Lancaster University Wind Turbine Project

Environmental Statement

Volume 1

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Preface

i. General Notes

Project Title:	Lancaster University Wind Turbine Project
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This Environmental Statement Volume 1, Environmental Statement Appendices Volume 2 and its Non Technical Summary Volume 3 will be made publically available at the following locations detailed below;

- Lancaster City Council Office, Palatine Hall, Dalton Square, Lancaster, LA1 1PW
- Lancaster Library, Market Square, Lancaster, LA1 1HY
- www.lancs.ac.uk/windturbines

Copies of the Environmental Statement including the Non Technical Summary can also be obtained from Segen Ltd. by calling on 01524 590590 or emailing info@segen.co.uk or writing to:

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LA1 1PP

The full Environmental Statement can be purchased for £150.00 per copy. Alternatively full sets of the documents are available free of charge as Adobe Acrobat files on CD-ROM.

Glossary

ii Abbreviations

Abbreviation	Description
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
BBC	British Broadcasting Corporation
BREEAM	Building Research Establishment Environmental Assessment Method
BWEA	British Wind Energy Association
CAA	Civil Aviation Authority
CAD	Computer Aided Design
CBP	Community Benefits Package
CDM	Construction Design and Management
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
dB	Decibels
dB (A)	Decibel (Acoustically Adjusted)
DEFRA	Department of Food and Rural Affairs
EIA	Environmental Impact Assessment
ES	Environmental Statement
GDPO	General Development Procedure Order
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GVM	Groundwater Vulnerability Map
HAP	Habitat Action Plan
HER	Historic Environment Record
HECMP	Higher Education Carbon Management Programme
Hz	Hertz measurement of sound frequency
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
LCA	Lancashire Character Area
LDF	Local Development Framework
LRO	Lancashire Records Office
LVIA	Landscape and Visual Impact Assessment
m/s	Metres per second – measurement of wind speed
MoD	Ministry of Defence
MWh	Megawatt hours
NATA	New Approach to Appraisal
NATS	National Air Traffic Services

NCA	National Character Area
NCC	Nature Conservancy Council
NVCC	National Vegetation Classification Communities
NOx	Nitrogen Oxides
NPPG	National Planning Policy Guidelines
Ofcom	Office of Communications,
PPG	Pollution Prevention Guidance
PPS	Planning Policy Statement
RAB	Renewables Advisory Board
RSNC	Royal Society for Nature Conservation
RSPB	Royal Society for the Protection of Birds
RSS	Regional Spatial Strategy
cSAC	Candidate Special Area of Conservation
pSAC	Proposed Special Area of Conservation
SAM	Scheduled Ancient Monument
SINC	Site of Importance for Nature Conservation
SO_2	Sulphur Dioxide
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
VP	Viewpoint
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Impact

ii Definitions

Term	**Definition**
Above Ordnance Datum	Ordnance Survey Classification describing height above mean sea level
Ancient Woodland	Land continuously wooded since AD1600 in England
Anemometry Mast	A mast upon which equipment is mounted to ascertain the wind speed and directions
Blade Diameter	Twice the turbine blade length
Cumulative Effect	This is the result of more than one scheme being constructed and is the combined effect of all the developments, taken together. This may be in terms of their effect on landscape and visual amenity, bird populations, other wildlife, the local economy, tourism etc.
Climate Change	A process of changes to weather patterns and temperatures largely caused by the emission of certain 'greenhouse gases' from earth, principally associated with the burning of fossil fuels.
Carbon Dioxide	The main greenhouse gas formed by the combustion of all fossil fuels.
Compensation	The measures taken to offset or compensate for adverse effects that cannot be mitigated, or for which mitigation cannot entirely eliminate adverse effects.
Environmental Impact Assessment	The process used for describing, analysing and evaluating the range of environmental effects that are caused by a wind energy proposal.
Environmental Statement	The document supporting a planning application that sets out the findings of the Environmental Impact

	Assessment.
Greenhouse Gases	The six main gases contributing to climate change found in the upper atmosphere. They prevent some energy being re-transmitted into space. The gases include carbon dioxide CO_2, methane CH_4, nitrous oxides NO_x, hydroflourocarbons, perfluorocarbons and sulphur oxides SO_2.
Hub Height	The height above ground level of the centre of the hub which the blades are attached
Kilowatt (kW): Kilowatt-hour (kWh)	A watt is an electrical unit of power A kilowatt is a thousand watts. One kilowatt-hour represents one hour of electricity consumption at a constant rate of 1kW.
Landscape	Human perception of the land conditioned by knowledge and identity with a place
Landscape Capacity	The degree to which a particular landscape character type or area is able to accommodate change without unacceptable adverse effects on its character. Capacity is likely to vary according to the type and nature of change being proposed.
Landscape Character	A distinct pattern or combination of elements that occurs consistently in a particular landscape.
Landscape Character Classification	The process of describing, classifying and analysing the character of landscape reflecting the distinct pattern or combination of elements that occurs consistently in a particular landscape
Landscape Sensitivity	The extent to which a landscape can accept change of a particular type and scale without unacceptable adverse effects on its character.
Landscape Value	The relative importance that stakeholders attach to a landscape for a verity of reasons including scenic quality, perceptual aspects such as wildness, remoteness or tranquillity that contribute to a sense of place, rarity, presence and influence of other conservation interests and special cultural associations.
Megawatt (MW): Megawatt-hour (MWh)	A watt is an electrical unit of power. A mega watt is a million watts. One megawatt-hour represents one hour of electricity consumption at a constant rate of 1MW.
Mitigation	Measures, including any process, activity or design to avoid, reduce or remedy adverse effects of a development proposal.
Nacelle	The housing unit at the top of the turbine tower, typically containing the generator and gearbox.
Photomontage	A photograph with the proposed windfarm digitally superimposed over the top of it, providing a computer generated image.
Swept Area	The swept area is the area of the circle delineated by the wind generator's rotating blades.
Tip Height	The maximum height of the wind turbine above ground level.
Wind Energy Development	Development consisting of one or more wind turbines, access tracks, ancillary buildings, substation, anemometer masts and supporting infrastructure.
Zone of Theoretical Visibility	A map showing theoretical visibility of a windfarm or other element to a wider landscape.
Zone of Visual Influence	The area within which a proposed development may have an influence or effect on visual amenity.

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Chapter 1: Project Introduction

1. Introduction

1.1 Development Proposal

This Environmental Statement (ES) has been prepared to accompany a planning application for two wind turbines at Lancaster University on land off Hazelrigg Lane, opposite the University Campus and adjoining the M6 motorway network, as shown in Appendix A sections A1 and A2.

The application is made under the Town and Country Planning Act 1990 to Lancaster City Council. The wind turbines fall within Schedule II of the Environmental Impact Assessment (EIA) (England and Wales) Regulations 1999 (as amended). Segen Ltd. are the appointed Town Planners for the project and for the production of the EIA and ES have brought together a specialist team to complete the individual studies required. Specialist contractors and consultants who have local knowledge, experience and specific technical skills were contracted to complete the assessment to a high standard. The specialists employed are listed in Figure 1.2.

The installed capacity of the development will be approximately 4.1MW which will generate an electrical output of approximately 10,775 MWh per annum which would in turn prevent the release of approximately;

- CO_2: 5743 tonnes per annum
- SO_2: 107 tonnes per annum
- NO_x: 32 tonnes per annum

Detailed calculations of these figures are provided in Appendix A section A3.

The turbines will have a life span of 25 years following which they may be removed from site or alternatively a planning application to replace the turbines will be submitted.

The turbines will be connected to the grid via a control building on the main University Campus. An application for this Grid Connection has been submitted to the District Network Operator (DNO) and is subject to DNO's own consenting procedures.

1.2 Developer

Lancaster University ("the developer") are committed to the UK Government's targets of reducing carbon emissions by 20% by the year 2020 and 80% by 2050.

The University recognises that sustainability and the reduction of carbon emissions is an essential part of future growth and development. The University also appreciates the social, economic and environmental benefits renewable energy installations can bring. Energy efficiency and carbon reduction are therefore a key University priority.

There are currently no universities in the England which have an installed large scale wind development due to the urban locations of many universities. Lancaster University's rural setting places it in a distinct position whereby the utilisation of wind power will make for a very high yielding form of sustainable energy supply which will make a significant contribution towards the UK Government's targets for reducing carbon emissions.

1.3 Development Drivers

1.3.1 UK Energy Reduction Strategy and CO_2 reduction strategy

The Climate Change Act 2008 was put in place to set a legally binding target for the UK to reduce carbon dioxide levels to 80% less than 1990 levels by the year 2050. The Planning Act 2008 and The Energy Act 2008 are also very positive towards renewables with a variety of measures to assist with their delivery and implementation.

The UK Government has also set a target of 10% of all electricity to be generated by renewable sources by 2010, rising to 15% by 2015 and 20% by 2020. In 2009, the UK was generating approximately 5.5% of its electricity from renewables and with less than 1 year to go until the first target, the UK is highly unlikely to reach this target.

On 15th July 2009 the UK Government announced its revised strategy for meeting carbon emissions targets and its plans for a massive increase in renewable energy. UK Energy and Climate Change Secretary, Ed Miliband, set out plans comprising three key components:

1. To speed up the approval and installation of renewables and to develop the renewable energy sector in the UK. The Department of Energy and Climate Change (DECC) set the UK Low Carbon Transition Plan stating the UK will meet the cut in emissions set out in the budget of 34% on 1990 levels by 2020.

2. The UK Renewable Energy Strategy (RES) was also published at the same time to strengthen and reinforce the points in the Low Carbon Transition Plan. The Renewable Energy Strategy maps out the UK Government's strategy for reaching the EU target of 15% of the UK's total energy consumption from renewables by 2020, from the current level of around 2%. It also sets out the government's strategy for removing barriers that are blocking the development of Britain's full potential in these areas.

3. The Government's Low Carbon Transport Plan which sets out how to reduce carbon emissions from domestic transport by up to 14% over the next decade.

The Government announcement said that around 50% of the annual emissions cuts between now and 2020 will be achieved by further greening of the electricity mix, Mr. Milliband stated that,

"We expect 40% of the electricity we use in 2020 to come from low carbon source; 30% from renewables, the rest from nuclear (including new build) and clean coal. We need to all-but eliminate carbon from electricity by 2050."

1.3.2 Regional Drivers

The Northwest Climate Change Partnership has identified the economic sectors for which the greatest impacts of climate change will be felt.

Climate Change: Impacts and Responses for Key Business Sectors and Public Services in the North West of England was published in April 2009[1] and states that climate change is a real issue for many key business sectors and public services in the North West region.

Although short term predictions (plus 10 years) are not envisaged to be dramatic, medium (plus 50 years) and long term (plus 100 years) are anticipated to have direct impacts for organisations. The cumulative effect of change will mean without early action on adaption, the region could face challenging and costly issues to resolve in the future. The study highlights that Organisations need to start considering how the changing climate elsewhere in the world will affects their suppliers, markets, resource costs, routes to market and labour supply.

[1] Climate Change: Impacts and Responses for Key Business Sectors and Public Services in the North West of England was published in April 2009

In July 2009, the Communities and Local Government report 'Renewable Energy Capacity in Regional Spatial Strategies' demonstrated how renewable energy targets are not being met in England. For the North West region, this report states that the North West is currently 51% towards its 2010 target of 937MW installed renewable energy capacity and only 36% towards its 2020 target of 1345MW. Current consumption of electricity generated by renewables falls well below the target for 2010 of 10% and the number of applications in the pipeline is not sufficient to meet 2010 targets.

The North West of England Plan Regional Spatial Strategy to 2021 (NWRSS) also details renewable energy policies. Of most importance, Policy EM17 states that 10% of the electricity supply in the North West Region is to be provided by renewable energy sources by 2010 with this rising to at least 15% by 2015 and 20% by 2020. Policy EM17 also outlines indicative targets for Lancashire with regards to overall renewable energy generation and electricity generation solely from onshore wind power which are as follows:

- 239MW of renewable energy by 2010; of which 195MW is to come from onshore wind;
- 297MW of renewable energy by 2015; of which 233MW is to come from onshore wind;
- 344MW of renewable energy by 2020; of which 233MW is to come from onshore wind.

The NWRSS targets have been superseded by the RES and therefore these targets will need to be increased from 20% to 40% by 2020 further increasing the need for renewable energy installation in the region.

1.3.3 Wind Energy Development

In line with current Government targets, the amount of energy in the UK generated from renewable resources is increasing. Renewables accounted for 5.5% of all electricity generated in the UK in 2008, up from 4.9% in 2007 and 2.6% in 2000.[2]

The energy of the wind has been harnessed for centuries in the UK. In more modern times, wind farms are proven to generate electricity on a commercial basis, with wind technology having been developed over many years. The UK has the best wind resource in Europe, and the use of wind turbines to generate electricity has expanded rapidly making it the fastest growing renewable energy resource. Since the first wind farm in the UK was built at Delabole in 1991, onshore wind energy has established itself as a mature, clean energy generating technology. In 2007 wind energy overtook hydropower to become the largest renewable generation source, contributing 2.2% of the UK's electricity supply, with onshore wind comprising the bulk of this. Wind has been the world's fastest growing renewable energy source for the last seven years, and this trend is expected to continue with falling costs of wind energy, energy security threats and the urgent international need to tackle CO_2 emissions to prevent climate change.

The Government's Renewable Energy Strategy states that in order to meet the ambitious renewables by 2020, 35-45% of electricity will have to come from green sources. The lion's share of these renewables will have to be wind, some 33GW of capacity, delivering over £60billion of investment and creating 160,000 green collar jobs.[3]

Currently the UK wind industry, both on and off-shore, has an installed capacity of 3831 MW, enough energy to power the equivalent of approximately 2.14 million homes and saving an annual 4.33 million tonnes of CO2.[4]

The amount of energy produced by a wind turbine is dependent on the average wind speed at that site. It is estimated that wind turbines generate electricity 70-85% of the time, and a report from the Environmental Change Institute research team at Oxford University, the first methodical investigation of Britain's wind resource, shows that there has never been a time over the past 35 years when the entire country has been without wind, and that the wind always blows strongly enough to generate electricity somewhere in Britain. The study also

[2] UK Energy in Brief 2008, Department of Energy and Climate Change, http://www.decc.gov.uk/en/content/cms/statistics/publications/brief/brief.aspx

[3] British Wind Energy Association, 2009 http://www.bwea.com/onshore/index.html

[4] British Wind Energy Association, 2009 http://www.bwea.com/ukwed/index.asp

showed that wind tends to blow more strongly when demand is highest, during the day and winter months.[5]

Against the backdrop of growing fears regarding the impacts of climate change, in the short and medium terms wind turbines are likely to be the only substantial new source of renewable energy which is both economically viable and environmentally acceptable. In addition, it is considered that on-shore wind could be the UK's cheapest source of electricity in 2020, costing an estimated 1.5-2.5p/kWh, compared with 1.9-2.0p/kWh for gas, 3.0-3.6p/kWh for coal and 3.0-4.5p/kWh for nuclear power.[6]

1.3.4 Met station Research has identified the site as suitable for renewables

Baseline windspeed data is available at 45m height on the Noabl database; this identifies the site's mean annual wind speed to be over 6m/s

The Hazelrigg Weather Station, located one kilometre to the northeast of the main campus, has been measuring daily weather conditions since its installation at the site in 1976. Weather observations are made every morning at 0900 GMT and the data is passed on to the Meteorological Office. The weather station provides an extremely valuable record of the weather in Lancaster over the last 30 years and it is against this research that this site has been chosen as a potentially excellent location for wind turbines.

Planning Permission for a hub height anemometer has also been granted and was installed at site in December 2009. This will enable assessment of not only annual mean wind speed but wind turbulence intensity and wind shear co- efficient. Wind monitoring of this nature will take place for approximately 12 months prior to the installation of the wind turbines.

1.3.5 Lancaster University Energy Reduction Strategy and Emissions Savings

Lancaster University's Energy and Carbon Management Plan sets out the University's principal strategy to manage and reduce carbon emissions in future years.[7]

The plan has been developed as part of the 08/09 Higher Education Carbon Management Programme (HECMP) process in which Lancaster University has participated. The purpose of the HECMP is to assist Lancaster University in understanding and reducing its carbon emissions. A large number of carbon and energy saving projects have been identified and prioritised as part of the HECMP process.

In addition, the University has produced a Sustainable Energy Strategy[8] which forms part of the University Infrastructure Masterplan. It details how the University plans to transform its electricity and heat generation systems on site over the next few years.

The key elements of the Sustainable Energy Strategy are as follows:

- Replacement of the existing Combined Heat and Power (CHP) gas engine (which has reached the end of its life) with one or two new high efficiency CHP gas engines (to be provided in 2010).
- Replacement of the four original 1960's heat boilers with up to four high efficiency gas fired boilers (to be provided in 2010).
- Installation of a high efficiency wood-fired biomass boiler.
- An in depth study undertaken by an independent energy consultants to assess the feasibility of the installation of renewable generation technologies, which has

[5] British Wind Energy Association, 2009 http://www.bwea.com/ref/capacityfactors.html
[6] The Energy Review, 2007.
[7] Lancaster University, 2009, Energy and Carbon Management Plan.
[8] Lancaster University, 2007, Sustainable Energy Strategy, Lancaster University Master Plan, 2007-2017
ARUPS Sustainable Infrastructure Study
Lancaster University Infrastructure Master Plan

identified that the installation of two large scale wind turbines at the campus would be the most effective and efficient renewable energy installations.

- Upgrading and improving the efficiency of the University's central heat distribution system.

The total electricity consumption of Lancaster University in the year 2008/2009 was 32.3 GWh. For the year 2009/2010 a target of a 5% absolute reduction in consumption has been set.

Total utilities carbon emissions from Lancaster University in the year 2008/2009 amounted to 27,450 tonnes. The emissions include those from electricity, gas and water use, waste disposal and recycling, procurement, maintenance and small projects. Planned works including infrastructure improvements and renewable installations will significantly improve the efficiency of the heat and electricity generation plant and will result in a major reduction in carbon emissions[7].

The installed capacity of the development will generate an electrical output of approximately 10,775 MWh per annum which represents a 33% of the overall electricity consumption and in turn would result in a 21% reduction to annual utilities carbon emissions at Lancaster University.

1.4 Environmental Impact Assessment (EIA)

1.4.1 EIA Overview

EIA can be defined as "a systematic process to identify, predict and evaluate the environmental effects of proposed actions and projects."[9] The EIA process is applied prior to major decisions and commitments being made and ideally is integrated into the project design process.

EIA procedure must be followed for certain types of development before they are granted development consent. The requirement for EIA comes from a European Directive (85/33/EEC as amended by 97/11/EC). The procedure requires the developer to compile an Environmental Statement (ES) describing the likely significant effects of the development on the environment and proposed mitigation measures. The ES must be circulated to statutory consultation bodies and made available to the public for comment. Its contents, together with any comments, must be taken into account by the competent authority (e.g. local planning authority) before it may grant consent.

The IEMA's Guidelines for Environmental Impact Assessment identify a number of immediate and long term objectives of EIA.

Immediate objectives of EIA are to:

- improve the environmental design of the proposal;
- check the environmental acceptability of the proposal compared to the capacity of the site and the receiving environment;
- ensure that resources are used appropriately and efficiently;
- identify appropriate measures for mitigating the potential impacts of the proposal; and
- facilitate informed decision making, including setting the environmental terms and conditions for implementing the proposal.

Long term objectives of EIA are to:

- avoid irreversible changes and serious damage to the environment;
- safeguard valuable resources, natural areas and ecosystem components;
- enhance the social aspects of proposals; and
- protect human health and safety."[10]

[9] The Institute of Environmental Management and Assessment www.iema.net/.../**Environmental**%20Impact%20Assessment

[10] Environmental impact assessment: A guide to procedures, 2000, ODPM, ISBN 9780727729606

Good practice guidance outlined by the OPDM 2000 advises that the EIA process is an iterative one containing many feedback loops to allow the development proposal to be continually refined. So whilst the process of EIA follows a number of commonly accepted steps, it does not observe a linear pattern. The EIA process is summarised in the Figure 1.1 below obtained from the IEMA.

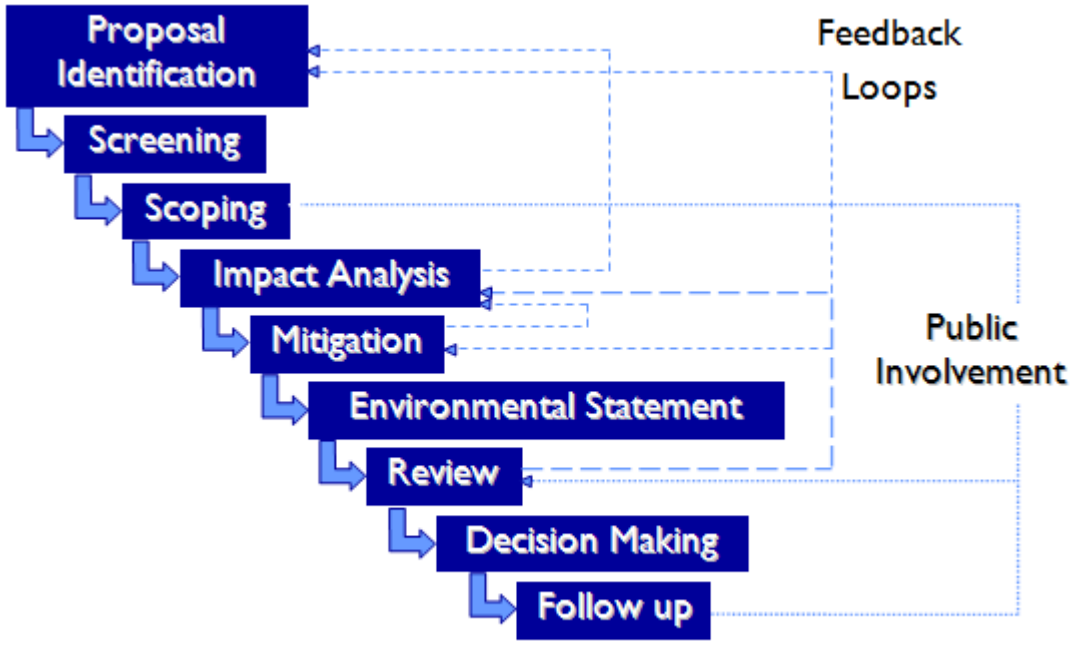

Figure 1.1: EIA Process[11]

In accordance with the EIA guide to procedures outlined above the preparation of this ES has been an iterative process to ensure that the environmental need for the proposal and existing constraints are balanced. The design of the wind turbines has been achieved following a series of revisions made to the layout as a result of information gathered during the extensive scoping activities and consultations with the local communities. These design revisions are outlined in Chapter 2 of the ES.

