivities: Underlain by blanket bog. Upgradient of Dolwen PWS but no likely connection.	Medium, crossing of small pocket of deep peat
R26 to R27, R40 and R43	Gradient: Shallow slopes Watercourse proximity: Approximately 75m to the Nant Ffriddycastell. Max peat depth: 1.15m Sensitivities: Upgradient of Dolwen PWS but no likely connection.	Low
Access Point 2 (SH 960 059)		
Access point 2 to R42	Gradient: Shallow to moderate slopes Watercourse proximity: >100m except at new crossing of an Afon Canon tributary. Maximum peat depth: 0.70m Sensitivities: Upgradient of the Neinthirion PWS but no likely connection.	Low

Section of track	Description	Magnitude
Track junction of R42 to R14 and R24	Gradient: Moderate slopes parallel to watercourse. Watercourse proximity: Within 100m of an Afon Gam tributary for approx. 850m. Maximum peat depth: 0.85m Sensitivities: Upgradient of the Neinthirion PWS but no likely connection but no likely connection.	Low
R14 to R15	Gradient: Along contour on moderate slope Watercourse proximity: New water crossing of an Afon Cannon tributary. Maximum peat depth: 1.40 m Sensitivities: Upgradient of Neinthirion PWS but no likely connection.	Medium, due to potential deeper area of peat (not cored only probed)
R42 to R16	Gradient: On shallow to moderate slope Watercourse proximity: Parallel to and within 100m of an Afon Cannon tributary for approx. 600m. New minor watercourse crossing over an Nant y Craig Lwyd tributary Maximum peat depth: 1.40m Sensitivities: Upgradient of the Cwmderwen, Abercannon and Neinthirion PWS but no likely connection. Part of track upgradient of watercourses that are potential spawning grounds for designated species.	Low
R42 to R17, R25 and R19	Gradient: Generally shallow slopes Watercourse proximity: Generally >100m except approaching four new water crossings (three tributaries to the Afon Cannon and one crossing of the Nant Gwyddior) Maximum peat depth: 1.50m Sensitivities: Some felling required. Some areas cross blanket bog. Upgradient of the Abercannon and Neinthirion PWS but no likely connection.	Low

Section of track	Description	Magnitude
Track junction of R42 to R23	Gradient : Cuts across steep slopes Watercourse proximity: One upgraded watercourse crossing of the Nant y Graig Lwyd and two new watercourse crossings of tributaries to the Nant y Graig Lwyd. Within 50m of Nant y Graig Lwyd for approximately 200m. Maximum peat depth: 2.25m (Coring has indicated this is clay) Sensitivities: Passes approx. 20m down gradient of the upper Cwmderwen PWS and 50m upgradient of the lower Cwmderwen PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Medium, due to proximity of watercourse and gradient.
R23 to R12 and R13	Gradient: On shallow and moderate slopes Watercourse proximity: Generally >100m from watercourses except at two new and two upgraded watercourse crossings of tributaries to the Nant y Graig Lwyd. Maximum peat depth: 1.50m Sensitivities: Upgradient of Cwmderwen PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
Access Point 4 (SH 947 043)		
Access point 4 to R9	Gradient: On shallow to moderate slopes Watercourse proximity: Within 50m of a tributary of the Afon Gam for about 300m. Maximum peat depth: 1.15m Sensitivities: Watercourses are potential spawning grounds for designated species.	Medium, due to proximity of works to watercourse
R9 to R41	Gradient: On shallow slopes Watercourse proximity: New watercourse crossing of a tributary of the Afon Gam. Maximum peat depth: 0.80m Sensitivities: Watercourses are potential spawning grounds for designated species.	Low

Section of track	Description	Magnitude
Track junction east of R9 to R18	Gradient: On slope Watercourse proximity: Approximately 200m from Afon Gam. Maximum peat depth: 1.15m Sensitivities: Some felling required. Watercourses are potential spawning grounds for designated species.	Low
R41 to R39	Gradient: Generally on contour, small section of shallow slopes Watercourse proximity: New watercourse crossing of the Afon Gam. Section of the track directly adjacent to the Afon Gam for approximately 20m. Maximum peat depth: 1.75m Sensitivities: Upgradient of the Ffridd Fawr PWS but no likely connection. Some felling required. Watercourses are potential spawning grounds for designated species.	Medium, due to deep peat, although it is degraded within forestry
Track junction of R9 to R6 and R5	Gradient: Generally cutting across contour on shallow slopes Watercourse proximity: At closest 150 m from watercourse Maximum peat depth: 0.60 m Sensitivities: Upgradient of the Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
R5 to R31 and R32	Gradient: On shallow to moderate slopes Watercourse proximity: One new watercourse crossing of the Afon Gam. Track is parallel to the Afon Gam at a distance of approximately 50m for about 400m. Maximum peat depth: 2.10m Sensitivities: Upgradient of the Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Medium, due to proximity of watercourse and deep peat, although it is degraded within forestry

Section of track	Description	Magnitude
R5 to R4	Gradient: Cuts across contours of shallow to moderate slopes Watercourse proximity: Over 150m to nearest watercourse Maximum peat depth: 1.90m Sensitivities: Minor felling required. Upgradient of the Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low
Track junction of R5/R4 to R6, R7 and R8	Gradient: On shallow to moderate slopes Watercourse proximity: Track is a minimum of 125m from any watercourse and all is outside of surface water catchment of soligenous fen. Maximum peat depth: 0.70m Sensitivities: Upgradient of the Ffridd Fawr PWS but no likely connection. Watercourses are potential spawning grounds for designated species.	Low, track is now outside of soligenous fen surface water catchment

Watercourse Crossings

8.6.4 The relevant elements are:

- 18 new watercourse crossings and 4 existing watercourse crossings (Table 8.16)

Table 8.16 Inventory of watercourse crossings.

Number	Watercourse	Description	Magnitude
1	Drain	Less than 2m wide drainage channel with existing culvert partly collapsed and in need of replacement. Small catchment area. Upgradient of Dolwen PWS but no likely connection.	Medium for sediment release, Low for flow alteration
2	Nant Craigyfrân tributary	New structure required over approx. 2m wide incised channel. Small catchment area.	Medium for sediment release, Low for flow alteration
3	Nant Craigyfrân	New structure required over incised channel with more significant floodplain – approx. 5m wide cut into a terrace. Catchment area >1km^2.	Medium for sediment release, Low for flow alteration
4	Nant Craigyfrân tributary	New structure required to cross narrow channel <1m width, generally incised to clay base with small catchment area.	Low for sediment release, Negligible for flow alteration
5	Nant Gwyddior	New crossing required for approx. 1.5 m wide channel but flood width will be significantly greater, exceeding 3m. This site seems the optimal area to cross the watercourse as it has less steep banks and a lower (moderate) gradient. Catchment >1m^2.	Medium for sediment release, Low for flow alteration
6	Afon Cannon tributary	New crossing structure required. Broad diffuse channel approx. 5m wide with no specific channel observed. Small catchment area.	Low for sediment release, Negligible for flow alteration
7	Afon Cannon tributary	New crossing structure required. Broad diffuse drain approx. 5m wide. Small catchment area.	Low for sediment release, Negligible for flow alteration
8	Afon Cannon tributary	New crossing structure required. Broad diffuse drain approx. 5m wide. Very boggy with no specific channel observed. Small catchment area. Upgradient of Abercannon PWS but no likely connection.	Low for sediment release, Negligible for flow alteration
9	Afon Cannon tributary	New crossing structure required. Drain within discharge zone about 0.5m wide. Small catchment area. Upgradient of Neinthirion PWS but no likely connection.	Medium for sediment release, Low for flow alteration
10	Afon Gam tributary	New crossing structure required, below watercourse crossing 11. Very narrow, steep and incised, only 1m or less wide with a steep approach. Small catchment area. Upgradient of Neinthirion PWS but no likely connection.	Medium for sediment release, Low for flow alteration

Number	Watercourse	Description	Magnitude
11	Afon Gam tributary	New crossing structure required. Diffuse flow and discharge zone with various small channels. About 1m wide and shallow side slopes with small catchment. Upgradient of Neinthirion PWS but no likely connection.	Low for sediment release, Negligible for flow alteration
12	Afon Gam tributary	New crossing structure required. Diffuse flow with no clear channel until further down gradient. Small catchment. Flows to watercourses that are potential spawning grounds for designated species.	Low for sediment release, Negligible for flow alteration
13	Nant y Graig Lwyd tributary	Existing crossing requiring upgrade of approx. 2m wide stream of shallow to moderate gradient. Existing watercourse crossing is comprised of one 0.3m pipe culvert. Catchment >1km^2. Upgradient of Cwmderwen PWS but no likely connection. Watercourse is a potential spawning ground for designated species.	Medium for sediment release, Low for flow alteration
14	Nant y Graig Lwyd tributary	New crossing structure required. Narrow <1m incised stream cut into soil. Downstream of watercourse crossing 19. Small catchment. Upgradient of Cwmderwen PWS but no likely connection. Flows to watercourses that are potential spawning grounds for designated species.	Medium for sediment release, Low for flow alteration
15	Nant y Graig Lwyd tributary	New crossing structure required. Narrow <1m incised stream cut into soil. Small catchment. Downstream of watercourse crossing 18. Upgradient of Cwmderwen PWS but no likely connection. Flows to watercourses that are potential spawning grounds for designated species.	Medium for sediment release, Low for flow alteration
16	Afon Gam tributary	Existing, newly constructed drains approx. 1m wide with 8" culvert. Small catchment. Flows to watercourses that are potential spawning grounds for designated species.	Low for sediment release, Negligible for flow alteration
17	Afon Gam tributary	Existing, newly constructed drains approx. 1m wide with 8"culvert. Small catchment. Upgradient of Cwmderwen PWS but no likely connection. Flows to watercourses that are potential spawning grounds for designated species.	Low for sediment release, Negligible for flow alteration
18	Afon Gam tributary	New crossing structure required. Wide channel, diffuse flow. Small catchment. Upgradient of Cwmderwen PWS but no likely connection. Flows to watercourses that are potential spawning grounds for designated species.	Low for sediment release, Negligible for flow alteration

Number	Watercourse	Description	Magnitude
19	Afon Gam tributary	New crossing structure required. Narrow channel <1m wide. Downstream of watercourse crossing 14. Small catchment. Upgradient of Cwmderwen PWS but no likely connection. Flows to watercourses that are potential spawning grounds for designated species.	Low for sediment release, Negligible for flow alteration
20	Afon Gam tributary	New crossing structure required. Narrow channel <1m wide. Upgradient of Ffridd Fawr PWS but no likely connection. Flows to watercourses that are potential spawning grounds for designated species.	Low for sediment release, Negligible for flow alteration
21	Afon Gam	New crossing structure required. Channel about 2m wide, plus floodplain. Downstream of watercourse crossing 22. Catchment >1km^2. Narrow channel <1m wide. Upgradient of Ffridd Fawr PWS but no likely connection. Watercourse is a potential spawning ground for designated species.	Medium for sediment release, Low for flow alteration
22	Afon Gam	New crossing structure required. Channel about 1m wide, plus floodplain. Upstream of watercourse crossing 21. Catchment >1km^2. Narrow channel <1m wide. Upgradient of Ffridd Fawr PWS but no likely connection. Watercourse is a potential spawning ground for designated species.	Medium for sediment release, Low for flow alteration

Construction Compounds

8.6.5 The relevant elements are:

- 5 temporary construction compounds (Table 8.17);

Table 8.17 Inventory of construction compound locations and their associated magnitude of potential effect of causing sedimentation, pollution, alteration of natural water flows, excavation of peat and changes to peat hydrology.

Construction Compound	Location	Comments	Magnitude
1	SH 9450 0425	On shallow slopes/flat area. Watercourse proximity: Adjacent to unnamed tributary of the Afon Gam. Average peat depth: 0.07m Other sensitivities: Watercourses in catchment are potential spawning grounds for designated species.	Medium due to proximity to watercourse
2	SH 92909 04225 Photo 51 Appendix 8.7	On moderate slopes with part of compound extending into forestry area that will be felled. Watercourse proximity: Nearest watercourse >200m distant. Average peat depth: 0.54m Other sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses in catchment are potential spawning grounds for designated species.	Low, due to distance from watercourse
3	SH 9600 0593 Photos 52 and 53 Appendix 8.7	On shallow slopes. Watercourse proximity: Approximately 150m from a tributary of the Afon Gam. Average peat depth: 0.06m Other sensitivities: Watercourses in catchment are potential spawning grounds for designated species.	Low, due to distance from watercourse and gradient
4	SH 9470 0630 Photo 54 Appendix 8.7	On plateau. Watercourse proximity: On watershed of Afon Canon and Nant y Graig Lwyd catchments. Closest watercourse >150m. Average peat depth: 0.41m Other sensitivities: Upgradient of Neinthirion PWS but no likely connection.	Low
5	SH 96889 07342 Photo 55 Appendix 8.7	On shallow slopes. Watercourse proximity: Within 150m of two tributaries of the Afon Gam Average peat depth: Not located on area of peat.	Low

Other Infrastructure

8.6.6 The relevant elements (Table 8.18) are:

- 6 borrow pits;
- one substation;
- two welfare buildings; and
- 1 permanent free standing wind monitoring mast(s) up to a height of 80m.

Table 8.18 Inventory of other infrastructure locations and their associated magnitude of potential effect of causing sedimentation, pollution, alteration of natural water flows, excavation of peat and changes to peat hydrology.

Infrastructure	Location	Comments	Magnitude
Borrow Pit 1	SH 9377 0380 By R18 and R9 Photo 56 Appendix 8.7	On shallow to moderate slopes. Watercourse proximity: Located within approximately 125m of uppermost tributaries of Afon Gam. Average peat depth: 0m Other sensitivities: Watercourses in catchment are potential spawning grounds for designated species.	Low, due to distance from watercourse
Borrow Pit 2	SH 9225 0393 By R31 Photos 57 and 58 Appendix 8.7	On moderate slopes. Watercourse proximity: Located within approximately 75m of uppermost tributaries of Afon Gam. Average peat depth: 0.08m Other sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses in catchment are potential spawning grounds for designated species.	Low, due to distance from watercourse
Borrow Pit 3	SH 9485 0645 By R14 and R15 Photos 59 Appendix 8.7	On moderate slopes. Watercourse proximity: Within approximately 50m of unnamed tributary of the Afon Gam. Average peat depth: 0.13m Other sensitivities: Upgradient of Neinthirion PWS	Low/Medium, due to gradient and watercourse proximity
Borrow Pit 4	SH 9455 0762 By R19	On moderate slopes. Watercourse proximity: Over 100m from Nant Gwyddior. Average peat depth: 0.55m Other sensitivities:	Low, due to distance from watercourse

Infrastructure	Location	Comments	Magnitude
Borrow Pit 5	SH 9700 0810 Photos 60 - 62 Appendix 8.7	On shallow/moderate slopes. Watercourse proximity: About 100m from Nant Craigyfrân and other tributaries of this watercourse. Average peat depth: 0.07m Other sensitivities:	Low, due to distance from watercourse
Borrow Pit 6	SH 9665 0900 Near R27 and R40 Photos 63 and 64 Appendix 8.7	Moderate slopes. Watercourse proximity: Adjacent to Nant Ffriddycastell Average peat depth: 0.05m Other sensitivities: Borrow pit has already been operated previously and there is evidence of quarried rock in the watercourse	Medium, due to proximity of watercourse
Substation		Gradient: On moderate slopes Watercourse proximity: Within about 50m of a Nant y Graig Lwyd tributary Maximum peat depth: 0.35m Other sensitivities: Upgradient of Cwmderwen PWS but no likely connection. Watercourses in catchment are potential spawning grounds for designated species.	Low/Medium, due to proximity of watercourse and gradient
Welfare Building (North)		Gradient: On moderate slopes Watercourse proximity: About 200m from minor Nant Graigfran tributary Maximum peat depth: 0.0m Other sensitivities: Upgradient of Dolwen PWS	Negligible, due to distance from watercourse
Welfare Building (South)		On moderate slopes with part of compound extending into forestry area that will be felled. Watercourse proximity: Nearest watercourse >200m distant. Maximum peat depth: 0.3m Other sensitivities: Upgradient of Ffridd Fawr PWS but no likely connection. Watercourses in catchment are potential spawning grounds for designated species.	Low, due to distance from watercourse

Infrastructure	Location	Comments	Magnitude
Met Mast		On moderate slopes. Watercourse proximity: Nearest watercourse >200m distant. Maximum peat depth: 0.3m Other sensitivities: Upgradient of Ffridd Fawr PWS. Watercourses in catchment are potential spawning grounds for designated species.	Negligible

Forestry

- Five areas of forestry plantation felling.

Table 8.19 Inventory of other forestry locations and their associated magnitude of potential effect of causing sedimentation, pollution, alteration of natural water flows, excavation of peat and changes to peat hydrology.

Forestry Area	Location	Comments	Magnitude
Part of Area 1 of HMP (27 ha)	To north of Nant Gwyddior in Afon Cannon catchment and containing turbine 19 and access track	Moderate slopes. Watercourse proximity: The Nant Gwyddior runs through the south eastern end of the forestry area for about 250m. This drains to the Afon Cannon. Other sensitivities:	Medium due to proximity of watercourse.
Part of Area 1 of HMP (35 ha)	To north of Area 3 within Afon Cannon catchment and absent of proposed wind farm infrastructure	Moderate slopes. Watercourse proximity: Located between two tributaries of the Afon Cannon. Other sensitivities:	Medium due to proximity of watercourse.
Part of Area 2 of HMP (30ha)	Adjacent to upper Afon Gam and near turbines 18, 39 and 41.	Generally shallow with some moderate slopes. Watercourse proximity: The Afon Gam runs through the forestry area for over 1km. Other sensitivities: Upgradient of Ffridd Fawr PWS. Watercourses in catchment are potential spawning grounds for designated species.	Medium due to proximity of watercourse.
Part of Area 2 of HMP (17.5 ha)	Adjacent to upper Afon Gam and by turbines 4 and 31, construction compound 2 and southern welfare building	Generally shallow slopes. Watercourse proximity: The Afon Gam runs through the western extreme of the forestry area for about 200m. Other sensitivities: Upgradient of Ffridd Fawr PWS. Watercourses in catchment are potential spawning grounds for designated species.	Medium due to proximity of watercourse.
Area 7 of HMP (41 ha)	On western slopes of Nant Graigyfran catchment and containing turbines 35, 36 and 37 and associated track	Generally shallow slopes Watercourse proximity: A tributary of the Nant Craigyfran intersects the southern corner of the forestry for about 500m. Other sensitivities: Upgradient of Dolwen PWS	Medium due to proximity of watercourse.

Infrastructure from Adjacent Proposal

- A number of infrastructure elements from the proposed wind farm at the adjacent site, Carnedd Wen, are located within the catchments where the proposed site infrastructure are located. There are no other possible cumulative impacts from other wind farm projects.

Table 8.20 Catchments with infrastructure of both Llanbrynmair and Carnedd Wen proposals.

Catchment	Llanbrynmair infrastructure	Carnedd Wen infrastructure
Upper Afon Gam	Turbines R4, R5, R6, R7, R8, R9, R18, R31, R32, R39, R41, Borrow Pit 1 and 2, Site Compound 1 and 2, Batching Plant, Met Mast, Southern Welfare Building, three new watercourse crossings and associated tracks	Turbines R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, two new watercourse crossings, two upgraded watercourse crossings, one site compound and associated tracks
Afon Cannon	Turbines R15, R16, R17, R19, R24, R25, R42, Borrow Pit 3 and 4, Site Compound 3 and 4, seven new watercourse crossings and associated tracks	Turbines R16, R17, R18, R46, R47, R48, Borrow Pits B1, C1 and C2, Batching Plant, two upgraded watercourse crossings and associated tracks
Afon Cralgyfran	Turbines R26, R27, R35, R36, R37, R38, R40, R43, Borrow Pit 5 and 6, Site Compound 5, Northern Welfare Building, three new watercourse crossings, one upgraded watercourse crossings and associated tracks	Turbines R19, R20, R21, Borrow Pit B4 and associated tracks

8.6.7 If the Carnedd Wen proposal were to be permitted it is assumed that the project would be undertaken in accordance with best practice (secured by planning condition) and therefore the significance of effect on each receptor would not be expected to increase.

Access Route

8.6.8 The access route to the site from the A458 at Llanerfyl to the north and from the A470 at Talerddig to the south requires a number of upgrading works. The potential impacts of the improvement works associated with this access route are addressed in Chapter 10.

8.7 Significance of Effect

Project Assumptions

8.7.1 The assessment of effect significance has been undertaken based on the project description provided in Chapter 3, the assessment of baseline conditions across the site, coordination with the ecological sections in Chapter 5 and the best practice techniques described in section 8.5.

Construction Phase

Erosion / Sedimentation

8.7.2 One general potential effect of construction of site facilities, turbines and tracks, dewatering of turbine foundations, passive road drainage and forestry felling, is disturbance to soils and a consequent rise in the sediment loads observed in rivers and streams. Potential effects may occur from the following:

- construction of up to 21.15 km of new track, involving stripping and stockpiling of material to expose underlying soils or bedrock, potentially increasing runoff and the potential for transportation of sediment;

- new or upgraded stream crossings increasing the potential for increased runoff of silt and debris;
- removal and stockpiling of material for each turbine foundation base and crane pad, which could result in increased silt run-off;
- dewatering of shallow groundwater and direct rainfall into excavations (potentially containing silt and other debris), which may result in transportation of fine sediments into watercourses. This would be compounded by increased movement over and around these disturbed environments;
- extreme rainfall events which could result in the overflowing of existing on-site drainage and resulting erosion and sediment transport, as well as the potential failure of pollution prevention measures to operate under high runoff flow conditions;
- silt generation caused by the operation of open borrow pits;
- felling of areas of forestry plantation for the siting of infrastructure which can disturb the soil and result in increased sediment loads in runoff;
- vehicle movements around the site transporting silt off site; and
- peat storage and reuse.

Effect Assessment

8.7.3 Following the methodology in Table 8.3, the significance of effect has been determined by considering the magnitude of predicted effect (determined in Tables 8.14 to 8.19) and the sensitivity of the receptor (Table 8.12).

8.7.4 Infrastructure within the site has been located in so far as possible over 50 m from watercourses, with the exception of where tracks they approach watercourse crossings, some sections of existing tracks that will be upgraded and some minor sections of track or infrastructure. In addition there are areas of forestry felling that will be undertaken adjacent to watercourses.

8.7.5 There are a number of areas where the infrastructure or forestry felling has been assessed with a maximum potential for a ***Medium*** magnitude of causing erosion/sedimentation to watercourses. These are generally in areas where the distance to the watercourses is less than 50m and there is a moderate gradient.

8.7.6 The sensitivity of some of the watercourses close to the proposed infrastructure and areas of felling are ***High*** (the Afon Gam main stem and its upper tributaries) in particular those in proximity to the Afon Gam main stem and its upper tributaries which are trout and salmon spawning grounds. The magnitude of potential effects due to sedimentation of the nearby watercourses due to construction of access tracks prior to mitigation and management is ***Medium*** and therefore the overall significance will be at most ***Moderate/Major.***

8.7.7 There are infrastructure located upgradient of a number of PWS including PWS 1 – Dolwen, PWS 3 – Abercannon, PWS 4a and 4b – Neinthirion, PWS 6a and 6b – Cwmderwen and PWS9 – Ffridd Fawr (Figure 8.1 and Table 8.8). These infrastructure are all located several hundreds of metres upgradient of the PWS, with the exception of PWS 6a, and none of them abstract directly from the watercourse therefore there is likely to be little connection. The property at Cwmderwen uses both PWS 6a and PWS 6b and the supply would be taken solely from PWS 6b (upgradient of all infrastructure) during the construction period, even though it is unlikely that there would be any effect on PWS 6a given the distance from the works and that it is a borehole. The sensitivity of these PWS is ***High***. The magnitude of potential effects due to sedimentation of the PWS due to construction of access tracks prior to mitigation and management is ***Low***. Thus, the overall significance is ***Minor/Moderate***.

8.7.8 Design parameters for watercourse crossings will be developed in consultation with EA following detailed engineering assessment, and will be provided in either the Construction Method Statement (CMS), or any required application for authorisation. Typical watercourse crossing details are shown in Figures 3.10 and 3.20. On the basis that any watercourse crossings will be subject to assessment and consent and are of small size, the magnitude of potential effect, and potential effects of stream crossing design in causing erosion and sedimentation, prior to mitigation and management, is assessed as ***Low***. Some sections of watercourse where the crossings are proposed are of ***High*** sensitivity, so the overall significance is ***Minor/Moderate***.

8.7.9 Trenches (~1m in depth) will be dug for the laying of electrical cables linking the turbines to the site substation. Where trenches are constructed on slopes the flow of water could lead to the erosion of soils. The removal of material and stockpiling could also lead to sedimentation of the local watercourses, some of which have a ***High*** sensitivity. However, standard cabling practice includes the rapid excavation and re-instatement of cables, thus there will be no exposed trench to allow for water flow causing erosion or sedimentation. Based on use of best practice cable installation, the magnitude of any potential effect of sediments due to erosion is assessed as a maximum of ***Low*** so the overall significance is ***Minor/Moderate***.

8.7.10 Water management will be by the use of diversion ditches around the structures to prevent water entry into open foundation bases. However, some dewatering is still likely to be required. Dewatering fluids will be directed into surface silt traps and discharged via settlement ponds and other sediment control structures onto surrounding vegetation to reduce the effect of dewatering and to avoid the sedimentation of ***High*** sensitivity watercourses. The magnitude of any potential effect of disposal of dewatering fluids is assessed as ***Low***, thus the overall significance is ***Minor/Moderate.***

8.7.11 As vehicles on site may be travelling over newly constructed roads or areas of exposed sediment, they may transport mud and silt away from site and onto public roads, where it may be washed into sensitive watercourses. However, experience has shown that the majority of such mud is shaken off the wheels before the vehicle reaches the public road. The magnitude of any potential effect of vehicles transporting sediment is ***Negligible to Low***, thus the overall significance will be ***Minor***.

8.7.12 In summary, and based on the effect significance criteria developed in regard to hydrology for the potential effects on surface water and groundwater water, the likely effect from erosion and sediment transport, prior to mitigation and management, is assessed as ***Negligible*** *to* ***Moderate/Major***. The infrastructure and forestry that will result in an overall significance of **Moderate/Major** for erosion/sedimentation of watercourses and therefore may require additional mitigation are:

- Turbine R31;
- Track sections: Track junction of R42 to R23, Access point 4 to R9 and the sections from R5 to R31 and R32;
- Watercourse crossings 13, 14, 15, 21 and 22 within the upper Afon Gam;
- Construction compound 1; and
- Forestry within Area 2 of HMP (30 ha) and (17.5 ha).