The preparation and production of the Environmental Statement has been undertaken in accordance with Circular 02/99 and advice on Good Practice found within the following documents;

- Planning Policy Statement 22, 2004
- Planning for Renewable Energy: A Companion Guide, 2004
- Institute of Environmental Management and Assessment, 2006

1.4.2 Screening Opinion

A Screening Opinion request was submitted to Lancaster City Council in August 2009 to establish whether or not the proposed Lancaster University wind turbine development would require an Environmental Impact Assessment (EIA). On 25th September, 2009 a response from the Council stated that an EIA would be required for the proposed development on the basis that the proposal falls outside that development listed in Schedule 1 of the Regulations.

The Screening Opinion identified the potential impacts of the proposal. The Council's response detail below considered that these should include;

[11] www.iema.net/.../Environmental%20Impact%20Assessment.pdf

- *"The visual impact of the turbine on both the local and wider landscape including distant views from a semi-circular arc across Morecambe Bay, medium distance views to the north west from within the AONB, and close range views from Bailrigg Village, the southern edge of the urban area and of the city and nearby dwellings on Hazelrigg Lane.*
- *The impact of the turbines on highway safety on the M6 due to the distraction of drivers passing so close to such large turbines and the effects of direct sun-light flicker on drivers and passengers passing the site in the a.m. hours and reflection light flicker in the p.m. hours.*
- *The impact of light flicker of both types on the residential amenities of nearby occupiers including University Halls of Residence.*
- *The impact of noise on the residential amenities of nearby occupiers including University Halls of Residence.*
- *The visual impact of the proposed access road on the local landscape.*
- *The southern turbine is located between and in close proximity to two significant areas of woodland and could have significant impacts on wildlife therein and on the future of the woodland itself due to its potential disturbance to the wind flow around the turbine".*

The Screening Opinion identified that the "*location of this proposal on elevated land at the edge of the coastal plain and in close proximity to the M6 motorway and surrounding residential properties gives rise to the potential for significant impacts on the issues of acknowledged importance identified above. The scale of these impacts and their consequences for the proposal can only be adequately assessed following the detailed study of the issues involved in relation to the circumstances of this particular site."*

1.4.3 Scoping Opinion

In response to the Screening Opinion, a Scoping Opinion, under the 1999 EIA Regulations, was requested to seek the views of Lancaster City Council, the relevant Statutory Consultees and Community Members and to get their agreement on the information that should be covered within the ES.

The request was accompanied by:

- A plan sufficient to identify the land.
- A brief description of the proposed development's nature, purpose and possible effects upon the environment.
- An outline of the proposed study methodology and environmental statement contents.

The scoping request outlined the structure of consultation regarding the approach to EIA and the proposed content of the ES. The aim of the Scoping Opinion was to identify key environmental issues at an early stage, and to determine which elements of the proposal are likely to cause significant environmental effects.

During the scoping stage the key issues that the EIA would address were identified. Good practice guidance outlined by IEMA was followed, this consists of three key components:

- **Consultation** with relevant stakeholders and interested parties to provide them with information on the development proposal and what technically appear to be the key issues and to find out what their key concerns are regarding the location and the development proposal. The Scoping Opinion was sent to Lancaster City Council, the Highways Agency, LCC Highways Authority, English Heritage, and Natural England. Copies were also made available to the public on the Lancaster University website and at the City Council Main Reception. Community members were made aware of the scoping opinion via a press advertisement in the Lancaster Guardian newspaper as well as notices posted on the relevant parish council notice boards. These provided information on where the scoping study could be viewed.
- **Analysis** of the issues identified during *consultation* to determine which are likely to be significant and therefore must be included within the scope of the EIA; and
- **Negotiation** with the decision makers and other interested parties to refine the scope of the EIA.

A copy of the Scoping response received are provided in Appendix A section A4

1.4.4 Identified Issues

Early consultation concentrated on the relevant statutory consultees and involved discussions on the findings of the Scoping Report and preliminary study work in order to gain agreement on the extent and nature of potential impacts. A list of Consultees and their responses are provided in Appendix A section A5. The reponses to the consultation informed the developer which specific environmental impacts needed to be studied further. The result of the scoping response and consultation exercise has identified the following issues which have been assessed in this ES.

- Landscape and visual impact
- Shadow flicker
- Electromagnetic interference and radar impact
- Ecology and Ornithology
- Land use
- Traffic and transport
- Noise
- Hydrology and geology
- Archaeology and cultural heritage

The relevant importance of each assessment area is proportional to the risk identified at scoping stage and is reflected in the level of assessment undertaken in each case.

Landscape and Visual Impacts:
A full Landscape and Visual Impact assessment (LVIA) to quantify the significance of the landscape character and visual amenity impacts from visual receptors agreed with the local planning authority has been undertaken by Stephenson Halliday Landscape Architects.

Shadow Flicker:
A Shadow Flicker Impact study has been undertaken by Segen ltd. to establish the worst case impact and any necessary mitigation requirements.

Electromagnetic Interference and Radar;
An Electromagnetic Interference and Radar impact study has been carried out by ADTI and John Taylor Aviation Specialist following consultation with the relevant consultees. Their responses have been used to finalise the design of the wind turbines.

Ecology and Ornithology;
An Ecology Assessment and Ornithology Assessment including a bird overwintering study were carried out by CSC Associates. The assessments considered the existing status of the area, the potential impacts of the proposed development and potential mitigation to minimise these effects.

Arboriculture Assessment;
An Arboriculture Assessment has been undertaken by Roger Cartwright to determine the existing status of the area, the potential impacts of the proposed development and potential mitigation to minimise these effects.

Land Use;
A Land Use assessment has been undertaken by Segen Ltd and using information provided within the Ecology Assessments, Arboriculture Assessment and Hydrology and Geology Assessment to identify short and long term land use implications.

Traffic and Transport;
A Traffic and Transport assessment has been undertaken consider transportation and access issues during the construction, operational and decommissioning phases of the development. Construction and decommissioning study work which included an analysis of preferred access routes to the wind turbines site were analysed by AECOM. The impacts of the development site on the surrounding highway network including the M6 motorway were analysed and quantified by Thomas Consulting. Their responses have been used to finalise the design of the wind turbines.

Noise;
A full Noise Impact Assessment was undertaken by Acia Engineering Acoustics ltd. This included a background noise survey of existing noise levels at sensitive receptors agreed with Lancaster City Councils Environmental Health Department. The wind turbines have been designed to minimise these effects and comply with noise limits. The assessment was conducted in accordance with Noise Working Group Guidelines, the assessment and rating of noise from wind turbines – ETSU-R-97.

Hydrology and Geology;
A Hydrology and Geology study was undertaken by Aecom to establish the baseline conditions at site; consultation was also undertaken with the Environment Agency and Lancaster City Council. Their responses have been used to finalise the design and construction of the wind turbines.

Archaeology and Cultural Heritage;
An Archaeology and Cultural Heritage Assessment has been undertaken by Oxford Archaeology to establish base line archeologically significance of the site, this was followed up by further exploratory works in the form of a Geophysical Ground Investigation. The significance of the visual impacts of the proposal on nearby listed buildings, schedules monuments and conservation areas were also quantified and assessed.

The EIA and ES has been produced by Segen together with a team of specialist consultants and contractors who have the appropriate, knowledge, skill and technical understanding to complete the assessment to a high standard. The specialist employed are listed in Figure 1.2 shown below

Environmental Assessment	**Environmental Consultant**
Landscape and Visual	Principle Assessment carried out by Neil Furber Principal Landscape Architect Stephenson Halliday 32, Lowther Street, Kendal, Cumbria LA9 4DH, United Kingdom Maps and Photomontages provided by; Segen ltd. City Lab 4-6 Dalton Square Lancaster LA1 1PP
Shadow Flicker	Segen ltd. City Lab 4-6 Dalton Square Lancaster LA1 1PP
Electromagnetic Interference and Radar	Torsten Zöhl Lead Engineer Germany ATDI Ltd, Niederlassung Deutschland Kurze Mühren1 / Spitaler Hof 20095 Hamburg
Ecology and Ornithology	Cameron S Crook Cameron S Crook & Associates Bio-Ecological Consultancy 8 Woodstock Close, Lostock Hall, Preston, Lancashire PR5 5YY
Arboriculture Assessment	Roger Cartwright Landscape and Woodlands Woodwell Cottage Lindeth Road, Silverdale

	Carnforth LA5 0TX
Land Use	Segen ltd. City Lab 4-6 Dalton Square Lancaster LA1 1PP
Traffic and Transport	AECOM 5th Floor, 2 City Walk, Leeds LS11 9AR John Sumner Thomas Consulting Civil & Structural Engineers 3 Friar Street Lancaster LA1 LPZ
Noise	Ian Bennett Acia Engineering Acoustics 39 Garners Lane, Stockport, SK3 8SD
Hydrology and Geology	Paul McQuillan BSc MSc AIEMA Principal Consultant Environment AECOM 1st Floor, One Trinity Gardens, Quayside Newcastle-upon-Tyne, NE1 2HF
Archaeology and Cultural Heritage	Emily Mercer Senior Project Manager Oxford Archaeology NORTH Mill 3 Moor Lane Mill Moor Lane Lancaster LA1 1GF

Figure 1.2: The Project Team

1.4.5 Impact Analysis

To enable the likely impacts of the development to be properly considered the baseline environmental conditions were first assessed. This was done through the reviewing of existing information and through a series of topic specific desk based appraisals carried out by the project team.

The impact analysis involves characterising the impact in terms of its likely nature, spatial and sequential distribution, duration, frequency, reversibility and magnitude. Finally a judgement must be made as to whether the impact is likely to be significant or not.

Conscientious efforts have been made to obtain data concerning the existing environment and to accurately predict the effect of the proposed wind turbines. Where assumptions have been made when evaluating impacts, these are reported in the relevant sections.

Significance of an impact is important in determining the measures that are required to avoid or mitigate impacts or to establish the value of the impact and minimise its affect.

1.4.6. Regulation 19

As EIA production is an iterative design process it is sometimes the case that minor revisions in design occur between scoping and final EIA completion. Having regard to the consultation responses received at scoping stage and the findings of preliminary study work there have

been a number of minor modifications to the turbine positions and scale, namely the turbines have been relocated further away from the motorway and have reduced in overall height from 125m to 101m. Full details of the design process that has been undertaken is provided in Chapter 2 of the ES.

It is important to note that a ES is not invalid if it does not fully comply with the scoping opinion. Similarly the fact that a local planning authority has given a scoping opinion or scoping direction does not prevent them from requesting further information at a later stage. To cover this issue the local authority may request additional information under regulation 19.

Where additional information is considered necessary, the authority must request that the applicant provide further information under regulation 19 concerning the relevant matters set out in Schedule 4. Any information provided in response to such a written request must be publicised, and consulted on, in a similar way to the document submitted as an ES (regulation 19(3)(9)). Authorities should only use their powers under regulation 19 when they consider that further information is necessary to complete the ES and thus enable them to give proper consideration to the likely environmental effects of the proposed development. The additional delay and costs imposed on applicants by the requirement to provide further information about environmental effects should be kept to the minimum consistent with compliance with the Regulations. Authorities should not use regulation 19 simply to obtain clarification or non-substantial information. However, where an applicant voluntarily submits additional information of a substantive nature, local planning authorities should consider advertising that information and sending it to the consultation bodies as if it had been provided in response to a formal request under regulation 19(1). A planning application is not invalid purely because the applicant does not provide all information set out in the scoping opinion. EIA regulations state that the determination period of 16 weeks continues to run while any correspondences about additional information are taking place.

In this instance it should be noted that Lancaster City Council, Natural England and the County ecologist have agreed that it is acceptable to submit the ES with three months of Bird Overwintering data and basic details of the Landscaping and Ecology mitigation measures, on the presumption that full details of the Habitat Mitigation strategy and February Bird Overwintering results will be provided during the course of the 16 week EIA determinaition process. The MOD have also confirmed that they are content to continue discussions regarding source mitigation meausres following submission of the EIA, see Appendix J.

1.4.7 Mitigation

The scope for improving the quality of the development and reducing potential adverse effects on the environment during the design process is an important aspect of the ES. Where analysis identifies that a development is likely to give rise to significant environmental impacts, mitigation measures are proposed to avoid, reduce and if possible, remedy them. As mentioned briefly in the section on proposal identification above, mitigation measures can be incorporated into the design of the development through Avoidance or Reduction. So called ‘end of pipe’ mitigation measures can also be incorporated into the development at a later stage through Compensation, Remediation or Enhancement. The approach to mitigation has been adopted with the aim of minimising effects through avoidance resulting in a minimum number of ‘end of pipe’ measures. All mitigation strategies will be formulated by the relevant study experts having regard to site specific study works.

1.4.8 Environmental Statement Overview

The environmental statement is the vehicle used to communicate the results of the EIA to the decision maker and other stakeholders in the development process. The environmental statement is a legal document and by UK law must include, at least, the following information[12]

- a description of the project comprising information on the site, design and size of the project.
- a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse impacts.

[12] As identified in article 5 (3) of the EIA Directive

- the data required to identify and assess the main effects which the project is likely to have on the environment.
- an outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
- a non technical summary of the information mentioned in previous bullet points.

The Environmental Statement should objectively document the EIA process and findings giving equal prominence to positive and negative impacts relative to their importance. The ES should be clear and concise. Since non specialists are likely to read the document, technical language should be avoided. Any necessary technical information should be provided in appendices.

Chapter 10: Radar and Electromagnetic Interference

10 Radar and Electromagnetic Interference Impacts

10.1 Introduction

The aim of this chapter of the ES is to describe and analyse the impact of the two proposed wind turbines on air traffic control radar and telecommunication systems and then to give options for mitigation should a problem be identified.

The study carried out by ADTI, John Taylor and Segen has been divided into three main parts:

- Research for potentially affected sites or links (radar, TV broadcast and microwave point to point links)
- Analyse the impact on each potential victim
- Propose mitigation option to overcome objections where possible

10.2 Consultation

Consultation requests have been carried out with the main communication and utilities providers identified as potentially affected by the proposed wind farm development. Below is a summary of the responses that were received from these companies. They are classified as: objection raised, no objection, response pending, further analysis required. Unfortunately, despite actively pursuing responses there is still one that has not been received so all analysis and conclusions in this report are based on the responses received to date. Full details of the consultation responses are provided in Appendix J.

Company	No obj.	Possible objections	Response Pending	future analysis
Northwest Ambulance	X			No action needed
Lancashire Police	X			No action needed
National Grid Electricity/ National Grid Gas	X			No action needed
Shell UK	X			No action needed
T-Mobile / Ericsson	X			No action needed
ISS Network Specialist Lancaster University	X			No action needed
Cable and Wireless	X			No action needed
Civil Aviation Authority	X			No action

(CAA)				needed
Geo Network	X			No action needed
Orange UK	X			No action needed
BT – British Telecom	X.	.		BT has removed their initial objection to the proposal. However because they provide a microwave link very close to the site analyse of the turbines impact has been undertaken
BBC – British Broadcast Corporation		The BBC provides an online of sight service as a guidance to wind farm developers. "It provides a rough estimate of the population that may suffer interference to their television services from a wind farm built at the location specified. The tool is not intended to be a substitute for an on-site survey where the potential for disruption to television services may be assessed more accurately" (BBC website)		An analyse the potential effects on broadcast service in the Lancaster area has been undertaken and demonstrates that impacts are within acceptable limits. .

Based on a Radar report produced by radar expert John Taylor the following radar transmitters are also potentially affected by the two turbines

- **Blackpool Airport**
  Contact: David McCamley
  Tel: 084404827171 – 8345
  Email: davidmccamley@blackpoolairport.com

  The Blackpool Airport radar will be able to see both wind turbines.

- **BAE Warton**
  Contact: Aadil Pathan
  Tel: 0121 311 2025
  Email: Aadil.Pathan@de.mod.uk

  BAE Warton / Warton Aerodrome is managed by the MoD. The MoD were contacted with a request from Segen

- **St Anne's / Great Dun Fell**
  These two radars are managed by NATS (National Air Traffic Service). NATS offer a consultation service which is currently undertaken. The results of this to this will be provided in due course.

The Lancashire Fire Authority has been contacted but has not yet responded

- **Lancashire Fire**
  Contact: Lindsey Johnston
  Tel: 01524 541670
  Email: LindseyJohnston@lancsfirerescue.org.uk

10.3 Guidance and Legislation

- "CAP 764, CAA Policy and Guidelines on Wind Turbines" , http://www.caa.co.uk/docs/33/Cap764.pdf
- St Anne's radar site description; http://www.geograph.org.uk/photo/98448
- Blackpool Airport radar site description; http://www.blackpoolinternational.com/about-us/operational-info.php
- Great Dunn Fell radar site description; http://en.wikipedia.org/wiki/Great_Dun_Fell
- BAE Warton radar site description; http://www.baesystems.com/WorldwideLocations/UnitedKingdom/Locations/Warton/autoGen_10711511596.html
- "A proposed method for establishing an exclusion zone around a terrestrial fixed radio link outside of which a wind turbine will cause negligible degradation of the radio link performance" ; http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms/windfarmdavidbacon.pdf
- BBC online wind farm assessment tool; http://www.bbc.co.uk/reception/info/windfarm_tool.shtml
- ITU-R BT 1368-8 "Planning criteria for digital terrestrial television services in the VHF/UHF bands" , www.itu.int
- ITU-R BT.805 "Assessment of Impairment Caused to Television Reception by a Wind Turbine"; www.itu.int
- ETSI Standard EN 300 197 V1.2.1 "Transmission and Multiplexing (TM);Digital Radio Relay Systems (DRRS);Parameters for DRRS for the transmission of digital signals and analogue video signals operating at 38 GHz" www.etsi.org
- John Taylor report "Lancaster University Wind farm Aviation Bullet Point"

10.4 Assessment Methodology and Baseline Description

The analysis of the impact of the turbines on the surrounding radio technologies is divided into four parts. The first paragraph describes the general turbine parameters. The second, third and fourth paragraphs describe the methods undertaken for radar, Microwave link and broadcast services in more detail.

10.4.1 General Wind Turbine Parameters.

Locations (British National Grid System):

Turbine 1:
Easting: 349093
Northing: 457073

Turbine 2:
Easting: 349175
Northing: 457789

Technical Parameter:

Blade Length:	41 m
Blade Width:	5 m
Hub Height:	59m

Figure 10.1: Turbine positions on land at Lancaster University

10.4.2 Analysis Method wind turbine impact on radar

The radar analysis follows the latest version of CAP 764 from February 2009[1]. This recommendation is the CAA's policy and guidelines for wind turbines. It considers all identified radar sites undertaking a radio line-of-sight check to see if the turbines are visible to the radar. This means, if there is a line of sight between the turbine and the radar station then there could be a problem where the wind turbine could be displayed as a false target on the radar. For the purposes of this assessment significant impacts on radar are identified as those that could lead to the turbines being identified at one or more radar stations. The potentially affected radar sites were identified by the radar expert John Taylor who was consulted by ATDI for this project. The following radar sites were identified as potentially affected by the two turbines:

- **Blackpool Airport**
- **BAE Warton**
- **St Anne's**
- **Great Dunn Fell**

The radar positions were shown or described in the relevant internet sites [2345] and verified by visual check from the application "Google Earth". All radar sites are managed by different organisations therefore it was not possible to get precise information about antenna type and height, or radiated power. Based on the make or typical radar parameters the following assumptions for the radar sites have been made:

Name	Easting	Northing	Ant. Height (m)	Power (kW)	Frequency (MHz)
St Anne's	**334700**	**430701**	**15**	**60**	**2900**
Great Dunn Fell	**371000**	**532099**	**16.5**	**150**	**1300**
BAE Warton	**341551**	**428264**	**15**	**50**	**2900**
Blackpool	**331983**	**430533**	**15**	**50**	**2900**

Table 10.2: radar site parameters (assumptions)

Wind turbine and radar site locations and heights were used in ICS Telecom to calculate a line-of-sight path (see figure below). In the path profile the free space loss (red line), the field strength (green line), the line of sight (light green line) and the Fresnel zone (blue ellipsoid) can be seen. The grey area describes the terrain along the path.

[1] CAP 764, CAA Policy and Guidelines on Wind Turbines" http://www.caa.co.uk/docs/33/Cap764.pdf

[2] St Anne's radar site description; http://www.geograph.org.uk/photo/98448

[3] Blackpool Airport radar site description; http://www.blackpoolinternational.com/about-us/operational-info.php

[4] Great Dunn Fell radar site description; http://en.wikipedia.org/wiki/Great_Dun_Fell

[5] BAE Warton radar site description; http://www.baesystems.com/WorldwideLocations/UnitedKingdom/Locations/Warton/autoGen_10711511596.html

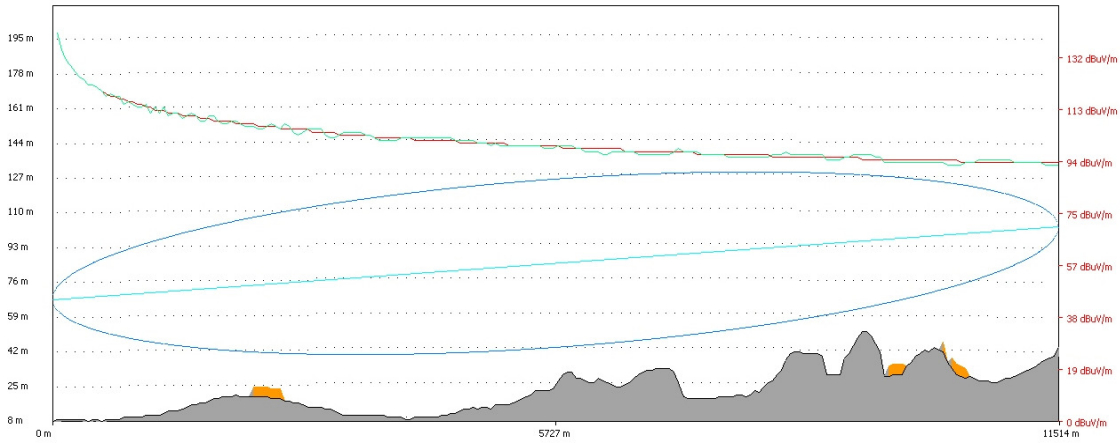

Figure 10.3: radar Line of sight analysis

10.4.3 Analysis method wind turbine impact on Microwave Point-to-Point links

The microwave analysis followed a method which is used by Ofcom. The method was developed by Dr. David Bacon and described in detail in[6]. This method accounts for three degradation mechanisms and will lead to an exclusion zone around a microwave link path where it is not advisable to install a wind turbine. For the purposes of the assessment significant impacts on existing telecommunications are categorised as those which could prevent normal operation due to any of the following mechanisms;

- Near field effects
- Diffraction in the Fresnel zone
- Reflection or scattering

These mechanisms are depicted in the diagram below.

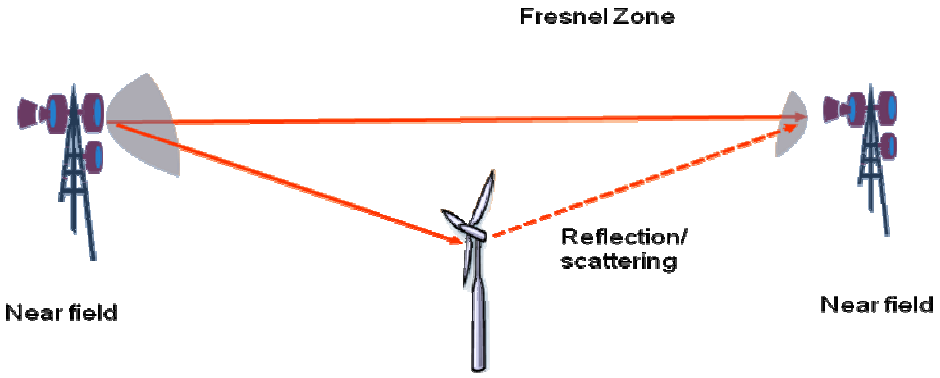

Figure 10.4: Wind turbine Microwave link analysis mechanisms, David Bacon method

The first analysis looked closer to the near field affect around the microwave link antennas. As there were no parameters provided by BT the following were assumed:

- Antenna efficiency 100%
- Typical 38GHz dish antenna diameter – 0.3m

[6] A proposed method for establishing an exclusion zone around a terrestrial fixed radio link outside of which a wind turbine will cause negligible degradation of the radio link performance" ; http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms/windfarmdavidbacon.pdf

The second analysis looked at weather a turbine blade will intrude into the 2nd Fresnel zone of the microwave link. “Diffraction effects will be insignificant if obstructions are kept outside a volume of revolution around a radio path known as Fresnel zone.” [6] Dr David Bacon explains in his method that for wind turbine exclusion zone the 2nd Fresnel zone must be free of obstacles.

The link location and frequency was used in ICS Telecom to model the line-of-sight and the second Fresnel zone. If the turbine is shown to intrude the 2nd Fresnel zone, then it will likely cause degradation to the microwave link and will be marked as a problem.

The third analysis investigated the reflected signal from the turbines. An interference analysis was undertaken comparing direct path signal (wanted) with the reflected path signal (unwanted). If the ratio between unwanted reflected signal and wanted signal, also known as C/I (carrier to interference), exceeds a threshold level the link will marked as a problem.

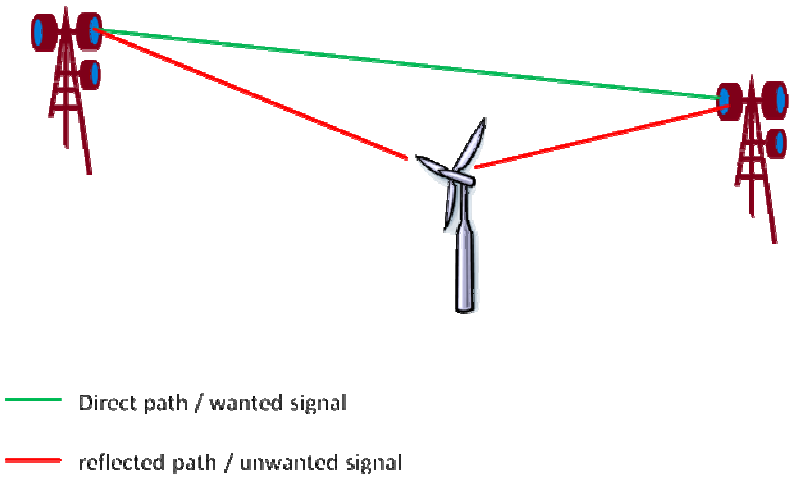

Figure 10.5: signal reflection from turbine

BT-British Telecom provided the following information regarding the link:

Site	A	B
Location (BNGR)	SD 47580 57960	SD 49260 57860
Antenna height (m)	14	15
Lowest Frequency (GHz)	37.95750	

Table 10. 6: Microwave link parameter

In the absence of complete information from BT some assumptions were made based on typical 38GHz microwave links. The C/I threshold is 30dB.This value was taken from the ETSI European standard [7] for a 38 GHz link class3 using a 28MHz channels and 51Mbit/s. David Bacon refers in his method to a RCS(Radar Cross section) value of 30 m^2. The RCS describes the reflection attributes of a turbine. Based on the ETSI standard and typically used antennas the following parameters were used:

Link direction	Bi-directional
Power	28dBm
Antenna	Andrews, VHP1-370A
Antenna Gain	39.5 dB
RSL at 10^{-3}	-71 dBm
RSL at 10^{-6}	-67.5 dBm
Noise figure	8dB

[7] ETSI Standard EN 300 197 V1.2.1 “Transmission and Multiplexing (TM);Digital Radio Relay Systems (DRRS);Parameters for DRRS for the transmission of digital signals and analogue video signals operating at 38 GHz” www.etsi.org

Table 10. 7: assumed microwave link parameters

Initially BT has provided a statement where they require a protection zone around their microwave links of 100m, which is much more than the required 2nd Fresnel zone around the link. Following negotiation this requirement has now been relaxed with the current turbine positions being deemed acceptable.

In the sample path profile below on can see the free space loss (red curve), the field strength (green curve), the line of sight (light green line) and the Fresnel zone (blue ellipsoid). The grey area describes the terrain along the path with the turbine as a clutter (pink bar).

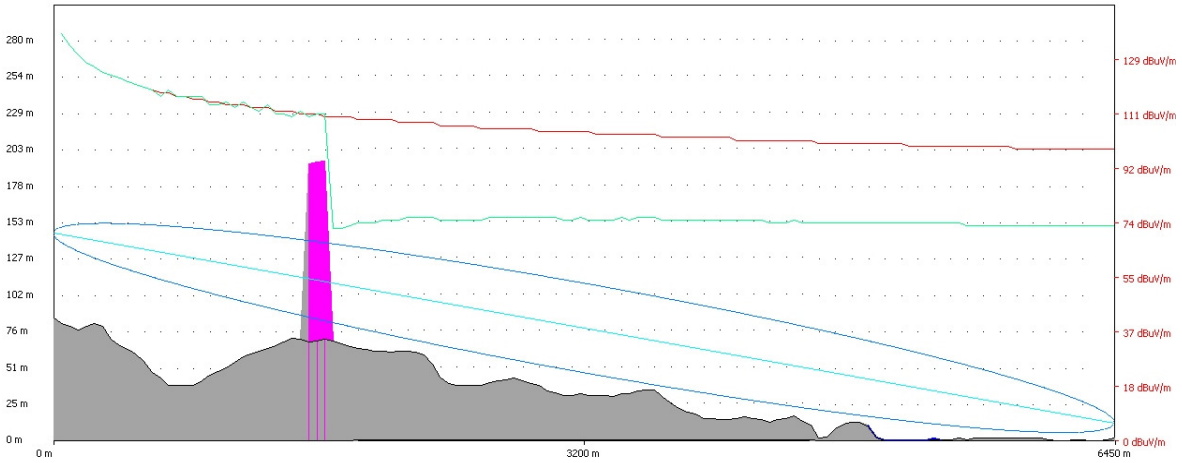

Figure10. 8: example of Microwave link Line-of-sight analysis

10.4.4 Analysis method wind turbine impact on TV broadcast Services

From the BBC online service [8] the following 2 broadcast transmitters have been identified as providing service to the Lancaster area:

- Lancaster
- Winter Hill

The BBC website provides the following station parameters, position, transmitted power, number of channels and antenna height. From the given number of channels the transmitted frequency range was calculated. To simplify the analysis only the middle frequency value was taken for further calculations.

Site	Lancaster	Winter Hill
Location	E: 349000 N: 466200	E: 366000 N: 414400
Antenna height (m) AGL	98	282
Frequency (MHz)	783.25000	511.25000
Power (kW)	10	500

Table10. 9: Broadcast transmitter parameters

The identified broadcast transmitters provide TV service to service areas. From the beginning of December 2009, BBC will switch all analogue TV service to digital in this particular area. Therefore this study only takes digital service into account . The ITU recommendation BT.805 [9] is the method used to analyse the turbine impact on the television reception. The main effect is the interference by

[8] BBC online wind farm assessment tool; http://www.bbc.co.uk/reception/info/windfarm_tool.shtml
[9] ITU-R BT.805 "Assessment of Impairment Caused to Television Reception by a Wind Turbine"; www.itu.int

refection and scattering. The figure below (figure 10.10) shows the typical reflection scenario between a transmitter (Tx), the receiver (R) and the wind turbine (WT). The reflected signal takes a longer path than the direct signal and therefore arrives later at the receiver. If the reflected signal is still quite strong it can cause problems with the reception of television pictures. For the purposes of the assessment significant impacts on broadcast services are categorised as those which could prevent normal operational services.

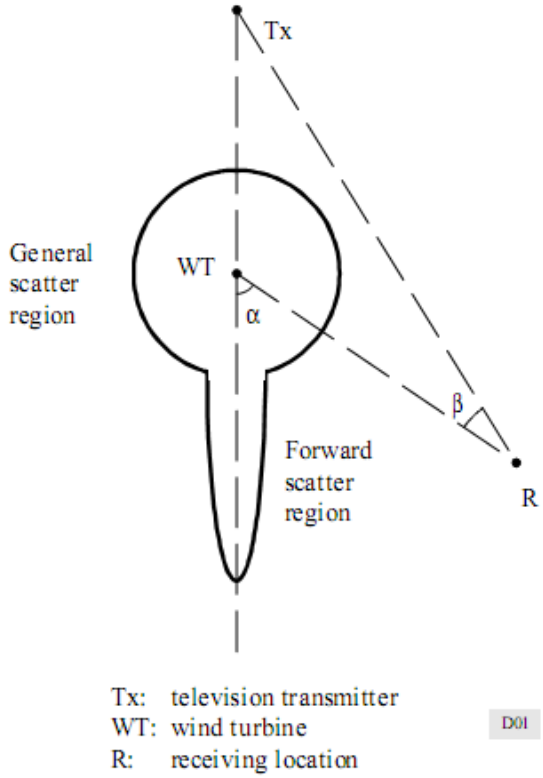

Figure 10.10: Scattering zones around a wind turbine

So scattering affects receivers all around the turbine in a circle area with the turbine in the middle (general scatter area). This area is normally less than a couple of hundred meters wide. The cigar shaped area pointing south is the forward scattered area. This effect will be caused by the moving blades “cutting” the signal. This area can be a few kilometres long. The direction of the forward scatter region depends on the transmitter location. If the ratio between the reflected/scattered signal strength and the direct signal strength is above a required minimum threshold (C/I threshold or protection ratio) the turbines will not affect any TV receiver

C/I plots were calculated for both identified TV transmitters the using the parameters above To undertake the analysis the minimum receiving signal level at the receiver and minimum C//I level which is also known as protection ratio.

The ITU recommendation ITU –R BT 1368-8 [8] provides the tables shown below (figure 10.11 and 10.12). In the UK digital TV uses a 16QAM modulation. The minimum signal strength was assumed for the highest frequency (783 MHz at Winter Hill). For the protection ratio the Rice channel (Rice distribution) was taken into account (see figure 10.12). The Rayleigh (distribution) channel represent protection ratio for mobile or indoor application while the Gaussian distribution represents cable connections. Therefore the following values were used:

- Minimum field strength: 39dBµV/m
- Protection ration: 14dB

TABLE 44

Calculation of minimum field strength DVB-T 8 MHz system

Frequency (MHz)	200			550			700		
System variant guard interval 1/4	QPSK 2/3	16-QAM 2/3	64-QAM 2/3	QPSK 2/3	16-QAM 2/3	64-QAM 2/3	QPSK 2/3	16-QAM 2/3	64-QAM 2/3
Receiver noise figure, F (dB)	5	5	5	7	7	7	7	7	7
Receiver carrier/noise ratio[1] (C/N) (dB)	8	14	20	8	14	20	8	14	20
Feeder loss Af (dB)	3	3	3	3	3	3	5	5	5
Antenna gain, G (dB)	5	5	5	10	10	10	12	12	12
Minimum field strength for fixed reception, E_{min} (dB(μV/m))[2]	27	33	39	33	39	45	35	41	47

(1) For Rice channel.

(2) For formula, see Appendix 1 to Annex 2.

Figure 10.11: ITU BT 1386-8 for minimum receiving field strength

TABLE 14

Co-channel protection ratios (dB) for a DVB-T signal interfered with by a DVB-T signal

Modulation	Code rate	Gaussian channel	Rice channel	Rayleigh channel
QPSK	1/2	5	6	8
QPSK	2/3	7	8	11
16-QAM	1/2	10	11	13
16-QAM	2/3	13	14	16
16-QAM	3/4	14	15	18
64-QAM	1/2	16	17	19
64-QAM	2/3	19	20	23
64-QAM	3/4	20	21	25

Figure 10.12: ITU BT 1386-8 for protection ration

10.5 Information Gaps

Details of any gaps in information that have arisen when undertaking the Electromagnetic Interference Impact and Radar Impact assessments is documented and discussed in the relevant assessment sections in this chapter of the ES.

10.6 Assessment of Potential Effects

10.6.1 Potential Effects- Construction

10.6.1.1 Television and Telecommunication

The British Wind Energy Association and Ofcom Guidance advise that the effect of construction and decommission should not be assessed as it is not standard practice to do so.

The only possible effect is likely to be as a result of tall cranes. The cranes will be in the immediate vicinity of each turbine and as such are likely to have similar effects. As the turbines have been sited in accordance with the requirements of the link operators, they are unlikely to affect the identified links. In addition the cranes are temporary structures which will not be erected for long periods. For example, following completion of ground works the turbines will then be erected as follows:-

- Day1: crane and components will be delivered
- Day 2: crane will be used to install turbine base at a max. height of 10m
- Day 3: crane will be used to erect the bottom 2 sections of the tower (up to 2/3 of end height which will be about 40m) with a arm length of up to 70m
- Day 4/5: crane will extend to its full height (up to 95m) to install the turbine nacelle and blades

The main concern for the construction work will be on the Microwave link side. As the one of the turbines will be quite close to the BT link and the crane's arm can be extended up to 95m it is possible that the link will be affected during the constructions. Therefore the crane would be only located to the south of the link to avoid any interference.

The crane itself will only have a small impact on the broadcast when it is deployed. There might be small signal degradations, but this is only on temporary nature.

As a result any effects during constructions are likely to be similar in nature but of a smaller magnitude than operational effects.

10.6.1.2 Aviation

The crane would be seen by the radar from all sites but this is a temporary in nature as a result any effect during construction are likely to be similar in nature but of a smaller magnitude than operational effects.

The MOD would be advised before construction commences in order that military air crew can be advised of the potential obstruction.

10.6.1.3 Utilities

Effects on existing utilities during construction can include disturbance to infrastructure in close proximity to construction areas. The wind turbines have been sited to avoid utilities impact and detailed consultations will be undertaken with the relevant authorities prior to commencement of the work. No effects on existing utilities are predicted during construction activities.

10.6.2 Potential Effects - Operational

10.6.2.1 Radar Analysis

NATS en route plc (NERL) provides an online assessment tool for a developer which has replaced its pre planning consultation process (http://bwea.com/aviation/nats.html). The online maps provide information about areas where wind turbines may be of concern to NERL. Maps are displayed for a range of tip height from 20m – 140m. The 100m height map was analysed for the proposed turbines. This assessment shows the turbines to be within an area where there are likely to be some effects on operational infrastructure of the NERL. However, these maps are for guidance only and the NERL would also assess the application at planning stage to establish the significance of the impact of the turbines on operational infrastructure.

The only airport within the 30Km consultation zone is Blackpool Airport, which is located at (Easting 331633; Northing 431634) approximately 30Km away.

Blackpool Airport was consulted for an opinion on the significance of the impact; an initial response has been received indicating that the turbines will not affect the operational infrastructure.

Consultation has been undertaken with the MoD and BAE Warton which has confirmed that there is a line of sight to Warton and Great Dunn Fell Radar. The MoD has expressed concerns regarding the proposal but will look at suggested mitigations measures (Appendix J). Discussions with the MoD regarding appropriate mitigation are currently underway. Details of the agreed mitigation will be provided in due course.

The first screen shot shows the position of the turbines and the radar stations:

Figure 10.13: Screen shot showing all radar sites and the turbine positions

The radar analysis was undertaken as a line of sight analysis (path profile). In the path profile the following parameters can be seen:

- red line - the free space loss
- green line - the field strength
- light green line - the line of sight
- blue ellipsoid - the Fresnel zone
- grey area - terrain along the path
- Orange/read area – clutter above the terrain

All profiles show turbine 2 on the left hand site and the radar station on the other.

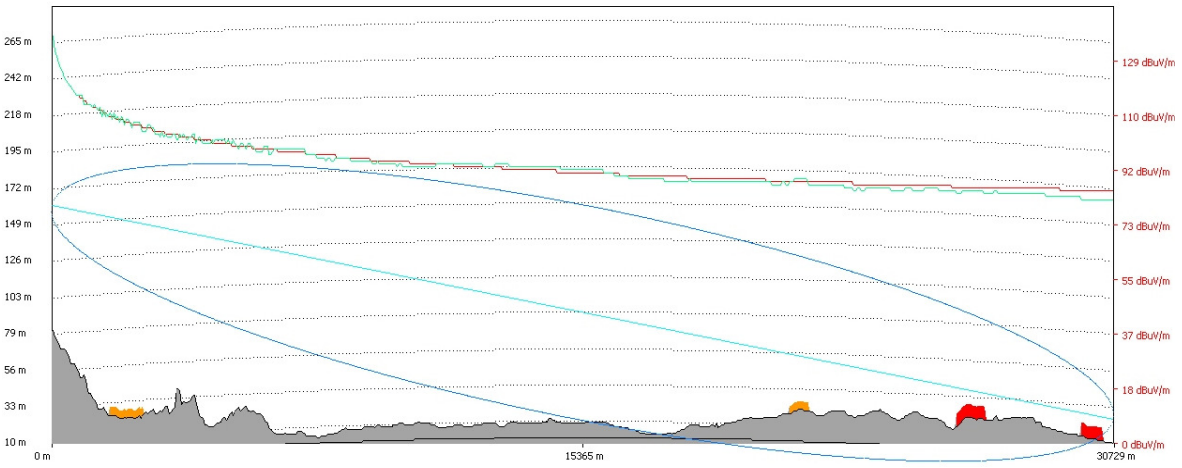

Figure 10.14: Path profile from turbine2 - BAE Warton

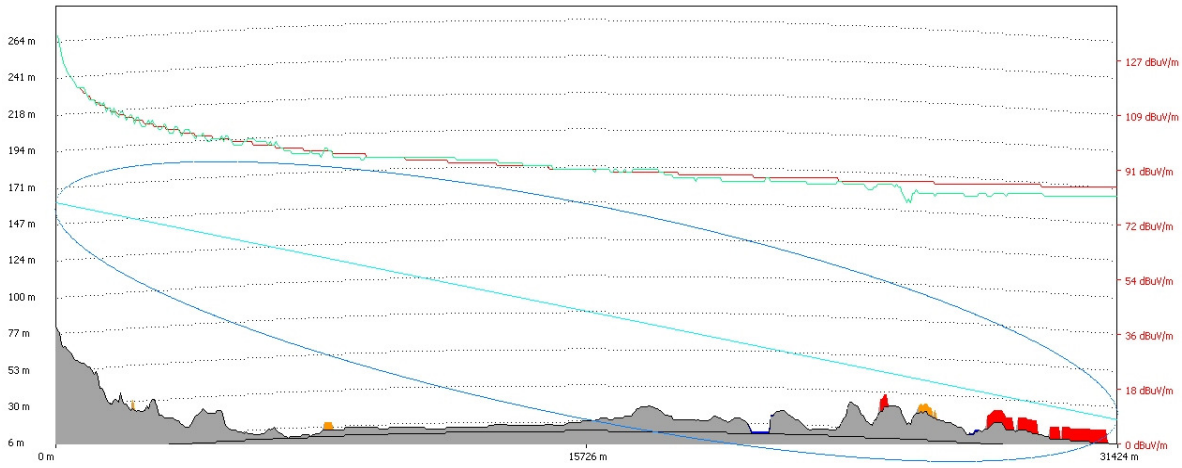

Figure 10.15: Path profile turbine 2 - Blackpool Airport

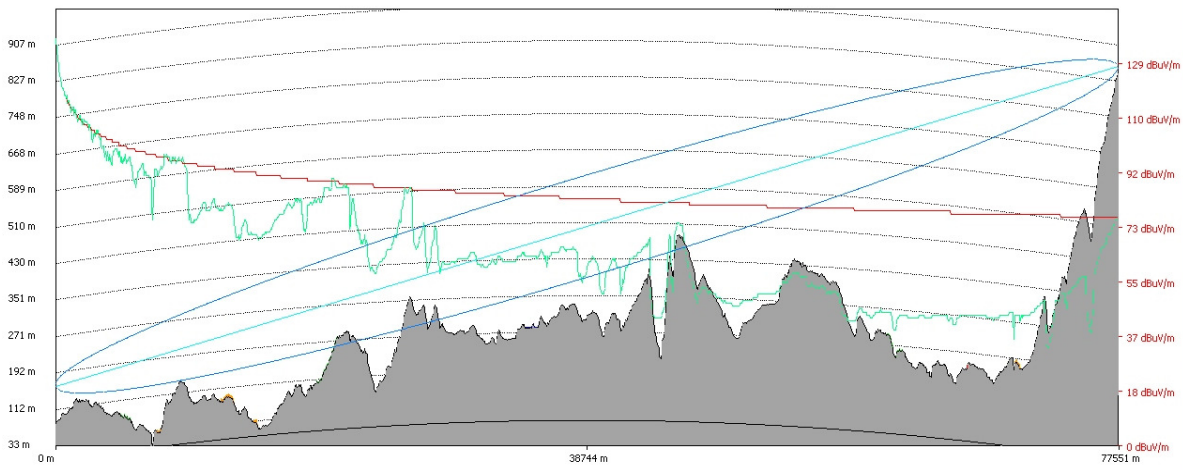

Figure 10.16: Path profile turbine 2 - Great Dun Fell

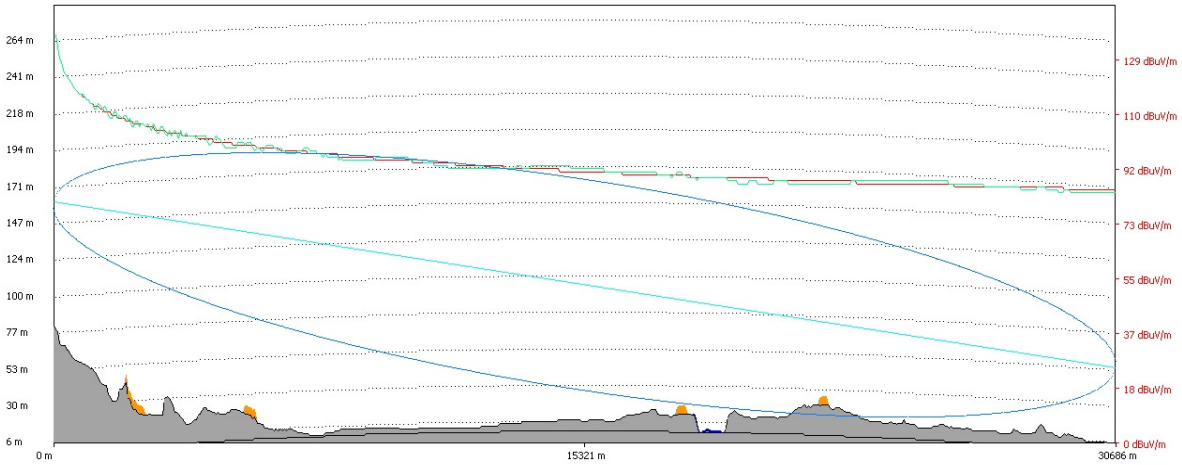

Figure 10.17: path profile turbine 2 - St Anne's

All profiles show a near line of sight connection between the turbine and the radar. It is called “near line of sight” as there are obstacles intruding the Fresnel zone. On the terrain view below (figure 10.18) it is obvious that BAE Warton, St Anne’s and Blackpool Airport are located in a very flat area and will see a turbine everywhere in the proposed area. The same applies for Great Dunn Fell (from high ground to lower ground). The radar is on a very high position and will be able to see every obstacle on the ground.