Pollution

8.7.13 Pollution of watercourses could potentially occur through the following pathways:

- Oil and chemical spills from:

- Oil leakages during vehicle movements or when on standby;
- Refuelling areas such as the compound; and/or
- Chemical/fuel storage areas.

- Leakage of cement powder or liquid concrete during pouring. Concrete is a highly alkali (high pH) and changes in the pH balance could effect the water quality and the species that depend on baseline conditions.
- Improper management of on-site waste.
- Poor sanitary plumbing.
- Poor water storage.

8.7.14 There will be no oil filled cables running across the site.

Effect Assessment

8.7.15 Even taking into account the application of best practice there is still a small risk of potential fuel spillage on site due to the number of vehicles and potential leaks or accidents. The magnitude of effect of a fuel/oil or chemical spillage and of contamination due to sanitary plumbing is ***Low***. However, the sensitivity of on-site receptors in terms of the Afon Gam main stem and its upper tributaries and private water supplies are assessed as being ***High***. Therefore, the likely effect on surface water from pollution is assessed as ***Minor/Moderate***.

Alteration to Natural Drainage Patterns / Runoff Volumes and Rates

8.7.16 The development of tracks and cable trenches has the potential to alter natural drainage on the site by the development of preferential flow pathways. If constructed against the topographic gradient, roads could act as barriers to run-off resulting in the ponding of water. If constructed in line with the gradient, the development of preferential flow down the roadway could occur.

8.7.17 Groundwater levels in peat could potentially be reduced in the immediate vicinity of site infrastructure. With regard to turbine bases and cable trenches this water level reduction will be temporary during excavation and concrete pouring/ cable installation. With respect to tracks the effects will be permanent as a seepage face will develop at the peat – track interface.

8.7.18 Other groundwater dependent terrestrial ecosystems (GWDTE) could also be impacted by alteration of the shallow groundwater and surface flows.

Effect Assessment

8.7.19 The reductions in groundwater levels within the peat have been calculated within Appendix 8.2 and demonstrate that there is minimal dewatering of the catotelm due to the low permeability and most dewatering occurs in the acrotelm, up to a maximum distance of about 9m. This results in a worst case total volume of dewatered peat of 55,000 m^3, with 20,000m^3 being only temporarily dewatered and 35,000 m^3 permanently dewatered. This represents a **Medium** magnitude of effect. The peat (mire habitat including blanket bog) is classed as ***High*** sensitivity and therefore the overall significance of this effect would be ***Moderate/Major*** and therefore additional mitigation has been proposed to reduce this impact.

8.7.20 Assessment of the relationship between proposed infrastructure and GWDTE show that there will be a loss of only 1% of high dependency GWDTE and 2% of moderate dependency GWDTE (Appendix 8.5 and Water Dependent Habitats in section 8.3). This would classify as a **Low/Medium** magnitude of effect. These habitats are classed as ***High*** sensitivity and therefore the overall significance of this effect

would be ***Moderate*** and therefore additional mitigation has been proposed to reduce this impact.

8.7.21 The effect of the access tracks will be no greater than normal forestry tracks and there will be no net effect on the total quantity of water flowing off the site. At the outset it is considered that the magnitude of potential effects predicted for interference to natural drainage patterns by tracks and cable trenching during construction is ***Low***. The watercourses on site are at the most ***High*** sensitivity and the PWS are of ***High*** sensitivity. Thus the overall significance would be ***Minor/Moderate***.

Soligenous Fen

8.7.22 Turbines 7 to 8 and associated track to the north have been sited deliberately to remain outside the fen catchments. As demonstrated by the cross sections, they will not interfere with groundwater or surface water flow paths leading to the fen.

8.7.23 The track to the west was deliberately sited in a large loop to the east to avoid the fen vegetation and again will not interfere with surface water flow or groundwater flow to the fen.

8.7.24 The CEMP will ensure that construction and excavation will not move from the ridgeline south and will preferentially remain on the axis and to the north for the track and the turbine. No micro-siting towards the south will be allowed in this area. Similarly, the track which has been relocated in the loop to the west will remain to the west of the ridge and will not be allowed to encroach to the east.

8.7.25 In addition CCW stated the following: *'The discovery of two raised mires, albeit neither in particularly good condition and over-planted with conifers, is highly noteworthy. The conifers on the western mire are poorly growing and consideration should be given to removing them from the bog surface. There appears to be natural pattering on the bog surface there and removal of the conifers would aid the continuation of natural function, including Carbon retention. The conifers on the eastern mire are better established for one reason or another; it is doubtful whether tree removal would allow the re-establishment of an ombrogenous bog surface, but in combination with grip blocking, the re-establishment of an ombrogenous bog surface is feasible.'* Dave Reed CCW HQ, 2010.

Effect Assessment

8.7.26 The relocation of this section of track and turbine bases outside of the surface water catchment of the fen reduces the magnitude of potential effects to ***Negligible***. Given that the soligenous fen is classified as ***High*** sensitivity the overall significance of effect is ***Negligible***.

Watercourse Crossings

8.7.27 Best practice with regard to avoiding or minimising stream crossings has been adopted. As well as construction, these water crossings may require ongoing maintenance to ensure they do not become blocked and prevent the passage of fish as well as posing a flood risk.

8.7.28 In England and Wales, works in, over or under a watercourse or works altering or repairing any structure in, over or under a watercourse must have prior authorisation from the Environment Agency in the form of a Land Drainage Consent. The application for consent will necessitate a detailed design of proposed engineering features and accordingly, will not be approved if there is likely to be a significant environmental effect.

Effect Assessment

8.7.29 On the basis that all crossing work is to be on minor watercourses (although some are of ***High*** sensitivity), and will require authorisation by NRW, the magnitude of potential effects of stream crossing design in impeding water flows are assessed as ***Low*** due to the requirement for suitable design. The significance before mitigation is then assessed as ***Minor/Moderate***.

8.7.30 In summary, and based on the effect significance criteria developed in regard to hydrology for the potential effects on geology, surface water and groundwater water, the likely effect from alteration of natural drainage patterns, runoff volumes and rates, prior to mitigation and management, is assessed as ***Negligible*** *to* ***Moderate/Major***. The infrastructure and forestry that will result in an overall significance of ***Moderate/Major*** for alteration of natural drainage patterns, runoff volumes and rates of watercourses and therefore will require additional mitigation are:

- Dewatering of peat across all areas of infrastructure that excavate through peat on a temporary or permanent basis;

8.7.31 And those resulting in an overall significance of ***Moderate*** for alteration of natural drainage patterns, runoff volumes and rates of watercourses and therefore also requiring additional mitigation are:

- 1% of high dependency GWDTE and 2% of moderate dependency GWDTE across the site.

Increase in the Magnitude of Frequency of Flood Events

8.7.32 The track network and turbine layout has been designed to avoid, as far as is practicable, areas that have been identified as at flood risk. Appendix 8.8 presents a flood risk assessment including estimated flood flows through hydrological modelling at the four river crossings of catchments greater than 1km^2 (detailed calculation sheets used for this analysis are available on request). The flood hazard has been assessed to be **Low**.

Alteration of the Geological Environment

8.7.33 The construction of the proposed site will involve the excavation of soils, peat, drift deposits and bedlock in varying amounts. Of these, peat is designated when it forms blanket bog and is also protected due to its ability to store carbon.

Effect Assessment

8.7.34 Over the whole of the site conservative estimates for the volume of peat that will be excavated are:

- Total volume of peat which will be excavated = 120,900m^3
- Total volume of acrotelm which will be excavated = 50,400 m^3
- Total volume of catotelm which will be excavated = 70,500 m^3

8.7.35 Generally across the site the depth of peat that will be excavated is <0.5m and these areas would have a negligible or low magnitude of effect depending on the presence or absence of peat. There are however several areas where deeper peat will be excavated and a ***Medium*** magnitude of effect is assigned. These include:

- Turbines - R18, R31, R35, R36 and R37; and
- Track – Track Junction to R35 and R36, R36 to R37 and R38, R37 to R26, R14 to R15, R41 to R39, R5 to R31.

8.7.36 Therefore the significance of effect prior to mitigation and management, is assessed as ***Moderate/Major*** for these areas of the site and additional mitigation is therefore required.

Operational Phase

8.7.37 During the operation and maintenance of the proposal the water environment will be subject to less potential adverse effects than during the construction phase of the proposal. Access tracks will be complete and no regular substantial works on the site will be expected during the life of the facility other than periodic maintenance. The potential for any additional sedimentation is low, therefore the likely effect from erosion and sediment transport, prior to mitigation and management, is considered to be ***Negligible*** on all receptors, thus the overall significance is also ***Negligible***.

8.7.38 A number of possible operational effects on the water environment have been identified including the potential for spillage of oil and fuels from vehicles used for accessing and traversing across the site. However, vehicle use will be minimal and the likely effects from pollution, on all receptors, prior to mitigation and management, are assessed to be ***Negligible***. The overall significance is also ***Negligible***.

8.7.39 Although the control building, substation and turbine bases are permanent, they represent only a small change to the hydrological characteristics of the site. The total area of all three combined will be small in relation to the overall catchment area. Therefore, the potential effects predicted for interference to natural drainage patterns by tracks and other infrastructure is considered to be ***Negligible*** on all receptors. The overall significance is also ***Negligible***.

8.7.40 There is potential for the water crossings of smaller streams to become blocked if not maintained. Due to the terrain and size of the crossings, this could result in minor flooding. Some of the streams are of ***High*** sensitivity. The likely magnitude of potential effects on natural water flows due to unmaintained stream crossings in the operational phase, prior to mitigation and management, is assessed as ***Low*** at the site of the stream crossings and ***Negligible*** downstream, thus the overall significance is ***Minor/Moderate***.

Decommissioning Phase

8.7.41 Details of decommissioning procedures are outlined in Chapter 3 (Project Description). The potential effects that the decommissioning could have on water resources will be very similar, although of lesser magnitude, to those detailed above. If new guidelines are published prior to decommissioning of the proposal then these will be incorporated into the decommissioning procedures.

8.8 Further Mitigation and Management and Residual Effects

8.8.1 From the assessment of potential effects, the following key issues which have demonstrated a potential effect significance of ***Moderate*** to ***Moderate/Major*** will need particular attention for mitigation and management:

8.8.2 The potential for erosion/sedimentation resulting from construction of the tracks, crane hardstandings, watercourse crossings, cable trenches, turbine foundations, substations, construction compounds, borrow pits, watercourse crossings, tree felling and dewatering of foundations where these are in close proximity to high sensitivity watercourses. Specific areas are:

- Turbine R31;
- Track sections: Track junction of R42 to R23, Access point 4 to R9 and the sections from R5 to R31 and R32;

- Watercourse crossings 13, 14, 15, 21 and 22 within the upper Afon Gam;
- Construction compound 1; and
- Forestry within Area 2 of HMP (30 ha) and (17.5 ha).

- The potential for an estimated worst case volume of 55,000 m^3 of peat to be dewatered on a temporary (20,000 m^3) and permanent (35,000 m^3) basis;
- The excavation of a total volume of peat of 120,900m^3 with the most significant areas being:
  - Turbines - R18, R31, R35, R36 and R37; and
  - Track – Track Junction to R35 and R36, R36 to R37 and R38, R37 to R26, R14 to R15, R41 to R39, R5 to R31
- The potential to effect 1% (4.5 ha) of high dependency GWDTE and 2% (4.3 ha) of moderate dependency ecosystems on site.

Additional Mitigation and Residual Effects

8.8.3 In order to reduce the proposal to an acceptable level those activities that have been assessed to result in a potential effect significance of ***Major*** to ***Moderate/Major*** have additional mitigation and management requirements including:

- Specific mitigation on sediment control will be required at the locations specified which will include the production of detailed drainage and sediment control plans in advance of works to capture and control all potentially sediment laden drainage and deal with it accordingly. Given the proximity of the watercourse in these locations, the gradient and the sensitivity of the watercourse additional vigilance and a higher frequency of monitoring is proposed at these locations.
- The development of a peat restoration plan in the five afforested areas to allow peat habitats to be restored and groundwater levels to be raised to near surface. This will be produced post consent and will expand on the detail in the Peat Management Plan (Appendix 8.9). A relatively conservative assumption of only a 0.1 m rise in groundwater level due to the blocking of all the drains and furrows across the 150 hectare area is equivalent to a total volume of peat re-saturation of 150,000 m^3. As many of the drains are 0.5m in depth and the dry furrows are generally 0.2m in depth the 0.1m rise in groundwater level is likely to be readily achievable. This volume of peat re-saturation is many times greater than the potential permanent impact from dewatering from infrastructure of 35,000 m^3.
- The peat management plan (Appendix 8.9) presents the areas where the estimated 70,500 m^3 of catotelm and 50,400 m^3 of catotelm that will be excavated from the infrastructure footprint will be reused to create new peat habitat and improve degraded peat habitat. These plans will enable the excavated peat to retain its integrity, retain carbon and allow areas of previous degraded and afforested peatland to regenerate and start to produce peat again.
- The 150 hectare restoration plan will also lead to the creation of flushes and other wetland features associated with the blocking of ditches and raising of groundwater levels that will compensate for the minor loss of high and moderate dependency GWDTE.

8.8.4 These mitigation measures and management plan would substantially reduce the Magnitude of effect of these activities to a Low or Negligible residual level resulting in acceptable significance of effect levels of ***Minor*** to ***Minor/Moderate***.

8.9 Conclusions

8.9.1 The assessment identified areas of activity, particularly during the construction operations that have the potential to effect the hydrological, hydrogeological and geological resources of the site. Following extensive consultation with NRW a significant amount of effort was undertaken to understand the spatial distribution and depth of peat across the site along with the potential effects of the proposed scheme. In addition consideration of impacts on private water supplies, groundwater, GWDTEs and the Afon Gam and its upper tributaries were also considered.

8.9.2 The magnitude and significance of potential effects was assessed, covering sedimentation/erosion, pollution and alteration to natural drainage patterns. Prior to specific additional mitigation, over and above best practice techniques, there is the potential for effects of ***Moderate*** and ***Moderate/Major*** significance to occur in regard to water quality, peat hydrology, peat resource and GWDTE. To reduce these effects a number of additional mitigation measures and management plans are recommended.

8.9.3 Following planning permission, and following more detailed site investigations and drainage design, Construction Method Statements and a Construction Environmental Management Plan (CEMP) will be prepared, and submitted and agreed to in writing by the relevant authorities prior to commencement of construction.

8.9.4 In addition, the design of all new or upgraded water crossings and borrow pits will be finalised with the relevant authority and appropriate consents or licences obtained before construction.

8.9.5 With the proposed additional mitigation and monitoring and management plans in place, the significance of the residual effects of the proposal on the hydrology and hydrogeology of the site would be ***Negligible*** to ***Minor/Moderate***.

9 ACOUSTIC ASSESSMENT

9.1 Glossary

Broadband Noise - Noise which covers a wide range of frequencies (e.g. from 10 Hz to 5 kHz).

dB(A) or decibel (A-weighted) - The human ear loses sensitivity at both high (>6 kHz) and low (<400 Hz) frequencies. The ear will attenuate noise at these lower and higher frequencies. dB(A) is an international weighted scale of sound levels or noise providing a good correlation with subjective impressions by individuals in most cases, of loudness and sense of annoyance by applying a correction to noise levels in each frequency band (octave band or third octave band). This correction is called A-weighting, and the corrected level is the A-weighted sound pressure level, denoted dB(A).

Frequency - The pitch of a sound in Hz or kHz. See Hz.

Hz - Sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

L_{eq} - The equivalent continuous noise 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.

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 the effects of, for example, aircraft or dogs barking on background noise levels.

L_W - Sound power level is the acoustic power (W) radiated from a sound source. This power is essentially independent of the surroundings, while the sound pressure depends on the surroundings (reflecting surfaces) and distance to the receiver.

Noise Emission - The noise energy emitted by a source (e.g. a wind turbine). Noise emission: 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 Frequency - Refers to how quickly the air vibrates, or how close the sound waves are to each other (in Hertz). Frequency is subjectively felt as the pitch of the sound. The lowest frequency audible to humans is 18 Hz and the highest is 18,000 Hz. The human ear is most sensitive to the 1 kHz, 2 kHz and 4 kHz octaves and much less sensitive at the lower audible frequencies.

Spectrum - Description of the sound pressure level of a source as a function of frequency.

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 - Noise which covers a very restricted range of frequencies (e.g. a range of <=20 Hz). This noise is more annoying than broadband noise.

9.2 Introduction

9.2.1 This chapter contains an assessment of the acoustic impact of the proposed Llanbrynmair wind farm according to the recommendations & guidelines detailed in the 'The Assessment and Rating of Noise from Wind Farms' (ETSU, 1996). The basic aim of these guidelines is to ensure noise levels that will offer a reasonable degree of protection to the amenity of wind farm neighbours.

9.2.2 The chapter supersedes all previous acoustic impact assessments for Llanbrynmair Wind Farm. The assessment methodology remains unchanged except for the cumulative assessment in Appendix 9.6 which has been revised for reasons of clarity and updated to consider the latest Carnedd Wen layout and turbine type.

9.2.3 To make the assessment, the following steps have been taken, as described subsequently in this chapter:

- determination of the noise emission characteristics of the candidate wind turbines – see section 9.4
- determination of the locations of the nearest, or most noise sensitive, neighbours – see section 9.4
- calculation of noise levels at the nearest neighbours due to the operation of the wind farm, using a sound propagation model – see section 9.4
- determination of indicative background noise levels for these neighbours, based on a background noise survey – see section 9.4
- determination of the acoustic assessment criteria in light of relevant guidance or regulations – see section 9.4
- evaluation of the acoustic assessment by comparing the estimated noise levels with the noise assessment criteria – see section 9.4
- assessment of construction noise – see section 9.5

9.2.4 RES have been project co-ordinators for several Joule[31] projects, leading European research into wind turbine noise and were involved in producing the guideline 'The Assessment and Rating of Noise from Wind Farms' (ETSU, 1996) for the DTI in 1996.

9.2.5 In addition RES has carried out noise assessments and reported to several local authorities on wind energy projects including taking measurements on newly constructed wind farms to ensure compliance with planning conditions.

9.2.6 Research work carried out by RES includes:

- An Investigation of Blade Swish from Wind Turbines, Dr P Dunbabin, RES, Proceedings of the 1996 International Congress on Noise Control Engineering, Book 1, pp 463-469
- An Automated System for Wind Turbine Tonal Assessment, R Ruffle, RES, Proceedings of the 1996 International Congress on Noise Control Engineering, Book 6, pp 2997-3002
- 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
- Noise from Variable Speed Turbines, JOR3CT950045, October 2000, Dr P Dunbabin, RES
- Fundamental research in amplitude modulation - a project by RenewableUK, Wind Turbine Noise 2011, Dr J Bass, RES *et al*.

9.2.7 Additional information, including a glossary, survey photos, instrumentation details and charts are provided in the Appendices.

General Overview of Wind Turbine Noise

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

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

9.2.9 As described by the Welsh Assembly Government Technical Advice Note 8 – Renewable Energy (TAN 8, 2005):

9.2.10 *"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. Aerodynamic noise from wind turbines is generally unobtrusive – it is broad-band in nature and in this respect is similar to, for example, the noise of wind in trees."*

9.2.11 Aerodynamic noise is usually only perceived when the wind speeds are fairly low. In higher winds, it is generally masked by the normal sound of wind blowing through trees and around buildings.

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

9.2.13 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.

9.3 Scope of Assessment

Operational Noise

9.3.1 The acoustic impact assessment of operational noise from the wind farm presented here considers the noise output from all turbines operating in combination. This consists of a combination of, predominantly, aerodynamic noise resulting from the movement of the blades and mechanical noise from the gearbox, generator and other components housed within the nacelle. 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

9.3.2 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 (Ontario Ministry of the Environment, 2010). 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.

9.3.3 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, indicates 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 (Ontario Ministry of the Environment, 2010). The degree of audibility depends upon the wind conditions, the degree of masking from background noise sources and the distance from the wind turbines (Ontario Ministry of the Environment, 2010).

9.3.4 Whilst low frequency content of the noise from wind farms is 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

9.3.5 In relation to modern, upwind turbines, there is strong evidence that the levels of infrasound produced are well below the average threshold of human hearing (Ontario

Ministry of the Environment, 2010). 'Community Noise', prepared for the World Health Organisation (WHO), states that:

> *"there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects"*

9.3.6 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." (Styles and Toon, 2005)*

9.3.7 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.

Vibration

9.3.8 A report by Snow gives details of low frequency noise and vibration measurements made at a wind farm (Snow, 1997). 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 (BSI, 1992). Noise and vibration levels were found to comply with recommended residential criteria, even on the wind turbine site itself.

9.3.9 Furthermore, the Keele University researchers state 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" (Styles & Toon, 2005)*

9.3.10 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

9.3.11 The noise associated with wind turbines referred to as "blade 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 (ETSU, 1996). However the DTI report researching low frequency noise (Hayes, 2006) noted that:

> *"The common cause of complaints associated with wind turbine noise at all 3 wind farms (where measurements were carried out) is not associated with low frequency noise but is the audible modulation of the aerodynamic noise, especially at night." (Hayes, 2006)*

9.3.12 To investigate whether or not this was an issue which might require attention in the context of the rating advice in ETSU-R-97, the Government subsequently commissioned the University of Salford to undertake further research in the area (DTI, 2006).

9.3.13 On 1 August 2007, the Government issued a statement (BERR, 2007) regarding the findings of the University of Salford report into amplitude modulation (AM) of wind turbine noise (University of Salford, 2007) published earlier in 2007 which found that, of 133 operational wind farms in the UK at the time of the report, there were only 4 cases where AM may have been a factor. It is known that complaints have now subsided for 3 of these cases (one due to introduced mitigation by a wind farm control system) and in the remaining case a settlement has been reached. The statement says that:

"…the Government does not consider there to be a compelling case for further work into AM and will not carry out any further research at this time."

9.3.14 In consequence the statement (BERR, 2007) makes it clear that the approach contained in the ETSU-R-97 report, to assess and rate noise from wind energy developments, is still recommended.

9.3.15 Several potential causes for these occurrences of enhanced or 'other' AM have been suggested including: high wind shear; stall; yaw error; blade-tower interaction; inflow turbulence; & wake interference between closely located turbines. There is, however, currently no clear evidence to support any of the proposed causative mechanisms of this effect. This is partly due to the difficulty in obtaining sufficiently detailed measurements of its occurrence and the conditions under which it occurs, this being as a direct consequence of the infrequency of occurrence and the small number of sites at which high levels of such effects have been reported. Consequently, the cause of higher levels of AM is still a subject of ongoing research.

9.3.16 Therefore, in accordance with literature and advice, it is not possible or 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.

Construction Noise

9.3.17 The acoustic impact assessment of construction noise from the wind farm presented here is based on RES' experience 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.

9.3.18 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.

9.4 Legislative Framework and Guidance

Operational Noise

9.4.1 Within Wales, noise is defined within the planning context by 'Planning Policy Wales' 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." (Planning Policy Wales, 2011)

9.4.2 Planning Policy Wales references Technical Advice Note 11: 'Noise' (TAN 11, 1997) 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." (TAN 11, 1997)

9.4.3 The Technical Advice Note 11: 'Noise' refers to detailed guidance on noise from wind turbines as being contained in Planning Guidance Technical Advice Note 8: 'Renewable Energy' (TAN 8, 2005).

9.4.4 In relation to noise from wind farms Planning Guidance Technical Advice Note 8, '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." (TAN 8, 2005)

9.4.5 It is therefore considered that the use of ETSU-R-97, as a criteria for assessment of wind farm noise, fulfils the objectives of 'Technical Advice Note 11: Noise' (TAN 11, 1997) and 'Planning Policy Wales'.

9.4.6 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.

9.4.7 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.

9.4.8 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." (ETSU, 1996)

9.4.9 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 the noise limits which have been derived according to ETSU-R-97 is considered to be acceptable. This approach is consistent with relevant planning policy and has been agreed with Powys County Council's Environmental Health Officer (Powys County Council, 2006).

9.4.10 An article published in the Institute of Acoustics Bulletin Vol. 34 No. 2, March/April 2009 (Institute of Acoustics, 2009), recommends a methodology for addressing issues not made explicit by, or outside the scope of, ETSU-R-97 – particularly in relation to wind shear and 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 working for both wind farm developers, local planning authorities and third parties and as such is a good indicator of best practice techniques. The Good Practice Guide, issued by the Institute of Acoustics in May 2013 and endorsed by the Welsh Assembly, provides guidance on all aspects of the use of ETSU-R-97 and, effectively, reaffirms the recommendations of the Acoustics Bulletin article with regard to propagation modelling and wind shear (Institute of Acoustics, 2013). The assessment presented herein adopts the recommendations made within the Acoustics Bulletin article and the Good Practice Guide.

Construction Noise

9.4.11 In Wales, advice on construction noise assessment is referred to in the Technical Advice Note 11: Noise which states:

"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." (TAN 11, 1997)

9.4.12 Since the publication of TAN 11, the 1984 version has been superseded by BS 5228-1:2009 'Noise control on construction and open sites' Part 1 – Noise (BSI, 2009). This latter document provides guideline noise criteria for minimising noise from construction activities, and is adopted herein.

9.5 Operational Noise Assessment

9.5.1 This acoustic impact assessment has been prepared by RES and is based on the proposed layout comprising 30 wind turbines.

9.5.2 In accordance with the recommendations of ETSU-R-97 (ETSU, 1996), the acceptance of the proposed wind farm is established by comparing the noise levels produced by the operation of the wind turbines with appropriate noise limits at nearby residential properties. The general principle is that the noise limits should be based on existing background noise levels (reflecting the variation in background noise with wind speed) except for very low background noise levels, in which case a fixed limit is applied or where predicted noise level can be shown to be below a 'simplified' limit of 35 dB L_{A90}.

Noise Emission Characteristics of the Wind Turbines

9.5.3 Although not finalised, the turbine type for the proposed Llanbrynmair wind farm is likely to be acoustically similar to the Vestas V90 2MW machine[32]. This chapter uses sound power level data from the manufacturer's general specification (Vestas, 2011). The manufacturer has identified these values as warranted and 1 dB has been added to the warranted turbine noise levels to allow for measurement uncertainty. Data regarding the frequency content of the acoustic emission at standardised 10 m wind speeds of 4-10 ms^{-1} is taken from an independent test report (Delta, 2011) and scaled to the warranted sound power level. Details assumed in this analysis are as follows:

- a hub height of 80 m;
- a rotor diameter of 90m;
- sound power levels, L_{WA}, for standardised 10 m height wind speeds (v_{10}) as shown in Table 9.1;
- 1/1 octave band spectra, for standardised 10 m height wind speeds (v_{10}), as shown in Table 9.2;
- tonal emission characteristics such that no clearly audible tones are present at any wind speed[33].