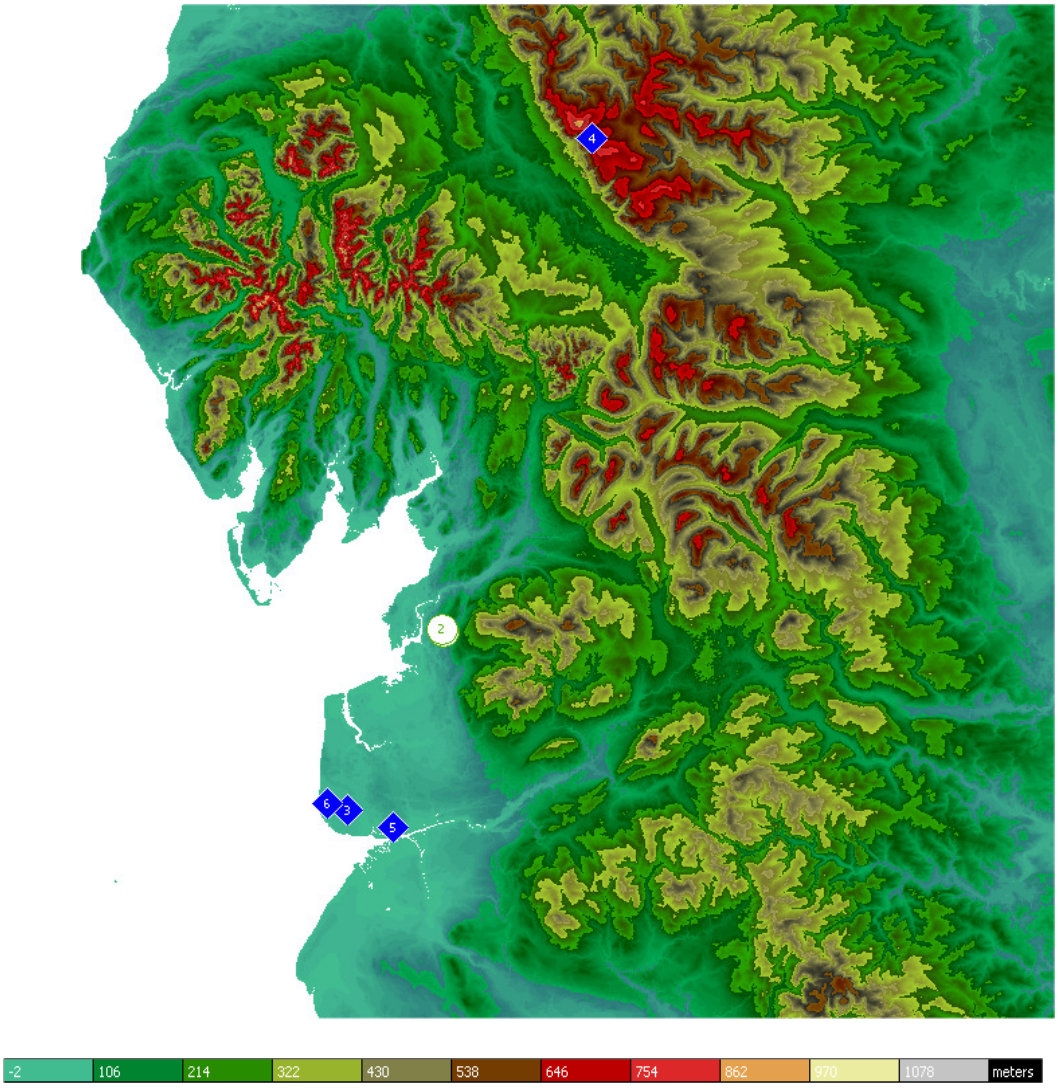

Figure 10.18: terrain view of the area including radar sites and wind turbines; light green low altitude, red high altitude

10.6.2.2 Microwave Link Analysis

As described in section 10.4.3 the Microwave link analysis followed the method used by Ofcom. ATDI was undertaking a Fresnel Zone clearance analysis and a signal reflection analysis. The only Microwave link that has been identified as potentially interfered is a link operated by BT.

The following screen shot shows the BT microwave link (brown circles and line) and the turbine positions (red circles).

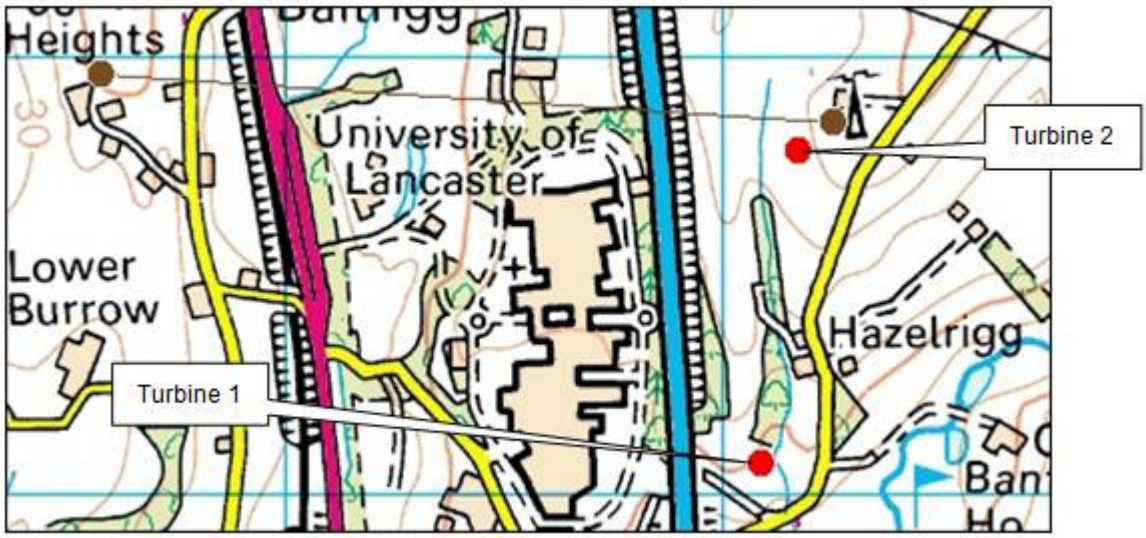

Figure 10.19: position BT Microwave Link (brown) and wind turbines (red)

The near field analysis gives a minimum clearance zone around the antennas of 26.3m. The closest turbine is about 110m away from a mast. Taking the blade length of 41m into account drops the distance down to 69m, which is greater than the required 26.3m

The absolute minimum distance between the blade and the beam should be 4m, based on the David Bacon method, which is the width of the 2nd Fresnel zone. Each turbine blade is 41m length. The distance between turbine 2 (Figure 10.19) and the microwave link beam is 81.7m. This means the tip of the blade is only 40.7m away from the main link beam.

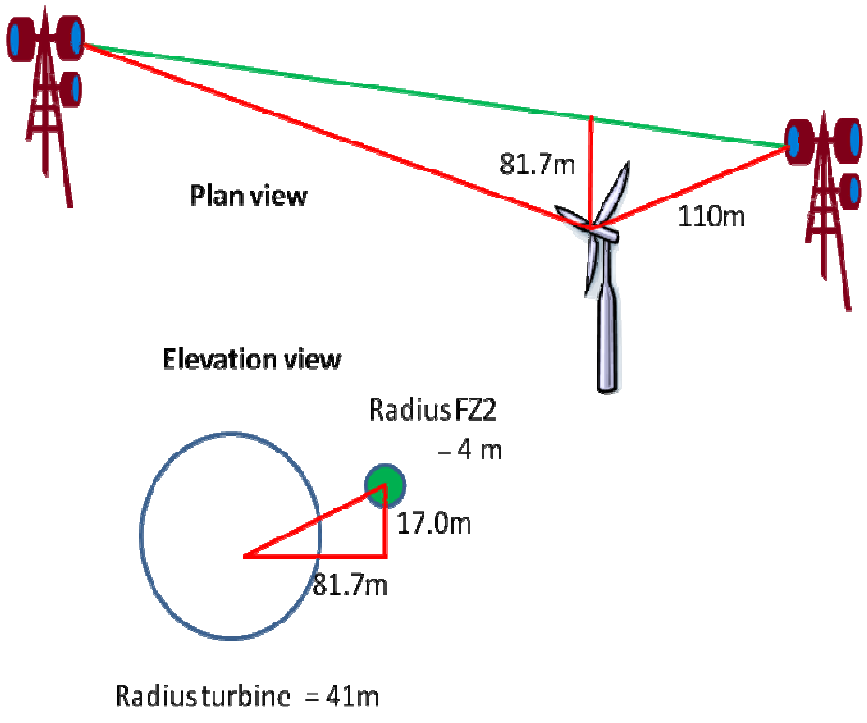

Figure 10.20: distance between BT microwave link and turbine 2

BT has generally a minimum exclusion zone of 100m form the main beam to the tip of a blade. The originally used turbine positions were objected by BT. However, BT has been consulted again with the actual reviewed locations and turbine parameters (blade length, tower height) and has withdrawn its objections (see Appendix J)

Turbine 1 (Figure 10.19) is more than 800m away from the BT link and therefore beyond the BT minimum exclusion zone.

The reflection analysis as described in section 10.4.3 required a minimum C/I of 30dB. Turbine 1 is outside of BT required exclusion zone and doesn't need to be considered. The analysis compares the free space loss (FSL) for the direct path signal and the reflected signal. The calculations for turbine 2 give a result for the actual C/I of 36.7dB. The C/I is better than the ETSI speciation for a 1dB degradation in threshold level. When links like this are licensed there is usually 2 -3dB extra margin planned in to allow for degradations due to other co and adjacent channel interferers. In this case some of that margin is being taken by its own co-channel interference.

It should be noted that, when links like this are licensed there is usually 2 - 3dB extra margin planned in to allow for degradations due to other co and adjacent channel interferers. In this case some of that margin is being taken by its own co-channel interference, which makes that analysis more conservative than the original ETSI requirement.

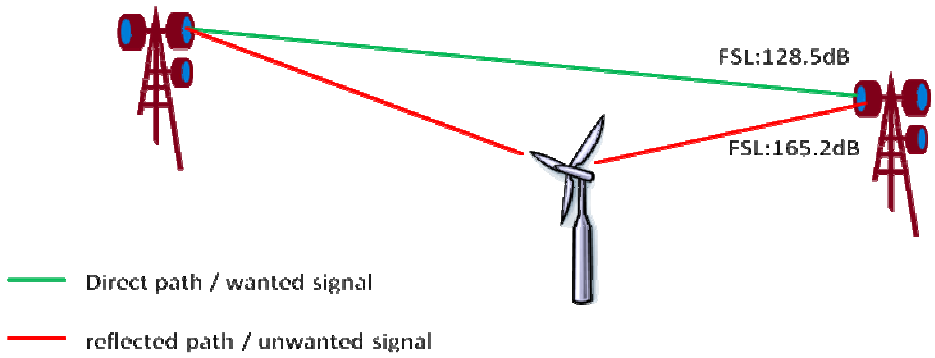

Figure 10.21: Reflection analysis for microwave link

10.6.2.3 Broadcast Analysis

The most important effect for the broadcasting service is the interference by reflection and scattering. The following screen shots (figure 10.22 and 10.23) show the C/I calculation maps based on the ITU–R BT. 805 [10], for each turbine on each broadcast transmitter. The green area indicates areas above the minimum required C/I of 14dB. The yellow coloured area indicates area where the C/I ratio is between 14dB and 0dB. The red area indicates the area with a C/I ratio below 0dB. The perfect circle denoting coverage is due to the distance limitation of the calculation.

[10] ITU-R BT.805 "Assessment of Impairment Caused to Television Reception by a Wind Turbine"; www.itu.int

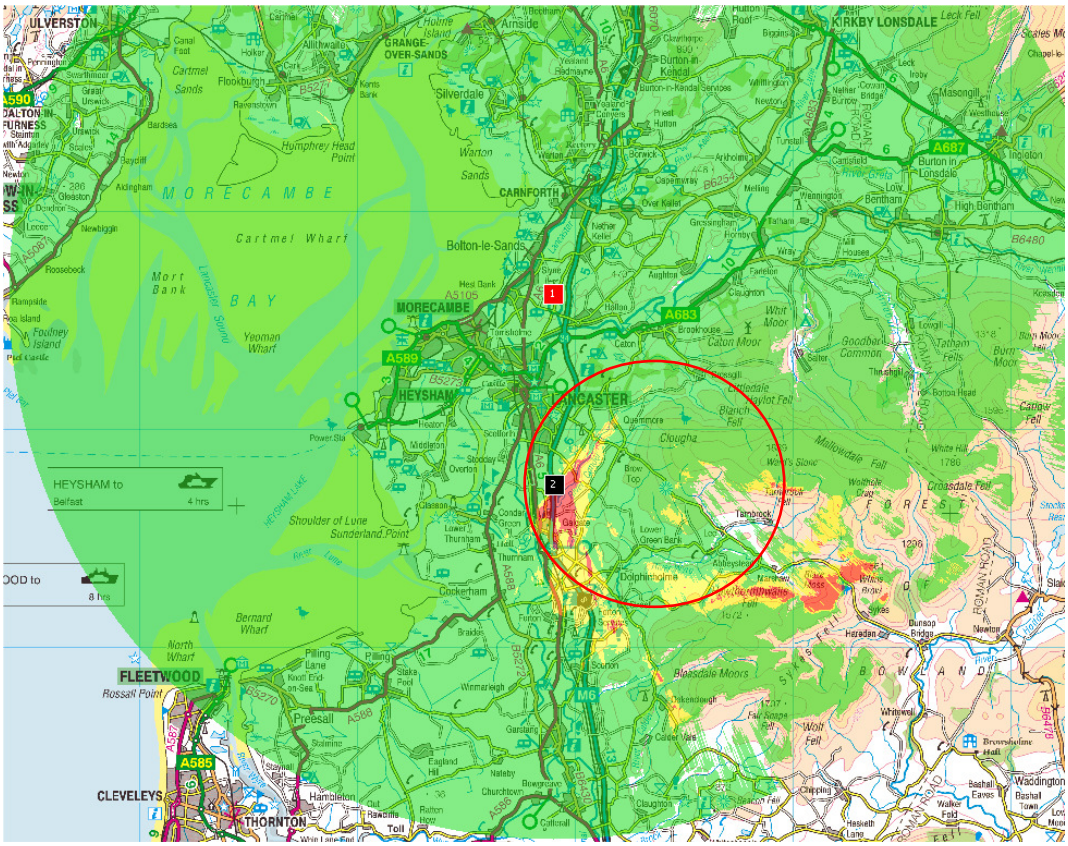

Figure 10.22: C/I map Lancaster - Turbine 1

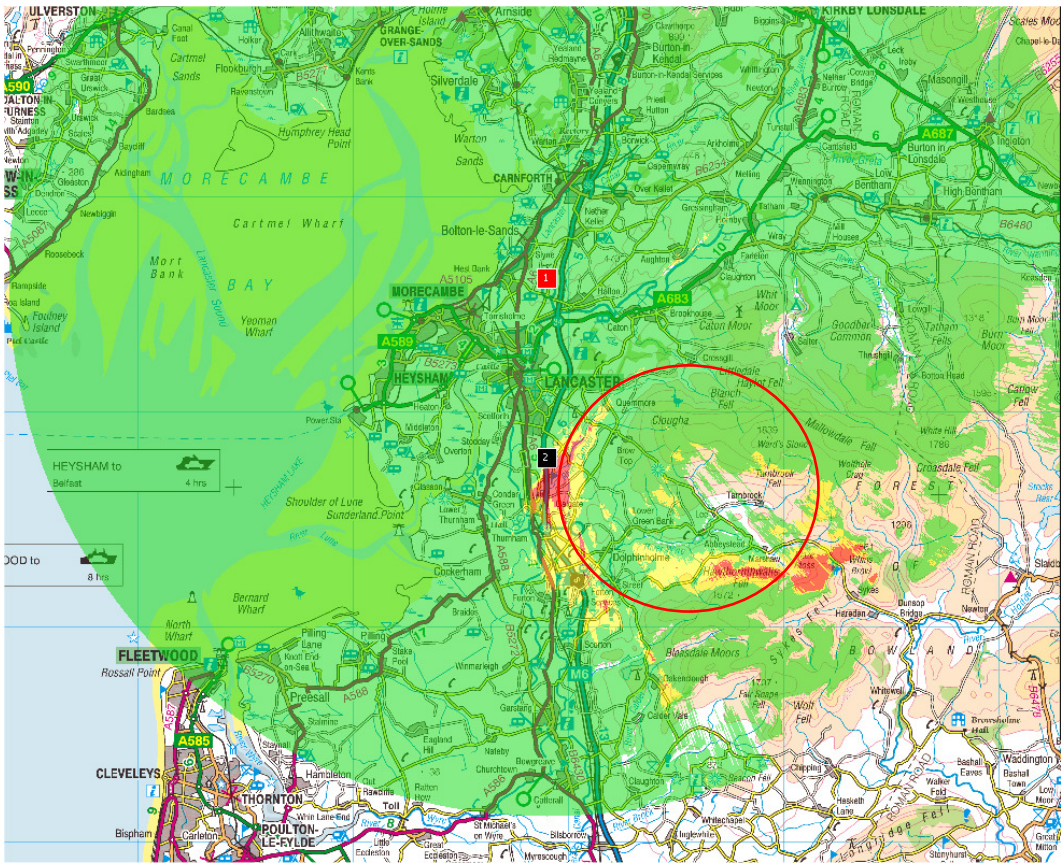

Figure 10.23: C/I map Lancaster - Turbine 2

The red and yellow area in south east of the wind turbine (inside red circle) is due to coverage effects. The wanted broadcast signal drops here below the minimum service threshold due to terrain effects in the Forest of Bowland area and therefore the distance between the wanted and unwanted signal drops below the minimum C/I value. This effect is independent from the turbines.

The scattering effect on the signal from Winter Hill is marginal and does not degrade the signal below the minimum C/I value, as shown in Figure 24.

The best server coverage plot below (figure 25) shows that the interference areas from both turbines (figures 22,23) are covered by the stronger signal from Winter Hill.

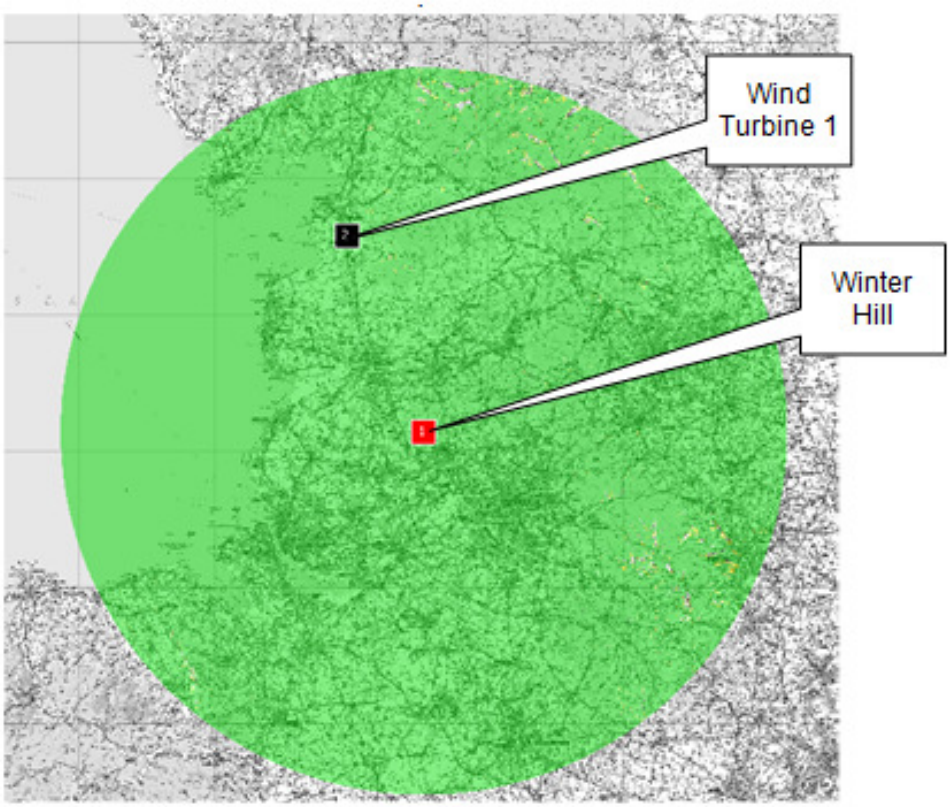

Figure10.24: C/I map Winter Hill - Turbine 1

In most cases, the receiving television antenna will normally, upon installation, be pointed at the mast that provides the strongest signal for reception. A best server plot shows identifies the best serving transmitter for each point in an area. Figure 10.25 and 10.26 show the best server in the potential affected areas. The blue coloured areas indicate the areas with the strongest signal from Winter Hill, the red ones from Lancaster. Both figures show that inside the potentially affected area both transmitters provide a strong signal.

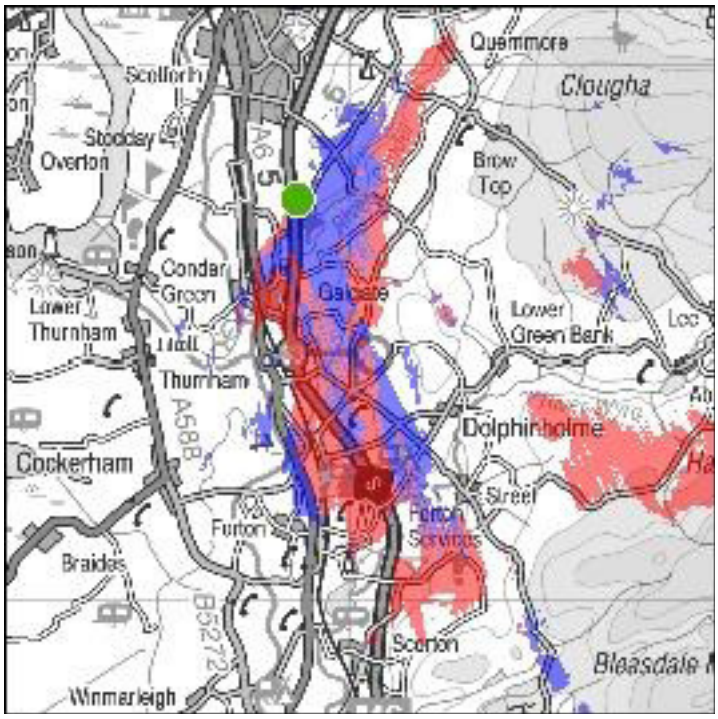

Figure10.25: Best Server coverage plot, Blue - Winter Hill, red – Lancaster

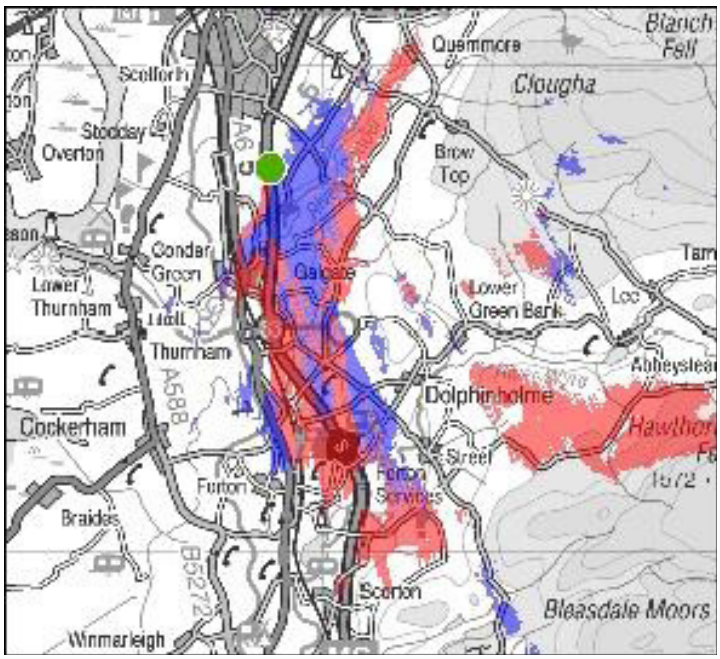

Figure 10.26: Best Server coverage plot for Turbine 2, Blue - Winter Hill, red – Lancaster

10.6.2.4 Utilities

The wind farm is considered unlikely to affect existing utilities once it becomes operational. Current UK guidance on siting of wind turbines close to pipelines containing hazardous substances recommend that the distance between turbines and such pipelines should be one and a half times the hub height of the turbine.

Stanlow complex has been identified within the vicinity of the site. However, GeoNetworks, National Grid Electricity, National Grid Gas and Shell UK have been consulted for their views on the impact of the turbines and all have confirmed that the operational effects of the turbines will be negligible.

10.6.3 Potential Effects - Decommissioning

Decommissioning effects are anticipated to be of a similar nature and scale as construction effects.

10.7 Summary of Potential Effects

10.7.1 Radar

Both turbines will be seen from all identified radar stations and therefore they will have a significant impact. A detected turbine will be permanently seen on the radar screen. Wind turbines and slow moving aircraft look similar to a Radar detector.

ATDI has contacted the NATs, MoD, BAE Warton and Blackpool Airport for consultation about the significance of the impact of the two proposed turbines. Nats, Blackpool Airport and BAE Warton authorities will only formally respond to a formal planning application. However, an informal response has been received from Blackpool Airport indicating that operational infrastructure is unlikely to be affected.

The MoD have identified that the turbines are in line of sight. The significance of this impact is currently being investigated. The MoD have confirmed that there will be no adverse impact on low flying aircraft or ranges however they have expressed concern regarding radar impact which will need to be appropriately mitigated to prevent objections to the wind development.

10.7.2 Microwave Link

As shown in Figure 10.20 the distance between Turbine 2 and the BT microwave link beam is 81.7m, and each turbine blade is 40.7m long. This means in the worst case, the blade is approximately 40.7m away from the main link beam. The blade is outside the 2nd Fresnel zone and will not harm the link itself.

In addition to the Fresnel zone, clearance signal reflection from the wind turbine is another important issue. As shown in figure 10.21, turbines also reflect the transmitted signal and can cause signal degradation on the receiving end. The analysis shows that the ratio between wanted and unwanted signal (C/I) is above the minimum required C/I level. Therefore the turbine will not interfere the microwave link.

BT confirmed that they have no objections to these turbine positions, evidence of this can be seen in Appendix J.

10.7.3 Broadcast

Signal scattering and reflection are the main impacts. Figures 10.22 and 10.23 show areas were the minimum C/I level will not be exceeded (red area) and therefore no acceptable broadcast reception can be guaranteed.

It is shown that there are small areas around each turbine of maximum 4km which will suffer from a significant signal degradation receiving from Lancaster broadcast station. However, the best server plot (figure 10.25) indicates that all these identified areas receiving the strongest signal from Winter Hill (blue area). So it is unlikely to be a problem as the user's antenna normally point towards the strongest server which is Winter Hill and not Lancaster.

10.8 Mitigation

A general mitigation strategy to reduce the impact on all radio systems can be adopted by using a radio signal absorbing material and reflection can also be minimised by coating the turbines,. The individual reflection degradation depends on the type and brand of material used.

10.8.1 Radar mitigation

Both turbines will be seen from all radar sites due to the contours of the land. Common mitigation options are:

- Moving the turbine to another location
- Reduce mast height
- Reduce blade size

None of these actions are available in this instance due to the limited size of the application site, the required energy generation output from the turbines and the flat lying nature of the landscape.

Other than those listed above there are no onsite technical mitigation options currently available to developers. However, in some instances mitigation at source, i.e. by Radar Operators, can be applied if the turbines are sited outside an area of operational significance. In order to determine whether mitigation can be applied in this instance NATS are undertaking a site assessment and discussions are also being undertaken with the MoD.

The map below shows the area of possible interest for some of the identified airports.

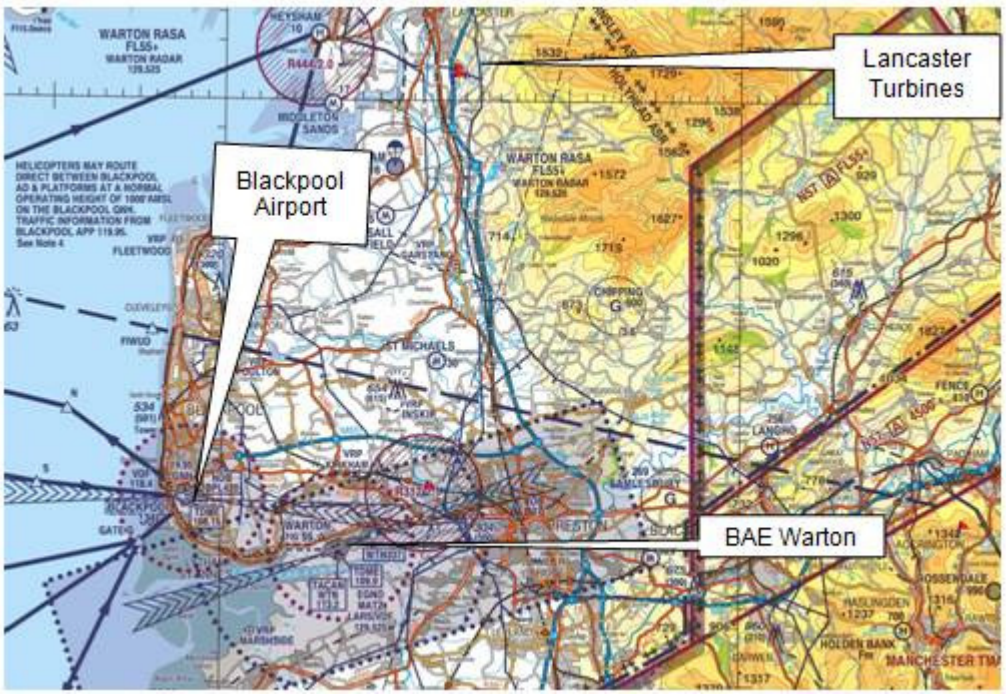

Figure10.27: Airfields around BAE Warton and Blackpool Airport

(source John Taylor radar Report, Wind Power Aviation Consultants Ltd)

10.8.2 Microwave Link

The screen shot below shows the original turbine positions (blue circles) and alternative new (red circles).

The alternative positions shown in figure 10.28 were found by preliminary analysis supplied in interim reports by ATDI, where alternatives to the original locations were evaluated. The one turbine (closer blue spot to the link) was moved about 40m to the south east of its original position. To avoid problems with the other turbine, it has been moved much further to the south (southern red spot).

Embedded mitigation in the form of site design will result in no effects on telecommunication as a result of the proposed turbines.

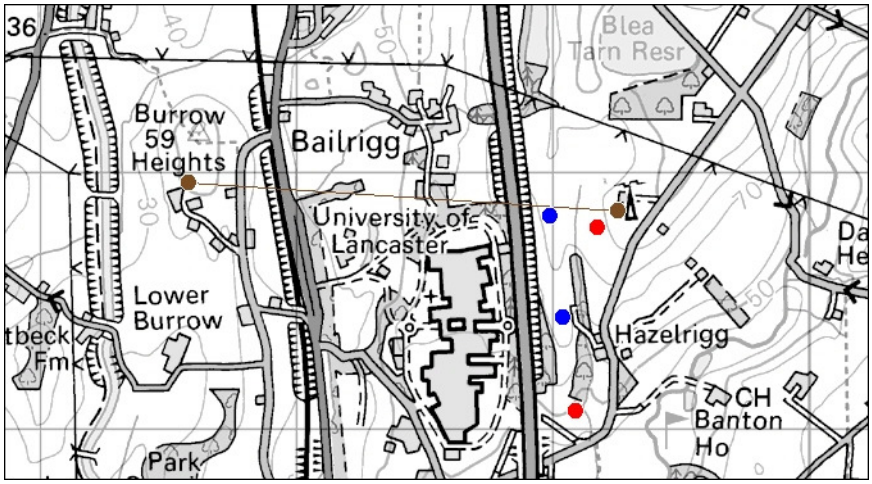

Figure 28: locations wind turbines

10.8.3 Broadcast

The analysis has shown that no service degradation should occur as the strongest signal in the relevant area is provided by Winter Hill which is unaffected by the turbines. Any adverse impact with regards to television interference can be resolved through technical solutions that can be agreed between Lancaster University and the local planning authority. Mitigation measures can include:

- Using directional antennas with a higher antenna gain to increase the C/I
- Using higher antenna location for a better direct signal reception
- Facing the TV antenna to another broadcast transmitter e.g. Winter Hill
- Provision of satellite or cable service to affected households

10.8.4 Utilities

Embedded mitigation in the form of site design will result in no effects on utilities as a result of the proposed wind turbines.

10.9 Residual Effects

10.9.1 Radar

As there are no on site mitigation options available no comments on remaining effects can be made.

10.9.2 Microwave Link

There are no significant effects predictable after the mitigation.

10.9.3 Broadcast

There are no significant effects predictable after the mitigation.

10.9.4 Utilities

There are no significant effects predictable after the mitigation.

10.9.5 Summary of Impacts

Receptor	Mitigation	Residual Effect
Constructions		
Utilities	Appropriate construction methods to be agreed with relevant authorities	No significant effect
Microwave link	Erection and cranes could cause a temporarily impact , crane pads be sited to the south of link	No significant effect
Radar	The crane would be seen from the Radar but this effect would be temporary	No significant effect
Operation		
BAE Warton (radar)	No mitigation possible, other than that which can be provided by the Radar controller at source. Discussions regarding the possibility of successful mitigation are being undertaken.	As there are no on site mitigation options available no comments on remaining effects can be made
Blackpool Airport (radar)	No mitigation possible, other than that which can be provided by the Radar controller at source. Discussions regarding the possibility of successful mitigation are being undertaken.	As there are no on site mitigation options available no comments on remaining effects can be made
St. Anne's (radar)	No mitigation possible, other than that which can be provided by the Radar controller at source. Discussions regarding the possibility of successful mitigation are being undertaken.	As there are no on site mitigation options available no comments on remaining effects can be made
Great Dun Fell (radar)	No mitigation possible, other than that which can be provided by the Radar controller at source. Discussions regarding the possibility of successful mitigation are being undertaken.	As there are no on site mitigation options available no comments on remaining effects can be made
BT Link (Microwave Link)	BT have confirmed that they have no objection to the scheme however if following installation adverse impact were experienced mitigation could be applied this would comprise of one of the	No significant effect

	following; Redirecting antennas Directional antennas Increase antenna height	
Lancaster (Broadcast)	Redirecting antennas Directional antennas Increase antenna height	No significant effect
Winter Hill (Broadcast)	No mitigation necessary in this case.	No significant effect
Decommissioning		
Utilities	Appropriate construction methods to be agreed with relevant authorities	No significant effect
Microwave link	Erection and cranes could cause a temporary impact , to prevent this the crane pads should be sited to the south of link	No significant effect
Radar	The crane would be seen from the Radar but this effect would be temporary	No significant effect

Table: 10.29; Summary of Impacts

10.10 Statement of Significance

The proposed Lancaster University turbines will have no significant effect on existing telecommunication or existing infrastructure.

There are several aviation issues caused by the two turbines. Both turbines will be seen from each identified radar stations and there are no on site mitigation options for any of the turbines. Consultation has been undertaken with the MOD, CAA and NATS. BWEA Consultation Proforma responses have been received from all relevant aviation bodies, these are documented in Appendix J. The MOD has expressed concerns regarding impact on aviation radar. A detailed assessment of the proposal by NATS is currently being undertaken to identify whether there are likely mitigation options. Until mitigation can be agreed with NATs and the MOD the impact on civil aviation radar must be classed as significant.

There is only one microwave link, managed by BT, which is potentially affected by one of the turbines. BT has confirmed that they have no objection to the currently proposed turbine locations.

Any possible problems associated with broadcast services will be resolved by providing signal from 2 transmitters, as described in section 10.6.2.3. In the unlikely event of signal degradation below the minimum signal level in an area simple mitigation options can be provided.

Chapter 11 : Hydrology, Geology, Hydrogeology & Soils

11. Hydrology, Geology, Hydrogeology and Soils

11.1 Introduction

This chapter of the ES presents an assessment of the likely impacts of the proposed development on hydrology, hydrogeology, geology and soils and is based on the findings of a site report produced by Aecom. The assessment provides a full characterisation of the existing hydrological and geological environment at the site, against which any potential effects are evaluated. This chapter also notes any potential constraints to the proposed wind turbine development and describes and evaluates the potential effects of the proposed wind turbines.

An assessment of the likely potential hydrological and hydro geological impacts is considered necessary because the site is bisected by a small watercourse and the closest turbine is 19m from this watercourse. This could result in potential effects due to an increased risk of pollution of the watercourse on site and watercourses with which it converges downstream. An assessment of the likely potential geological impacts is also considered necessary due to drift material present on the site.

Finally mitigation measures that are likely to be required during the construction and operation of the proposed development to protect the environment are also discussed.

11.2 Consultation

or sustained rainfall events have the potential to effect on- A summary of the consultation responses relevant to potential impacts on hydrology, geology, hydrogeology and soils are contained in Table 11.1, on the following page.

Consultee	Date of Response	Response
Lancaster City Council	03/11/2009	The methodology identified in the scoping report appears adequate in this instance. The County ecologist has advised that the ES should include an assessment of the likely impacts on the water table, water courses, ground and surface water and the aquatic environment in general. Proposed actions for reducing run-off and mitigation from the development (associated areas of hardstanding, access roads etc.) should also be considered as part of the ES.
Environment Agency (EA)	06/10/2009	There is no main river on the site, but the River Conder passes not far from the southern edge of the site. The EA would like to see a SUDs system or other type of floodwater mitigation, so the proposed development does not increase flood flows to the river network. Have no comments on the report, it covers all those matters which are of concern to the Agency.
Natural England (NE)	02/09/2009	No comment received on hydrological or geological effects.
United Utilities	24/08/2009	United Utilities were consulted to obtain service plans for the site and immediate surrounding area. The services plan provided by United Utilities shows there are no public sewers or water mains located on site.

Table 11.1 Consultation responses relevant to hydrology and geology.

11.3 Guidance and Legislation

EA has statutory obligations with regard to hydrology, management of water-borne pollution and the management and control of pollution into water resources. Accordingly, it is considered appropriate that EA Best Practice Guidelines are followed during design and construction of the development.

Relevant statutory guidance includes:

- PPG 1 General Guide to the Prevention of Water Pollution;
- PPG 3: The use and design of oil separators;
- PPG 5 Works in, near or liable to affect watercourses;
- PPG 6 Working at Construction and Demolition Sites;
- PPG 8 Storage and disposal of used oils;
- PPG 18 Control of spillages and fire fighting run-off;
- PPG 21 Pollution Incident Response Planning;
- PPG 23 Maintenance of structures over water;
- PPG25 Development and flood risk; and,
- PPG 26 Pollution Prevention Storage and Handling of Drums & Intermediate Bulk Containers.

Other compliance guidance that will be followed includes:

- CIRIA Report C502: Environmental Good Practice on Site;
- CIRIA Report C532: Control of water pollution from construction sites: guidance for consultants and contractors;
- CIRIA Report C697: The SUDS Manual; and,
- CIRIA Report C698: Site handbook for the construction of SUDS.

At detailed design phase the designers will ensure that relevant environmental legislation is followed, including:

- Control of Pollution Act 1974;
- Environment Protection Act 1990;
- Land Drainage Act 1991;
- Water Resources Act 1991, as amended;
- Environment Act 1995;
- Groundwater Regulations 1998;
- Water Framework Directive (2000/60/EC).
- UK Water Quality (Water Supply) Regulations 2000
- EC Dangerous Substances Directive (76/464/EEC);
- EC Fisheries Directive (78/659/EEC);
- Land Drainage Act 1991.

11.4 Assessment Methodology

The assessment has been carried out for two 2MW wind turbine. The grid references for the turbines are as follows; T1; 349175, 457789 and T2 349093, 457073.

The assessment involved:

- analysis of current policy and guidance in relation to wind energy and the effects of development on the hydrological, geological and hydro geological environment;
- desk study to establish the existing baseline hydrological, geological and hydro geological conditions on site;
- site walkover survey to verify the accuracy of the baseline information;
- evaluation of the potential effects of the development on the hydrological, geological and hydro geological environment;
- identification of measures to mitigate against any potential adverse effects; and
- assessment of the significance of residual effects following mitigation taking into account the sensitivity of receptors, magnitude of effects and the probability of these effects occurring.

The data and other sources of information collected are listed in Appendix K Section K1

The approach to and the scope of the assessment take account of consultations with the EA over the course of other similar wind turbine projects. The methodology of this assessment is based on the collection of a wide range of data and information from published material, plus consultations with statutory bodies. The site visit was undertaken on 9th December 2009 and included a full site walkover to:

- confirm the presence of all surface water bodies identified in the baseline study;
- observe any evidence of potential ground contamination;
- determine the presence of any geological features; and,
- assess the topography of the site.

This assessment has been undertaken primarily using a qualitative assessment based on professional judgement and statutory and general, national and local guidance. In determining the potential significance of an effect, the value of the receptor (Table 11.2) and the magnitude of the potential change (Table 11.3) are combined, to determine the significance of that effect using a significance matrix (Table 11.4).

Value	Criteria	Typical Examples
Very High	Feature has a high quality and rarity on a regional or national scale	**Surface Water** EC Designated Salmonid or Cyprinid fishery EA River Water Classification A. Site protected by EU legislation (SAC, SPA, Ramsar site) Sites containing species or habitats listed due to national importance in a Local Biodiversity Action Plan (LBAP) **Groundwater** Major aquifer providing a regionally important resource, providing potable water to a large population or supporting site protected under conservation legislation
High	Feature has a high quality and rarity on local scale Feature with a medium quality and rarity, regional or national scale	**Surface Water** Major Salmonid or Cyprinid fishery EA River Water Classification B Site contains area designated as a SSSI Sites containing species or habitats listed due to regional or local importance in a Local Biodiversity Action Plan (LBAP) **Groundwater** Major aquifer providing locally important resource, providing potable water to a small population or supporting a river ecosystem
Medium	Feature has a medium quality and rarity on local scale Feature with a low quality and rarity, regional or national scale	**Surface Water** EA River Water Classification C Sites designated by local authority as having local conservation status **Groundwater** Aquifer providing water for agricultural or industrial use with limited connection to surface water
Low	Feature has a low quality and rarity on local scale	**Surface Water** EA River Water Classification D or E Low grade or common habitats with no conservation status **Groundwater** Non-aquifer

Table 11.2 Value Criteria

Magnitude	Criteria	Typical Examples
Major	Results in change of attribute and/or quality and integrity of the attribute	**Surface Water** Fundamental change to hydrological conditions including deterioration in water quality Loss or extensive damage to a fishery Loss or extensive damage to a designated conservation site High risk of pollution from surface water run-off or accidental spillages. **Groundwater** Loss of an aquifer Potential high risk of pollution to groundwater from routine runoff or accidental spillages.
Moderate	Results in change to part of the integrity of the attribute, or loss of part of the attribute	**Surface Water** Detectable but non-fundamental change to hydrological conditions Some deterioration in water quality likely to temporarily affect sensitive receptors. Partial loss in productivity of a fishery. Medium risk of pollution from surface water run-off or accidental spillages. **Groundwater** Partial loss or change to an aquifer Potential medium risk of pollution to groundwater from routine runoff
Minor	Results in some measurable change in attributes quality or vulnerability	**Surface Water** Detectable but minor change to hydrological conditions Slight deterioration in water quality unlikely to affect sensitive receptors Low risk of pollution from surface water run-off or accidental spillages **Groundwater** Potential low risk of pollution to groundwater from routine runoff
Negligible	Results in negligible change to the attribute	**Surface Water** Undetectable change in hydrological conditions including water quality The proposed scheme is unlikely to affect the integrity of the water environment. Very low risk of pollution from surface water run-off or accidental spillages. **Groundwater** No measurable change to an aquifer or risk of pollution from accidental spillages

Table 11.3 Magnitude Criteria

		Value Criteria			
		Very High	High	Medium	Low
Magnitude Criteria	Major	Extremely significant	Highly significant	Significant	Negligible
	Moderate	Highly significant	Significant	Negligible	Not significant
	Minor	Significant	Negligible	Not significant	Not significant
	Negligible	Negligible	Not significant	Not significant	Not significant

Table 11.4 Significance of Effect Matrix

11.5 Baseline Description

This section describes the existing hydrological, geological and soil conditions at the proposed site and its immediate surroundings.