Table 9.1 Sound Power Levels for the for the Vestas V90 2MW Wind Turbine.

Standardised[34] 10m Height Wind Speed, v_{10} / ms^{-1}	A-Weighted Sound Power Level / dB(A) re 1 pW	
	Warranted noise levels	+1dB uncertainty
4	95.6	96.6
5	99.8	100.8
6	102.8	103.8
7	103.7	104.7

[32] The operation of this type turbine may be altered by changing the pitch of the wind turbine blades resulting in a trade-off between power production & noise reduction. The data presented here is for the full power output operational mode or 'Mode 0'.

[33] Before turbines are installed, RES will seek to obtain a warranty from the manufacturer that the turbines will not produce a turbine tonal component warranting a penalty correction according to the ETSU-R-97 guideline definition at the nearest noise sensitive properties.

[34] Note that all wind speeds in this report, unless explicitly stated otherwise, refer to 10m wind speed derived from a standardised extrapolation from the assumed hub height wind speed, see Appendix 9.2 for details.

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 9.2 Assumed Octave Band Sound Power Level Spectra for the Vestas V90 2MW Wind Turbine.

Octave Band / Hz	A-Weighted Sound Power Level / dB(A) re 1 pW						
	v_{10} = 4 ms^{-1}	v_{10} = 5 ms^{-1}	v_{10} = 6 ms^{-1}	v_{10} = 7 ms^{-1}	v_{10} = 8 ms^{-1}	v_{10} = 9 ms^{-1}	v_{10} = 10 ms^{-1}
63	70.7	74.0	77.7	81.3	84.2	84.9	84.3
125	79.3	85.7	87.7	87.5	87.7	87.6	87.3
250	82.3	86.1	89.5	90.9	91.6	91.7	91.4
500	88.0	91.9	94.6	95.8	95.9	95.1	95.0
1000	90.9	95.0	97.7	98.4	98.9	97.9	97.8
2000	88.9	93.6	96.8	97.5	98.1	98.6	98.7
4000	87.8	91.9	95.3	96.3	96.1	97.1	97.2
8000	79.4	83.6	87.7	88.5	89.0	89.6	90.0
OVERALL	96.6	100.8	103.8	104.7	105.0	105.0	105.0

Locations of Wind Turbines

9.5.4 The proposed Llanbrynmair wind farm is located approximately 3km from the village of Llanbrynmair, Powys. The surrounding area is predominantly rural in nature with one an A-class road running to the south of the site another to the north.

9.5.5 The locations of the 30 proposed turbines are shown in Figure 9.1 (Appendix 9.1).

Locations of Nearest Neighbours

9.5.6 The locations of the nearest neighbours to the turbines have been determined by inspection of relevant maps and through site visits. Fifty-two of the most acoustically sensitive and geographically spread neighbours have been considered for analysis, these being representative for all the others (more properties may have been identified but have not been considered critical to this acoustic assessment). These 52 locations are listed in Table 9.3 and are also shown in Figure 9.1 (Appendix 9.1)[35].

9.5.7 Elevations, given in metres above mean sea level, have been determined from digital terrain data.

9.5.8 Planning consent has been gained for a single dwelling at Ysgubor Uchaf (291794, 303228). The applicant for this dwelling, being already in a position to financially benefit from the proposed Llanbrynmair wind farm, has entered into agreement with RES that this property, should it be built, will not be occupied during the life-time of the Llanbrynmair wind farm. Therefore, this consented property has not been considered further in this assessment.

Table 9.3 Location of Nearby Neighbours.

House ID	House Name	British National Grid Co-ordinates	Elevation[36] / m	Description

[35] It should be noted that the grid references used for noise calculation purposes do not necessarily correspond to the centre of buildings, of even the facades facing the site. Rather they are intended to allow modelling of noise levels at locations where residents might reasonably be expected to be enjoying the outdoor amenity of their properties during afternoons, evenings and weekends.
[36] Elevation represents height above mean sea level for a listener 1.8m tall.

		X / m	Y / m		
H1	Ysgubor Cannon	295941	307427	276	Occupant with financial involvement in wind farm
H2	Pen yr Eisteddfod	297925	310831	280	
H3	Dolwen Isaf	297529	307560	230	
H4	The Barn - Blaen y Cwm	291684	307903	272	
H5	Rhydymeirch	292058	306823	246	
H6	Abercannon	296279	306935	250	Occupant with financial involvement in wind farm
H7	Beulah Chapel House	296391	306648	241	
H8	Neinthirion	296386	306621	242	
H9	Delfryn	295709	305450	262	
H10	Berth-lwyd	291029	303782	175	
H11	Castell y Gwynt	294857	302951	375	
H12	Pant y Powsi	294820	302356	336	
H13	Nant yr Esgairwen	294406	302236	330	
H14	Capel yr Aber	293953	301802	301	
H15	Hafodowen	292785	302747	327	
H16	Cwm-carnedd-isaf	291916	302705	233	
H17	Cwm-carnedd-uchaf	291578	302872	246	Occupant with financial involvement in wind farm
H18	Dolau	297042	306720	232	
H19	Dolau-ceimion	296367	305821	253	Occupant with financial involvement in wind farm
H20	Bryn Du	298673	309646	272	
H21	Glegyrnant	292154	307624	266	
H22	Blaen y Cwm	291582	308033	277	
H23	Cwm Pen Llydan	292893	306371	317	
H24	Cwm-y-ffynnon	291242	305314	228	Occupant with financial involvement in wind farm
H25	Pwll-melyn	291008	304715	174	
H26	Ffriddfawr	294629	303945	292	
H27	Cwmderwen	295533	305435	269	Occupant with financial involvement in wind farm
H28	Cannon	295885	307416	279	Occupant with financial involvement in wind farm
H29	Dolwen Uchaf	297496	307622	232	Occupant with financial involvement in wind farm
H30	Ffridd Newydd	298558	309877	285	
H31	Caecrwn	298045	310848	282	
H32	Llwyn	297508	311561	203	
H33	Maes Llymystyn	297081	311578	205	
H34	Moel Ddolwen	299312	307798	247	
H35	Tyn-y-fedw	298458	311040	226	
H36	Gesail-ddu	295260	312217	242	
H37	Caer-lloi	295255	312635	230	
H38	Dol-y-maen	294289	313607	271	
H39	Nant-y-dugoed	291872	313235	237	
H40	Talglannau	291309	312606	243	
H41	Barwn	290298	312458	199	
H42	Ty-coch	290257	312064	222	
H43	Groes-heol	289577	311083	177	
H44	Glan-yr-afon	289377	310403	186	
H45	Blaentafalog Farm	289347	309423	214	
H46	House 46	289127	308752	234	
H47	Nant Carfan	289367	307302	239	
H48	Dol Fawr	288957	306421	187	
H49	Gerddi-gleision	289397	305491	165	
H50	The Lodge	290237	305472	158	
H51	Cefn	292539	302062	321	
H52	Caeau-gleision	290993	305193	206	

9.5.9 The distances from each house to the nearest turbine are given in Table 9.4. It can be seen that the minimum house-to-turbine separation is 810m, however this relates to a property where the occupant has a financial interest in the wind farm. For the nearest neighbour without a financial interest in the wind farm, the minimum house-to-turbine separation is 873m.

Table 9.4 Distances from Nearby Neighbours to Nearest Proposed Turbine.

House ID	House Name	Distance / m	Nearest Turbine
H1	Ysgubor Cannon	862	R17
H2	Pen yr Eisteddfod	2210	R40
H3	Dolwen Isaf	1154	R43
H4	The Barn - Blaen y Cwm	2808	R19
H5	Rhydymeirch	2092	R7
H6	Abercannon	1014	R42
H7	Beulah Chapel House	1055	R42
H8	Neinthirion	1048	R42
H9	Delfryn	984	R24
H10	Berth-lwyd	1310	R31
H11	Castell y Gwynt	1338	R39
H12	Pant y Powsi	1530	R39
H13	Nant yr Esgairwen	1293	R39
H14	Capel yr Aber	1455	R39
H15	Hafodowen	881	R39
H16	Cwm-carnedd-isaf	1100	R32
H17	Cwm-carnedd-uchaf	1206	R32
H18	Dolau	1710	R42
H19	Dolau-ceimion	1260	R42
H20	Bryn Du	2014	R40
H21	Glegyrnant	2334	R19
H22	Blaen y Cwm	2921	R19
H23	Cwm Pen Llydan	1426	R8
H24	Cwm-y-ffynnon	1699	R4
H25	Pwll-melyn	1510	R31
H26	Ffriddfawr	873	R9
H27	Cwmderwen	862	R23
H28	Cannon	810	R17
H29	Dolwen Uchaf	1085	R43
H30	Ffridd Newydd	2005	R40
H31	Caecrwn	2288	R40
H32	Llwyn	2722	R40
H33	Maes Llymystyn	2635	R27
H34	Moel Ddolwen	2583	R43
H35	Tyn-y-fedw	2686	R40
H36	Gesail-ddu	3204	R26
H37	Caer-lloi	3614	R26
H38	Dol-y-maen	4819	R26
H39	Nant-y-dugoed	5834	R26
H40	Talglannau	5788	R37
H41	Barwn	6327	R19
H42	Ty-coch	6065	R19
H43	Groes-heol	5953	R19
H44	Glan-yr-afon	5773	R19
H45	Blaentafalog Farm	5415	R19
H46	House 46	5409	R7
H47	Nant Carfan	4303	R7
H48	Dol Fawr	4162	R31
H49	Gerddi-gleision	3297	R31
H50	The Lodge	2569	R31
H51	Cefn	1515	R39
H52	Caeau-gleision	1804	R31

Calculation of Noise Levels at Receivers

Noise Propagation Model

9.5.10 Whilst there are several sound propagation models available, here RES has used the ISO 9613 Part 2 model (ISO, 1996), this being identified as most appropriate for use in such rural sites (ETSU, 2000). The specific interpretation of the ISO 9613 Part 2 propagation methodology that has been employed is consistent with the aforementioned Institute of Acoustics bulletin article (Institute of Acoustics, 2009) and the subsequent Good Practice Guide (Institute of Acoustics, 2013).

9.5.11 To make these predictions, it is assumed that:

- the turbines are identical;
- the turbines radiate noise at the power specified in this chapter;
- each turbine can be modelled as a point source at hub-height; &
- each dwelling is assigned a reference height of 4 m to simulate the presence of an observer.

9.5.12 The model takes account of:

- attenuation due to geometric spreading;
- atmospheric absorption;
- ground effects; &
- barrier effects.

9.5.13 The barrier attenuations predicted by ISO 9613 Part 2 have been shown to be significantly greater than those measured in practice under downwind conditions (ETSU, 2000). 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 property in question and any part of the wind turbine, 2 dB attenuation has been assumed as recommended in the aforementioned Institute of Acoustics bulletin article (Institute of Acoustics, 2009) and the subsequent Good Practice Guide (Institute of Acoustics, 2013).

9.5.14 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.

9.5.15 The predicted noise levels are changed from the L_{Aeq} to the L_{A90} descriptor (to allow comparisons to be made) by the use of an adjustment factor of 2 dB, as specified by ETSU-R-97 (ETSU, 1996).

Conservatism in Propagation Modelling

9.5.16 It has been shown by measurement-based verification studies that the ISO 9613 Part 2 model tends to slightly over-estimate noise levels at nearby dwellings (ETSU, 2000). Examples of additional conservatism modelled are:

- downwind propagation is modelled 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 Institute of Acoustics bulletin article (Institute of Acoustics, 2009) and the subsequent Good Practice Guide (Institute of Acoustics, 2013);

- receiver heights are modelled at 4.0 m above local ground level, which equates roughly to first floor window level. This results in a predicted noise level anything up to 2 dB(A) higher than at the 'standard' assessment height of 1.2 - 1.8 m;
- trees and other non-terrain shielding effects have not been considered; and
- warranted sound power levels of the presented turbine have had 1 dB added to allow for measurement uncertainty should the turbine emission levels be specifically tested.

9.5.17 Additionally, verification studies have also shown that ISO 9613 Part 2 tends to slightly under-estimate noise levels at nearby dwellings in certain exceptional cases, notably in a valley type environment where the ground drops off between source and receiver (ETSU, 2000). In these instances an addition of 3 dB(A) has been applied to the resulting overall A-weighting noise level[37] as recommended by the Good Practice Guide (Institute of Acoustics, 2013).

Predictions

9.5.18 The wind speeds at which the acoustic impact has been considered, 4 – 12 ms^{-1} at standardised 10 m height, have been chosen as these are likely to be the acoustically critical wind speeds. Below this wind speed range there is insufficient strength in the wind for the wind turbines to operate effectively and the noise emitted decreases rapidly. Above this wind speed range, as stated in ETSU-R-97 (ETSU, 1996), 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 12 ms^{-1} at standardised 10 m height, it is most 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.

9.5.19 Table 9.5 shows the predicted noise emission levels at the nearest neighbours for each wind speed considered, calculated from the operation of the proposed wind farm. The maximum predicted noise emission level is 38.3 dB (A) at Cannon (H28) (at standardised v_{10} equal to 8 ms^{-1})[38], however it should be noted that this property is occupied by a person with a financial interest in the wind farm. The maximum predicted noise emission level at locations with no financial interest in the wind farm is 36.9 dB (A) at Hafodowen (H15) (at standardised v_{10} equal to 8 ms^{-1}).

9.5.20 Figure 9.1 (Appendix 9.1) shows a noise contour plot for the site at a standardised 10 m height wind speed of 8 ms^{-1}. Such plots are useful for evaluating the noise 'footprint' of a given development and indicating the number of properties with predicted noise levels greater than the ETSU-R-97 simplified limit of 35 dB L_{A90}.

Table 9.5 Predicted Noise Levels At Nearby Dwellings (dB(A) re 20 μPa).

Values in bold indicate the maximum predicted noise level
Shading indicates properties with predicted noise levels greater than 35 dB(A)

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}								
		4	5	6	7	8	9	10	11	12
H1	Ysgubor Cannon	29.5	33.7	36.4	37.4	37.9	37.4	37.2	37.2	37.2
H2	Pen yr Eisteddfod	15.9	20.2	22.9	24.0	24.6	24.2	23.9	23.9	23.9
H3	Dolwen Isaf	24.0	28.2	31.0	32.0	32.5	32.0	31.8	31.8	31.8
H4	The Barn - Blaen y Cwm	16.3	20.6	23.4	24.5	25.1	24.8	24.5	24.5	24.5
H5	Rhydymeirch	18.9	23.1	25.9	27.0	27.5	27.1	26.9	26.9	26.9
H6	Abercannon	27.3	31.5	34.2	35.2	35.7	35.2	35.0	35.0	35.0
H7	Beulah Chapel House	26.3	30.4	33.2	34.2	34.7	34.2	34.0	34.0	34.0
H8	Neinthirion	26.3	30.4	33.2	34.2	34.7	34.2	34.0	34.0	34.0

[37] This modification increases the predicted noise levels at 24 of the properties considered in the assessment (Dolwen Isaf, The Barn – Blaen y Cwm, Castell y Gwynt, Pant y Powsi, Nant yr Esgairwen, Capel yr Aber, Dolau, Bryn Du, Blaen y Cwm, Dolwen Uchaf, Ffridd Newydd, Moel Ddolwen, Tyn-y-fedw, Nant-y-dugoed, Talglannau, Barwn, Ty-coch, Groes-heol, Glan-yr-afon, Blaentafalog Farm, House 46, Nant Carfan, Dol Fawr and Gerddi-gleision).

[38] Although the sound power emitted by the turbines is the same for standardised 10 m wind speeds of 8 ms^{-1} and above (see Table 9.1) the predicted noise level at nearby dwellings for standardised 10 m wind speeds of 8 ms^{-1} and above differs as the different frequency content of the acoustic emission (see Table 9.2) affects the way that sound propagates from the source to the receiver.

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}								
		4	5	6	7	8	9	10	11	12
H9	Delfryn	27.4	31.6	34.4	35.4	35.8	35.3	35.2	35.2	35.2
H10	Berth-lwyd	20.4	24.5	27.3	28.4	29.0	28.5	28.3	28.3	28.3
H11	Castell y Gwynt	25.5	29.8	32.5	33.5	34.1	33.6	33.4	33.4	33.4
H12	Pant y Powsi	21.7	25.9	28.6	29.7	30.2	29.8	29.6	29.6	29.6
H13	Nant yr Esgairwen	20.7	24.9	27.6	28.6	29.2	28.7	28.5	28.5	28.5
H14	Capel yr Aber	19.3	23.5	26.3	27.3	27.8	27.4	27.2	27.2	27.2
H15	Hafodowen	28.5	32.7	35.5	36.4	36.9	36.4	36.2	36.2	36.2
H16	Cwm-carnedd-isaf	22.4	26.5	29.3	30.3	30.9	30.4	30.2	30.2	30.2
H17	Cwm-carnedd-uchaf	22.8	26.9	29.7	30.7	31.2	30.7	30.5	30.5	30.5
H18	Dolau	24.0	28.2	31.0	32.0	32.5	32.0	31.8	31.8	31.8
H19	Dolau-ceimion	24.8	29.0	31.7	32.7	33.2	32.7	32.5	32.5	32.5
H20	Bryn Du	17.9	22.2	24.9	26.0	26.5	26.2	25.9	25.9	25.9
H21	Glegyrnant	17.5	21.7	24.5	25.6	26.3	25.9	25.7	25.7	25.7
H22	Blaen y Cwm	16.0	20.3	23.1	24.2	24.8	24.6	24.3	24.3	24.3
H23	Cwm Pen Llydan	22.9	26.9	29.7	30.9	31.5	31.0	30.8	30.8	30.8
H24	Cwm-y-ffynnon	19.5	23.6	26.4	27.5	28.2	27.8	27.5	27.5	27.5
H25	Pwll-melyn	19.7	23.8	26.5	27.7	28.3	27.8	27.6	27.6	27.6
H26	Ffriddfawr	27.5	31.7	34.4	35.4	35.9	35.4	35.2	35.2	35.2
H27	Cwmderwen	28.5	32.7	35.5	36.4	36.9	36.4	36.2	36.2	36.2
H28	**Cannon**	**29.9**	**34.1**	**36.9**	**37.8**	**38.3**	**37.8**	**37.6**	**37.6**	**37.6**
H29	Dolwen Uchaf	24.3	28.5	31.2	32.2	32.7	32.2	32.1	32.1	32.1
H30	Ffridd Newydd	18.0	22.3	25.0	26.1	26.7	26.3	26.1	26.1	26.1
H31	Caecrwn	15.5	19.8	22.5	23.6	24.2	23.8	23.6	23.6	23.6
H32	Llwyn	13.2	17.5	20.3	21.4	22.0	21.7	21.5	21.5	21.5
H33	Maes Llymystyn	13.8	18.1	20.9	22.0	22.6	22.3	22.0	22.0	22.0
H34	Moel Ddolwen	15.5	19.8	22.5	23.7	24.3	24.1	23.8	23.8	23.8
H35	Tyn-y-fedw	12.9	17.2	19.9	21.0	21.7	21.4	21.2	21.2	21.2
H36	Gesail-ddu	11.6	15.9	18.7	19.9	20.7	20.5	20.2	20.2	20.2
H37	Caer-lloi	10.4	14.8	17.5	18.6	19.4	19.2	18.9	18.9	18.9
H38	Dol-y-maen	7.3	11.8	14.5	15.7	16.6	16.6	16.3	16.3	16.3
H39	Nant-y-dugoed	5.8	10.5	13.2	14.4	15.4	15.5	15.1	15.1	15.1
H40	Talglannau	6.3	11.0	13.7	14.9	15.9	16.0	15.7	15.7	15.7
H41	Barwn	5.6	10.3	12.8	14.2	15.3	15.5	15.1	15.1	15.1
H42	Ty-coch	6.1	10.8	13.5	14.7	15.9	16.0	15.5	15.5	15.5
H43	Groes-heol	6.4	11.1	13.8	15.0	16.1	16.2	15.8	15.8	15.8
H44	Glan-yr-afon	7.3	11.9	14.7	15.9	17.0	17.2	16.8	16.8	16.8
H45	Blaentafalog Farm	8.8	13.4	16.1	17.4	18.4	18.5	18.1	18.1	18.1
H46	House 46	9.9	14.4	17.1	18.3	19.3	19.3	18.9	18.9	18.9
H47	Nant Carfan	12.5	16.9	19.7	21.0	21.9	21.9	21.6	21.6	21.6
H48	Dol Fawr	12.7	17.1	19.8	21.1	21.9	21.8	21.5	21.5	21.5
H49	Gerddi-gleision	15.2	19.6	22.3	23.4	24.1	23.9	23.6	23.6	23.6
H50	The Lodge	15.0	19.2	22.0	23.1	23.8	23.5	23.2	23.2	23.2
H51	Cefn	22.7	26.9	29.6	30.6	31.1	30.7	30.5	30.5	30.5
H52	Caeau-gleision	18.8	23.0	25.7	26.8	27.4	26.9	26.7	26.7	26.7

9.5.21 For illustrative purposes only, Figure 9.2 (Appendix 9.1) shows the measured wind rose at Llanbrynmair over the period March 2006 – March 2008, as measured by a meteorological mast located on the wind farm site. As previously mentioned, the noise prediction model employed is likely to overestimate the real noise emission levels for locations not downwind of the turbines. Figure 9.2 therefore may aid the reader as to the likelihood of over-estimation due to this factor.

Simplified Noise Assessment Procedure

9.5.22 Whilst ETSU-R-97 presents a comprehensive and detailed assessment methodology for wind farm noise, it also states that:

"if the noise is limited to an $L_{A90,10min}$ 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'" (ETSU, 1996).

9.5.23 Table 9.6 shows a comparison of the predicted noise levels at the appropriate wind speed (standardised v_{10} up to 10 ms^{-1}) with this recommended 35 dB(A) noise limit for each house. 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.

Table 9.6 Comparison of Predicted Noise Levels and Simplified Noise Limit (dB(A) re 20 μPa).

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}		
		Up to 10ms^{-1}		
		L_p	Limit	ΔL
H1	Ysgubor Cannon	37.9	35.0	2.9
H2	Pen yr Eisteddfod	24.6	35.0	-10.4
H3	Dolwen Isaf	32.5	35.0	-2.5
H4	The Barn - Blaen y Cwm	25.1	35.0	-9.9
H5	Rhydymeirch	27.5	35.0	-7.5
H6	Abercannon	35.7	35.0	0.7
H7	Beulah Chapel House	34.7	35.0	-0.3
H8	Neinthirion	34.7	35.0	-0.3
H9	Delfryn	35.8	35.0	0.8
H10	Berth-lwyd	29.0	35.0	-6.0
H11	Castell y Gwynt	34.1	35.0	-0.9
H12	Pant y Powsi	30.2	35.0	-4.8
H13	Nant yr Esgairwen	29.2	35.0	-5.8
H14	Capel yr Aber	27.8	35.0	-7.2
H15	Hafodowen	36.9	35.0	1.9
H16	Cwm-carnedd-isaf	30.9	35.0	-4.1
H17	Cwm-carnedd-uchaf	31.2	35.0	-3.8
H18	Dolau	32.5	35.0	-2.5
H19	Dolau-ceimion	33.2	35.0	-1.8
H20	Bryn Du	26.5	35.0	-8.5
H21	Glegyrnant	26.3	35.0	-8.7
H22	Blaen y Cwm	24.8	35.0	-10.2
H23	Cwm Pen Llydan	31.5	35.0	-3.5
H24	Cwm-y-ffynnon	28.2	35.0	-6.8
H25	Pwll-melyn	28.3	35.0	-6.7
H26	Ffriddfawr	35.9	35.0	0.9
H27	Cwmderwen	36.9	35.0	1.9
H28	Cannon	38.3	35.0	3.3
H29	Dolwen Uchaf	32.7	35.0	-2.3
H30	Ffridd Newydd	26.7	35.0	-8.3
H31	Caecrwn	24.2	35.0	-10.8
H32	Llwyn	22.0	35.0	-13.0
H33	Maes Llymystyn	22.6	35.0	-12.4
H34	Moel Ddolwen	24.3	35.0	-10.7
H35	Tyn-y-fedw	21.7	35.0	-13.3
H36	Gesail-ddu	20.7	35.0	-14.3
H37	Caer-lloi	19.4	35.0	-15.6
H38	Dol-y-maen	16.6	35.0	-18.4
H39	Nant-y-dugoed	15.4	35.0	-19.6
H40	Talglannau	15.9	35.0	-19.1
H41	Barwn	15.3	35.0	-19.7
H42	Ty-coch	15.9	35.0	-19.1
H43	Groes-heol	16.1	35.0	-18.9
H44	Glan-yr-afon	17.0	35.0	-18.0
H45	Blaentafalog Farm	18.4	35.0	-16.6
H46	House 46	19.3	35.0	-15.7
H47	Nant Carfan	21.9	35.0	-13.1
H48	Dol Fawr	21.9	35.0	-13.1
H49	Gerddi-gleision	24.1	35.0	-10.9
H50	The Lodge	23.8	35.0	-11.2
H51	Cefn	31.1	35.0	-3.9
H52	Caeau-gleision	27.4	35.0	-7.6

9.5.24 Noise levels at 45 of the 52 properties considered are below the 35 dB(A) limit, indicating that the noise emission levels would be regarded as acceptable and the householders' amenities as receiving 'sufficient protection'.

9.5.25 There are seven locations that do not pass this simplified noise criteria so that, strictly, the 'full' acoustic assessment need only be considered at these. Note that at four of these properties the occupant has a financial interest in the wind farm. The 'full' acoustic assessment will also be presented at two additional properties where background noise measurements have been made for completeness.

Indicative Background Noise

9.5.26 Since, in rural areas, background noise levels depend, to a large extent, on wind speed, as indeed do wind turbine noise emissions, it is important when making background noise measurements to put them in that context. Thus, the assessment of background noise levels at potentially sensitive neighbouring locations requires the measurement of not only noise levels, but concurrent wind conditions on the proposed site, covering a representative range of wind speeds.

Background Noise Survey Procedure

9.5.27 Background noise measurements were undertaken by RES over the period 6th June 2006 – 29th June 2006 in accordance with ETSU-R-97 (ETSU, 1996). Measurements were made at four locations: Cannon (H28), Cwm-y-ffynnon (H24), Ffriddfawr (H26) & Hafodowen (H15). Furthermore RES have entered an agreement with an adjacent wind farm developer (NPower[39]) to share selected noise information resulting in use of an additional background noise survey location result at Cwm Pen Llydan (H23) where data was recorded over the period 14th February 2008 – 4th March 2008.