11.5.1 Geology

The solid geology at the site consists of Roeburndale Formation which is mainly a grey siltstone with sidertic mudstone, sandstone and interbedded sandstone and siltstone.

There are significant deposits of drift material over the whole area of the site. This is a till comprised of grey or reddish brown, stony clayey silt. It is not know what depth the layer of till is, but it is possible that it is several meters in depth across the whole site. The detailed Site Investigation will determine the depth of drift material present on the site.

There are two geological faults on the site that intersect east of Hazelrigg Farm. One of the geological faults travels in a north-easterly to south-westerly direction, bisecting the site from Hazelrigg Lane to the southern extent of the woodland alongside the M6 motorway. The second fault is perpendicular to this first fault and extends from this intersection in a south easterly direction passing close to the location of Turbine 2.

11.5.2 Soils

The proposed development site is situated on agricultural land used primarily for pasture. There are also two distinct areas of woodland within the site boundary.

The dominant soil type across the site is slowly permeable, seasonally wet, acid loamy and clayey soils (National Soil Resources Institute, 2009). These soils are typical of seasonal wet pastures and woodlands. They typically have impeded drainage and present less of a risk to the water environment as they provide a low mobility to contaminants to enter both surface and ground water.

The Environment Agency Groundwater Vulnerability Map states that the soil classification is ‘soils of low leaching potential’. These are soils in which pollutants are unlikely to penetrate the soil layer, because either water movement is largely horizontal, or they have the ability to attenuate diffuse pollutants. They generally have high clay or organic matter contents and include soils of the Brickfield Associations. The Environment Agency consultation response has confirmed that the soil type is Brickfield 2, seasonally wet deep loam; and that it is slowly permeable, seasonally waterlogged, fine loamy soil.

The European Topsoil Organic Carbon Content Map (European Soil Bureau Network, 2009) indicates that values of 2 to 6% organic carbon content by mass are typical for soils in the area of

Lancaster University. Therefore the soils at the proposed site are not peat-rich or high in organic carbon, and therefore there is minimal risk of significant CO2 release from the soil during construction activities.

The Environment Agency has confirmed that there are no current or historical landfill sites within 1km of the site. However, it is not known if there is the potential for contamination or made ground within the site boundary.

11.5.3 Climate

Global climate change from both anthropogenic and natural forcing is likely to occur during the operational life of the wind farm. Anthropogenic effects are due to a combination of industrial emissions of greenhouse gases such as methane and carbon dioxide along with changes in land use and vegetation. The UK Climate Impacts Programme (www.ukcip.org.uk) has produced CO^2 emissions scenario forecasts. For Lancashire the central estimate (50% probability) scenarios for 2020 suggests that summer precipitation will decrease by up to 10% and mean winter precipitation will increase by up to 10%. This will impact upon the hydrology of the site, with greater seasonal variation in runoff and groundwater recharge, although the actual magnitude and seasonality of these changes remains uncertain.

11.5.4 Topography

At the northern boundary of the site there is an existing Lancaster University Meteorological Station at 96 m Above Ordnance Datum (AOD). At the southern boundary of the site the onsite access track merges with Hazelrigg Lane at approximately 40 m AOD.
There is a small valley where the stream travels through the site. In the northern part of the site where the Meteorological Station is located, the topography falls towards the valley.

There is ridge line to the west of the river valley that passes between the two areas of woodland. The ridge is at approximately 85m AOD in the north and falls to approximately 40 m AOD at Hazelrigg Lane. This is a fall in height of 45 m over a distance of 800 m, which results in a angle of descent from north to south of approximately 17.75°.

To the west of this ridgeline the topography of the site falls towards the M6 motorway and the western area of woodland.

11.5.5 Surface water

There is a small stream which flows from the northern boundary of the site, along the western boundary of the site and exits the site at the southern boundary, adjacent to the road access point, where the stream flows under Hazelrigg Lane through a culvert.

In the northern part of the site where the Meteorological Station is located, the topography falls towards the valley and all surface water drainage will flow in the direction of the stream.

The site is bisected by a ridge which travels though the site north to south. To the east of this ridge the surface water will flow toward the onsite stream. To the west of this ridge the surface water drainage will flow towards the M6 motorway.

The drainage from the site flows into the River Conder, which flows into the River Lune.

There is a gauging station on the River Conder downstream at Galgate, which indicates that the mean flow is 0.67 $m^3 s^{-1}$. The catchment area of the River Conder is 28.5km^2.

Ordnance survey mapping has four small ponds on the site. During the site visit only two ponds were identified on site. One is located in a depression within the wooded area along the western edge of the site. The second is located in the river valley along the eastern boundary of the site. The pond is part of the unnamed tributary of River Conder.

To the north of the site there are two water reservoirs; Blea Tarn Reservoir and Langthwaite Reservoir.

11.5.6 Groundwater

The Environment Agency Groundwater Vulnerability Map (Appendix K section K2) shows that the solid geology of the site is classified as a Minor Aquifer. This is a formation that does not have a high primary permeability. Although these aquifers do not produce large quantities of water for abstraction they are important both for local supplies and in supplying base flow to rivers

The site is not within a currently defined Groundwater Source Protection Zone (Appendix K section K3). There are no Groundwater Source Protection Zones within the vicinity of the site.

11.5.7 Water quality

Surface water quality data was acquired from the Environment Agency. A summary of the water quality classification is in Table 11.5 below.

Classifications for surface water quality are taken from a six-point scale (A to F) where A is the highest quality (very good) and F the lowest (bad). Selection of the class is based on both chemical and biological surveys plus visual inspections.

Year	Chemistry Grade	Biology Grade
2008	A	D
2007	-	D
2006	-	D

Table 11.5 Summary water quality results for the River Conder (Church Bridge to Conder Green) (Environment Agency, 2009)

The Environment Agency provided details of pollution incidents in the vicinity of the site. There have previously been incidents of discharges from septic tanks from dwellings and discharges of oil in highway drainage outfalls entering watercourses in this area.

11.5.8 Abstractions and Discharges

The Environment Agency has confirmed that there are no abstractions within 1 km of the site.

The Environment Agency has not provided any records of consented discharges.

Lancaster City Council has not provided any records of abstractions for private water supplies.

11.5.9 Conservation designations

There are no statutory designations within or immediately adjacent to the survey area.

The drainage from the site flows into the River Conder at a point which is 6.5km upstream from the confluence of the River Conder and the River Lune. The confluence of these two rivers is part of the Morecambe Bay SAC and SPA.

There are no Notified Regionally Important Geological and Geomorphological Sites within 1km of the site.

11.5.10 Flood Risk

A separate Flood Risk Assessment (FRA) has been carried out for the site and can be found in Appendix K section K4-7.

The FRA states that the site is located entirely within Flood Zone 1, therefore, all of the proposed wind turbines and associated infrastructure will be located in an appropriate flood zone, with the lowest probability of flooding.

The landowner provided information on flooding from the unnamed tributary and explained that there has been some localised flooding around the culvert under Hazelrigg Lane in the past. Due to the topography of the site surrounding the tributary of River Conder and the culvert, only a very small area surrounding the tributary flooded.

11.5.11 Value of Sites within the Study Area

The value of receptors is based on the definitions provided in Table 11.2. Important receptors that may be directly or indirectly affected by the proposed development and the value of each receptor are summarised in Table 11.6.

Receptor	Value
Morecambe Bay SAC and SPA	Very High
River Lune	Very High
River Conder	Very High
Small watercourse on site	Low
Two ponds on site	Low
Minor aquifer	Medium

Table 11.6 Potentially sensitive receptors of hydrological, hydrogeological or geological effects due to the proposed development.

11.6 Information Gaps

At the time of writing this chapter of the ES there was no exploratory borehole data. This will be produced as a result of the detailed Site Investigation, which will include a ground investigation at each of the turbine locations.

Only basic plans of for the clearance of woodland and its vegetative regeneration have been finalised.

The design of the SUDS system has not been finalised, this will be completed as part of the detailed design. It will be designed in accordance with the guidance listed in Section 11.3 and to accommodate all of the potential surface water flow from the proposed development areas in the site.

11.7 Assessment of Potential Effects

11.7.1 Construction Effects

All construction will be carried out according to the detailed descriptions provided in Chapter 2: Project Description of this ES.

Potential effects on the environment (without mitigation) that could arise during of the construction phase of the development are outlined below.

11.7.1.1 On-site Access Tracks and Cable Trenches

The construction process will involve stripping of surface vegetation which will expose underlying soils and bedrock. This could increase total surface runoff and the speed of overland flow and will therefore increase the potential for erosion and transportation of sediment.

Excavations on site will require the removal of groundwater and direct rainfall. Unless this dewatering process is correctly managed it may result in transportation of sediments into local watercourses.

Sediment could also be transported from stockpiled material excavated from the turbine bases and other areas of hard standing such as the construction compound and crane pads.

Track location and design may allow surfaces to erode and result in deposition of sediment in watercourses or smothering of local vegetation. Tracks can increase the speed of surface water runoff which will increase the potential for erosion, transportation of sediment and localised flooding.

The development of tracks and cable trenches has the potential to alter natural drainage on the site by the development of preferential flow pathways. There will be no effect on the total quantity of water flowing off the site, but the speed of runoff may be increased with the potential for erosion and transportation of sediment.

Trenches longer than 30 m pose the greatest risk, especially if mineral soil is exposed. If individual trenches carry large amounts of water, this could result in significant erosion and siltation.

The construction period is anticipated to begin in August 2010 and last until January 2011. During this autumn and winter period, extreme site drainage with consequences for erosion and sediment

transport, as well as the potential to overwhelm pollution prevention measures under high runoff flow conditions.

The construction of access road networks and hard-standing areas around the turbine bases will require large quantities of rock aggregate. It is proposed that this aggregate will be excavated from off site and some of this may be stored on site. There will be indirect effects caused by stockpiling of the aggregate on the site, including a potential increase in erosion and suspended solids in surface water runoff.

11.7.1.2 Turbine Bases and Crane Pads

The construction process will involve stripping of surface vegetation which will expose underlying soils and bedrock. This could increase total surface runoff and the speed of overland flow and will therefore increase the potential for erosion and transportation of sediment.

Excavations on site will require the removal of groundwater and direct rainfall. Unless this dewatering process is correctly managed it may result in transportation of sediments into local watercourses. Sediment could also be transported from stockpiled material excavated from the plant construction site. The excavated material will be stockpiled and used for reinstatement of the turbine bases, these stockpiles may be a source of suspended solids in surface water runoff.

The increase in the area of less permeable hard standing on site will marginally reduce potential infiltration rates.

Concrete is highly alkaline (high pH) and changes in the pH balance could impact on the chemical water quality and the species that depend on the current baseline conditions. This could occur from leakage of liquid concrete during pours resulting in release of suspended solids into the onsite watercourse. Given the linkage to the downstream SAC and the sensitive nature of the SAC any concrete spillage incident could, without mitigation, give rise to significant adverse effects on the habitats or the species that are a primary reason for the designation of the Morecambe Bay SAC.

It is proposed that this aggregate will be excavated off site located at an existing quarry and temporarily stored on site before use.

11.7.1.3 Temporary Construction Compound

All cement will be transported to the site, pre-mixed from local sources; therefore there will be no concrete batching on site.

Fuel and oil spillages are potential sources of contaminants. Tracks and compounds where vehicles are re-fuelled or are on stand-by, and areas of chemical and hydrocarbon storage, are potential sites of contamination. Pollution of watercourses could occur through leakage or leaching of chemicals such as fuels, lubricants and solvents.

The location of the temporary construction compound is such that surface water runoff would flow towards the onsite watercourse which is linked to the Morecambe Bay SAC. Given the sensitive nature of the Morecambe Bay SAC, any fuel or oil spillage incident could without mitigation give rise to significant adverse effects on the species that are a primary reason for the designation of the SAC.

Pollution of groundwater and surface water can also arise due to improper management of rubbish, sanitary plumbing and other water storage in the construction compound.

11.7.1.4 Designated Conservation Sites

The qualifying interests within the Morecambe Bay SAC (estuaries, mudflats, large shallow inlets and bays, Atlantic salt meadows and *Salicornia* and other annuals colonising mud and sand) are influenced by water quality and are likely to be sensitive to pollution and siltation. Silt, oils, or other chemicals carried from the access road or other elements of the proposed wind farm by surface run-off may present a risk to the interests of the SAC.

Water flowing off the site or changes in the hydrological regime on site could therefore potentially affect the Morecambe Bay SAC.

11.7.1.5 Woodland Clearance

Felling operations can disturb the soil and removal of the intercepting canopy allows more precipitation to reach the ground. Potential effects on watercourses include significant increases in sediment and ingress of excessive amounts of bark or woody debris. These can smother the stream bed, damage spawning grounds, block streams, and prevent fish movement.

11.7.2 Operational Effects

11.7.2.1 Impermeable surface area

It has been calculated that the wind turbine development (access road, turbine foundations and ancillary crane pads) will occupy a total surface area of 1,500m^2. With this and a 10% increase in rainfall intensity due to climate change, there could be an increased risk of surface water flooding both on site and off site if mitigation measures are not implemented.

11.7.2.2 On-site Access Tracks

Track location and design may allow surfaces to erode and result in deposition of sediment in watercourses or smothering of local vegetation. Tracks can increase the speed of surface water runoff which will increase the potential for erosion and localised flooding.

The location of the access track adjacent to Turbine 2 is aligned in such a way that it will create a preferential pathway for water flowing down the ridge towards the south of the site. Surface water flow gathered on the increased area of impermeable surface area at the turbine base and the crane hard-standing has the potential to follow this pathway along the access track at a relatively high speed and potentially increase erosion, localised flooding and deposition of sediments in the River Conder.

The proposed access tracks will cross the onsite steam at one location and a culvert will be constructed which has the potential to affect natural water flows and stream geomorphology.

11.7.2.3 General Site Activities

On site activities will be limited to the maintenance of wind turbines. During maintenance activities there may be the need to use oils, grease, fuels, lubricants or cleaning agents on site. There is a small risk of chemical pollution arising from accidental spillages during these operations.

11.7.3 Decommissioning Effects

The potential effects that decommissioning could have on water resources will be very similar to those detailed for site construction.

11.8 Mitigation

The mitigation strategy has been formulated to address potential effects over the whole life of the wind turbine development from construction, operation and decommissioning. The specific mitigation measures that have been utilised in each of these stages are described in detail in the following section.

11.8.1 Construction

Mitigation measures in relation to the water environment include use of best practice during construction to prevent or minimise spillage risk and spillage effects. This will require compliance with all of the guidance contained in the relevant Pollution Prevention Guidance (PPG) notes listed in Section 11.3. Specific construction method statements will be developed for each construction activity before construction commences.

11.8.1.1 Project Management

The Contractor will be required to demonstrate application of the relevant PPGs, as outlined in Section 11.3 in addition to detailing specific application of SUDS as detailed in the CIRIA publications listed in Section 11.3.

The contractor will appoint a CDM Coordinator according to the Construction (Design and Management) Regulations (2007), and an Environmental Clerk of Works will be present on site during construction.

An overarching construction management plan will be agreed with EA prior to construction that will ensure that there is no significant negative effect on the water quality or quantity of either the River Conder of the River Lune. This will include construction method statements which will incorporate best working practices and measures from PPGs, in addition to the mitigation measures set out within this chapter. The method statements will include reference to:

- a series of method statements relating to activities which may have the potential to affect surface and ground water within the site, and outlining preventative measures;
- an incident plan outlining actions to be taken in the event of accidental mobilisation of sediments and /or chemical spill. The plan will include arrangements for the implementation of contingency measures, the provision of spill kits, and staff and contractor training requirements; and,

- a water monitoring plan to be agreed with EA.

The application of such practices will ensure there are no significant risks to surface waters and groundwater.

There will be ongoing communication with the EA and NE to ensure that construction activities are timed to minimise the potential effects and ensure that none of these are likely to be significant

11.8.1.2 On-site Access Tracks and Cable Trenches

The track layout has been designed to minimise the total track length and to minimise the number of watercourse crossings to one.

The cable routes will follow the access tracks so the construction process for the laying of cables will not result in any additional stripping of surface vegetation or exposure of additional areas of soil. As cables are likely to be partially bedded in a layer of sand, there is likely to be some superfluous excavated material that will not be used for backfilling trenches.

All areas of unused and exposed soil following reinstatement of the access track route and cable trenches will be reseeded or otherwise covered as soon as possible. Geo-textile matting may also be used to minimise sediment being entrained by water flow or becoming entrained by the wind if allowed to dry out. If appropriate, consideration will be given to the use of small dams or other interceptors in any ditches that run from the site to any watercourse. It is likely to be impractical to cover the ground with geo-textile matting in the areas of the trench works and therefore these areas of trench works will be stripped of vegetative cover for as short a time as possible before the laying of the cables in order to limit the amount of time that the soil is exposed. The excavated area will be re-seeded as soon as possible after cable laying.

Temporary drainage ditches will be installed upslope of the excavations of access tracks to incept surface water flow. Water from the drainage ditches will be treated to remove suspended solids before being pumped to soak away areas.

Silt-traps will be created to capture suspended sediment in water issuing from excavations.

A SUDS drainage system will be constructed in order to minimise discharge rates and remove suspended solids.

11.8.1.3 Temporary Construction Compound

The temporary construction compound will be located at least 50m from all surface water bodies.

All cement will be transported to the site, pre-mixed from local sources; therefore there will be no concrete batching on site.

A location map of all potential contamination sources will be produced, and will include fuel, oil and chemical storage areas; vehicle compounds, refuelling sites, waste storage areas.

An inventory of all chemicals, fuels and oils will be kept up to date and available on site. Spill contingency plans will be created for each of the items on the inventory. These will be supported by warning notices and appropriate spillage containment equipment and materials at key locations.

A site drainage plan and a pollution incident response plan in accordance with PPG21 will be prepared and agreed with the EA prior to commencement of the construction process.

All re-fuelling of plant must take place in an appropriate area i.e. one that has an impervious base and is bunded or provided with interceptor drains. A spill kit will be kept on site and all bowsers are to be double skinned or have a bund. Vehicles and equipment will not be left unattended during re-fuelling.

All pumps, generators and similarly fuelled equipment will be placed on drip trays or in a bunded area and no vehicles or equipment will be allowed to enter the watercourse at any stage. Drip trays will be positioned away from any watercourse or drain.

All valves, hoses and associated re-fuelling equipment will be regularly inspected to ensure that they are still in a suitable condition. This equipment will be protected from vandalism and unauthorised interference and should be turned off and securely locked when not in use.

All tanks or drums of fuel, oil, grease, chemicals and all other hazardous material will be kept in a secure, bunded area. Any spillages or leaks will be dealt with promptly and all waste disposed of in an appropriate manner. All tanks, drums and other containers will be clearly marked as to their contents and will only ever to contain the substance for which the tank was designed or supplied. Before any tank is removed or perforated, all contents and residues must be emptied by a competent operator for safe disposal.

All bunds or interceptors will be adequate for the amount of spillage that could happen in a worst case scenario and should be designed to the appropriate standards. All bunds will have a capacity of at least 110% of the tank volume.

All of the appointed contractors staff who are involved in fuel handling will be given training in the correct procedures for handling this and other potentially polluting material in an appropriate manner and if required, site specific procedures will be developed that all relevant staff must adhere to when handling such material.

11.8.1.4 Woodland Clearance

The Forest and Water Guidelines (Forestry Commission, 2003) will be followed with regard to clearing and felling trees adjacent to watercourses. All mitigation measures in these guidelines will be considered for inclusion in a construction method statement to be agreed with the EA before any felling operations commence.

Consideration will be given to phased clearance of the woodland to minimise the effects of removal of vegetative cover.

The system of drainage in the woodland clearance area will be improved by blocking or bypassing existing drains that lead directly into the watercourses, and the creation of drains aligned with the contours of the valley to maintain an even shallow gradient which will create an effective riparian zone buffer area. These drains will lead to a SUDS drainage system.

11.8.2 Operation

11.8.2.1 Access tracks

Drainage channels for access tracks will be inspected on a regular basis to ensure they are free of debris and that the natural water flow pathways are being maintained.

A SUDS drainage system will be designed and constructed created in the south of the site between the access track and the watercourse. The SUDS system will be designed to reduce runoff rates, thus reducing the risk of flooding at the culvert under Hazelrigg Lane. The SUDS system will also be designed to minimise pollutant and sediment concentrations in surface water runoff, thus protecting the quality of the watercourse leaving the site and consequently the River Conder.

11.8.2.2 Sustainable Drainage Systems (SUDS)

The SUDS systems will be designed and constructed within the site boundary that will ensure that:

- the impact of the development does not exacerbate flood risk at any other point (either upstream or downstream);
- the frequency of discharge rates from the new development is equal to the frequency of discharge rates discharged at the undeveloped site;
- that the frequency of volumes of runoff from the new development is equal to the frequency of volumes that discharged at the undeveloped site;

Serious pollution events can be wholly contained within SUDS components so minimising the damage to the drainage system, and helping ensure that high concentrations of contaminants are not conveyed to the receiving watercourse.

11.8.2.3 Monitoring During Operation

Periodic inspection of drainage channels will be undertaken during the operational phase of the works to ensure that they are operating correctly and they will be cleaned of silt or vegetation if required.

Periodic water quality monitoring will be carried out if required, in agreement with the EA.

11.8.3 Decommissioning

The decommissioning process is anticipated to have similar effects to those in the construction phase but on a smaller scale. Therefore, similar mitigation measures to the construction phase will

be implemented, details to be provided prior to decommissioning and implemented as and when appropriate. Any new legislation/guidelines that arise prior to decommissioning will be adhered to.

11.9 Residual Effects

This section takes into account the mitigation measures described in the previous section and hence effectively forms an assessment of residual impacts and effects once mitigation measures have been taken into consideration.

11.9.1 Construction Impacts

Potential effects of the construction phase of the development on the environment are outlined in the following paragraphs.

11.9.1.1 Access Tracks

The construction process will involve stripping of surface vegetation which will expose underlying soils and drift material (till). This could increase total surface runoff, the speed of overland flow and consequently the potential for transportation of sediment. The magnitude of this effect is considered to be Minor.

Excavations on site will require the removal of groundwater and direct rainfall (dewatering). Even with the use of cut off drains and silt traps, this may result in transportation of sediments into the onsite watercourse. The magnitude of this effect is considered to be Minor.

The construction period is anticipated to begin in August 2010 and last until January 2011. This autumn and winter period is likely to experience the most extreme and sustained annual rainfall events. This is likely to increase erosion and sediment transport, as well as the potential to overwhelm pollution prevention measures under high runoff flow conditions. The magnitude of this effect is considered to be Minor.

There will be indirect impacts caused by stockpiling of the aggregate on the site. The magnitude of this effect is considered to be Negligible.

The development of tracks and cable trenches will alter natural drainage on the site by the development of a preferential flow pathway towards the culvert under Hazelrigg Lane, although this will be minimised due to the creation of a SUDS drainage system to attenuate this overland flow. The magnitude of this effect is considered to be Minor.