9.5.28 Measurements were made at these locations as they are the most noise sensitive dwellings geographically spread around the proposed site and are likely to be representative of other houses in the locale. The background noise measurement locations as measured by RES were agreed in consultation with Paul Bufton, EHO at Powys County Council (Powys County Council, 2006).

Table 9.7 Background Noise Survey Details.

House ID	House Name	Measurement Period			Instrument Type
		Start	End	Duration	
H28	Cannon	06/06/06	29/06/06	23 days	Rion NL31
H24	Cwm-y-ffynnon	06/06/06	29/06/06	23 days	Rion NL31
H26	Ffriddfawr	06/06/06	29/06/06	23 days	Rion NL31
H15	Hafodowen	06/06/06	29/06/06	23 days	Rion NL31
Hoare Lea Acoustics Background Noise Survey Details					
H23	Cwm Pen Llydan	14/02/08	04/03/08	20 days	SVAN 945A

Instrumentation Arrangements

9.5.29 Sound level meters and associated apparatus, as used for the RES background noise survey, were set-up over the dates shown in Table 9.7 to record the required acoustic information. These were housed in weather-proof enclosures, and powered by lead-acid batteries. The microphones were placed at a height of approximately 1.5 m above ground, and equipped with wind shields which also provide an element of water resistance.

9.5.30 Noise levels were monitored continuously, and summary statistics stored every 10 minutes in the internal memory of each meter. The relevant statistics for noise assessment are: $L_{A90,10min}$ (The A-weighted sound pressure level exceeded for 90 % of the 10 minute interval), and $L_{Aeq,10min}$ (the equivalent A-weighted continuous sound pressure level).

[39] The acoustic assessment for NPower has been fulfilled by Hoare Lea Acoustics

9.5.31 The meters were placed in moderately sheltered positions in order to provide a degree of protection from the wind, away from reflecting walls and vegetation. Photos of the equipment, in situ, may be seen in Photos 9.1 – 9.4 (Appendix 9.3). The apparatus were calibrated before and after the survey period and no significant drift was detected. All instrumentation was subject to laboratory calibration within the previous 12 months (see Appendix 9.4).

9.5.32 Wind speed and direction (at 51m and 70m height) have been recorded by a data logger mounted on a meteorological mast at OSGB Grid reference (294911, 306491). Data were collected as 10 min averages, the same period as for the noise measurements, and were synchronised with the acoustic data to allow correlations to be established. The instantaneous wind shear exponent was calculated for each 10 minute period and used to derive the wind speed at hub height (80m). These hub height wind speeds were then translated to a standardised 10m wind speed to be consistent with the methodology to which wind turbine noise levels are reported. Refer to Appendix 9.2 for details.

9.5.33 It has been confirmed with NPower's acoustic consultants, Hoare Lea Acoustics, that the methodology and instrumentation set-up at Cwm Pen Llydan (H23) is to a similar standard. A photo of their equipment, in situ, is shown as Photo 5 (Appendix 9.3).

Results

9.5.34 During the period of the RES survey, 6th – 29th June 2006, the standardised 10 m wind speeds ranged from 0.2 – 13.3 ms^{-1}. A scatter plot of wind direction against standardised 10 m wind speed is shown in Figure 9.3 (Appendix 9.1).

9.5.35 The $L_{A90,10min}$ noise level time series recorded at Cannon (H28), Cwm-y-ffynnon (H24), Ffriddfawr (H26) & Hafodowen (H15), for the duration of the survey, are shown in Figure 9.4 (Appendix 9.1). The concurrent 10 min average standardised wind speeds, at 10 m height, are shown superimposed on the figure. The higher level of noise measured at Cannon (H28) is attributable to running water in the nearby river.

Data Processing

9.5.36 Prior to analysis, the acoustic data were filtered to remove the effects of rainfall, the 'dawn chorus' and other atypically high levels of noise such as periodic or intermittent operation of farm machinery. Periods of rainfall were identified using UK Met Office hourly rainfall radar data for coordinate (294900, 306500). Appendix 9.5 provides further details regarding the filtered data set.

9.5.37 It has been confirmed with Hoare Lea Acoustics, that the data measured at Cwm-Pen-Llydan (H23) was subject to a similar process of data quality control measures.

9.5.38 For each background noise measurement location, the measured noise data have been divided into two sets, as specified by ETSU-R-97 (ETSU, 1996):

Table 9.8 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

9.5.39 Figure 9.5 (Appendix 9.1) shows $L_{A90,10min}$ against the standardised 10 m wind speed for quiet waking hours at Cannon (H28). A 'best fit' line has been fitted to the data and the derived noise limits added (see Table 9.12 for details). Figure 9.6-9.8 (Appendix 9.1) shows similar results for Cwm-y-ffynnon (H24), Ffriddfawr (H26) & Hafodowen (H15). Hoare Lea Acoustics have provided RES with similar results from Cwm Pen Llydan (H23) (although without suggested noise limits marked), as shown in Figure 9.9.

9.5.40 Figure 9.10 (Appendix 9.1) shows $L_{A90,10min}$ against the standardised 10 m wind speed for night-time hours at Cannon (H28). A 'best fit' line has been fitted to the data and the derived noise limits added (see Table 9.13 for details). Figure 9.11-9.13 (Appendix 9.1) shows similar results for Cwm-y-ffynnon (H24), Ffriddfawr (H26) & Hafodowen (H15). Hoare Lea Acoustics have provided RES with similar results from Cwm Pen Llydan (H23) (although without suggested noise limits), as shown in Figure 9.14.

9.5.41 Tables 9.9 & 9.10 below detail the $L_{A90,10min}$ background noise levels calculated from the derived 'best fit' lines, as described above. A minimum of ten data points per wind speed bin was deemed to be necessary in order to fit a 'best fit' line to the data. At high wind speeds, where less than ten data points were recorded, the background noise level was assumed to be the same as the previous wind speed bin as a conservative measure.

Table 9.9 Quiet Waking Hours Noise Levels (dB(A) re 20 μPa).

House ID	House Name	Quiet Waking Hours Noise Levels at Indicated Locations Standardised 10 m Wind Speed / ms^{-1}								
		4	5	6	7	8	9	10	11	12
H28	Cannon	34.7	35.1	35.6	36.4	37.4	38.5	38.5	38.5	38.5
H24	Cwm-y-ffynnon	30.7	31.1	31.9	33.0	34.7	37.1	37.1	37.1	37.1
H26	Ffriddfawr	30.4	31.7	33.2	35.0	37.0	39.2	39.2	39.2	39.2
H15	Hafodowen	32.0	33.9	36.2	38.8	42.0	45.2	45.2	45.2	45.2
H23	Cwm Pen Llydan	31.2	33.0	35.0	37.2	39.4	41.4	43.1	44.4	45.1

Table 9.10 Night-time Noise Levels (dB(A) re 20 μPa).

House ID	House Name	Night Time Noise Levels at Indicated Locations Standardised 10 m Wind Speed / ms^{-1}								
		4	5	6	7	8	9	10	11	12
H28	Cannon	35.1	35.3	35.5	35.8	36.0	36.2	36.5	36.5	36.5
H24	Cwm-y-ffynnon	25.3	26.9	29.0	31.6	34.6	34.6	34.6	34.6	34.6
H26	Ffriddfawr	24.2	26.5	29.2	32.1	34.9	37.5	39.5	39.5	39.5
H15	Hafodowen	22.9	28.1	34.0	40.0	45.4	45.4	45.4	45.4	45.4
H23	Cwm Pen Llydan	31.1	32.0	33.2	34.5	36.0	37.8	39.7	41.9	44.2

9.5.42 Please refer to Appendix 9.2 for details of the standardised 10m wind speed derivation.

Acoustic Acceptance Criteria

9.5.43 The acceptance of the proposed wind farm is established in accordance with the recommendations of ETSU-R-97 (ETSU, 1996). This is achieved by comparing the predicted noise levels produced by the proposed wind turbines at nearby residential properties with the noise limits at those properties, these derived from existing background noise levels. This approach has the advantage that the limits can directly reflect the existing noise environment (before the construction and operation of any wind farm) at the nearest properties and the impact that the wind farm / wind farms may have on this environment. ETSU-R-97 considers that absolute noise limits applied at all wind speeds are not suited to wind farms and that limits set relative to the background noise are more appropriate in the majority of cases.

9.5.44 ETSU-R-97 states that different limits should be applied during quiet waking and night-time hours. The quiet waking hour's 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 L_B is the background $L_{A90,10min}$ and is a function of wind speed. During quiet waking hours 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. Considering this criteria, as specified by ETSU-R-97, RES have adopted a 40 dB(A), level.

Table 9.11 Permissible Noise Level Criteria.

Time of Day	Permissible Noise Level
Quiet waking hours	• 40 dB(A) for L_B less than 35 dB(A) • L_B + 5 dB(A), for L_B greater than 35 dB(A)
Night-time hours	• 43 dB(A) for L_B less than 38 dB(A) • L_B + 5 dB(A), for L_B greater than 38 dB(A)

9.5.45 Note that a higher noise level is permissible during night-time hours than during quiet waking hours, as it is assumed that residents would be indoors. 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 L_{A90}, rather than L_{Aeq}. Further details are given in ETSU-R-97 (ETSU, 1996).

Calculation of Acceptable Noise Limits from Background Noise Data

9.5.46 The 'best-fit' lines of Figures 9.5 – 9.14 (Appendix 9.1) have been used to deduce the acceptable noise limits at the background noise measurement locations. Table 9.12 shows the suggested quiet waking hours noise limits and Table 9.13 the suggested night time noise limits.

Table 9.12 Recommended Quiet Waking Hours Noise Limits (dB(A) re 20 μPa).

House ID	House Name	Derived Quiet Waking Hours Noise Limits at Indicated Locations Standardised 10 m Wind Speed / ms^{-1}								
		4	5	6	7	8	9	10	11	12
H28	Cannon	40.0	40.1	40.6	41.4	42.4	43.5	43.5	43.5	43.5
H24	Cwm-y-ffynnon	40.0	40.0	40.0	40.0	40.0	42.1	42.1	42.1	42.1
H26	Ffriddfawr	40.0	40.0	40.0	40.0	42.0	44.2	44.2	44.2	44.2
H15	Hafodowen	40.0	40.0	41.2	43.8	47.0	50.2	50.2	50.2	50.2
H23	Cwm Pen Llydan	40.0	40.0	40.0	42.2	44.4	46.4	48.1	49.4	50.1

Table 9.13 Recommended Night-time Noise Limits (dB(A) re 20 μPa).

House ID	House Name	Derived Night Time Noise Limits at Indicated Locations Standardised 10 m Wind Speed / ms^{-1}								
		4	5	6	7	8	9	10	11	12
H28	Cannon	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H24	Cwm-y-ffynnon	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H26	Ffriddfawr	43.0	43.0	43.0	43.0	43.0	43.0	44.5	44.5	44.5
H15	Hafodowen	43.0	43.0	43.0	45.0	50.4	50.4	50.4	50.4	50.4
H23	Cwm Pen Llydan	43.0	43.0	43.0	43.0	43.0	43.0	44.7	46.9	49.2

9.5.47 Refer to Appendix 9.2 for definition of the standardised 10m wind speed.

9.5.48 The recommendations of ETSU-R-97 (ETSU, 1996) 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. It is assumed, therefore, that:

- for Ysgubor Cannon (H1), Dolwen Isaf (H3), Abercannon (H6), Beulah Chapel House (H7), Neinthirion (H8), Dolau (H18), Dolau-ceimion (H19), Cannon (H28), Dolwen Uchaf (H29) & Moel Ddolwen (H34) the noise limits derived for Cannon (H28) would apply. These were chosen as Cannon (H28) is relatively close by and experiences a broadly similar exposure as these properties.

- for Berth-lwyd (H10), Cwm-carnedd-isaf (H16), Cwm-carnedd-uchaf (H17) , Cwm-y-ffynnon (H24), Pwll-melyn (H25), Gerddi-gleision (H49), The Lodge (H50), Cefn (H51) & Caeau-gleision (H52) the noise limits derived for Cwm-y-ffynnon (H24) would apply. These were chosen as Cwm-y-ffynnon (H24) is relatively close by and experiences a broadly similar exposure as these properties.
- for Delfryn (H9), Castell y Gwynt (H11), Pant y Powsi (H12), Nant yr Esgairwen (H13), Capel yr Aber (H14), Ffriddfawr (H26) & Cwmderwen (H27) the noise limits derived for Ffriddfawr (H26) would apply. These were chosen as Ffriddfawr (H26) is relatively close by and experiences a broadly similar exposure as these properties.
- for Hafodowen (H15) the noise limits derived would apply to that property only. This is a conservative measure given that the noise levels measured at this location are, whilst not unreasonable (that is, no instrumentation error suspected), generally higher than those measured elsewhere around the site.
- for The Barn - Blaen y Cwm (H4), Rhydymeirch (H5), Glegyrnant (H21), Blaen y Cwm (H22), & Cwm Pen Llydan (H23) the noise limits derived for Cwm Pen Llydan (H23) would apply. These were chosen as Cwm Pen Llydan (H23) is relatively close by and experiences a broadly similar exposure as these properties.
- As a conservative measure at all other properties specified in this chapter a simplified noise limit of 40dB(A) for quiet daytime periods & 43dB(A) for night time periods has been adopted in lieu of nearby background noise survey data.

9.5.49 As stated in ETSU-R-97 (ETSU, 1996), the absolute lower noise limit for both daytime and night-time hours can be increased to 45 dB(A) if the occupant has a financial involvement in the wind farm. However, although some properties are eligible for such an increase, these limits have not been adopted in the presented results.

Acoustic Assessment

9.5.50 Table 9.14 shows a comparison of the predicted noise levels with the recommended quiet waking hours noise limits for each house where the full assessment procedure is being applied. 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. Table 9.15 shows a comparison with the recommended night-time noise limits.

9.5.51 Noise levels at all locations are within both the quiet waking hours limit and night-time noise limits, at all wind speeds considered.

9.5.52 The minimum margin of predicted noise levels below derived noise limits, for all wind speeds considered, during quiet waking hours, is -3.6 dB(A). Similarly the minimum margin during night time periods, for all wind speeds considered, is -4.7 dB(A). However, the minimum margin occurs at a property where the occupant has a financial interest in the wind farm. The minimum margin of predicted noise levels below derived noise limits for properties whose occupant does not have a financial interest in the wind farm is -4.6 dB(A) during quiet waking hours, and is -7.1 dB(A) during night time periods.

Table 9.14 Comparison of Predicted Noise Levels and Quiet Waking Hours Limits - (dB(A) re 20 μPa).

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}											
		4			5			6			7		
		L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	Ysgubor Cannon	29.5	40.0	-10.5	33.7	40.1	-6.4	36.4	40.6	-4.2	37.4	41.4	-4.0
H6	Abercannon	27.3	40.0	-12.7	31.5	40.1	-8.6	34.2	40.6	-6.4	35.2	41.4	-6.2
H9	Delfryn	27.4	40.0	-12.6	31.6	40.0	-8.4	34.4	40.0	-5.6	35.4	40.0	-4.6
H15	Hafodowen	28.5	40.0	-11.5	32.7	40.0	-7.3	35.5	41.2	-5.7	36.4	43.8	-7.4
H23	Cwm Pen Llydan	22.9	40.0	-17.1	26.9	40.0	-13.1	29.7	40.0	-10.3	30.9	42.2	-11.3
H24	Cwm-y-ffynnon	19.5	40.0	-20.5	23.6	40.0	-16.4	26.4	40.0	-13.6	27.5	40.0	-12.5
H26	Ffriddfawr	27.5	40.0	-12.5	31.7	40.0	-8.3	34.4	40.0	-5.6	35.4	40.0	-4.6
H27	Cwmderwen	28.5	40.0	-11.5	32.7	40.0	-7.3	35.5	40.0	-4.5	36.4	40.0	-3.6
H28	Cannon	29.9	40.0	-10.1	34.1	40.1	-6.0	36.9	40.6	-3.7	37.8	41.4	-3.6

Table 9.14 Continued.

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}														
		8			9			10			11			12		
		L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	Ysgubor Cannon	37.9	42.4	-4.5	37.4	43.5	-6.1	37.2	43.5	-6.3	37.2	43.5	-6.3	37.2	43.5	-6.3
H6	Abercannon	35.7	42.4	-6.7	35.2	43.5	-8.3	35.0	43.5	-8.5	35.0	43.5	-8.5	35.0	43.5	-8.5
H9	Delfryn	35.8	42.0	-6.2	35.3	44.2	-8.9	35.2	44.2	-9.0	35.2	44.2	-9.0	35.2	44.2	-9.0
H15	Hafodowen	36.9	47.0	-10.1	36.4	50.2	-13.8	36.2	50.2	-14.0	36.2	50.2	-14.0	36.2	50.2	-14.0
H23	Cwm Pen Llydan	31.5	44.4	-12.9	31.0	46.4	-15.4	30.8	48.1	-17.3	30.8	49.4	-18.6	30.8	50.1	-19.3
H24	Cwm-y-ffynnon	28.2	40.0	-11.8	27.8	42.1	-14.3	27.5	42.1	-14.6	27.5	42.1	-14.6	27.5	42.1	-14.6
H26	Ffriddfawr	35.9	42.0	-6.1	35.4	44.2	-8.8	35.2	44.2	-9.0	35.2	44.2	-9.0	35.2	44.2	-9.0
H27	Cwmderwen	36.9	42.0	-5.1	36.4	44.2	-7.8	36.2	44.2	-8.0	36.2	44.2	-8.0	36.2	44.2	-8.0
H28	Cannon	38.3	42.4	-4.1	37.8	43.5	-5.7	37.6	43.5	-5.9	37.6	43.5	-5.9	37.6	43.5	-5.9

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.

Table 9.15 Comparison of Predicted Noise Levels and Night Time Hours Limits - (dB(A) re 20 μPa).

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}											
		4			5			6			7		
		L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	Ysgubor Cannon	29.5	43.0	-13.5	33.7	43.0	-9.3	36.4	43.0	-6.6	37.4	43.0	-5.6
H6	Abercannon	27.3	43.0	-15.7	31.5	43.0	-11.5	34.2	43.0	-8.8	35.2	43.0	-7.8
H9	Delfryn	27.4	43.0	-15.6	31.6	43.0	-11.4	34.4	43.0	-8.6	35.4	43.0	-7.6
H15	Hafodowen	28.5	43.0	-14.5	32.7	43.0	-10.3	35.5	43.0	-7.5	36.4	45.0	-8.6
H23	Cwm Pen Llydan	22.9	43.0	-20.1	26.9	43.0	-16.1	29.7	43.0	-13.3	30.9	43.0	-12.1
H24	Cwm-y-ffynnon	19.5	43.0	-23.5	23.6	43.0	-19.4	26.4	43.0	-16.6	27.5	43.0	-15.5
H26	Ffriddfawr	27.5	43.0	-15.5	31.7	43.0	-11.3	34.4	43.0	-8.6	35.4	43.0	-7.6
H27	Cwmderwen	28.5	43.0	-14.5	32.7	43.0	-10.3	35.5	43.0	-7.5	36.4	43.0	-6.6
H28	Cannon	29.9	43.0	-13.1	34.1	43.0	-8.9	36.9	43.0	-6.1	37.8	43.0	-5.2

Table 9.15 Continued.

House ID	House Name	Reference Wind Speed (Standardised v_{10}) / ms^{-1}														
		8			9			10			11			12		
		L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	Ysgubor Cannon	37.9	43.0	-5.1	37.4	43.0	-5.6	37.2	43.0	-5.8	37.2	43.0	-5.8	37.2	43.0	-5.8
H6	Abercannon	35.7	43.0	-7.3	35.2	43.0	-7.8	35.0	43.0	-8.0	35.0	43.0	-8.0	35.0	43.0	-8.0
H9	Delfryn	35.8	43.0	-7.2	35.3	43.0	-7.7	35.2	44.5	-9.3	35.2	44.5	-9.3	35.2	44.5	-9.3
H15	Hafodowen	36.9	50.4	-13.5	36.4	50.4	-14.0	36.2	50.4	-14.2	36.2	50.4	-14.2	36.2	50.4	-14.2
H23	Cwm Pen Llydan	31.5	43.0	-11.5	31.0	43.0	-12.0	30.8	44.7	-13.9	30.8	46.9	-16.1	30.8	49.2	-18.4
H24	Cwm-y-ffynnon	28.2	43.0	-14.8	27.8	43.0	-15.2	27.5	43.0	-15.5	27.5	43.0	-15.5	27.5	43.0	-15.5
H26	Ffriddfawr	35.9	43.0	-7.1	35.4	43.0	-7.6	35.2	44.5	-9.3	35.2	44.5	-9.3	35.2	44.5	-9.3
H27	Cwmderwen	36.9	43.0	-6.1	36.4	43.0	-6.6	36.2	44.5	-8.3	36.2	44.5	-8.3	36.2	44.5	-8.3
H28	Cannon	38.3	43.0	-4.7	37.8	43.0	-5.2	37.6	43.0	-5.4	37.6	43.0	-5.4	37.6	43.0	-5.4

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.

9.6 Construction Noise Assessment

9.6.1 This section provides an assessment of the likely noise levels that may be produced during the construction of the proposed Llanbrynmair Wind Farm and the acceptability of these levels under current UK standards and guidance.

9.6.2 Sources of construction noise will vary both in location and duration as the different elements of the wind farm are constructed. However all construction noise effects will be temporary during the construction phase of the wind farm, estimated to be less than one year in length for significant works. Whilst noise will also arise during decommissioning of the wind farm (through turbine deconstruction) this is not discussed separately as noise levels resulting from it are expected to be lower than those from the construction activity.

Significance Criteria

9.6.3 Construction activities are generally recognised as producing relatively high noise levels in comparison to other activities (e.g. industrial/commercial sites), but only for a limited duration. It is generally accepted that some degree of construction activity (hence construction noise) is essential and therefore that higher noise limits are appropriate for construction activities as opposed to other long term sources of noise. BS 5228:2009 "Code of practice for noise and vibration control on construction and open sites" Part 1 – Noise (BSI, 2009), provides guidance on the setting of environmental noise targets. Several methods of assessing the significance of noise levels are presented. One such assessment methodology indicates that daytime construction noise levels below 65 dB(A) during weekdays (0700-1900) and Saturdays (0700-1300), and below 55 dB(A) at evenings and weekends, would be considered acceptable. At Llanbrynmair construction activities will be limited to 0700-1900 Monday to Saturday except during turbine erection and commissioning.

Noise Predictions

9.6.4 Primary construction activities for which noise arises during the construction period are from: the construction of the turbine bases; the erection of the turbines; the excavation of trenches for cables; and the construction of associated hard standings, access tracks, construction compound, substation, water crossings and the excavation of borrow pits. 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. 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 Plant and Activities

9.6.5 The plant assumed for each construction activity is shown in Table 9.16. 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 12h day period needed for that plant to operate. Overall sound power levels are based upon the data in Annex C of BS 5228:2009, Part 1 – Noise.

Table 9.16 Construction Phases and Sound Power Levels.

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
Upgrade Access Track	Tracked excavator	113	2	100	120
	Dump truck	113	2	100	
	Tipper lorry	107	4	50	
	Dozer	109	2	75	
	Vibratory roller	102	1	75	
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	117
	Concrete mixer truck	108	2	50	
	Lorry	108	1	50	
	Telescopic Handler	99	1	100	
	Piling Rig	117	1	50	
Construct crane hardstandings	Tracked excavator	113	3	100	120
	Dump truck	113	2	100	
	Tipper lorry	107	4	50	
	Vibratory roller	102	1	50	
Construct turbine foundations	Tracked excavator	113	2	75	122
	Dump truck	113	2	75	
	Concrete mixer truck	108	4	50	
	Mobile telescopic crane	110	1	50	
	Concrete pump	106	2	50	
	Water pump	93	1	100	
	Hand-held pneumatic breaker	111	1	75	
	Compressor	103	3	50	
	Piling Rig	117	1	100	
	Poker vibrator	106	3	50	
Excavate and lay site cables	Tracked excavator	113	2	100	119
	Dump truck	113	2	75	
	Tractor with hydraulic winch (towing equipment)	108	1	75	
	Tractor (towing trailer)	107	1	75	
	Vibratory plate	108	1	50	
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	1	75	115
	Dump truck	113	1	75	
	Tandem roller	102	1	75	
Lay cable to substations	Wheeled loader	108	1	100	120
	Saws	114	1	50	
	Hydraulic breaker	121	1	50	
	Dump truck	113	1	75	
	Tipper lorry	107	1	50	

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
	Vibratory plate	108	1	75	
	Tandem roller	102	1	75	
	Tractor & cable drum trailer	108	1	50	
	Lorry	108	1	75	
Water Crossings	Tracked excavator	113	1	50	114
	Dump truck	113	1	50	
	Mobile telescopic crane	110	1	25	
	Vibratory roller	102	1	25	
	Lorry	108	1	50	
Borrow Pits	Tracked excavator	113	1	100	124
	Dump truck	113	1	75	
	Hydraulic breaker	121	1	50	
	Excavator mounted rock breaker	121	2	50	
Construct Batching Plant	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	
Operating Batching Plant	Concrete pump	106	1	100	106

9.6.6 Predictions of noise levels have been carried out using the methods prescribed in BS 5228:2009[40] with adoption of the worst case scenario where all major construction activities take place at the nearest possible location to each assessed house. The results of these predictions, made at 10 representative critical properties to the proposed wind farm, are shown in Table 9.17. In all cases average noise levels over the construction period will be lower, particularly where high levels are predicted for work on the access tracks at close proximity to housing.

Table 9.17 Results of Construction Noise Predictions.

Activity*	Predicted Sound Pressure Level (dB L_{Aeq})									
	Dolwen Isaf	Neinthirion	Castell y Gwynt	Hafodowen	Dolau-ceimion	Cwm Pen Llydan	Cwm-y-ffynnon	Ffriddfawr	Cwmderwen	Cannon
Upgrade Access Track	52.4	51.2	46.1	47.0	58.6	39.4	40.7	60.9	51.1	50.8
Construct temporary site compounds	51.4	50.6	44.4	43.3	58.7	40.6	41.3	57.6	50.0	46.9
Construct site tracks	52.9	51.8	46.7	51.3	59.1	45.0	43.3	61.4	55.2	51.5
Construct Sub-Station	32.9	38.1	36.9	34.0	40.0	38.3	33.3	42.2	47.2	36.9
Construct crane hardstandings	46.9	47.8	45.5	49.5	46.0	44.8	43.1	49.6	49.8	50.4
Construct turbine foundations	48.3	49.2	46.8	50.9	47.4	46.2	44.5	51.0	51.1	51.8
Excavate and lay site cables	45.6	46.5	44.1	48.2	44.7	43.5	41.8	48.3	48.7	49.0
Erect turbines	45.2	46.1	43.7	47.8	44.3	43.1	41.4	47.9	48.0	48.6
Reinstate crane bases	41.4	42.3	39.9	44.0	40.5	39.3	37.6	44.1	44.2	44.8

[40] A 50% mixed ground attenuation has been used throughout to conservatively account for the arable nature of ground conditions at Llanbrynmair

Activity*	Predicted Sound Pressure Level (dB L_{Aeq})									
	Dolwen Isaf	Neinthirion	Castell y Gwynt	Hafodowen	Dolau-ceimion	Cwm Pen Llydan	Cwm-y-ffynnon	Ffriddfawr	Cwmderwen	Cannon
Lay cable to substations	47.1	48.0	45.6	49.7	46.2	45.0	43.3	49.8	50.2	50.5
Water Crossings	46.1	43.9	35.8	44.6	40.4	38.0	35.3	38.4	43.1	43.8
Borrow Pits	54.5	47.3	48.6	49.4	46.7	45.5	46.5	53.1	49.6	49.9
Construct Batching Plant	31.0	34.2	42.2	43.6	35.6	38.7	38.0	46.4	38.6	33.5
Operating Batching Plant	17.6	20.8	28.8	30.2	22.1	25.3	24.6	33.0	25.2	20.1

*Note that these activities may not take place simultaneously

Construction Traffic

9.6.7 Due to the provision of construction material and wind farm components, vehicle movements either into or away from the site will increase levels of traffic flow on public roads in the area. The worst case in terms of number of deliveries will be the days that turbine foundations are being poured when deliveries of concrete, or delivery of the materials required to batch concrete on site, will be made. There will be 30 such days, one for each proposed turbine. Peak traffic on these days would be equivalent to 14 deliveries per hour for a period of six hours and is assumed to be characterised by the sound power levels of concrete mixer trucks as no other large deliveries would be made on these days.

9.6.8 Construction traffic noise has been quantified at the previously identified 10 representative properties 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 9.18. The predicted noise levels are calculated over a time period of one hour although it is assumed that deliveries will be evenly distributed over the six hour period and as such the calculated L_{Aeq} is applicable for both the hourly and six hour period. According to the assumptions made the maximum sound pressure level due to traffic flows during the most intensive period of activity (the days when turbine foundations are being poured) will be 60.4 dB L_{Aeq} at Neinthirion which is situated next to the proposed access route and therefore represents the worst case.

Table 9.18 Results of the Traffic Noise Predictions.

Activity	Predicted Sound Pressure Level (dB L_{Aeq})									
	Dolwen Isaf	Neinthirion	Castell y Gwynt	Hafodowen	Dolau-ceimion	Cwm Pen Llydan	Cwm-y-ffynnon	Ffriddfawr	Cwmderwen	Cannon
Concrete mixer truck	50.0	60.4	39.1	36.5	47.4	36.0	34.8	44.6	47.2	41.1

General Construction Noise in Conjunction with Traffic noise

9.6.9 Worst case construction noise levels may occur when the following simultaneous activities occur: construction of nearest access tracks; construction of substation; construction of nearest crane hardstandings; construction of nearest turbine foundations; work at the borrow pits; and the operation of the batching plant. Therefore cumulative predictions of these construction activities and the additional noise contribution from construction traffic

have been calculated and are shown in Table 9.19. At all other times construction noise activity is predicted to be less than these levels. 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 9.19 Predicted Noise Due to Combined Traffic Noise and Turbine Construction.

Activity	Predicted Sound Pressure Level (dB L_{Aeq})									
	Dolwen Isaf	Neinthirion	Castell y Gwynt	Hafodowen	Dolau-ceimion	Cwm Pen Llydan	Cwm-y-ffynnon	Ffriddfawr	Cwmderwen	Cannon
Construction Plant Noise	57.8	55.5	53.2	56.4	59.9	51.7	50.7	62.6	58.5	57.0
Traffic Noise	50.0	60.4	39.1	36.5	47.4	36.0	34.8	44.6	47.2	41.1
Combined Noise	58.4	61.6	53.4	56.5	60.1	51.8	50.8	62.7	58.8	57.1

Assessment

9.6.10 Table 9.19 shows that predicted noise levels from the combined effect of increased traffic flows and activities associated with construction of the wind farm are below the 65 dB(A) daytime target level specified by BS 5228 at all locations. The predictions made represent the worst case combination of most intensive traffic activity with simultaneous construction activity at the nearest possible location to each noise receptor.

9.6.11 On Saturdays, from 1300-1900, a lower 55 dB(A) limit is suggested by BS 5228. Table 9.19 shows seven properties where, given the conservative assumptions made, combined traffic noise and site construction noise may be greater than this. Whilst unlikely to occur in reality, the next section outlines mitigation available to ensure this target can be adhered to.

Mitigation

9.6.12 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.

9.6.13 BS 5228 states that the 'attitude of the contractor' is important in minimising the likelihood of complaints and therefore consultation with the local authority will be required along with letter drops 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.

9.6.14 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. Where appropriate, quieter items of plant and equipment will be given preference;
- 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;

- 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.

9.6.15 Site operations will be limited to 0700-1900 Monday to Saturday except during turbine erection and commissioning. Should it be considered necessary, despite the conservatism of the predictions, to reduce the noise levels to adhere to the 55 dB(A) target level for 1300-1900 on Saturdays then the following mitigation measures would be considered:

- The number of construction activities occurring simultaneously would be reduced;
- Construction activities greater than 55 dB(A) would be kept below this limit by restricting the distance from the nearest property; and
- Construction traffic would also be reduced as appropriate.

9.6.16 It should be acknowledged that 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.

9.7 Conclusions

9.7.1 The acoustic impact for the proposed Llanbrynmair wind farm on nearby neighbours 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' (ETSU, 1996).

9.7.2 Noise levels due to the operation of the proposed wind farm have been predicted at nearby properties and, at all of these properties, the predicted noise levels are 38.3 dB(A) or below, at all considered wind speeds.

9.7.3 ETSU-R-97 recommends the use of a 'Simplified Assessment Method':

> "*if the noise is limited to an* $L_{A90,10min}$ *of 35 up to wind speeds of 10 m/s at 10 m height*' going on to say '*then these conditions alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary*'" (ETSU, 1996)

9.7.4 The condition applies to 45 of the 52 properties considered and, in consequence, these properties would be regarded as having *sufficient protection of amenity.* For the remaining 7 properties, and an additional 2 properties where background noise measurements have been made, the full assessment method is used.

9.7.5 Background noise surveys have been carried out by RES at 4 nearby properties and, in addition, noise survey results from an adjacent wind farm developer have been used at 1 additional location. The measured background noise levels have been used to determine appropriate noise limits, as specified by ETSU-R-97 (ETSU, 1996).

9.7.6 For those properties requiring the full acoustic assessment procedure, the predicted noise levels are within both quiet waking hours and night-time noise limits at all considered wind speeds. The minimum margin of predicted noise levels below derived noise limits, for all wind speeds considered, during quiet waking hours, is -3.6 dB(A). Similarly the minimum margin during night time periods, for all wind speeds considered, is -4.7 dB(A). However, the minimum margin occurs at a property where the occupant has a financial interest in the wind farm. The minimum margin of predicted noise levels below derived noise limits for properties whose occupant does not have a financial interest in the wind farm is -4.6 dB(A) during quiet waking hours, and is -7.1dB(A) during night time periods.

9.7.7 The proposed wind farm therefore complies with the relevant guidance on wind farm noise and the impact on the amenity of all nearby properties would be regarded as acceptable.

9.7.8 A construction noise assessment, with due regard to mitigation outlined, indicates that predicted noise levels likely to be experienced at representative critical properties are below relevant construction noise criteria.

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10 TRANSPORTATION AND ACCESS

10.1 Topic Glossary

- AADT – Average Annual Daily Traffic
- LTMP: Local Traffic Management Plan
- STMP: Strategic Traffic Management Plan
- AIL: Abnormal Indivisible Load
- HGV: Heavy Goods Vehicle
- NON-HGV: General construction traffic including vans and cars
- Construction Traffic: Vehicles serving the proposal during the construction period, inclusive of AIL, HGV and NON-HGV traffic.
- SPA: Swept Path Analysis
- SSA: Strategic Search Area
- SEI: Supplementary Environmental Information
- Multi-disciplinary: refers to collaboration between transport, ecology, hydrology, landscape, visual, noise and vibration specialists.
- ATC: Automated Traffic Counter
- PCC: Powys County Council
- NRW: Natural Resources Wales, formerly Countryside Council for Wales
- WG: Welsh Government
- PROW: Public Rights of Way
- UDP: Powys County Council Unitary Development Plan (Powys County Council, 2010)
- IDCG: Interim Development Control Guidance (Powys County Council, 2008)

10.2 Introduction

10.2.1 This Chapter sets out the transportation and access impact and mitigation assessment for the proposed Llanbrynmair Wind Farm.

10.2.2 The Transportation and access proposals have evolved since the previous proposal was submitted and these include substantial beneficial layout changes. Consultation with the key stakeholders and the multi-disciplinary design team has resulted in an improved scheme that minimises the traffic impacts on receptors along the construction route.

10.2.3 This transport and access proposal uses information provided in the September 2012 Powys Cabinet meeting to identify key areas requiring additional consideration and these are detailed within the LTMP in Appendix 10.1.

10.2.4 Based on experience of previous wind farm developments, it is acknowledged that the proposal generates construction traffic of a temporary nature during the construction programme for the external enabling works and the internal site construction. Within this transportation and access chapter, relevant legislation and policy is considered followed by a discussion of the design evolution towards the current transportation and access proposals which includes the consultation undertaken to shape the design philosophy. Potential receptors were quickly identified and this influenced the revised route choice for construction traffic.

Therefore the choice of routing has been carefully considered and the highway enabling works proposed have been designed to minimise the traffic impact on local receptors.

10.2.5 The proposals have also been designed in accordance with the requirements of the PCC UDP Policy E3 which provides requirements for the treatment of Public Rights of Way (PROW) in the vicinity of wind farm developments.

10.2.6 The safe use of highways and PROW is a key consideration to the transportation and access proposals and consultation with Countryside Services at PCC has taken place to ensure that the proposals thoroughly consider PROW and the impact upon them. The proposed approach, guided by Countryside Services at PCC, to maintain the enjoyment and safe use of the highways and PROW during construction is detailed in Section 10.9 and is detailed in the LTMP in Appendix 10.1.

10.2.7 Further details of proposed highway works which are referred to in this Chapter are presented in the LTMP (provided in Appendix 10.1) and the STMP (provided in Appendix D of the LTMP).

10.2.8 This chapter then provides a description of the transportation and access scope of works. The assessment of alternative transport methods and routes, detailed within the LTMP in Appendix 10.1, are also summarised in this chapter.

10.2.9 The Guidelines which have been followed in the transportation and access assessment of significance of effects are then detailed followed by a description of the data used in the assessment and associated assumptions.

10.2.10 Potential effects are then detailed followed by proposed mitigation.

10.2.11 The national and local policies and guidance have been considered throughout the design evolution. The Second Draft Interim Development Control Guidance (IDCG) requires that consideration be given to cumulative traffic impacts from wind farms in close proximity which has been recognised by the Llanbrynmair Wind Farm specialist team. This chapter therefore also reports how cumulative effects have been considered through utilising information from other Wind farm developers to quantify the traffic impact along the local and trunk highway network in the vicinity of the Development.

10.2.12 The Chapter concludes with the transportation and access assessment statement of significance.

10.2.13 It should be noted that the temporary traffic generated during construction falls into two categories. The majority of temporary traffic falls into the first category which comprises HGVs and NON-HGVs. This transportation and access assessment focuses on those vehicles as they have the highest intensity and quantity through the construction programme. The other categories of temporary construction traffic are AILs which have been considered in detail within the STMP and LTMP in Appendix 10.1. AILs are relatively few in number, but have been considered separately as they are subject to specific legislation and traffic management controls

10.3 Relevant Legislation and Policy

10.3.1 A review of relevant national and local legislation and policy, which has been undertaken as part of the transportation and access element of the proposal. A short summary of the key points raised are contained within the LTMP in Appendix 10.1

10.3.2 The following documents have been reviewed and considered within the design of the works within the LTMP:

- The Regional Transport Plan (Trafnidiaeth Canolbarth Cymru, 2009);

- The 2011 to 2012 annual progress report on the RTP (Trafnidiaeth Canolbarth Cymru, 2012);
- The Powys County Council Unitary Development Plan (UDP) (Powys County Council, 2010);
- Second Draft Interim Development Control Guidance (IDCG) (Powys County Council, 2008);
- Traffic Management Act 2004;
- Road Traffic Act 1988 and Motor Vehicles (Authorisation of Special Types) General Order 2003; and
- The Electricity Act 1989.

10.3.3 PCC UDP Policy E3 states, in relation to transport matters, that applications for wind farms will be approved where:

- They do not unacceptably adversely affect the enjoyment and safe use of highway and the public rights of way network, especially bridleways, including during the construction phase;
- They would be capable of being served by an acceptable means of highway access and any new or improved roads and accesses required would not have unacceptable environmental impacts.
- Any ancillary structures or buildings are so sited and designed (including the use of locally appropriate construction material) so as to adequately blend into their setting.

10.3.4 The mitigation works have been designed taking account of the comments from PCC and NRW which make reference to requirements of Policy E3. Discussions and commentary between the designers and PCC and NRW have been undertaken to discuss the impacts of the scheme on the environment and public rights of way during construction and the permanent term. Following discussion with PCC Countryside Services, specific measures have been agreed with respect to Public Rights of Way. These are detailed in the LTMP Appendix 10.1 - A and include the preparation of a specific management plan for the section of Glyndwr's Way which runs along the Talerddig to Llanerfyl road.

10.3.5 Policy E5 states that planning obligations or other legally binding agreements will be sought to ensure the implementation of off-site works where these are necessary in order to facilitate wind turbine development proposals or to ameliorate their impact.

10.3.6 Planning Conditions have been proposed, associated with the highway works, that contain detail of proposed bonds or other financial provision to ensure that the necessary works can be carried out.

10.3.7 PCC has published a Second Draft Interim Development Control Guidance (IDCG) (Powys County Council, 2008) with regard to onshore wind farm development as Supplementary Planning Guidance. This document has been issued as a response to TAN 8 (Welsh Assembly Government, 2005) as to how these national policies are applied at a local level.

10.3.8 It states that planning obligations may include highway infrastructure improvements outside the application site and that PCC will liaise with Transport Wales and other local highway authorities to deliver a strategic approach to road improvements on the Powys highway network. The IDCG requires that consideration be given to cumulative traffic impacts from wind farms in close proximity and the level of disruption during the construction period and that developers of wind farm schemes liaise with each other at the pre-application stage in order to mitigate cumulative traffic impact.

10.3.9 These documents and policies have been used to guide the philosophy for the design of the enabling works to the Development.

10.4 Design Evolution and Mitigation

10.4.1 A multi-disciplinary approach to the design of the enabling works has been adopted and has resulted in significant variations to the transportation and access elements for the scheme. The LTMP and the original proposals have been reassessed following comments raised by WG, PCC and NRW.

10.4.2 This scope of this LTMP has therefore been expanded from the original planning submission to encompass the local road from Llanerfyl at the A458 to Talerddig at the A470.

10.4.3 The highway works proposals have therefore undergone several iterations to provide additional highway detailing and to mitigate environmental effects. The design philosophies used for the works are designed to ensure that:

- Safety – that the operation of the road is safely managed during the construction period for all road users and that closure of the road is minimised as much as possible,
- Operational efficiency - The proposed traffic on each section of this route has only a minimal impact on local traffic movements and other users of this road,
- Environment - that the enabling works will aim to minimise permanent visual and ecological impact, with only an impact in the short term during the construction period.

10.4.4 These aims are achieved through:

- Review and amendment of the construction programming of the internal site and the enabling works on the public highway have been scheduled to reduce the total traffic using the roads at any one time. In addition to this, the highway works have been designed to minimise the need for road closures along the road.
- The works allow for the safe management and passing of oncoming traffic with the construction traffic through the provision of passing places for construction traffic delivering to the site. These passing facilities are designed to fit in with the existing landscape and to provide community benefit in the long term.
- The enabling works along the route have been minimised as far as is practicable to ensure the safe operation of construction traffic and delivery of turbine components through the construction period. The works have been designed so that there is permanent access for turbine components in the future which are provided by engineering solutions which fit into the existing landscape along the road. This has been achieved through minimising the use of “hard” construction materials, use of local materials and sustainable construction methods and undertaking replanting in areas where there has been vegetation loss.

10.4.5 These aims and philosophies have been arrived at through an iterative process of discussions with the multi-disciplinary design team and continuous consultation with the statutory consultees.

10.5 Approach and Methodology

Consultation

10.5.1 As detailed above, collaboration between various specialists and a consultation exercise has taken place since SEI Volume 4 to guide the transportation and access

proposals to the current position. This has included consultation with the following parties:

Statutory	Natural Resources Wales; Welsh Government; PCC, Highways PCC, Countryside Services (Public Rights of Way)
3rd Party Consultants	Hauliers – Collett and Sons Ltd; Road Safety Auditors - TMS Consultancy;
Design Team	Landscape Consultants – (LUC) Land Use Consultants; Ecology – Ecology Matters Archaeology – Headland Archaeology Hydrology – Fluid Environmental

10.5.2 Further details of the consultation, including correspondence, meeting minutes and notes, is provided in the LTMP in Appendix 10.1.

Identified Potential Receptors

10.5.3 Consideration has been given to potential receptors along the Llanerfyl to Talerddig Road; this has guided the proposed access route for all construction traffic. The following is a list of the potential receptors impacted when accessing from the A458 junction at Llanerfyl.

- Llanerfyl Village;
- Llanerfyl Church in Wales School;
- Diosg;
- Gosen;
- Sychtyn;
- Dolwen; and
- Neinthirion.

10.5.4 The following is a list of the potential receptors impacted when accessing from the south via the A470 Talerddig junction:

- Ffridd Fawr Farm;
- Nantyr Esgair Wen Farm; and
- Pantglas Farm.

10.5.5 These receptors have been considered when planning the routing to the site with an aim to minimise overall impact from the construction traffic.

Route Choice, Public Highway and Public Rights of Way

10.5.6 AILs have been considered separately from other construction traffic.

10.5.7 Access to the site for construction traffic via the Talerddig to Llanerfyl road is required due to the location of the proposal. Enabling works on the adjacent public highway are required due to the currently identified access points. An appraisal

process has been undertaken to identify the routes to the site and along this road using visual inspections and swept path analysis based on a range of candidate turbines. This process is detailed in the LTMP in Appendix 10.1.

10.5.8 The following options for routing construction traffic were considered:

- Shared access from the A458 via Carnedd Wen
- All traffic via A470, with access via Talerddig Junction;
- All traffic via A458 Llanerfyl Junction; and
- Split of traffic between the A458 Llanerfyl Junction and the A470 Talerddig Junction.

10.5.9 The shared access route between Carnedd Wen has been discounted. The reasoning for this decision was detailed in correspondence to PCC and NRW in July 2013.

10.5.10 The routing choice for construction traffic and alternative forms of transportation is discussed in Section 5.2 of the LTMP. The routing of AILs has been determined by the outcomes of the STMP and this is detailed in Section 7.2 of the LTMP.

10.5.11 The route for construction traffic, except for AILs is via the A470 from Talerddig. AILs will access the site from the A458 at Llanerfyl.

10.5.12 Construction traffic for the proposal uses the A470 trunk road and other trunk roads in mid Wales. The established trunk road network has been designed to accommodate freight traffic including construction vehicles and therefore no enabling works are proposed or expected on the trunk road network for general construction traffic.

10.5.13 There are some Public Rights of Way footpaths and bridleways which interact with the Llanerfyl to Talerddig road at some locations and guidance from PCC on how to ensure that the proposals do not unacceptably adversely affect the enjoyment and safe use of highways and public rights of way has been embedded in the design philosophy for the mitigation works along the Llanerfyl to Talerddig road.

Scope of Works

10.5.14 The LTMP considers the impacts of the construction traffic from the proposal on the adjacent trunk roads and the county road.

10.5.15 Vehicle movements for the proposal's construction, operation and decommissioning periods were calculated using RES and AECOM's experience of constructing and operating wind farms. Baseline traffic numbers for the trunk road network were obtained from the Department for Transport (DfT).

County Road

10.5.16 The Llanerfyl to Talerddig road is a minor, rural route along the Nant yr Eira valley. It links the settlements of Llanerfyl on the A458 to the north and Talerddig on the A470 to the south. The length of the road is 17.5km in length between Llanerfyl and Talerddig and the road is not subject to any speed restrictions along its length. Between Llanerfyl and Neinthirion the road is classified as the C2031. The remainder of the road from Neinthirion to Talerddig is unclassified as the U2319. The speed of the road is unrestricted with the actual speed variable along its length due to the visibility and alignment. The road has had only a single minor road traffic incident within the last five years (2007 – 2012).

10.5.17 The Llanerfyl to Talerddig road has been split into three sections to assist in the referencing of the existing road conditions and the referencing of the works along the route. These sections and their proposed traffic uses are as follows:

- Section 1 – Llanerfyl A458 (Chainage 0m) to Llanbrynmair Site Access 1 (Chainage 8250m) – 8250m in length. This section is proposed to be used y AILs only.
- Section 2 – Llanbrynmair Site Access 1 (Chainage 8250m) to Llanbrynmair Site Access 4 (Chainage 12350m) – 4150m in length. This section is used for both AILs and construction traffic arriving to site from Talerddig A470 and between the site accesses.
- Section 3 – Llanbrynmair Site Access 4 (Chainage 12350m) to Talerddig A470 (Chainage 17510m) – 5100m in length. This section is used for construction traffic only arriving to site from Talerddig A470.

Site Accesses

10.5.18 Previously there had been four site entrances proposed along the road as follows (Chainage 0 is the Llanerfyl junction at the A458 and Chainage 17510 is the Talerddig junction at the A470):

- Site Access 1 - (Chainage 8250m);
- Site Access 2 - (Chainage 10150m);
- Site Access 3 - (Chainage 12000m); and
- Site Access 4 - (Chainage 12350m);

10.5.19 Site Access 3 has since been removed from the proposals and all construction vehicles which would have used Access 3 are now proposed to use Access 2. The access names remain as 1, 2 and 4.

10.5.20 The remaining three site accesses are existing junctions off the Llanerfyl to Talerddig road, leading to access tracks. These will be upgraded to form the site access junctions which are designed to accommodate the temporary construction traffic and AILs. The design for the site entrance junctions are included within the LTMP.

On-Site Access Tracks

10.5.21 From the site accesses the proposed access tracks lead to the site compounds and the construction platforms for the wind turbines. The access tracks are 5.5m in width. The total length of access tracks is up to approximately 25.2km. The layout of the turbines and access tracks on site has been designed to use existing tracks and avoid environmentally sensitive areas e.g. the more sensitive ecological, archaeological and hydrological areas, wherever possible.

Off-site works

10.5.22 Some sections of the construction traffic route from Talerddig to the site entrances require mitigation so that the proposal does not adversely affect the enjoyment and safe use of highways, the PROW or have a detrimental impact on the long term character of the route. The required mitigation works along the proposed construction and AIL traffic routes to the site are detailed within the LTMP.

Alternative Transport Methods and Routes

Road Routes for Abnormal Load Access

10.5.23 A route to Mid Wales via Shrewsbury was discounted owing to the alignment of the bridge at Buttington near Welshpool. Works on this bridge to accommodate the abnormal loads of the Proposal were considered to be too disruptive.

10.5.24 The low railway bridge approximately 4km west of Newtown on the A489 was considered to be a constraint to large vehicles, as is the low bridge at Pontdolgoch on the A470 which has poor alignment. Consequently an approach to the site from the A470 to the south was discounted.

10.5.25 The poor alignment of the B4392 at Groes-lwyd and the narrowness of the road from there to the south resulted in this route avoiding Welshpool being discounted.

10.5.26 This assessment demonstrates that it would not be feasible to move turbine components by rail or water to the site. It is anticipated that turbine components will therefore be moved by road from the UK port of entry, assumed to be Ellesmere Port but could be from other ports located on the UK strategic trunk road network. This agrees with the outcome of the sTMP.

10.5.27 The sTMP identifies the preferred route to potential wind farms in the northern part of SSA B is M53 – A55 – A483 – A5 – A483 to Welshpool, through Welshpool town centre on the B4381 then west on the A458 past Llanerfyl. Turbine components associated with the Llanbrynmair Wind Farm will leave the trunk road network at Llanerfyl and turn south along the C2031 and then the U2319 towards Access 4 and Talerddig.

Local Transportation Alternatives to Road Transport

10.5.28 As a part the base reassessment of the LTMP, alternative forms of carrying bulk materials has been explored. An outline review of the rail freight options for the Llanbrynmair Wind Farm was undertaken.

10.5.29 Options for rail freight at the Welshpool station terminal and at the Talerddig passing loop which is located less than a mile away from the A470 junction serving the Llanbrynmair Wind Farm were explored and it was concluded that signalling and line capacity upgrades would be required, as well as improvements to infrastructure at Welshpool and Talerddig to allow for the coupling/uncoupling of freight trains at these locations, as well as local highway upgrades to allow for a transfer of materials from rail freight to road freight at the termini. These improvements to the railway network are significant and would require co-ordination and agreement between landowners, Network Rail and local stakeholders.

10.5.30 This option has not been taken forward because of the timescales for delivery of the railway improvement works and the significant nature of them.

10.5.31 Water transport has not been considered as there are no facilities capable of carrying freight in the vicinity of the site.

Assumptions and Limitations

Time Assumptions:

10.5.32 The on-site construction programme has been based on a 24 month construction period; see Appendix 3.3. This includes the construction of all off-site enabling works.

10.5.33 The trip generation calculations are based on a 12 hour working day (7am to 7pm) with a 6 day working week Monday to Saturday. The average working days per month are 25.

Material Quantities Assumptions:

10.5.34 The LTMP Appendix 10.1 - F, contains a detailed assessment of the quantities of construction materials required and associated number of external construction

generated trips over time, together with assumptions used for the density of materials and the transporter vehicles.

10.5.35 All concrete required for construction is proposed to be batched on-site. It is proposed to source the majority of aggregate required for wind farm construction from on-site borrow-pits where possible in order to minimise construction generated HGV movements on the external highway network. It is considered that if all materials were suitable, up to 94% of the aggregate requirements for the site could be sourced on-site. However, in order to provide a robust analysis at this stage, three construction traffic generation scenarios have been calculated as follows:

- Best Case Scenario – 94% aggregate won onsite with 6% imported material;
- Central Scenario – 60% aggregate won onsite with 40% imported material; and
- Worst Case Scenario – 0% aggregate won onsite with 100% imported material.