The watercourse on site will be crossed by a culvert. The design of this culvert will be agreed with the Environment Agency before construction commences. This is likely to cause some effect on natural water flows and stream bed geomorphology. The magnitude of this effect is considered to be Moderate.

11.9.1.2 Cable Laying

The cable routes will follow those for the access tracks so the construction process for the laying of cables will not result in any additional adverse effects. The magnitude of this effect is considered to be Minor.

Excavations on site will require the removal of groundwater and direct rainfall. Even with the use of cut off drains and silt traps, this may result in transportation of sediments into the onsite watercourse. The magnitude of this effect is considered to be Minor.

11.9.1.3 Turbine foundations

The construction process will involve stripping of surface vegetation which will expose underlying soils and drift material (till). This could increase total surface runoff, the speed of overland flow and consequently the potential for transportation of sediment. The magnitude of this effect is considered to be Minor.

Excavations on site will require the removal of groundwater and direct rainfall. Even with the use of cut off drains and silt traps, this may result in transportation of sediments into the onsite watercourse. Small amounts of sediment could also be transported from stockpiled material for use in turbine base reinstatement. The magnitude of this effect is considered to be Minor.

Concrete is a highly alkali (high pH) and changes in the pH balance of the onsite watercourse could occur from leakage of liquid concrete during pours resulting in release of suspended solids into water features. This is particularly the case at Turbine 2 where these is only 11.5 m between the turbine foundation and the watercourse. However the risk of a pollution incident will be minimised by the mitigation measures proposed above, including the incident plan outlining actions to be taken in the event of accidental chemical spill. The plan will include arrangements for the implementation of contingency measures, the provision of spill kits, and staff and contractor training requirements. The magnitude of this effect is considered to be Moderate.

11.9.1.4 Crane Pads

The crane pads will increase the area of less permeable hard standing on site and will increase surface water run-off. All surface water runoff will be directed to an onsite SUDS system and this will minimise the adverse effects of increased surface water flow. The magnitude of this effect is considered to be Minor.

11.9.1.5 Temporary construction compound

All cement will be transported to the site, pre-mixed from local sources; therefore there will be no batching, lime or cement storage on site. The magnitude of this effect is considered to be Negligible.

Fuel and oil spillages are potential sources of contaminants. Tracks and compounds where vehicles are re-fuelled or are on stand-by, and areas of chemical and hydrocarbon storage, are potential sites of contamination. These will be constructed to anticipate leakage and leaching of contaminants following the guidance listed in section 11.3 and the mitigation and management measures discussed in section 11.8. The magnitude of this effect is considered to be Minor.

Pollution of watercourses could occur through leakage or leaching of chemicals such as fuels, lubricants and solvents. However, standard practice requires the storage of materials within protective bunding of sufficient capacity to contain all spillages. The magnitude of this effect is considered to be Minor.

Pollution of groundwater and surface water can also arise due to improper management of rubbish, sanitary plumbing and other water storage in the construction compound. However, the construction compound will comply with all Pollution Prevention Guidance listed in section 11.3 the magnitude of this effect is considered to be Minor.

11.9.2 Operational Effects

11.9.2.1 Impermeable surface area

It has been calculated that the wind turbine development (access road, turbine foundations and ancillary crane pads) will occupy a total surface area of 1.5 hectares. With this and a 10% increase in rainfall intensity due to climate change, there could be an increased risk of surface water flooding both on site and off site if mitigation measures are not implemented. The magnitude of this effect is considered to be Moderate.

11.9.2.2 On-site Access Tracks

Track location and design may allow surfaces to erode and result in deposition of sediment in watercourses or smothering of local vegetation. Tracks can increase the speed of surface water runoff which will increase the potential for erosion and localised flooding. The magnitude of this effect is considered to be Minor.

The location of the access track adjacent to Turbine 2 is aligned in such a way that it will create a preferential pathway for water flowing down the ridge towards the south of the site. Surface water flow gathered on the increased area of impermeable surface area at the turbine base and the crane hard-standing has the potential to follow this pathway along the access track at a relatively high speed and potentially increase erosion, localised flooding and potential deposition of sediments in the River Conder. Due to the fact that the SUDS system will be designed to capture all of this run-off the magnitude of this effect is considered to be Minor.

The proposed access tracks will cross the onsite steam at one location and a culvert will be constructed which has the potential to affect natural water flows and stream geomorphology. The magnitude of this effect is considered to be Moderate.

11.9.2.3 Accidental Spillages

There is the potential for accidental spillages during the operation and maintenance of the wind farm. A location map of all potential contamination sources will be produced, and will include fuel, oil and chemical storage areas; vehicle compounds, refuelling sites, waste storage areas. An inventory of all chemicals, fuels and oils will be kept up to date and available on site. Contingency plans will be created for each of the items on the inventory. These will be supported by warning notices and appropriate spillage containment equipment and materials at key locations. The magnitude of this effect is considered to be Minor.

11.9.3 Decommissioning Impacts

The potential impacts on the hydrological and geological environment during decommissioning are similar to those during the construction phase, and similar mitigation measures are likely to be required.

Details of decommissioning procedures are outlined in the Chapter 2: Project Description of this ES. The potential impacts that the decommissioning could have on water resources will be very similar to those detailed above for site construction and the procedures as outlined for site construction will be adopted. If new guidelines are published prior to decommissioning of the site then, where appropriate, these will be incorporated into the decommissioning procedures. The magnitude of this effect is considered to be Minor.

11.9.4 Summary of Residual Effects

Proposed Activity	Value of Receptor (Table)	Magnitude of Residual Effect after Mitigation (Table)	Significance (Table)	
			Level	Summary
Construction				
Access Tracks				
Erosion of exposed ground and track surfaces producing silt-laden runoff which enters the onsite watercourse	Low	Minor	Not Significant	Mitigation to prevent silt laden run-off and contamination entering watercourses is critical to achieving a low significance of effect.
Dewatering of excavations	Low	Minor	Not Significant	Silt traps, cut-off drains and directing drainage water towards SUDS system, will minimise adverse effects of dewatering excavations.
Construction during the winter period maximises potential rainfall on exposed soils and surface water runoff.	Low	Minor	Not Significant	The use of silt traps and SUDS will minimise the rate of overland flow and sediment transportation.
Stockpiles of aggregate stored on site	Low	Negligible	Not Significant	Aggregate will be stored at least 50 m from the onsite watercourse
Preferential flow pathway towards the culvert under Hazelrigg Lane	Low	Minor	Not Significant	All drainage from the access tracks will be directed into an onsite SUDS system which will reduce runoff rates, thus reducing the risk of downstream flooding
The watercourse on site will be crossed by a culvert.	Low	Moderate	Not Significant	This is likely to cause some effect on natural water flows and stream bed geomorphology. The design of this culvert will be agreed with the Environment Agency before construction commences.
Cable Laying				
Erosion of exposed ground surfaces producing silt-laden runoff	Low	Minor	Not Significant	The cable routes will follow those for the access tracks so the construction process will not result in any additional adverse effects
Dewatering of excavations	Low	Minor	Not Significant	Silt traps, cut-off drains and directing drainage water towards SUDS system, will minimise adverse effects of dewatering excavations.
Turbine Foundations				

Proposed Activity	Value of Receptor (Table)	Magnitude of Residual Effect after Mitigation (Table)	Significance (Table)	
			Level	Summary
Erosion of exposed ground and track surfaces producing silt-laden runoff which enters the onsite watercourse	Low	Minor	Not Significant	Mitigation to prevent silt laden run-off and contamination entering watercourses is critical to achieving a low significance of effect.
Dewatering of excavations	Low	Minor	Not Significant	Silt traps, cut-off drains and directing drainage water towards SUDS system, will minimise adverse effects of dewatering excavations.
Concrete spillage entering watercourse on site.	Low	Minor	Not Significant	Incident plan outlining actions to be taken in the event of accidental chemical spill including arrangements for the implementation of contingency measures, the provision of spill kits, and staff and contractor training requirements.
Concrete spillage entering watercourse and causing chemical pollution of River Conder.	Very High	Minor	Significant	Incident plan outlining actions to be taken in the event of accidental chemical spill including arrangements for the implementation of contingency measures, the provision of spill kits, and staff and contractor training requirements.
Crane Pads				
Less permeable hard standing increasing surface water run-off.	Low	Minor	Not Significant	All surface water runoff will be directed to an onsite SUDS system and this will minimise the adverse effects of increased surface water flow.
Temporary Construction Compound				
Concrete batching, lime or cement storage on site.	Low	Negligible	Not Significant	All cement will be transported to the site, pre-mixed from local sources; therefore there will be no batching, lime or cement storage on site.
Fuel and oil spillages during refuelling.	Low	Minor	Not Significant	Refuelling areas will be constructed to anticipate leakage and leaching of contaminants following the guidance listed in paragraph 11.3 and the mitigation and management measures discussed in section 11.8.
Pollution of onsite watercourses through leakage or leaching of chemicals such as fuels, lubricants and solvents.	Low	Minor	Not Significant	Standard practice requires the storage of materials within protective bunding of sufficient capacity to contain all spillages.
Pollution of groundwater and surface water due to management of water on the construction compound.	Low	Minor	Not Significant	The construction compound will comply with all Pollution Prevention Guidance listed in paragraph 11.3.

Proposed Activity	Value of Receptor (Table)	Magnitude of Residual Effect after Mitigation (Table)	Significance (Table)	
			Level	Summary
Operation				
Impermeable surface area				
Increase in impermeable surface area	Low	Moderate	Not Significant	All surface water runoff will be directed to an onsite SUDS system and this will minimise the adverse effects of increased surface water flow.
On-site Access Tracks				
Surface erosion and deposition in on-site watercourse	Low	Minor	Not Significant	Limited land take, working area around foundations/pads re-vegetated following construction period with only minimal area retained with a surface layer of stone aggregate for maintenance access.
Track layout adjacent to turbine 2 creating a preferential pathway which could increase sedimentation and flooding adjacent to Hazelrigg Lane	Low	Minor	Not Significant	All surface water runoff will be directed to an onsite SUDS system and this will minimise the adverse effects of increased surface water flow.
On-site watercourse culverted	Low	Moderate	Not significant	This is likely to cause some permanent effect on natural water flows and stream bed geomorphology. The design of this culvert will be agreed with the Environment Agency before construction commences.
Accidental Spillages				
Chemical spillages during maintenance operations or from on-site storage	Low	Minor	Not Significant	A location map of all potential contamination sources will be produced, An inventory of all chemicals, fuels and oils will be kept up to date and available on site. Contingency plans will be created for each of the items on the inventory. These will be supported by warning notices and appropriate spillage containment equipment and materials at key locations.
Decommissioning				
Potential impacts arising from decommissioning activities	Low	Minor	Not Significant	Impacts similar to, but on a smaller scale, than construction impacts. Similar mitigation measures will be implemented at the time taking account of any new best practice available at the time.

Table 11.7: Significance of Residual Effects

11.10 Statement of Significance

The significance of residual effects is summarised in Table 11.7. In determining the potential significance of an effect, the value of the receptor (Table 11.2) and the magnitude of the potential change (Table 11.3) are combined, to determine the significance of that effect using a significance matrix (Table 11.4).

It should be noted that to compensate for the tree removal and culverting described within this chapter a habitat mitigation strategy involving compensatory tree planting and wetland creation is currently being designed, basic details of this are provided in Appendix F section F7. Full details of this mitigation strategy will be supplied as an addendum following submission of the EIA. Should the proposed mitigation plan have any additional hydrological impacts other than those defined above these will be addressed as part of the addendum.

Chapter 12:

Traffic, Transport and Highway Impact

12. Traffic and Transport

12.1 Introduction

The technical content of this chapter of the ES is based on the finding of a Traffic and Accessibility Assessment carried out by Aecom on behalf of Lancaster University, and a separate Highways Impact report carried out by Thomas Consulting to assess the operational impact of the turbines on the M6 motorway.

This chapter of the ES evaluates the requirements for transporting the turbine components; assesses the route against these transportation requirements and identifies any likely temporary works required on the local authority highway network. The chapter describes and details the proposed design for the access junction and the internal tracks to the crane pads and turbine bases. This chapter also appraises the highway impacts of the proposal once operational and provides an assessment of the traffic generation for the site based on the three phases of the wind farm's life: construction, operation and maintenance and decommissioning and mitigation against the impact of the development.

12.2 Consultation

As part of the Pre Application consultation process and Scoping process relevant organisations were contacted with regard to the proposal. These being;

- Lancashire County Highways Department
- The Highways Agency
- Network Rail

Their responses are outlined in Appendix A Section A4 and A5

12.3 Guidance and Legislation

The relevant legislation and guidance that have been used to inform this section of the ES are listed within the assessment sections below.

12.4 Assessment Methodology

The relevant methodologies and assumptions that have been used to inform this section of the ES are listed within the assessment sections below.

12.5 Baseline Description

12.5.1 Introduction

The site is situated on the eastern side of the M6 motorway adjoining Hazelrigg Lane approximately 1.7 miles north of Junction 33, as shown in Appendix A sections A1 and A2.

The turbines will need to be transported from a port which is likely to be located on the east coast to the turbine site. This is likely to involve the use of the strategic road network and the M6 and therefore the accessibility of the site will be based upon the ease by which the turbine components can be moved from the strategic road network to the site.

The development site is located between junctions 33 and 34 of the M6. The route from junction 34 has been discounted due to the necessity for the turbine components to travel through Lancaster to reach the site. Therefore the most suitable route to the site will be based on Junction 33 and the A6 utilising major roads and avoiding significant population centres.

12.5.2 Oversized Vehicle Assessment

This section presents the information gathered from turbine manufacturers regarding the component and transportation requirements for each turbine. This then summarises the worst case scenario calculating a swept path analyses of the access junction on Hazelrigg Lane and the route from the M6 to the site for the largest vehicle.

12.5.2.1 Assumptions

The analysis is based upon turbines that are capable of generating in excess of 2 Megawatts of electricity during normal operation. For the purposes of the assessment the maximum hub height has been set at up to 80m and the maximum tip height at upto130m, thus incorporating the current turbine scale of 59m hub and 101 tip, as well as, building in flexibility as the current turbine manufacture will not be finalised until the detailed design phase of the project.

12.5.2.2 Transportation of Turbine Components

The turbine manufacturers have supplied information on the size of the turbine components and the vehicles used to transport them. The size and number of turbine components for each turbine type is identified and detailed in the sections below with the worst case scenarios highlighted for each one and overall.

The turbine consists of 3 No tower sections. Figures 12.1-12.3 provide examples of typical vehicle dimensions for the transportation of this turbine.

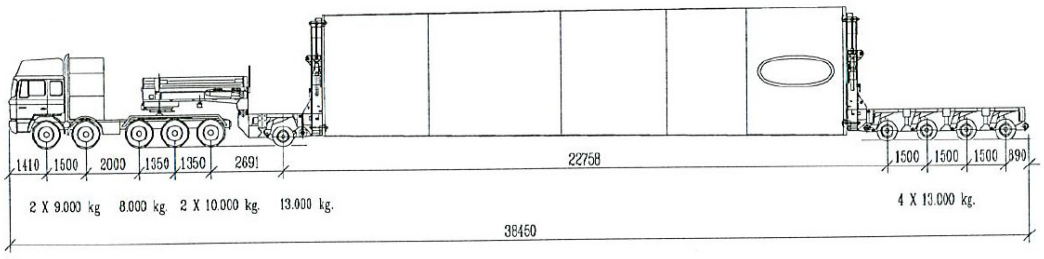

Figure 12.1 - Tower base vehicle, maximum width - 4.82m, maximum height – 5m

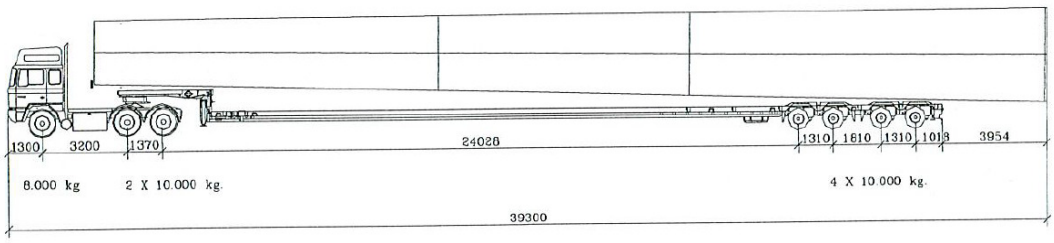

Figure 12.2 - Tower top vehicle, maximum length 39.3m.

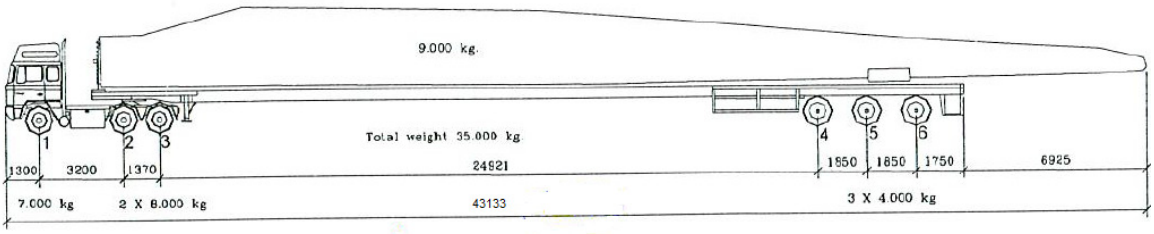

Figure 12.3 - Single blade transport vehicle, maximum length = blade length + 5m (51m).

12.5.3 Swept Path Analysis Vehicle Dimensions

The horizontal clearance required for the vehicles was assessed employing a swept path analysis using the AutoTrack program created by Savoy. The vehicle used for this analysis is based on one with the maximum dimensions of all of the components above. This produces a conservative, worst case scenario and the various actual transportation vehicles for the movement of the turbine blades, tower sections and nacelles will be modelled and selected at a later stage during the wind turbine project detailed design.

Based on the turbine component information above the vehicle modelled has the following maximum dimensions:

- Overall Length: 56.1m
- Wheelbase width: 2.52m
- Length of load: 51m
- Width of load: 4.9m
- Height of load: 4.9m

The vehicle configuration for the swept path analyses is shown below and on drawing 60102072-1-001 and 60102072-1-002 in Appendix L section L2.

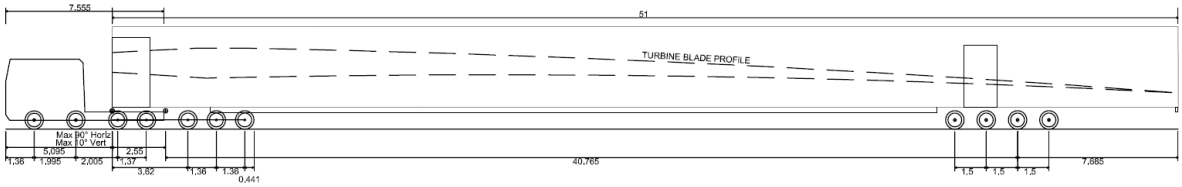

Figure 12.4 - Vehicle used for swept path analysis

12.5.4 Route Assessment

12.5.4.1 Introduction

This section evaluates the route from where the oversize and abnormal loads leave the strategic highway network (M6 Junction 33) onto the local authority highway network (A6) to the site access on Hazelrigg Lane and details any mitigation and temporary works required in order to allow for the transportation of the turbine components.

12.5.4.2 Information Gathering

The information for this route assessment was produced using the following data sources:

- All diagrammatic information is based on Ordinance Survey vector mapping products acquired for the area.
- The layout of the A6 signalised junction at Hazelrigg Lane and the layout of the roundabout on Hazelrigg lane has been obtained from a topographical survey sent by Lancaster University.
- A visit to the site to obtain measurements and photographs occurred on the 22nd September 2009. The aim of this site visit was to survey the route from the M6 to the site entrance with photographs taken of geographical details along the way. These photographs have been used within this report and are shown on the photograph schematic in Figure 12.6 below.
- In addition to a walkthrough of the route, digital video of the route from a car driving at the speed limit was obtained from the M6 to the site entrance and back. This will be used to identify specific issues and obstacles along the route for abnormal loads and vehicles.
- Measurements obtained via the use of a measuring wheel and 5 metre tape measure were obtained for the major obstacles on routes, the Skew Bridge, the A6/Hazelrigg Lane and the M6 overbridge.

12.5.4.3 Route Summary

The oversized and abnormal load vehicles will be escorted under traffic management from the chosen harbour along the strategic road network to the M6 junction 33.

The loads will leave the strategic road network at junction 33 onto the A6/M6 roundabout. The loads will then turn right onto the A6 northbound, through Galgate, continuing on the A6 for a mile until the signalised junction at Hazelrigg Lane. The loads will turn right at the signalised junction, onto Hazelrigg Lane, through the university mini-roundabout, east towards the development site.

12.5.4.4 Assessment Methodology of Height and Width Restrictions and Consulted Reponses

According to the Lancashire County Council mapping service (http://mario.lancashire.gov.uk) the A6 is a high load route with no bridge height or width restrictions.

Queries have been issued to Lancashire County Council and Network Rail on Monday 5th October 2009 to confirm ownership of the bridges crossed en-route and to provoke initial contact. No responses have been received to this date. Lancashire County Council had stated that they will be available for consultation when the planning application is submitted.

The ESDAL process (http://www.esdal.com) which the movement of the abnormal loads will need to undergo prior to being given approval by the Highways Agency requires details of

vehicle types and transportation dates to be known. This information will not be available until after the planning phases of the project.