10.5.36 Although it is proposed to use on-site borrow pits for 94% of aggregate required on-site, for robustness, all scenarios are separately considered for the purposes of a percentage increase assessment on baseline flows reported in Section 10.7 Potential Effects, below.

10.5.37 Within the detailed assessment of the quantity of construction trips required, which is provided within Appendix 10.1 - F of the LTMP, allowance is made for all elements of construction by drawing on the experience of the specialist project team in delivering wind farms throughout the UK. Allowance is made for the following elements required to construct the wind farm:

- External Works (Enabling Works) HGV trips;
- Site Servicing HGV trips;
- Wind Farm Construction HGV Trips including:
    - Mobilisation, Site Compound and Access Junctions;
    - New Tracks;
    - Forestry Clearance;
    - Hardstanding Areas;
    - Substation;
    - Turbine Foundations;
    - Cable Infrastructure;
    - Demobilisation; and
    - Turbines - Mobilisation and Delivery of Equioment
- Turbine Delivery AIL trips;
- Non-HGV Trips including:
    - Substation Commissioning;
    - Turbine - M&E and Commissioning; and
    - Site Personnel (Including personnel working external of the site).

10.5.38 The construction assumptions used and consequent calculation of the required quantities of the various materials, are presented within the tables in Appendix 10.1 - F of the LTMP. This appendix also includes detailed tables and trip generations for the three scenarios and the construction activities.

Traffic Network Distribution Assumptions

10.5.39 It is proposed that non-HGV trips associated with construction would access the site via the A470 and the Talerddig junction. It is anticipated that the majority of externally sourced aggregate, if required for the site, would be sourced from the local Tan-y-Foel Quarry, operated by H.V.Bowen & Sons. This quarry is situated approximately 14 miles (22.5km) from the site. Consultation has taken place with the quarry to confirm that it can supply the maximum quantity of externally sourced aggregate that has been calculated as necessary in the 'worst-case' assessment of importing 100% of site aggregate. It is, therefore, anticipated that this quarry could provide all externally sourced aggregate required for the site, with the exception of sand and cement which is assumed to be sourced from other suppliers in Wales and Shropshire.

10.5.40 The assumed source of each material and corresponding route of delivery is outlined in Table 10-1.

10.5.41 The material sources assumed in Table 10-1 below are indicative and provided for the purposes of the calculations only. Final material sources will be determined by the Contractor appointed for the construction phase.

Table 10.1 Construction Traffic Network Distribution Assumptions.

Construction Traffic Generation Type	Origin/Destination	Example Supplier/Trip Origin	Route to site
Aggregate	A470	Tan-y-Foel Quarry	Tan-y-Foel Quarry-A470-Talerddig Junction-Site
Cable Bedding Sand	Wrexham	Borras Quarry	Wrexham-A483-Newtown-A489-A470-Talerddig Junction-Site
Materials for Reinforced Concrete	Flintshire	Hanson Cement	Flintshire-A483-Newtown-A489-A470-Talerddig Junction-Site
Cable	North Wales	Prysmian Cables & Systems Ltd	North Wales-A483-Newtown-A489-A470-Talerddig Junction-Site
Off-site works & Servicing & Mobilisation & Forestry Clearance & Reinstatement & Demobilisation & Turbines	Shropshire or North Wales	Various	North Wales-A483-Newtown-A489-A470-Talerddig Junction-Site
Workforce	North Wales	Various	North Wales-A483-Newtown-A489-A470-Talerddig Junction-Site

Vehicle Loads and Behaviour

10.5.42 AIL movements have been assessed by undertaking an extensive vehicle swept path analysis using computer software Savoy AutoTRACK 10.2 based on vehicles suitable for the candidate turbines and using topographical survey information for the local highway and trunk roads. The parameters used and the results of this assessment

have been checked by the independent haulage contractors, Collett and Sons Ltd. The outcomes from this check is detailed in Appendix 10.1 - L of the LTMP.

Guidance

10.5.43 The available guidelines for the environmental assessment of road traffic focus predominantly on the long term increase in traffic flows as a result of a proposed development and do not specifically reference the temporary increase borne by construction activities.

10.5.44 The Guidelines for the Environmental Assessment of Road Traffic (IEA, 1993) is a guidance document that sets out a methodology for assessing potentially significant environmental effects where a proposed development is likely to give rise to changes in traffic flows. The IEA guidelines suggest that:

- Highway links are included where traffic flows will increase by more than 30% (or the number of heavy goods vehicles will increase by more than 30%),
- Highway links in other specifically sensitive areas are included where traffic flows have increased by 10% or more.

10.5.45 The significance of each effect is considered against the criteria within the IEA guidelines, where possible.

10.5.46 Whilst the criteria relate to the operational impacts of development, they have been applied to assess the temporary construction phase. This is accepted best practice and considered a conservative approach in the absence of wholly applicable criteria.

Site Surveys

10.5.47 Baseline traffic flow data has been downloaded from the Department for Transport website for use in this study as well as traffic surveys undertaken.

10.5.48 The data has been assessed for the A458, A470 and for the C2031 which are both on the haul route for construction traffic into the site.

10.5.49 The DfT traffic data provides the Annual Average Daily Traffic (AADT) at the locations listed above, aggregating all motor vehicles and all HGVs. The most recent year in which the data is available, at the time of writing, is 2011.

10.6 Baseline Conditions

10.6.1 The relevant traffic flow data (DfT, 2011) is factored to the potential year of Wind farm construction commencement of 2016 using DfT TEMPro (Trip End Model Presentation Program) growth factors.

Existing Traffic Data

10.6.2 As stated above, existing annual average daily flows have been obtained from the DfT website and are detailed in the Table 10-2.

Table 10.2 2011 Traffic Count Data.

Base Year	Road	HGVs	AADT
2011	A458 - FROM A495 TO B4395	160	4495
2011	A470 BETWEEN CARNO AND CEMMAES	245	2089
2013	C2031 - TALERDDIG TO LLANERFYL ROAD	28	106

Future Baseline (Do-Nothing Scenario)

10.6.3 The 2011 traffic data has been factored to 2017 baseline traffic flows by using the average of the TEMPRO growth factors for Welshpool and Newtown as shown in Table 10-3 below. The flows are factored to 2017 which is the proposed commencement of the construction of the Wind farm site, although enabling works are proposed to take place prior to this. The average traffic flows considering Welshpool and Newtown between 2011 and 2017 actually decrease, according to the TEMPRO factors. This provides a robust basis for the traffic increase assessment because the lower the baseline flow is, the higher the increase would be.

Table 10.3 2017 Future Baseline Traffic Flows.

Base Year	Road	HGVs Base Year	AADT Base Year	TEMPRO Growth Factor	HGVs Factored to 2017	AADT Factored to 2017
2011	A458 - FROM A495 TO B4395	160	4495	1.014	162	4558
2011	A470 BETWEEN CARNO AND CEMMAES	245	2089	1.014	249	2118
2013	C2031 - TALERDDIG TO LLANERFYL ROAD	28	106	1.014	28	108

10.7 Potential Effects

10.7.1 The potential effects from the Proposal will relate to the construction phase as once operational, the development would not be considered to result in any material increase of traffic flows on the highway network.

10.7.2 The LTMP in Appendix 10.1 provides details of the traffic and construction impact. Section 4.3 of the LTMP details the construction programme and the phasing of the construction works external and internal of the site. Section 4.4 and 4.5 details the cumulative impact of the site and neighbouring wind farm sites on the county road.

10.7.3 The trip generation for both the construction and operational phase of the development is informed by the assumed sources of construction materials and the size and type of vehicles required.

10.7.4 Trips are assigned to the strategic highway network and assessed against the base traffic levels as presented above. The traffic increase from the development is then quantified.

10.7.5 Although road capacity is not seen as an issue with the temporary addition of construction traffic, the safety of the road for all users is paramount in the design philosophy of enabling works as consistent with policy E3 of the UDP.

10.7.6 The three site scenarios for the sourcing of aggregate as detailed in the Material Quantity Assumptions in Section 10.6 are considered separately in the percentage increase assessment for a robust analysis. The proposed programme of works, together with detailed calculations and assumptions for each construction traffic generation scenario are provided in Appendix 10.1 - F of the LTMP. For the purposes of this assessment, an average daily traffic generation is calculated for each scenario to determine the overall temporary traffic increase of the proposal over

the construction period. This is an average over the construction period and includes the internal and external works within this figure.

10.7.7 The percentage increase on two-way flows is calculated using the 2017 factored traffic data and is compared against the three scenarios for the Llanbrynmair Wind Farm for the average and peak months, for both AADT and HGV traffic. This is the basis for the analysis in the LTMP Section 5 and the calculations in Appendix 10.1 - F. Table 8 of the LTMP indicates the construction traffic levels associated with the various sections of the road, the various borrow pit scenarios and the highway enabling works period. Table 9 of the LTMP indicates the associated traffic impact.

10.7.8 Application of the Institute of Environmental Assessment (IEA) guidelines to the county road in relation to Table 10 of the LTMP, indicates that:

- For Llanbrynmair, the impact on the most environmentally sensitive, and most populated, Section 1 is not significant with the maximum daily increase in the peak month during the enabling works period being 6%. The corresponding average month daily figure is 5%. These figures are the same at Llanerfyl when considering the cumulative impact with Mynydd Waun Fawr. It is only the part of Section 1 south of the access to the Mynydd Waun Fawr wind farm (which is 3 km from the A458 at Llanerfyl) does the cumulative impact increase to 18% in the peak month and 14% in the average month. No receptors have been identified in this southern part of Section 1.
- the impact on the less environmentally sensitive, and less populated, Sections 2 and 3 is significant with the maximum increase in the peak month for Llanbrynmair ranging between 54% and 125% on Section 3 and between 40% and 92% on Section 2 depending on borrow pit usage. The corresponding average month figures are 43% - 82% and 31% - 61% respectively.
- The cumulative impact of Llanbrynmair and Mynydd Waun Fawr increases the worst case impact to between 166% and 228% on Section 3 and 122% and 167% on Section 2. However, this analysis has assumed the worst case scenario of both developments occurring at the same time.

10.7.9 Application of the IEA Guidelines to the county road defines the impact as significant on Sections 2 and 3, but not Section 1. This potential of significance informed the access strategy and design process which removed traffic from Section 1 and led to the highway modifications proposed for Sections 2 and 3 to mitigate traffic impact.

10.7.10 This is also the case when considering the list of traffic receptors identified within the LTMP at paragraph 3.4. The location of these receptors assisted decision-making regards the revised access strategy and the highway works proposed.

Operation

10.7.11 After construction, traffic associated with a wind farm is minimal. Site traffic would be limited to small maintenance vehicles with typically four maintenance crew visits per month. These visits are for general maintenance work and fault repair. A maintenance crew consists of two people for safety. There would be no appreciable effect of operation and maintenance traffic on the local road.

10.7.12 There will likely be occasional HGVs required to allow for high level access and inspections and these will consist of high-reach cherry pickers, or other specialist access equipment.

10.7.13 In the rare event that a component of the turbines needs replacing, craneage and component transport will be required to the site and this traffic will use the AIL route from the A458.

Decommissioning

10.7.14 The decommissioning phase after the 25 year operational life of the wind turbines would require access by heavy vehicles to and from the site to remove all items of plant, including turbines and associated infrastructure. The number of vehicle movements required would be substantially fewer than the number required during construction. The long vehicles needed for construction would also not be required as turbine components would be cut up on site prior to removal.

10.8 Mitigation

Offsite Highway Works

10.8.1 It is recognised that the temporary effect of the traffic during construction on the access road between Talerddig and Llanerfyl requires mitigation.

10.8.2 Mitigation is therefore proposed, as summarised in the LTMP, to ensure that the proposal is in line with policy E3 of the UDP, in that it does not unacceptably adversely impact the enjoyment and safe use of highways and public rights of way during construction.

10.8.3 The proposed mitigation for the impacts on the road is detailed in the LTMP in Appendix 10.1 and these have been presented as a series of infrastructure proposals in Appendix 10.1 - A of the LTMP. These works are designed to mitigate the temporary impact of construction traffic and provide infrastructure for permanent access for AILs.

10.8.4 Those mitigation works for the temporary construction traffic provide additional infrastructure which has a number of lasting permanent positive effects on the routes. There is considered to be permanent community and general network benefits of the road improvement works proposed once the works have bedded in.

10.8.5 The LTMP contains details of the access routes; identify points along the access routes which require engineering works, traffic flows, delivery timings, signage and escort requirements and any necessary additional mitigation measures.

10.8.6 In all areas of enabling works there will be no negative effects of the proposals post-construction. This is to be achieved through a design process that is sympathetic to the existing landscape, the ecology and hydrology of the area. Consistent materials would be used in any required enabling works and there would be a seamless transition between the existing road surfaces and any required widening to maintain the character of the road. Existing constrained areas would be improved. Therefore, it is considered that there would be a permanent beneficial effect on the enjoyment and safe use of highways and public rights of way.

10.8.7 In addition to physical mitigation, the LTMP details means of managing the access route into the site for all construction traffic throughout the construction period. This includes measures for communication, signage and scheduling of construction traffic with an aim to minimising the temporary impact of the development.

10.8.8 With the mitigation measures and the means of controlling traffic, both described in the LTMP, the temporary traffic impact of the construction traffic during the construction period is significant, but this impact is mitigated through the re-routing of construction traffic, the management of on-site activities using the LTMP and the construction of enabling works along the affected route.

10.9 Residual Effects

10.9.1 Increased traffic levels would be experienced during the construction period. These effects are temporary and any disturbance to local residents and other road users would be short term when considered over the life of the project. The mitigation

measures in place for permanent access for AIL traffic over the design life of the development will be designed to provide community benefit wherever possible and be sympathetic to the existing character of the road.

10.9.2 It is considered that the mitigation works for the temporary construction traffic would provide a number of improvements of existing roads and bridges in many areas which would have a lasting permanent positive effect on the routes. These benefits are discussed in the LTMP in Appendix 10.1 with specific infrastructure benefits identified in Section 8.3 of the LTMP. It is the aim of the LTMP to provide whole route benefit for road users and local receptors.

10.10 Cumulative Effects

10.10.1 The Llanbrynmair Wind Farm is one of a number of schemes within the TAN 8 SSA B development area. It is likely that due to the associated application lodged for the new Mid-Wales 132kV substation and grid connection, many of the applications for wind farms submitted within the SSA B area could occur concurrently.

10.10.2 Consideration has been given for the other scheme using the Llanerfyl to Talerddig access road and this is detailed in the cumulative impact section above. The impact of the delivery of this second scheme with Llanbrynmair will increase traffic along the road and the temporary traffic impact. It is envisaged that this scheme will use a similar LTMP to Llanbrynmair and will be dependent on the works installed for the Llanbrynmair scheme for access. The cumulative impact assessment detailed above assumes that this second scheme will be delivered at the same time as Llanbrynmair. However, specific programme and delivery timeframes have not been provided for this second scheme. Because of this, the cumulative impact shown is a robust case. It is expected that this scheme will be delivered later than Llanbrynmair which will mean that the impact is lessened.

10.10.3 With respect to the strategic route network, the impact from both these schemes and others has been considered as a part of the STMP. For the SSA B south route via the A470, the impact of both schemes is not-significant on this trunk road.

10.11 Statement of Significance

10.11.1 This assessment of effects has shown that, in terms of the transportation and access element of the scheme, effect of the construction traffic is significant on the more southern sections of the county road. This significant impact is temporary in nature through the construction period only and will be mitigated through the re-routing of construction traffic away from receptors, the management of traffic generation using the LTMP and the construction of enabling works.

10.11.2 It is considered that the enabling works for the temporary construction traffic will provide improvements of existing roads and bridges in many areas and would have a lasting permanent positive effect on the routes.

10.12 References

10.12.1 Institute of Environmental Assessment (IEA) 1993. Guidelines for the Environmental Assessment of Road Traffic. IEMA, Lincoln, UK.

10.12.2 Welsh Assembly Government, 2005. Planning Policy Wales. Technical Advice Note 8: Planning for Renewable Energy. Publications Centre, National Assembly for Wales. July 2005

11 OTHER ISSUES

11.1 Topic Glossary

- Hertz (Hz) - a unit of frequency.
- Revolution per minute (rpm) – a measure of rotation.

11.2 Introduction

11.2.1 This Chapter assesses the potential impact of the proposed wind farm at Llanbrynmair on communication systems that use electromagnetic waves as the transmission medium (e.g. television, radio or microwave links). This chapter also assesses the potential impact on aviation facilities around the wind farm and the shadow flicker effect of the wind farm In addition; this chapter covers the impact of the wind farm on public safety.

11.2.2 This assessment provides baseline information, identifies potential effects for each type of potential impact, assesses the significance of the effects with regard to magnitude of and type of effect, describes what measures will be taken to reduce the likelihood of those effects, and assesses the significance of the residual effects.

11.2.3 RES consulted widely with all relevant organisations and system operators, which could be affected by a proposed wind farm. These are listed in Appendix 1.3. The main comments received from consultees are discussed below together with details of RES' own technical assessments. The study area differed according to the type of medium being investigated: within 1km of the proposed turbines for civil fixed links, such as those used by mobile phone operators; up to 10km from the turbines for television interference, and nationally for aviation interests.

11.3 Relevant Legislation and Policy

Electromagnetic Interference

11.3.1 Planning Policy Wales TAN 8 (2005): Planning for Renewable Energy acknowledges that:

> '*A wind turbine can interfere with the electromagnetic transmission in two ways; by emitting an electromagnetic signal itself, and by interfering with other electromagnetic signals. The very low level of electromagnetic radiation produced by the turbine itself poses no greater threat to health than do most domestic appliances*.' [Annex C, para 2.29]
>
> '*SSAs are largely unaffected by broadcast transmission, radar, MOD Mid-Wales Tactical Training Area (TTA) and other constraints*' [page 6, para 2.9]
>
> '*Preliminary discussions with NATS have indicated that there are no significant problems likely for wind farm development in the SSAs*' [Annex C, para 2.38]
>
> '*Provided careful attention is paid to siting, wind turbines should not cause any significant adverse effects on communication systems which use electromagnetic waves as the transmission medium (e.g. television, radio and microwave links)*.' [Annex C, para 2.30]

11.3.2 This section assesses the potential impacts of the proposed wind farm on communication systems, following the guidance provided in Planning Policy Wales TAN 19 Telecommunications (2002).

Aviation

11.3.3 Planning Policy Wales TAN 8 (2005) : Planning for Renewable Energy states that:

> '*Developments within a specified radius of major airports and aerodromes are subject to mandatory consultation with the Civil Aviation Authority (CAA) and/or the Ministry of Defence (MoD) under the Town and Country Planning (Aerodromes and Technical Sites) Directive 1992.*' [Annex C, para 2.35]

Safety

11.3.4 TAN 8(2005): Planning for Renewable Energy states that:

> '*The build-up of ice on turbine blades is unlikely to present problems on the majority of sites in Wales. Even when icing does occur the turbines' own vibration sensors are likely to detect the imbalance and inhibit the operation of the machines.*' [Annex C, para 2.34]

Shadow Flicker

11.3.5 Planning Policy Wales TAN 8 (2005): Planning for Renewable Energy states that:

> '*developers should provide an analysis of the potential for shadow flicker impacting upon any nearby properties.*' [Annex C, para 2.32] but does not provide guidelines to undertake such an analysis.

11.4 Electromagnetic Interference

11.4.1 Wind turbines have the potential for causing interference to television reception, primarily where a viewer is in the 'shadow' of and within a few kilometres of the wind farm, with their aerial pointing through the wind farm. Viewers in such locations can have their signal 'scattered' causing loss of picture detail, loss of colour or buzz on sound. Viewers situated to the side may experience periodic reflections from the blades, giving rise to a delayed image or 'ghost' on the picture, which is liable to flicker as the blades rotate.

11.4.2 RES have gained considerable experience in this area and in practise RES have only experienced problems when the receiver already has a poor signal. Specifically, if the wind farm is illuminated by the TV transmitter, problems can occur when the receiver has no line of sight to the transmitter, but has a clear line of sight to the wind farm. We have also learnt that generally TV interference problems are predictable and that normally there are a range of solutions available.

11.4.3 It is also possible for a wind farm to interfere with a TV rebroadcast links (RBLs) or super high frequency (SHF) links that carry the TV signal between transmitters. However such interference is predictable and is screened by the network operators. RBL and SHF TV distribution links are operated by National Grid Wireless (NGW) and Arqiva.

Responses from Television Consultees

11.4.4 Arqiva and National Grid Wireless (NGW) were consulted with respect to their links. Arqiva have responded that a project at this location is unlikely to affect any of their UHF RBLs and therefore do not object. NGW have responded to state that the Site is within an area for which Arqiva have responsibility and therefore NGW do not anticipate that this project will affect their links.

11.4.5 The Office of Communications (Ofcom) and the BBC have joint responsibility for protecting TV services in the UK. They state that digital television is much more

robust to interference than the analogue system and so the following comments refer specifically to existing analogue services.

11.4.6 It is normal practice that the planning authority enters into an agreement with the developer to meet the cost of investigating and rectifying any problems that may arise. This can be made under Section 106 of the Town and Country Planning Act 1990 or a similarly binding agreement to meet the costs of investigating and rectifying any problems that may occur.

11.4.7 RES have performed a full technical assessment through prediction modelling of the scale and location of TV interference that might occur as a result of the wind farm. The prediction model is based upon International Telecommunication Union recommendations on signal propagation and impairment to television reception by wind turbines (ITU-R, 805 & 526-7). The model is generally conservative using a high value of signal reflectivity from the turbines and assuming that reflections from different turbines all add in-phase. The model has been validated using data from existing wind farms where RES has experienced TV interference.

11.4.8 The assessment consists of three stages. The first is an analysis of TV coverage from the transmitters in the area, and the second is to predict possible interference to reception from each transmitter in turn. Finally, an assessment of practical solutions is performed based on the predictions of coverage and potential interference. The assessment considered the transmitters of Llanbrynmair, Carno, Llangadfan, Afon Dyfi, Llandinam, Llanfyllin, Tregynon and Moel-y-Sant and was performed at all locations within a 10km radius of the wind farm.

11.4.9 The coverage model confirmed that the study area is generally not well-served by the transmitters, some of which serve only very localised areas or scattered coverage.

11.4.10 Application of the interference model showed that any interference caused by the proposed wind farm is not predicted to be widespread. There is no predicted interference to any of the transmitters in inhabited areas. However, isolated cases of interference at properties close to the wind farm can never be ruled out, and so terrestrial television reception at isolated properties within 2.5km of the wind farm could be affected.

11.4.11 An assessment of practical solutions for TV interference mitigation indicates that in all areas of predicted interference mitigation can be achieved either by an improved aerial installation, aerial redirection or by conversion to digital. These are discussed later in this chapter.

11.4.12 Analogue television has since switched over to digital television. Digital television is more robust to interference, reducing the probability of interference at any isolated properties.

Radio Reception

11.4.13 The BBC have no evidence to suggest that wind farms cause interference to local or national radio reception.

Microwave Communications

11.4.14 Microwave links can be affected by reflection, diffraction, blocking and radio frequency interference caused by wind turbines in their 'line of sight'. In general the directional nature of microwave links means that interference can be avoided by defining clearance zones beyond which any degradation will be insignificant. A methodology to calculate clearance zones for microwave links has been defined in a paper published by Ofcom (Bacon, 2002).

11.4.15 RES consulted widely with organisations and system operators, which could be affected by the proposed wind farm, details are listed in Appendix 11.1. Ofcom identified that there were links operated by two companies that were within the consultation area considered by RES. Both companies have confirmed that a project at the Site will not affect their existing or currently planned operations. A further consultation with Ofcom in September 2008 confirmed that no new links have been installed since the previous consultation.

11.4.16 The proposed wind farm is not therefore predicted to cause any interference problems to microwave links.

Aviation

11.4.17 The Ministry of Defence (MoD) and Civil Aviation Authorities (CAA) have been consulted using the protocol and proforma agreed between the aviation industry and the BWEA. NERL were consulted in the formulation of TAN8 and it is considered that they have no objection in principle to wind farms in TAN8 SSAs.

11.4.18 In the UK, the need for aviation obstruction lighting on 'tall' structures depends upon their location in relationship to aerodromes. If the structure constitutes an 'aerodrome obstruction' it is the aerodrome operator that will review the lighting requirement by applying CAP 168 - Licensing of Aerodromes (CAA, 2007a). Away from aerodromes the UK Air Navigation Order (CAA, 2007b) applies, specifically Article 133 of Section 1. This requires that for en-route obstructions, away from aerodromes, lighting only becomes legally mandated for structures that are 150m or higher. However, structures of lesser height may need aviation obstruction lighting if, by virtue of their location and nature, they are considered a significant navigational hazard.

11.4.19 The turbines at Llanbrynmair would have a tip height of up to 126.5m. All aviation stakeholders have been consulted and no concerns over obstruction or hazard have been raised plus the turbines do not constitute an 'aerodrome obstruction'.

11.4.20 The CAA confirmed in August 2012 that they have no observations regarding this Proposal.

11.4.21 NATS (En-Route) Public Limited Company (“NERL”) confirmed no safeguarding objection to the proposal in August 2012.

11.4.22 The MoD confirmed in September 2012 that they have no objection to a wind farm at this location.

11.4.23 The MoD have requested that the turbines are fitted with aviation lighting. All turbines should be fitted with 25 candela omni-directional red lighting or infrared lighting with an optimised flash pattern of 60 flashes per minute of 200ms to 500ms duration at the highest practicable point.

11.4.24 In addition, the MoD requests that should permission be granted the following details are provided to update flying charts:

- the date construction starts and ends;
- the maximum height of construction equipment;
- the latitude and longitude of every turbine.

11.4.25 The MoD does not, except where proposed turbines are covered by the Air Navigation Order (ANO), have the power to order that lighting is installed. RES are in discussion with the MoD on this matter and contend that such lighting is not required at this location as it is not a designated MoD low flying area or an area of intense aerial activity and that mapping the turbines on flying charts will be sufficient protection for pilots to locate turbines; as has been used in other areas of the UK. Should there remain a request for aviation lighting from the MoD, visual

impact would be minimised by the use where reasonably practicable of a lighting design that is invisible to the naked eye, whilst visible to pilots wearing night vision goggles.

11.5 Safety

11.5.1 This section will address the potential safety concerns that are, or are perceived to be, relevant to wind farms. In each case the safety issue is described and there follows an explanation of the measures that would be taken, and guidelines that would be adhered to, to mitigate the likelihood of those potential impacts occurring to an acceptable level.

Safety During Construction

11.5.2 Large construction plant have the potential to injure workers.

11.5.3 All site work would comply with the Construction (Design and Management) Regulations 1994 approved code of practice, which came into force on 31st March 1995, the Health and Safety at Work Act 1974 and the Construction (Health, Safety and Welfare) Regulations 1996.

11.5.4 This would be done in conjunction with the British Wind Energy Association Guidelines for Health and Safety in the Wind Energy Industry (BWEA 2005) and the Management of Health and Safety at Work Regulations 1999 (HMSO, 1999).

11.5.5 When not in use, any potentially hazardous machinery would be stored in secure containers or locked and immobilised to prevent use by unauthorised persons.

RES Safety Procedures

11.5.6 Further to the above measures, during construction and subsequent operation of the development, all normal site safety procedures would be strictly enforced. RES has developed its own Safety manual to be adhered to throughout the lifetime of the project. The Llanbrynmair Wind farm would comply with all safety regulations and display appropriate warning signs concerning restricted areas on the turbines, substation enclosure and control building. Authorised personnel and persons under their supervision who visit the restricted areas of the site during its operation would operate under site-specific safety rules established by the owner and operator.

11.5.7 Since its first schemes were constructed in 1992, RES has had a long track record of safe operation and maintenance of wind farms across the UK, and ensures safe, prudent and cost effective long-term operation of its plant. RES manages and operates a range of wind farms that it has developed and constructed itself, and also manages wind farms for other owners, to the highest international safety and environmental standards.

General Turbine Safety

11.5.8 RES will require the selected wind turbine model to have full certification from an internationally recognised authority, and have a proven track record of safe operation. The wind turbines would incorporate a sophisticated supervisory control system that continually interrogates the operational status and safe working of key components of each turbine and allows an operator to remotely monitor the turbines via modem. Were a fault to develop, the particular turbine would automatically shut down and send an alarm to the maintenance engineer. For any safety-critical fault, the turbine would not re-start until the maintenance engineer had diagnosed and rectified the problem.

11.5.9 Properly designed, constructed and maintained wind turbines are safe. The highest risk of damage is in extreme wind speed conditions (>100mph) when no one would be on the site. Even in these conditions the risk of damage is very small. The turbines proposed for the site would be certified to withstand appropriately extreme conditions. In very high winds the rotor blades are braked and parked in a safe position. The turbines have operational and maintenance safety manuals, which would be available on site alongside RES safety manuals and procedures. Regular safety checks would be undertaken.

11.5.10 Although the possibility of attracting lightning strikes applies to all tall structures, wind turbines have specific protection requirements due to their size and nature. Specific design features are required to ensure safety and to ensure that the turbines can ride through lightning storms without damage and without impact on reliability. Specific features are incorporated into the blades to ensure strikes are conducted harmlessly past the sensitive parts of the nacelle and down the tower into the earth. This protection includes a buried earthing mat round each turbine foundation.

Icing

11.5.11 In some countries, icing of wind turbine blades presents a potential risk that must be managed. In particularly cold climates such as in northern Scandinavia, hazardous situations can be avoided by incorporating heating elements into the blades.

11.5.12 In the warmer climates of the UK, icing has not been a problem to date, but at higher elevations and at locations further north, the risk will be greater and needs to be suitably assessed.

11.5.13 There is no inherent danger in operating a wind turbine at low temperatures, and there is no particular risk simply because it is frosty or snowing. However, should atmospheric conditions, specifically temperature and humidity, be such that hard ice could form on the blades (this might happen either when rain freezes on contact with a blade or should the turbine be operating in low, freezing, cloud), then ice accretion can occur. If action is not taken to shut the turbine down, then a build-up of ice ultimately resulting in ice-throw might happen.

11.5.14 A turbine control system will normally detect icing indirectly. The system will continually monitor the turbine power output and the wind speed seen by the control anemometer mounted on the nacelle. Any icing of the blades will degrade performance significantly, and the control system having detected that the turbine is now operating outside the expected power to wind speed 'envelope' will take precautionary shut-down action in the knowledge that an unspecified fault has arisen. In the unlikely event that the turbine continues to operate and that an ice build-up or throw occurs, then vibration sensors would cause the turbine to stop.

11.5.15 At locations where icing is an occasional risk but where any ice shedding is likely to be particularly dangerous (e.g. should the turbines be adjacent to a busy highway), then special precautions can be taken. This might involve the wind farm control system monitoring meteorological conditions on the site, and when temperature and humidity fall within a pre-defined risk-zone then the turbines can be shut down as a precaution to avoid a risk developing.

11.5.16 Due to the low likelihood of icing and the provisions for shutting down as described at 13.6.14, there is no reason to believe that a wind farm at Llanbrynmair Wind farm would require such special protection.

Public Safety

11.5.17 The site would remain working farmland throughout the lifetime of the wind farm. Many existing wind farm sites are safely farmed with stock grazing right up to the turbine bases.

11.5.18 As for any structure, storm damage can be sustained during severe events. A few isolated cases of turbine blade damage have occurred in exceptionally high wind conditions. However, putting this in context:

'In over 25 years of operating experience and with more than 68,000 machines installed around the world, no member of the public has ever been harmed by the normal operation of wind turbines'. (BWEA, 2005).

11.5.19 The plant, equipment and their enclosures are designed to incorporate the best available technology and access to the site should pose no danger to the public. During routine maintenance operations 'warning men at work' signs would be erected.

11.5.20 A sign would be placed on the site giving details of whom to contact in an emergency. This information would also be posted at the local police station and with the operator of the local electricity distribution network.

11.5.21 Given the paramount importance RES attaches to safety issues, and the safe operating history of turbines, no effect on public safety is anticipated from the proposed wind farm.

Risk Assessment

11.5.22 As for any mechanical or electrical installation, wind farms could pose a safety risk if not managed and maintained correctly. However, under the Construction (Design and Management) Regulations, detailed risk analysis and avoidance limitation measures are required for every facet of the development and operation of a wind farm. These measures would be contained in the Health and Safety file for the site, which would be open to inspection by the Health and Safety Executive. All site personnel will have full safety training, to ensure an absolute minimal risk of accidents occurring. Electrical installation will be to standards and recognised codes of practice with adequate signage and protection.

11.6 Shadow Flicker

Introduction

11.6.1 In sunny conditions, any shadow cast by a wind turbine will mirror the movement of the rotor. When the sun is high, any shadows will be confined to the wind farm area, but when the sun sinks to a lower azimuth, then moving shadows can be cast further afield and potentially over adjacent properties. Shadow flicker is generally not a disturbance in the open as light outdoors is reflected from all directions. The possibility of disturbance is greater for occupants of buildings when the moving shadow is cast over an open door or window, since the light source is more directional.

11.6.2 Whether shadow flicker is a disturbance depends upon the observer's distance from the turbine; the direction of the dwelling and the orientation of its windows and doors from the wind farm; the frequency of the flicker and the duration of the effect, either on any one occasion or averaged over a year.

11.6.3 In any event and irrespective of distance from the turbines, the flickering frequency will depend upon the rate of rotation and the number of blades. It has been recommended (Clarke, 1991) that the critical frequency should not be above 2.5 Hz, which for a three bladed turbine is equivalent to a rotational speed

of 50 rpm. The Proposal turbines would rotate at approximately 14 rpm, well below this threshold.

Methodology

11.6.4 An analysis of shadow flicker throughout the year from Llanbrynmair Wind farm was carried out, taking into account the behaviour of the sun, the local topography and the turbine layout and dimensions[41]. The analysis was performed using a turbine layout consisting of 30 turbines, each with maximum tip heights of 126.5m and maximum rotor diameters of 93m.

11.6.5 The Scottish Office (2002) PAN 45 guidelines and Clarke (1991) & (1995) have predicted that houses located further than ten rotor diameters away from a wind turbine are unlikely to experience a disturbance from shadow flicker. Therefore, the analysis was performed on all occupied houses within 930 metres of any proposed wind turbine. The coordinates of these 6 houses are given in Table 11.1, along with their proximity to the nearest turbine.

Table 11.1 Location of houses less than 10 rotor diameters away from Proposal turbines.

House	House Name	Easting	Northing	Nearest	Distance to nearest
H1	Ysgubor Cannon	295941	307427	R17	862
H15	Hafodowen	292785	302747	R39	881
H26	Ffriddfawr	294629	303945	R9	873
H27	Cwmderwen	295533	305435	R23	862
H28	Cannon	295885	307416	R17	810
H53	Ysgubor Uchaf	291794	303228	R32	829

Assumptions

11.6.6 It should be noted that the analysis was performed using the following assumptions:

- The sun will always be visible during daylight hours (conservative assumption; the location is known to encounter cloud cover approximately 75% of the year, (IPCC, 2004).
- The wind will always be sufficient to turn turbine blades at these times (conservative assumption).
- The alignment of the turbine rotor blades with respect to the sun's position will always produce maximum shadow casting (conservative assumption; it is unlikely that the wind, and therefore the rotor blades, will track the sun in practice). The analysis looks at shadow casting over the building from all directions rather than over vertical orientated windows only (conservative assumption).
- The intensity of the sun will be insufficient to cast strong shadows at elevations less than 5°.
- Shielding due to features such as trees or other obstacles has not been taken into account. Terrain shielding, however, is modelled.

[41] Turbine ref 01592D0004-10, house ref 01592D0201-06

Results

11.6.7 The results of the analysis are shown in the Table 11.2. The times when shadow could occur at each house have been rounded up to the nearest quarter of an hour.

Table 11.2 Predicted times of potential shadow flicker from turbines at Site.

House	House Name	Days with	Max Time	Annual Total	Month and Time of potential flicker
H1	Ysgubor Cannon	71	0.46	24.5	Feb- Mar; 1545- 1630 Mar-Apr; 17 Sept;
H15	Hafodowen	65	0.49	26.8	May- Jun; 0415- 0500 Jul; 0430 – 0515
H26	Ffriddfawr	39	0.45	13.9	Apr & May; 1745- 1830 Aug; 1800 - 1830
H27	Cwmderwen	44	0.46	15.7	Apr & May; 1730- 1815
H28	Cannon	74	0.48	26.9	Feb; 1530- 1615 Mar; 1530-1600 & 1700- 1730 Apr, Aug & Sep; 1645- 1730 Oct; 1500- 1545
H53	Ysgubor Uchaf	0	0	0	-

11.6.8 The results show that five of the houses considered in the analysis could be subject to shadow flicker from the Llanbrynmair Wind farm.

11.6.9 House 1 is located to the east of the proposed wind farm and belongs to a financial beneficiary of the project. It could experience up to 28 minutes per day of shadow flicker during the afternoon, in February to April, from turbine R17 and R25.

11.6.10 House 15 is located to the south of the proposed wind farm. It could experience shadow flicker in the early mornings in May to July when the sun is rising, for up to 29 minutes per day from turbine R39.

11.6.11 House 26 is located to the east of the proposed wind farm. It could experience shadow flicker in the early evening in April and August when the sun is setting, for up to 27 minutes per day during from turbine R9.

11.6.12 House 27 is located to the east of the proposed wind farm. It could experience shadow flicker in the early evening during April, May and August when the sun is setting, for up to 28 minutes per day during from turbine R23.

11.6.13 House 28 is located to the east of the proposed wind farm. It could experience shadow flicker in the afternoons during February to April and August to November when the sun is setting, for up to 29 minutes per day during from turbines R17 and R25.

11.6.14 It should be emphasised that this analysis provides an extremely conservative estimate of the extent that houses will be affected by shadow flicker. Due to frequent cloud cover, turbines not turning at all times and turbine rotors not being aligned with the sun in a way to cast maximum shadow onto habitations, the actual amount of shadow flicker seen in these areas is likely to be much less.

11.6.15 It is therefore concluded that the Proposal will not cause a material reduction to residential amenity owing to shadow flicker and is therefore not significant under the EIA Regulations.

11.7 Reflected Light

11.7.1 A related visual effect to shadow flicker is that of reflected light. Theoretically, should light be reflected off a rotating turbine blade onto an observer then a stroboscopic effect would be experienced. In practice a number of factors limit the severity of the phenomenon and there are no known reports of reflected light being a significant problem at other wind farms.

11.7.2 Firstly, wind turbines have a semi-matt surface finish which means that they do not reflect light as strongly as materials such as glass or polished vehicle bodies.

11.7.3 Secondly, due to the convex surfaces found on a turbine, light will generally be reflected in a divergent manner.

11.7.4 Thirdly, the variability in flow within a wind farm results in slightly differing orientation of rotor directions, therefore it is unlikely that an observer will experience simultaneous reflections from a number of turbines.

11.7.5 Fourthly, as with shadow flicker, certain weather conditions and solar positions are required before an observer would experience the phenomenon.

11.7.6 It is therefore concluded that Llanbrynmair wind farm will not cause a material reduction to amenity owing to reflected light.

11.8 Mitigation Measures

11.8.1 Embedded mitigation measures have been incorporated into the siting and design process for the wind farm so as to avoid electromagnetic interference effects.

11.8.2 The BBC note that the wind farm should not have a detrimental effect upon national or local BBC Radio reception.

11.8.3 The proposal will not affect any TV RBL links.

11.8.4 The wind farm will not have an effect on microwave links as there are none crossing the site or in close enough proximity to be affected.

11.8.5 The wind farm will have no effect on aviation operations.

11.8.6 No mitigation measures needed for public safety as no effect on public safety is anticipated from the proposed wind farm.

11.8.7 No mitigation measures needed for reflected light as no effect is anticipated from reflected light.

11.8.8 No mitigation measures needed for shadow effect as no effect is anticipated from shadow flicker.

11.8.9 As a proposed mitigation strategy to address potential interference to television reception RES would commission a suitable organisation such as Arqiva to carry out a benchmark site survey of television reception quality in the area around the wind farm site between obtaining planning permission and starting construction. This would provide reference points against which future measurements could be

compared once the wind farm is constructed and enable any remedial measures to be implemented expediently.

11.8.10 Analysis has demonstrated that there will be no widespread interference to TV reception. A range of viable mitigation measures are available and the most appropriate solution must be decided on a case by case, location specific basis. Solutions include:

- Alternative transmitter – tuning existing aerial to one of the other main transmitters in the area
- Improved aerial system - by improved directionality, increasing aerial height, directing aerial away from or shielding from wind farm
- Digital TV (terrestrial free view or satellite) – likely to be an improvement to television service and can be installed if necessary

11.8.11 Any necessary work would be carried out in a timely manner by RES at its own expense.

11.8.12 Given the limited extent of any predicted interference, the need for corrective action would best be identified once the benchmark site survey has been undertaken and the wind farm is commissioned.

11.8.13 Ofcom also suggest that in view of potential interference arising, should the planning authority ask for their views, Ofcom would suggest they enter an agreement with RES to meet the cost of investigating and rectifying any problems that may arise. They suggest this is made under Section 106 of the Town and Country Planning Act 1990 or similarly binding agreement. RES have similar agreements in place at existing facilities.

11.8.14 Given the range of available mitigation measures for potential effects on television reception it is concluded that there would be no significant residual effects.

11.9 Statement of Significance

11.9.1 It is not considered that there would be a significant negative effect from electromagnetic interference, aviation, safety, ice throw, or shadow flicker.

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12 SOCIO-ECONOMIC ASSESSMENT

12.1 Topic Glossary

- CCL – Climate Change Levy.
- CHP – Combined Heat and Power.
- MtC - tonnes of Carbon.
- PrOWs - Public Right of Ways.
- TAN 8 – Technical Advice Note 8.

12.2 Introduction and Scope

12.2.1 This chapter considers the predicted adverse and beneficial effects of the proposed Llanbrynmair Wind farm on the socio-economics at local, regional and national scales during construction, operation and decommissioning of the proposed wind farm as described in Chapter 3 and referred to as the Proposal.

12.2.2 The chapter will describe the economic effects of the Proposal and wind energy in general, the potential effects on tourism, recreation and education, it will set out the proposed mitigation measures designed to reduce any potentially significant effects, and assesses the residual effects.

12.2.3 Information is provided on government support mechanisms, commercial viability and hidden economic effects of wind energy.

12.2.4 The assessment has been informed by a combination of information from other proposed and built wind farms, past surveys and other published information.

12.3 Relevant Legislation and Policy

12.3.1 National and local government, together with national and regional tourist boards, has recently adopted tourism-related policies and practices designed to maximise the economic and social benefits of tourism whilst simultaneously minimising tourism's negative environmental impacts. This policy agenda is particularly important for those authorities and agencies with responsibility for developing tourism in rural and remote areas such as Mid Wales. To ensure the sustainable development of tourism attention has thus focussed on developing strategies that seek to promote quality of experience and level of tourist expenditure over quantity of tourists. Achieving Our Potential: Tourism Strategy for Wales 2006-2013 Mid Term Review (Welsh Assembly Government, 2009) and the Sustainable Tourism Framework (Welsh Assembly Government, 2007) set out the strategies for tourism and sustainable development across Wales.

12.3.2 The Sustainable Tourism Framework for Wales has been developed within the context of both the overarching national tourism strategy for Wales Achieving Our Potential: Tourism Strategy for Wales 2006-2013 (Welsh Assembly Government, 2006a) and wider national strategies that respond to the Wales Spatial Plan: People, Places Futures (Welsh Assembly Government, 2004a). These wider national strategies have been developed in relation to economic, social, cultural and environmental policy priorities identified by the Welsh Assembly Government and are outlined in the following policy documents addressing economic, social and environmental policy priorities:

- Well-being in Wales (2002);
- Health Challenges Wales (2004a);

- Sustainable Development Strategy: Starting to Live Differently (2004b);
- Wales: A Vibrant Economy (2005a);
- The Rural Development Plan for Wales Strategic Approach 2007-2013 (2005b);
- The Environment Strategy for Wales (2006b);
- Starting to Live Differently: Sustainable Development Strategy (2004b).

12.4 Economic Assessment

12.4.1 This section sets out the potential economic effects of the Proposal on the local and wider economies.

Methodology

12.4.2 To predict the potential economic effects of the Proposal, the economics of wind energy in general will be examined and examples of economic effects of existing wind farms and associated industry will be given. By comparing the economics of wind energy with alternative forms of electricity generation it is possible to demonstrate the economic viability of wind farms.

12.4.3 Specific details will be given regarding the likely direct contributions from the Proposal to the economy and more general effects arising from employment.

General Wind Energy Economics

12.4.4 The cost of generating electricity from wind is no different from other methods with the total cost being made up of capital cost (for the building of the power plant and connecting to the grid); the running costs (buying fuel, operation and maintenance) and the cost of financing (how capital is repaid).

12.4.5 As fuel is free with wind energy, once capital costs are paid, the only remaining costs are those of operation, maintenance and fixed costs such as land rent. Capital costs make up 75-90% of the total cost of wind energy developments, with total costs being primarily affected by technical and financial considerations.

12.4.6 Onshore wind energy is one of the most competitive renewable technologies currently available in the UK (DTI, 2007). By 2020 it is projected that onshore wind is likely to become amongst the cheapest of all generating technologies (PIU, February 2002) with lower costs than all fossil fuel sources.

12.4.7 A recent report by the National Audit Office (NAO 2010) states that in 2009, total public support for renewable technologies in the UK was worth more than £1 billion, with most of this coming via the Renewables Obligation.

12.4.8 The 2007 UK Energy White Paper notes that onshore wind can efficiently and cost effectively replace electricity from fossil fuel fired forms of generation in the medium, to long term (DTI 2007).

Hidden Benefits of Renewable Energy

12.4.9 Direct comparisons between renewable and conventional costs of generation can be misleading as they disregard a number of important issues.

12.4.10 First, the use of renewable energies provides a 'hedge' against future fuel cost inflation. Several oil-fired generation plant built in the 1970s have had to be converted to other fuels or mothballed because of unforeseen increases in the cost of fuel supplies. Wind energy, being a renewable source with zero fuel cost has complete forward security in this regard. Against a backdrop of increasing

usage and diminishing national reserves, where the UK is now a net importer of gas (DTI 2005), volatility in gas prices is to be expected, and deriving a high proportion of our supplies from wind energy will help minimise this impact, whilst also increasing our energy security and independence.

12.4.11 Secondly, wind farms do not have large future decommissioning costs compared with other types of generation, and site restoration is quick, straightforward and effective. Compared with nuclear energy, there is far greater certainty regarding end-of-life costs, both financial and environmental.

12.4.12 Third, a major and most important benefit of using renewable forms of energy in preference to fossil fuels is the avoided cost of pollution and other external costs. Effects on human health and the environment are often not internalised into the overall cost of a project or reflected in the price of electricity

12.4.13 During operation, renewable energy projects do not contribute to global warming. The Government, via the Renewables Obligation, discussed in Section 2, and the Climate Change Levy, discussed below, has established mechanisms to create economic value from these benefits.

12.4.14 A European Commission report 'ExternE: Externalities of Energy' (European Commission, July 2001) concludes that the cost of producing electricity from coal and oil would double, and gas would increase by 30%, if the external costs such as damage to the environment and to health were taken into account. Electricity from coal has one of the highest external costs ranging from $0.02 to $0.15/kWh. Natural gas is better at $0.01 to $0.04/kWh and nuclear ranges from $0.002 to 0.006/kWh. The figure for wind energy came out best with external costs of just $0.0005 to $0.0025/kWh (Wind Power Monthly, January 2002). More recent research by the ExternE project and its successor 'NEEDS' (New Energy Externalities Development for Sustainability) suggest fossil fuel electricity systems exhibit far higher external costs than wind energy, remaining greater by a factor of ten to twenty (European Commission, 2004, NEEDS Project, 2009).

12.4.15 In March 1999 Chancellor Gordon Brown announced the introduction of the Climate Change Levy (CCL) on business use of energy, effective from April 2001. The levy adds 0.43p/kWh to the cost of electricity supplied to non-domestic users, but this has now risen to 0.47 p/kWh in 2010. The levy is designed to improve energy efficiency in business and help the UK meet its national and international targets for reducing greenhouse gas emissions. The principal aim of the levy is to encourage non- domestic electricity users to become more energy efficient and so reduce carbon emissions. An independent evaluation by Cambridge Econometrics in 2005 (HMCE, 2005) examined the levy since its introduction, concluding that the CCL is estimated to deliver annual CO_2 savings of over 3.5million MtC in 2010, well above the 2 MtC figure forecast at the time of the levy's introduction. Annual revenues from the CCL have been close to £700 m since 2005, with £695 m being taken in the financial year of 2009/2010 (CCL Bulletin, August 2010). Part of the proceeds is used to promote energy efficiency and invest in low-carbon technologies and research via The Carbon Trust. The levy differentiates between non-carbon fuels (such as renewables) and high carbon fuels (such as coal). For example, energy consumers of renewable energy sources (wind power) and combined heat and power (CHP) are exempt from the levy which makes it favourable over conventional forms of energy production. Thus, as outlined in the HMCE 2005 Report, the overarching objective of the CCL to stimulate and promote renewable energy over conventional supplies has been realised as the levy essentially sets the avoided cost of pollution at 0.47 p per unit of electricity generated by renewables such as wind energy.

12.4.16 The report '*Wind Power in the UK'* report by the Sustainable Development Commission, the Government's independent watchdog on sustainable development (SDC 2005) notes that accounting for the social cost of carbon may reduce the system cost of wind power. Therefore, the social benefit of having increased wind

output may outweigh any costs in the future. However, any benefits will not be reflected in the cost of electricity until carbon values are sufficiently internalised in the price of fossil fuels and their resultant electricity.

The Renewable Energy Market and Job Creation

12.4.17 The Government consultation paper on renewable energy notes that estimates based on World Energy Council projections indicate cumulative investment in renewables ranging from £150 billion to £400 billion between 2000 and 2010. A feasibility study by the EWEA shows that the investment value of wind energy will increase to a peak of €82.7 billion by 2019 (Windforce 12, 2004. Pp69). In 2006 the technology installed was worth €18 billion (GWEC, 2007). The market is expanding rapidly. At the end of 1998, 9.8GW of wind energy had been installed worldwide; this has progressively risen to over 93GW in February 2008 (WWEA, 2008). The overall long term growth rate is 30% as it has been for the last 10 years. Global wind power generation is therefore doubling every 3 years. At the start of 2007, 65% of the installed world capacity was in Europe (WPM, April 2007). The wind energy market is clearly a significant economic and employment stimulus.

12.4.18 Total monetary value, adjusted for imports, is currently of the order of £290 million in the UK. By 2020 it is estimated that £15 billion to £19 billion capital expenditure is required to meet the target of 20% electricity generation from renewable sources, (Mott MacDonald, Bourton Group, Renewables UK, 2003).

12.4.19 Pioneering turbine development work carried out in the UK in the 1980s did not result in an indigenous UK wind turbine manufacturing industry, largely because of the lack of a domestic market at that time. However, the market does seem to be strengthening, evidenced by the opening by Mabey Bridge in May 2011 of a new state-of-the-art wind turbine tower and monopile manufacturing factory in Chepstow, and the confirmation in March 2012 by Gamesa, a Spanish wind turbine manufacturer, that they will be investing £125 m in the development of a turbine manufacturing plant in the Port of Leith, Scotland.

12.4.20 It is now calculated that in Europe alone the wind industry employs 154,000 people (EWEA, 2009); this is forecast to double by 2020, to 330,000 people. It has recently been estimated that an expansion of renewable energy in the UK has the potential to create 160,000 new jobs (BERR, 2009).

Local Baseline Environment

12.4.21 It is beyond the scope of this assessment to conduct an in-depth analysis of Powys socio- economics, however, some key characteristics of the area are provided for information.

12.4.22 In Powys there is a claimant unemployment rate of 2.3%; this is compared to a Wales rate of 4.0% (Powys, April 2013).

12.4.23 In 2009 the average weekly gross wage in Powys was £434.00, compared to a Welsh average of £506.00 (Powys, 2013).

12.4.24 According to 2001 census data 66% of people in Powys are economically active, whereas the Welsh average is 60.9%.

Local Economic Effects During Development and Construction

12.4.25 RES tries to ensure that wherever possible local contractors and employees are used in all aspects of wind farm development and one post has already been created in Wales by this project during its development. The major opportunity lies during the construction phase when suitably qualified local firms are identified and invited to bid for a significant portion of the construction work, on roads, foundations and buildings. Construction materials are normally sourced locally and

local transport and plant hire companies used wherever possible. At Llanbrynmair Wind farm a temporary workforce of up to 40 would be created during the 24 month construction stage. It is anticipated that 80% of these construction jobs would be sourced locally. The wind farm would also create a permanent job in operation and maintenance (see Section 4.5).

12.4.26 In the case of Slieve Divena wind farm in County Tyrone in Northern Ireland which started construction in July 2008, approximately 20 local jobs have been created for the period of construction and one long-term part-time job will result from the operation of the wind farm. This project has also had a positive effect on the local services such as hotels, builders and associated contractors.

12.4.27 Although each project differs in detail, an indicative capital-cost for a typical 90MW UK wind farm project such as at Llanbrynmair is approximately £100 million. Of this the civil engineering element (roads, foundations etc.) accounts for approximately 10% and the grid connection a further 3-5%. The greater part of this work is likely to be sourced from local suppliers, subject to the availability of the appropriate skills and resources. It is considered that spending approximately £13m on works undertaken by local contractors would benefit the local economy.

Economic Effects During Operation

12.4.28 Business rates for wind farms in England and Wales have been recently changed and the future mechanism is not yet determined, however, it is expected they will be subject to business rates according to the load factor and that it will be around 41.4 p in the pound, with a rateable value of £17,500 per MW of installed capacity. This means that based on an installed capacity of up to 90 MW, Llanbrynmair Wind Farm would contribute up to £1,575,000 per annum to the funding of central government services.

12.4.29 Wind farm developments are a new yet important form of rural diversification. The host farms and estates will derive rental income from the turbines, and the new income stream generally helps sustain the economic viability of the estate or farm business. These new finances allow investment in the other aspects of the estate/farm business, which in turn spins off into local economic benefit. Anecdotal evidence from local farmers would suggest that the farming industry in mid Wales is currently struggling economically and the potential direct income from the Proposal may encourage younger people to continue the farming tradition in the area.

12.4.30 During operation of the wind farm local people would be employed where practicable to carry out routine inspections and maintenance.

Community Fund

12.4.31 TAN 8 recognises that major wind farm development can provide community benefits either as mitigation for potential impacts of the development, or as benefits not directly related to the planning process. It further suggests that local planning authorities should encourage such proposals, but that these proposals should not influence the decision-making process, and are hence not material considerations in the determination of a planning application.

12.4.32 RES has sought the views of the community and stakeholders as to what initiatives could be introduced to provide tangible benefits to the local community throughout the wind farm's life. Various schemes were suggested, however the general consensus is that a community benefit fund, whereby the owner of the wind farm makes annual payments to a fund intended for community projects, would offer the greatest value to the local area. This would be a readily tangible benefit that could be targeted as the community sees fit. Furthermore, the fund could obtain match funding from other sources and therefore facilitate ambitious projects.

12.4.33 The funds would be distributed by a committee made up of members of the local communities as they see fit, and it is likely that a salaried person would be responsible for the administration. The actual composition and mandate for the committee would be determined by the relevant stakeholders. Similar funds in Wales have provided bursaries for university students; computer equipment for schools; grants for sports clubs; improving community centres, and providing domestic scale renewable energy systems.

12.4.34 The fund will be at least £3,000/MW of installed capacity per annum. This means that, based on a nominal 90MW total installed capacity, the project would give up to £270,000 per annum to the local communities around the wind farm. This is not a benefit directly related to the planning process, and so should not influence the local planning authority in the determination of the planning application for the Llanbrynmair Wind farm. RES would be willing to enter into a unilateral Section 106 Agreement to set out the principles of the community benefit fund.

12.4.35 RES has also recently introduced an innovative form of community benefits in the form of a local electricity discount scheme (LEDS) for properties close to its new wind farms, which it intends to offer at Llanbrynmair in addition to the community benefit fund. The combination of a community fund and LEDS represents a total community benefit of £5,000/MW of installed capacity per annum.

12.4.36 Although community benefit funds are not a material consideration for a planning application, it is important that local communities are aware of the potential benefits to them.

12.5 Recreation Assessment

12.5.1 This section will set out the existing recreational activities on and around the proposed wind farm Site (as shown in Figure 3.6), assess the potential impacts of the scheme and propose suitable mitigation measures where necessary.

Baseline

12.5.2 From desk studies and searches, a number of public rights of way were identified on the Site and in its proximity.

12.5.3 These include

- Glyndŵr's Way National Trail,
- Open access land in the northern part of the Site
- Footpaths predominantly in the southern part if the Site
- Use of the minor road passing down Nant yr Eira which forms part of the William Morgan Route by horse riders

12.5.4 It is known that horse riders and walkers use the different rights of way but the amount of use has not been ascertained.

Impact Assessment and Mitigation

12.5.5 During the design process of the Llanbrynmair Wind farm, consideration was given to the various Public Rights of Way across the site. This is discussed in Chapter 3.

12.5.6 Direct effects on Public Rights of Way (PRoWs) will occur where the site tracks cross and coincide with them:

- The access track leading from Site entrance 2 (SH 960 059) towards R42 coincides with the route of Glyndŵr's Way for approximately 560m;

- The access track from south of R42 towards R14 crosses a bridleway twice and runs approximately on the same route;
- The track leading to R14 crosses Glyndŵr's Way;
- Track from R3 to R28 in the west of the site crosses and coincides with Glyndŵr's Way, which is also a bridleway at this point, for approximately 200m;
- Tracks from south of R9 in the south of the site leading to R30 cross a footpath five times;
- Track between R41 and R39 cross a footpath once.

12.5.7 RES has met with representatives of the Dyfnant and Vyrnwy Horse Riding and Carriage Driving Association and they have confirmed that at present the bridleway on the Site is not thought to be used by horse riders and is very poorly marked. The Site in general is not considered to be used much by horse riders.

12.5.8 RES met Powys Public Rights of Way officers on the Site where it was agreed that access tracks running along the route of Glyndŵr's Way could improve the condition of the route.

12.5.9 There is potential for users of the rights of way on Site to be affected by the construction activities as the routes are crossed by construction vehicles. A length of Glyndŵr's Way from the road at Dolauceimion towards may not be available to the public whilst being upgraded and used as an access track. In order to mitigate or reduce such effects, temporary diversions will be put in place. Areas of construction activity would be cordoned off to exclude the public.

12.5.10 To mitigate perceived effects RES propose to create a new permissive right of way in the area of R24 – R14 maintaining a distance of approximately 200m from the turbines (see Figure 12.1).

Horse Riders

12.5.11 Anecdotal evidence suggests that horses quickly habituate to wind turbines and there are many examples of horses and wind farms to co-exist without any problems. The British Horse Society (2007) guidance states that wind turbines should be located at least three times their height away from all routes (bridleways, roads and byways); however, this guidance was published without consultation and has not been adopted into any government policies. The guidance also suggests that in some cases a minimum separation distance of 200m would be acceptable. RES would consider that a 200m separation distance on wind farms in Strategic Search Areas, particularly where the site is not used by horse riders as in the case of Llanbrynmair, is acceptable.

12.5.12 Two turbines, R14 and R24 lie within 200m from Glyndŵr's Way, and R14 is within 200m of the bridleway. It should be noted that as horse riders would not stick rigidly to the bridleway as shown on definitive mapping, the 200m separation distances should not be interpreted too strictly.

12.5.13 The existing route of Glyndŵr's Way as it passes R24 is permissive. RES would be willing to work with the relevant stakeholders to move this permissive section after construction of the Proposal onto the official bridleway route, which RES shall improve, that runs 200m to the north of R24.

12.5.14 Should stakeholders wish, RES would be willing to assist in moving the section of bridleway and Glyndŵr's Way that pass within 200m of R14 onto a new proposed permissive right of way that would maintain a separation distance of approximately 200m from the turbines, see Figure 12.1.

12.5.15 Should stakeholders think it appropriate RES would finance the installation of signs on bridleways approaching the wind farm where the turbines first come into

view. These signs would allow riders with horses not familiar with wind turbines to dismount and lead the horse should they consider the horse to be nervous.

12.5.16 Considering the above, direct effects on the use of Public Rights of Way in the vicinity of the proposal are likely to be minimal and primarily occurring during the construction process. Once operating, public rights of way will be accessible as normal. It is therefore not considered that there would be any significant effect on users of the PRoWs such as horse riders and walkers. RES will work with stakeholders such as the Dyfnant and Vyrnwy Horse Riding and Carriage Driving Association prior to and during the construction period to reduce or mitigate any perceived effects on local horse riders where reasonably practicable.

12.5.17 Visual effects of the wind farm upon walkers' amenity during operation are addressed in Chapter 4.

Enhancement Measures

12.5.18 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 resources 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 Countryside-Code. Such activity would require the agreement of the landowner and relevant bodies and interest groups.

12.5.19 RES would be willing to finance the cost of improving Glyndŵr's Way and the bridleway that runs from R14 north west into the forest to the forestry road, see Figure 12.1.

12.5.20 RES would also be willing to make the bridleway that leads from Neinthirion west to the forest at Graig Llwyd more suited for horse riders. It is likely that such works would involve turning the top soil over, improving the drainage to the sides, and allowing the path to reseed, see Figure 12.1.

12.5.21 Between Dolwen and Dolauceimion where Glyndŵr's Way runs along the minor road RES would be willing to undertake works within the highways verge to make it more suited for horse riders, see Figure 12.1.

12.6 Tourism Assessment

12.6.1 The assessment will consider studies that have been carried out on the effects of wind farms that have been constructed and operate in the UK. This will facilitate prediction of the likely effects of Llanbrynmair Wind farm upon the local tourism industry.

Tourism Impact Analysis Report

12.6.2 The evidence submitted here is designed to provide data, information and informed analysis of the actual and potential impact of wind farms on tourism and, specifically, the potential impact on tourism of a wind farm at Llanbrynmair, Powys.

12.6.3 The report concludes that although tourism research relating to wind farm developments is limited compared with that on policy, landscape, ecology and noise it is increasingly evident that there is an emerging consensus within the research examining the actual and potential impact of wind farms on tourism. The clear consensus is that there has been no measurable economic impact, either positively or negatively, of wind farms on tourism. Similarly, there is consensus among researchers of studies that have sought to predict the more specific potential economic impact of wind farms on tourism. Here again, there is no

evidence to support the assertion that wind farms are likely to have a negative economic impact on tourism.

12.6.4 Within the local, regional and national context it is clear that the area surrounding Llanbrynmair receives low numbers of visitors and income from tourism relative to other areas in Mid Wales. This reflects the lower concentration of visitor attractions and tourist accommodation than seen in many other areas of Mid Wales. In conclusion, the findings from the secondary research relating to the potential impact of Llanbrynmair Wind farm indicate that there is likely to be neither an overall decline in the number of tourists visiting the area nor any overall financial loss in tourism-related earnings as a result of the wind farm development.

12.6.5 A full copy of the report can be found in Appendix 12.1.

Background Information

12.6.6 Tourism plays an increasingly important role in contributing to rural regeneration in the UK. New forms of rural tourism associated with landscape, culture and active recreation are increasingly important to rural tourism economies (Scottish Government, 2012)

12.6.7 Local tourism has seen no negative effect due to the wind farms operating in the UK. Indeed the evidence from wind farms operated by RES, and others, suggests that the general public is often interested in visiting wind farms particularly in a holiday area. The clear consensus is that there has been no measurable economic impact, either positively or negatively, of wind farms on tourism. All of the studies that have sought to predict impact have demonstrated that any negative impact of wind farms on tourism will be more than outweighed by the increase in tourists that are attracted by wind farms or by the increase in employment brought about by the development of wind farms or by the continuing growth of tourism.

12.6.8 A survey undertaken by the University of the West of England (2004) of 379 day visitors and tourists in three areas in the UK found strong support for the use of renewable energy. In Mid Wales 93 interviews were conducted near Bryn Titli and Carno wind farm sites: only 5.4% of those respondents were opposed to the use of renewable energy in Wales. 57% of the Wales respondents thought that more wind farms should be constructed onshore in the UK. The results suggest that the development of a wind farm would not impact negatively on tourism.

12.6.9 Previous research from other areas of the UK has demonstrated that wind farms are very unlikely to have any adverse impact on tourist numbers (volume), tourist expenditure (value) or tourism experience (satisfaction) (Glasgow Caledonian University, 2008; Aitchison, 2004). Moreover, to date, there is no evidence to demonstrate that any wind farm development in the UK or overseas has resulted in any adverse impact on tourism.

12.6.10 The Llanbrynmair area has a low density of visitor attractions and tourist accommodation relative to many other areas of Wales. Those day visitors and tourists attracted to the area are drawn by a range of features, most notably the landscape which provides scenic beauty and tranquil environments for a range of outdoor leisure, recreation and sport.

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12.6.11 Given the evidence above, it is not considered likely that tourism would be adversely affected by the construction of the Llanbrynmair Wind farm. It is considered that the proposal to install information boards and rights of way improvements would benefit local tourism.

12.7 Education

12.7.1 The wind farm would represent a useful educational resource for the area given that most schools and colleges now have energy, sustainable development and the environment on the curriculum. Wind farms make an ideal study topic for technical, social and environmental projects. RES undertakes talks at schools and arranges site visits for school groups at its existing wind farms in the UK. With the co-operation of landowners, similar activities could be arranged at Llanbrynmair Wind farm if requested by local schools and other groups. RES is happy to explore the potential for this with the local authority. The wind farm development could therefore have a positive effect on education in the area.

12.8 Conclusion

12.8.1 It is concluded that the development of Llanbrynmair wind farm is likely to have little or no impact on tourist numbers (volume), expenditure (value) or experience (satisfaction). Any impact is as likely to result in more tourist visitors as it is fewer tourists because of mitigation measures and the strengthening of identification of the area with the popular Centre for Alternative Technology.

12.8.2 Although a very small number of current visitors might choose not to repeat their visit because of the presence of a wind farm this number is likely to be off-set by additional tourist who visit irrespective of the presence of a wind farm, return because of the wind farm or visit for the first time because of the wind farm.

12.8.3 Tourist numbers are likely to increase significantly if the wind farm is accompanied by a visitor attraction and the proximity of the Centre for Alternative Technology makes Llanbrynmair a very realistic site for such a centre.

12.8.4 Additional benefits will be realised by the project owing to its embedded generation, lack of fuel cost inflation, low decommissioning costs and no associated costs from pollution.

12.8.5 The wind farm will become a feature of the area, and is likely to attract interest from locals and visitors alike. RES is also prepared to commit to direct community benefits from the operation of the wind farm.

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13 MITIGATION SUMMARY

13.1 Introduction

13.1.1 This section contains a summary of the mitigation measures proposed to address any potential effects identified during the environmental impact assessment process. In addition, enhancement measures proposed in the assessment are summarised.

13.1.2 Primary, or embedded, mitigation measures, which are those measures undertaken during the design process, such as avoiding statutory designations by locating the wind farm appropriately, are not considered here.

13.1.3 Secondary mitigation measures include any process, activity or design to avoid, reduce, remedy or offset any likely significant adverse effects of the proposed development.

13.1.4 Other measures are those which seek to avoid, reduce, remedy or offset any non-significant adverse effects of the proposed development.

13.1.5 Enhancement measures are those which do not seek to remedy any specific adverse effect associated with the wind farm, but would be beneficial.

13.2 Mitigation Measures

Table 13.1 Proposed Mitigation Measures.

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
Landscape and Visual					
4.6.10	Landscape and visual effects of substation	Substation was relocated and ground modelling developed to hide the substation as far as possible. Use of local materials/finishes on buildings will make sure that any visible parts of the buildings will integrate with the character of the area.	By Condition	Construction period	RES
4.6.11	Visual effects of onsite access tracks	Total length of track has been minimised; tracks have been routed to minimise visibility from surrounding areas where possible; and edges of tracks will be reinstated after construction using turf that has been removed prior to construction and stored appropriately.	By Condition	Approval of CMS prior to commencement of construction	RES
4.6.13	Visual effects of felling conifer plantation within site boundary	Felling will follow best practice in forest design in order that remaining areas of plantation fit with the surrounding landscape.	By Condition	Construction period	RES
4.6.15	Landscape and visual effects from offsite highway works	Minimising loss of landscape features as far as possible particularly mature trees, hedge banks and hedgerows; using grass reinforcement surfacing for road widening and laybys to minimise impact on the character of the road; using open ditches rather than culverts where possible; ensuring any signage is temporary; replacing all vegetation lost ensuring the same placement of features to maintain the character of road; using wooden gates over metal where possible and avoiding urbanizing features such as black and white posts along ditches; improving the condition of features e.g. through reinstatement of poor quality hedge banks and introducing management that reflects local character; strengthening lines of trees in the area between	By Condition	Construction period	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		Glyndwr's Way and the Neintherion by-pass to help filter views of the by-pass.			
Ecology					
5.19.2	Contractors unaware of best practice guidelines and measures required	Contractors will be informed which areas are especially sensitive and that care must be taken not to damage sensitive habitats. Construction vehicles must remain within designated routes and not stray across habitats. An ecological clerk of works could be present when decisions are taken on issues such as micro-siting of turbines and could advise on the detail of the mitigation proposed below on a day to day basis Contractors will be informed which areas are especially sensitive and that care must be taken not to damage sensitive habitats; an ecological clerk of works could be present during the construction; All subcontractors subject to RES Environmental Management Procedures.	RES Contracts and conformity with ISO14001:2004	Internal EMS procedure	RES
5.19.3	Topsoil removal on less sensitive habitats	Topsoil would be retained and reinstated on completion of the construction phase over the cable trenches, track shoulders and turbine foundation areas as far as reasonably possible.	CMS	Construction period	RES
5.19.5	Increase of hardstanding impacting on rainfall run-off	Tracks and areas of hardstanding would be constructed of compacted stone, which would not result in significant increased run-off following rainfall that might increase soil erosion or result in localised changes to hydrology.	CMS	Construction period	RES
5.19.6	Existing hydrological systems may be disrupted.	Various pollution prevention measures would be implemented.	CMS	Construction period	RES
5.19.7	Impact on badgers	Prior to any work commencing a badger survey will be conducted for all areas within 30m of infrastructure and at all proposed sites of works along the access route. If badgers are found to have moved into the areas then NRW will be consulted and suitable action undertaken and / or	By Condition	Prior to construction	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		licensing procedures will be followed.			
5.19.8	Impact on otters	Prior to construction a repeat otter survey will be undertaken at all proposed water crossings and for 50 metres up and down stream. If signs of otters are found, especially any sign of holts or lying up areas, NRW will be consulted and suitable action undertaken and/or licensing procedures followed.	By Condition	Prior to construction	RES
5.19.2	Effects on Blanket Bog	Construction vehicles to remain in designated areas; topsoil and turves to be retained and replaced; the overall quality of the blanket bog habitat will be improved.	By Condition	Approval of CMS prior to commencement of construction	RES
5.19.12	Impact on peat habitats	Prior to construction, the top layer of vegetation on areas to be destroyed or used temporarily will be stripped off as turf by an experienced specialist contractor. Turves will be stored adjacent to the construction area to ensure that they remain moist and viable. Peat will then be removed and stored separately and kept damp; following construction some turves will be replaced along the road edges to allow quicker re-vegetation and soften the road edges. Peat will be replaced around the turbine base excavations, and re-turfed. Peat will be spread over the parts of the crane pads, rotor assembly pads and other areas used in the construction and re-turfed. The construction areas will be fenced and stock excluded for up to two years to allow full and proper recovery of vegetation; re-vegetated areas will be monitored.	Peat Management Plan	Prior to construction/ Construction period	RES
Ornithology					
6.14.3	Site clearance work impact on bird habitats	Initial site work that involves habitat clearance would take place outside of the bird breeding season; or a survey undertaken immediately prior to work starting to avoid destruction of any nests in habitat to be cleared; It would be important to ensure that no Schedule 1 species	By Condition Habitat Management Plan Barn Owl Protection	Prior to construction/ Decommissioning	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		are disturbed during the breeding season, particularly during the construction phase of the wind farm. A further survey would therefore be undertaken immediately prior to construction, if construction were planned for the bird breeding season (April-July). If any were found then potentially disturbing activities would be suspended for the breeding season within an appropriate zone (dependent on the location of the birds and the species involved).	Plan		
6.14.7	Major routine maintenance impact on birds	Major routine maintenance would be scheduled to occur outside the bird breeding season to minimise potential disturbance effects.	By Condition	Operation	RES
Cultural Heritage					
7.8.4 – 7.8.5	Disturbance of known and unknown archaeological features	An appropriate programme of archaeological works would be produced which would be prepared and submitted to Clwyd Powys Archaeological Trust for approval prior to the commencement of construction works; Protection of assets at risk from accidental damage by appropriate fencing; provision for the excavation and recording of any known feature of interest prior to the commencement of construction works in a manner proportionate to its importance.	By Condition Scope of works to be approved as part of CMS prior to commencement of construction and implemented prior to and during construction	Pre-Construction / Construction period / Decommissioning	RES
Hydrology and Hydrogeology					
8.5.5	Impact on Peat Hydrology	On slopes above tracks the cut off ditch should be positioned close to the track so that as much water as possible has the opportunity to infiltrate into the upgradient peat; Regular discharge of water from the track and from the upgradient diversion channel to the down gradient land is required; dressing the cut slopes	Peat management Plan By Condition	Construction and Operation period	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		alongside the tracks with low permeability material can potentially help reduce flow rates from more permeable sections as it will act as a barrier to groundwater flow; dewatering of the turbine bases may be required depending on the permeability of the surrounding geology, however current understanding suggests this is low; any water from dewatering excavations should be discharged to peat areas surrounding the turbine base excavation during this period to promote recharge and reduce the impact of dewatering; Cut off ditches on upgradient slopes should also be close to the excavated areas as it practical to allow water to recharge the surrounding peat excavations should be left open for as short duration as practical to reduce the impact of dewatering on the surrounding peat; areas of peat will be reinstated; additional micrositing of infrastructure will be undertaken in conjunction with the ECoW prior to construction.			
8.5.7	Contractors unaware to control water pollution from construction activities	During the induction of contractors a specific session on good practice to control water pollution from construction activities would be included based on Pollution Prevention Guidance and best practice documents.	By Condition CMS	Prior to construction	RES
8.5.10	Existing hydrological systems may be disrupted.	SUDs design to be implemented.	CMS	Approval of CMS prior to commencement of construction and implemented prior to and during construction	RES
8.5.11	Micro-siting	Micro-siting of up to 50m may be used in order to	By Condition	Construction period	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		appropriately relocate infrastructure whilst on site for environmental reasons.			
8.5.18 – 8.5.20	Impact of Track and Cable Trenching Design on hydrology	All tracks will be excavated and the material removed replaced in the same manner; Standard design features are required such as cut off drains, spoon drains or water bars etc. for tracks, and internal plugs for cables, to be installed such that water flow and sedimentation is minimized; tracks have been designed to run with the contours where possible.	By Condition	Construction period	RES
8.5.21 – 8.5.22	Water Abstraction and Dewatering Activities	All dewatering activities will be managed through dewatering permits and method statements and the ECoW must be consulted and agree pumping and associated mitigation measures prior to commencement of works; installation of upgradient cut off drains to reduce the volume of water entering excavations; In order to prevent disturbance from the base of excavations or from the bed of watercourses during abstraction, any pump intakes will be protected from sediment by raising the intake using a floating rose and a geotextile filter; The discharge of abstracted water through sediment control structures and over natural vegetation to filter and infiltrate.	By Condition	Construction period	RES
8.5.23 – 8.5.26	Loose track material may drift into watercourses	Adequate maintenance of the track would prevent loose track material reaching watercourses; in dry weather dust suppression methods will be employed; drainage will be installed on either side of tracks to enable appropriate management, capture and discharge of clean and potentially sediment laden runoff; Roadside drains likely to carry high sediment loads will not be allowed to discharge directly into watercourses but will discharge into sediment control structures or buffer areas of adequate width.	By Condition	Construction period	RES
8.5.42 – 8.5.43	Management of Soil Stockpiles	Careful consideration will be given to the location of topsoil and subsoil storage areas for all facilities during construction, either by siting in a flat dry area away from	By Condition	Construction period	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		watercourses or by the addition of cut-off drains above the storage, which will help to maintain a buffer from streams; settlement lagoons and silt traps will be inspected regularly especially after periods of heavy rainfall.			
8.5.44 – 8.5.45	Impact of tree felling on nearby watercourses	areas of tree felling required will be kept to a minimum to minimise the disturbance to soils, except in those areas designated for peat habitat restoration purposes where all trees will be felled.	By Condition	Construction period	RES
8.5.47	Water contamination from potential oil, fuel and chemical spillages	Construction compound provision for the storage of fuel, oil and chemicals in designated areas, together with areas for vehicle compounds, refuelling sites, waste depots and on-site sewage systems. Mitigation is to be determined in accordance with PPG1, PPG2, PPG4, PPG6, PPG8 and PPG26.	By Condition	Construction period	RES
8.5.54	Disposal of waste materials	The cess-pit associated with the substation compound/ control buildings will be constructed and located in accordance with the relevant Building Standards and agreed with Powys County Council and the Natural Resources Wales prior to construction; On site engine and hydraulic oil waste will be stored in an appropriately constructed compound and storage bund; Waste oils will be stored in the construction compounds in an above ground tank within a concrete bunded area to prevent oil escaping to the environment in the event of leakage from the main tank.	By Condition	Construction period	RES
Acoustic Assessment					
9.6.14	Disturbance owing to increase in noise due to construction activities	Consideration will be given to noise emissions when selecting plant and equipment to be used on site. Where appropriate, quieter items of plant and equipment will be given preference; All equipment should be maintained in good working order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable;	By Condition	Construction period	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		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; 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; Site operations will be limited to 0700-1900 Monday to Saturday except during turbine erection and commissioning.			
Transportation and Access					
10.8	Impact from offsite highways works	Specific routing dependent upon vehicle type, improvement and upgrade of existing network, provision of community benefit, consideration of ecology, hydrology, visual impact, noise and vibration within the design of the proposals.	LTMP By Condition	Construction Period	RES
Other Issues					
11.8.1	Electromagnetic interference effects	Embedded mitigation measures have been incorporated into the siting and design process for the wind farm so as to avoid electromagnetic interference effects.	By Condition	Prior to Construction	RES
11.8.9	Interference to television reception	To address potential interference to television reception RES would commission a suitable organisation such as Arqiva to carry out a benchmark site survey of television reception quality in the area around the wind farm site between obtaining planning permission and starting construction. This would provide reference points against which future measurements could be compared once the wind farm is constructed and enable any remedial measures to be implemented expediently.	By Condition	Prior to Construction	RES
Socio-Economic					
12.4.32	Community Fund	A community benefit fund, whereby the owner of the wind farm makes annual payments to a fund intended for community projects, would offer the greatest value to the		Operation	RES

SEI Section	Potential Effect	Mitigation Measure: Scope and Extent	Mechanism for Implementation, Monitoring, Review & Corrective Action	Timing of Mitigation	Responsibility
		local area. This would be a readily tangible benefit that could be targeted as the community sees fit. Furthermore, the fund could obtain match funding from other sources and therefore facilitate ambitious projects.			
12.5.15	Visiting horses concerned by view of turbines	Should stakeholders think it appropriate RES would finance the installation of signs where turbines first come into view on bridleways; Should stakeholders wish, RES would be willing to assist in moving the section of bridleway and Glyndŵr's Way that pass within 200m of R14 onto a new proposed permissive right of way that would maintain a separation distance of approximately 200m from the turbines.	By Condition	Start of operation	RES