12.5.4.5 Route Description Maps

In order to assess the route it has been broken down into legs which consist of major movements or sections of the journey from the M6 to the development site. These legs are shown on the route schematic in Figure 12.5 below;

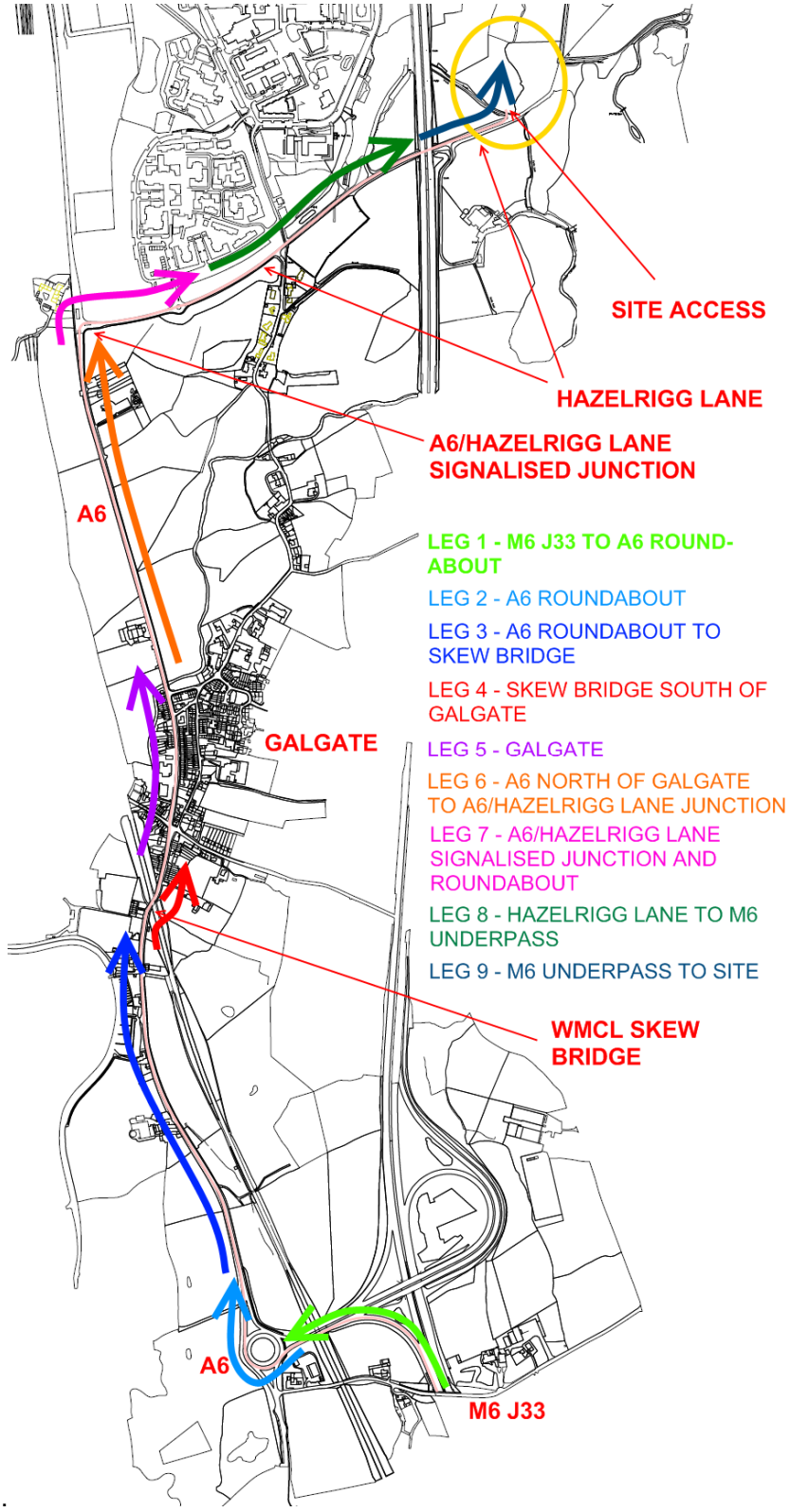

Figure 12.5 - Route Schematic from M6 J33 to Site Access showing Route Legs

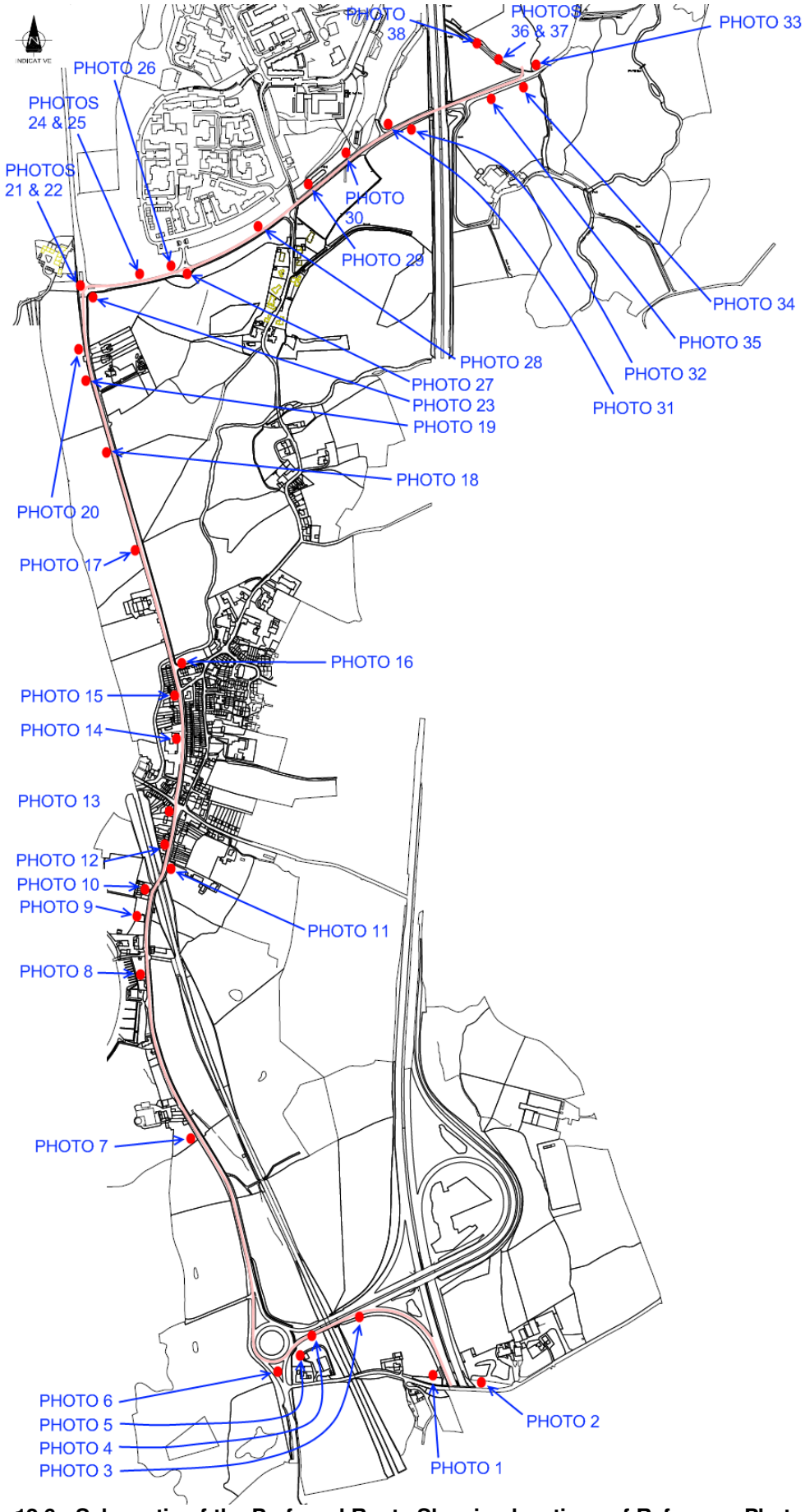

Figure 12.6 - Schematic of the Preferred Route Showing locations of Reference Photographs used in the Assessment

Full details of the reference photographs are provided in Appendix L section L1

12.5.4.6 Detailed Description of Route

- **Leg 1 – M6 J33 to A6 Roundabout**

  The diverge to the A6 consists of a full standard length and width ancillary lane which passes under the Hampson Lane bridge. This auxiliary lane leads onto the slip road from the M6 which curves to the west with a positive gradient before merging with the southbound slip road prior with the entry to the roundabout.

- **Leg 2 – Northbound on A6 at A6 Roundabout**

  At the A6 roundabout the loads will move into the right hand lane before manoeuvring around the roundabout onto the northbound arm of the A6.

- **Leg 3 – A6 Roundabout to Galgate Skew Bridge**

  Upon exiting the roundabout the loads will continue north on the A6 towards Galgate. The loads will pass businesses and properties with off-street parking on both sides of the road and will pass under overhead BT telecoms cables before positioning themselves prior to passing under the Skew Bridge (West Coast Main Line Masonry Arch) outside The Plough public house.

- **Leg 4 – Skew Bridge (West Coast Main Line Masonry Arch) South of Galgate**

  The Skew Bridge is a masonry arch bridge which carries the West Coast Mainline over the A6. The arch through which the A6 passes in is between 11.2 metres and 12.9 metres in width and is greater than 8 metres in height at the centre of the arch. The bridge is at a 21 degree skew. The bridge is owned by Network Rail and has a reference of CGJ6 16M 62.5CH.

- **Leg 5 – Galgate**

  It is proposed that the loads will pass through the town of Galgate along the A6 north past houses, public houses and shops on both sides of the road, through a signalised junction, and then past more houses, public houses and shops on both sides of the road. Within the village there is on-street parking allowed and regularly spaced bus stops both of which will constrain the movement of any abnormal vehicles and loads in the village.

- **Leg 6 – A6 North between Galgate and Lancaster University Southern Entrance**

  The A6 between Galgate and the university is a 50 mph wide single carriageway road with several accesses to businesses and farms on both sides of the road. The road has excellent visibility. The A6 is approximately 7.7 metres in wide on this stretch.

- **Leg 7 – Signalised junction with A6 and Hazelrigg Lane up to the University mini-roundabout**

  At the signalised junction the loads will turn right into Hazelrigg lane. The ahead-only lane is 4.5 metres wide, with a 2 metre traffic island and the right turn lane is 3

metres wide with a 1.5 metre traffic island. There are signal posts and signs along each of the traffic islands. When the loads turn right they will over-run the traffic islands on both the right arm and the right turn lane and this movement will require works to be done to allow for these items to be temporarily removed. The vehicle and load is likely to over-run the traffic islands and the south eastern radius of the junction during the right turn movement onto Hazelrigg Lane.

Hazelrigg lane is positively graded up towards the mini roundabout. Upon entering the mini-roundabout the loads will overrun the small central island and the splitter island on either side of the roundabout and then continue along the Hazelrigg Lane. Between the signalised junction and the roundabout, Hazelrigg Lane is a minimum of 7.4 metres in width. After the roundabout Hazelrigg Lane narrows to 6 metres wide.

- **Leg 8 – Hazelrigg Lane to M6 Underpass**

Hazelrigg Lane continues east of the roundabout along a single carriageway 30mph road with double yellow markings on either side up towards the Chapel Lane priority junction. After Chapel lane the road narrows to 5 metres and increases in speed up to the national speed limit while dropping down a slight gradient towards the M6 Underpass. The road levels and widens to 7.4 metres leading up to the M6 underpass and is flat passing through the structure. The M6 underpass on Hazelrigg lane has been measured to be approximately 5.1m high on the western side and approximately 5.6m high on the eastern side.

- **Leg 9 – M6 Underpass into Development Access Junction**

Once the load has passed underneath the M6 the load will position itself in the road to turn left across the existing access track and junction and up the slope into the wind turbine site. The existing field, hedgerows, trees and landform will be reprofiled and removed as required to allow the vehicle to safely traverse the access junction without obstruction.

12.5.4.7 Swept Path Analysis of Route

The swept path analysis results below are shown on drawings 60102072-1-001 and 60102072-1-012 in Appendix L Sections L2. Section 12.5.2 provides details of the vehicle used and the overall route.

- L**eg 1 – M6 J33 to A6 Roundabout – Drawing 60102072-1-002 Viewport 1**

  On exiting the M6 northbound the transport vehicle will bear left, allowing the load to over-hang the hard shoulder as it travels up an incline in a westerly direction onto the A6 slip road. It will not be possible for vehicles to pass the transport vehicle on this slip-road due to the load extending over the centreline of the slip road. The transport vehicle will not have a physical impact on the network on this section of the movement.

- **Leg 2 - Northbound on A6 at A6 Roundabout – Drawing 60102072-1-003 Viewport 1**

  As the transport vehicle crosses the West Coast Main Line onto the A6 the load will occupy a portion of the left lane and will prevent vehicles over-taking. As the transport enters the A6 roundabout northbound the rear of the load will swing around, not crossing the left kerb line, but preventing vehicles from passing the vehicle on its right. The vehicle will then straighten up and leave the roundabout heading north onto the A6. The transport vehicle will not have a physical impact on the network on this section of the movement.

- **Leg 3 – A6 Roundabout to Galgate Skew Bridge - Drawings 60102072-1-004 and 60102072-1-005 Viewports 1, 2, 3 and 4.**

  Upon exiting the roundabout the load will bear left with the leftmost edge of the load being in line or just over the left kerbline in areas of verge. The width of the load will restrict vehicles in the opposite carriageway forcing them to slow down on approach to the transport vehicle. The road is approximately 9 metres wide with 4.9 metres of the available road width being taken up by the transport vehicle and its load. The transport vehicle will not have a physical impact on the network on this section of the movement.

- **Leg 4 – Skew Bridge (West Coast Main Line Masonry Arch) South of Galgate - Drawing 60102072-1-006 Viewport 4.**

  On approach to the Skew Bridge the transport vehicle will position itself to move through the arch. The front of the vehicle will mount the left footway for a distance of 36 metres prior to the arch in order to negotiate the right turn. After this the vehicle will come off the footway and run parallel to the left channel while the rear wheels mount the left footway behind it. As the vehicle's rear wheels mounts the footway the load will overhang and will require a single street lighting column to be relocated or temporarily removed.

  The vehicle will move underneath the arch with no further incursions onto the footway as it straightens up on the northern side of the bridge. The rear wheels will mount the right footway prior to passing underneath the bridge as the load straightens up on the northern side of the bridge. As the vehicle passes underneath the bridge the load will first overhang the left footway and then overhang the right footway. To achieve this on-street parking will need to be regulated during the movement in order to allow for the movement of the vehicle through the arch.

- **Leg 5 – Galgate - Drawing 60102072-1-006 and 60102072-1-007 Viewports 4 and 5.**

  The vehicle will straighten up using both sides of the A6 prior to passing underneath the Skew bridge and it will then continue across the signalised junction, remaining in the left carriageway as it travels north. The A6 north of the signalised junction between numbers 59 and 3 is generally less than 7 metres wide which means that bidirectional operation through Galgate during the movement of the transport will not be possible. It will be possible, however, for vehicles to be parked on the right hand side of the road during the movement of the load. The vehicle will then straighten up as it heads north and over the Galgate Bridge. The transport vehicle will not have a physical impact on the network on this section of the movement.

- **Leg 6 - A6 North between Galgate and Lancaster University Southern Entrance – Drawings 60102072-1-007 Viewports 5 and 6.**

  The vehicle will continue north on the A6 after it crosses the Galgate Bridge and will stay on the left hand side of the road and as the road widens to approximately 7.5 metres it will be possible for southbound traffic to pass the transport vehicle at reduced speeds. The transport vehicle will not have a physical impact on the network on this section of the movement.

- **Leg 7 - Signalised junction with A6 and Hazelrigg Lane up to the University mini-roundabout – Drawing 60102072-1-008 Viewport 6 and Drawing 60102072-1-011 and 60102072-1-012 Details 1 and 2.**

  The transport vehicle will turn right into Hazelrigg Lane at the signalised junction. The vehicle will need to turn right prior to the central traffic island and will pass directly over the island as it begins its manoeuvre. It will then pass over the pedestrian traffic island on the right arm as it enters the road. The rear axle will follow the front during this movement.

  At this junction, the load will encroach first on the verge on the left side of the carriageway and the left traffic island before encroaching on the right hand footway as it cuts the corner of the junction. The load will then cut across the northern footway of Hazelrigg lane as it straightens up eastbound.

  As the vehicle travels along Hazelrigg lane it will then need to pass over the roundabout central island and the two small traffic islands as it travels across the roundabout.

  The movement of the vehicle will require all the signals, bollards, signs, pedestrian guardrail and lighting columns in the affected areas to be installed in post boxes in order to allow them to be temporarily removed during the movement of the loads. At the roundabout the illuminated bollards and signs on the islands will need to be removed temporarily during the movement of the loads. The movement of the vehicles and the installation of the temporary works will require the signals and their controller to be shut down. This will require careful traffic management and temporary signals.

  Uncontrolled bidirectional operation will not be possible during these movements due to the need for the transport vehicle to cut across the junction and the roundabout.

- **Leg 8 – Hazelrigg Lane to M6 Underpass, Drawing 60102072-1-009**

  The load will proceed east along Hazelrigg Lane. As the load approaches the Chapel Lane priority junction it will need to move into the centre of the road so that the load will avoid the speed limit signs situated in the left and right verges. The load will then align itself in a favourable position in order to negotiate the downward incline on approach to the M6 Underpass (it is likely that some trimming of the overhanging tree branches at this location will be required, this is to be assessed prior to the movement). The transport vehicle will not have a physical impact on the network on this section of the movement.

- **Leg 9 – M6 Underpass to Development Site Access, Drawing 60102072-1-010**

  The load will position itself on the left side of the road while passing underneath the M6 as this side of the road will have more height clearance than the right hand side due to the incline of the M6. The load will move underneath the structure slowly making absolutely certain to avoid any risk of contact between the bridge structure and the turbine components. The vehicle will then position itself in the centre of the road in order to allow the vehicle to swing into the site access. The movement into the site access will cause the load to overhang the right verge and cause the rear wheels to track onto the opposite carriageway during the movement. It will not be possible for uncontrolled bidirectional movement to be in operation on Hazelrigg Lane during these movements due the load requiring the use of both carriageways.

10.5.4.8 Associated Impacts and Mitigation

Based on the above swept path analysis, the impacts of this scheme on the local and strategic highway network are as follows:

- **Leg 1**: The transportation vehicle will prevent two lane operations on the slip road from the M6 onto the A6 roundabout.
- **Leg 2 and 3**: The transportation vehicle will prevent normal two lane operation on the A6 between the A6/M6 roundabout and Galgate due to the limited width of the road and the necessity for the closure of the southbound lane at Skew Bridge.
- **Leg 4:** At the Skew Bridge (60102072-1-005 and 60102072-1-006, Appendix L section L2, Viewport 4), the load will overhang both footways as it passes underneath the masonry arch. A single lighting column located on the footway outside number 90 will need to be temporarily removed for this movement to occur. Additionally, parking restriction to prevent on-street car parking will be required between numbers 56 and 78 on the western side of the road, and between numbers 79 and 103 on the eastern side of the road.
- **Leg 5:** The transportation vehicle will prevent normal two lane operation on the A6 in Galgate due to the reduced width of the road.
- **Leg 7:** There will be a need for existing signs, signals, guardrail, street lighting columns to be reinstalled in post boxes at the Hazelrigg Lane signalised junction on the south and Hazelrigg Arms. This will be in order to allow the vehicle to cut across the junction during the movements. Kerbs and paving will require protecting using other methods, such as steel loading plates.
- **Leg 8:** Trees overhanging the carriageway on Hazelrigg Lane will require checking and trimming to prevent branches and detritus from impacting the turbine components during transportation.
- **Leg 8:** Traffic management will be required along Hazelrigg Lane east of Chapel Lane in order to accommodate the vehicles due to the reduced width of the road and the likelihood that normal bidirectional flow will not be possible.
- **Leg 9:** Vehicle and load will need to traverse under the M6 underpass, with the highest part of the load passing through the highest section of the bridge. This will require the vehicle to use both carriageways. Three dimensional information for the

road and the structure will be required in order to properly assess the clearance underneath the structure.

- **Leg 9:** Traffic management will be required on Hazelrigg Lane at the site access in order to allow the vehicle to turn left into the site where movements on the opposite carriageway are required.

12.5.5. Proposed Access and Internal Tracks

12.5.5.1 Introduction

This section develops a layout for the access into the wind turbine site and a layout for the access tracks to the turbine foundations, crane pads and assembly areas. The proposed access will redevelop the existing field accesses to allow for the movement of abnormal and heavy goods loads into and out of the site.

12.5.5.2 Proposed Arrangement of Access

The proposed access uses an existing field access located approximately 180 metres north east of the M6 under bridge on Hazelrigg Lane. The existing access is a 40° skew junction which is surfaced with bituminous material. This access is fronted by a secured steel gate and provides access into the surrounding fields.

The proposed site access will reuse this existing access junction and materials and will provide additional means for abnormal loads and heavy goods vehicles to turn left into and right out of the site. This will be achieved by widening the access to the west by constructing the access as shown on drawing 60102072-1-013 in Appendix L section L2.

The proposed access consists of a bituminous surfaced bell mouth incorporating the existing access junction, and will have a 17 metre radius on the western side and a 15 metre radius on the eastern side and a total width of 40 metres. These radii will tie into the access road which is 7.2 metres wide at the gate. This bell mouth will be used by the heavy goods vehicles to enter and exit the site as shown in the swept path analyses on drawing 60102072-1-016 in Appendix L section L2.

On the western side of the junction there will be an over-run area which will be used to accommodate the movements in and out of the junction for abnormal load vehicles. This over-run area will be constructed of compacted granular material and surfaced using a grass reinforcement geogrid product which is capable of taking a gross axle loading of 17 tonnes. The geometry of this over-run will consist of a compound curve which has a 61 metre radius, an 8 metre radius and another 61 metre radius which then leads into 13 metre long 1 in 12 taper into the access road.

The vertical profile of the road will be suitable for the transportation and movement of abnormal loads and heavy goods vehicles and based on site observations it is estimated that this gradient will be no more than 1 in 25 across the access while steepening up to approximately 1 in 15 along the access track.

Alongside the over-run is a verge which varies in thickness and will be constructed of topsoil and low height foliage. This verge provides the necessary clearance for the loads when they are entering and exiting the site. This verge will be backed by hedgerow.

The construction of the proposed access will require the removal of some existing hedgerow; see Appendix F section F7 for further details.

The construction depths and materials for the access are detailed in Section 12.5.6.3 below.

12.5.5.3 Proposed Arrangement of Internal Tracks

The internal tracks in the vicinity of the access junction are generally 5 metres in width. At the access junction the access tracks widen from 5 metres to 7.2 metres using a 1 in 12 taper and this is to allow left turning vehicles to straighten up and overtake exiting vehicles.

To allow large vehicles entering the site to pass vehicles exiting the site a lay-by which can accommodate the largest abnormal loads will be provided prior to the access junction. This lay-by will be 75 metres in length with a 30 metre long 1 in 5 taper on entry and a 75 metre long 1 in 12 taper on the exit. The width of the lay-by will be 6 metres.

The arrangement for the access tracks is shown on drawings 60102072-1-016 and 023 in Appendix L section L2.

The construction depths and materials for the internal tracks are detailed in Section 12.5.6.3 below.

12.5.5.4 Swept Path Analysis of Access and Internal Tracks

Swept path analyses have been produced using the abnormal load vehicle described in Section 12.5.2 and a 16.5 metre articulated heavy goods vehicle. The abnormal load movement into the site will cater for the worst case scenario during the construction phase, and the movement out of the site will cater for the worst case scenario during the decommissioning phase.

On the movement into the site as shown in drawing 60102072-1-014 Appendix L section L2, the abnormal load vehicle will begin to turn left at the beginning of the over-run area with the front steering tractor aligned to allow the vehicle to cut across the junction and swing the rear axles into the opposite carriageway on Hazelrigg Lane. The over-hang of the abnormal load will encroach on the opposite verge in the vicinity of overhead telephone cables before being brought into the access as the front tractor moves forward. The abnormal load will overhang the western verge of the access as the front tractor straightens up onto the access track. It will not be possible for other vehicles to use this access while this movement is taking place.

When leaving the site the abnormal load vehicle will align itself to run over the western over-run area prior to turning right onto Hazelrigg Lane. The vehicle will straighten up in stages, letting its load overhanging the western verge before moving into Hazelrigg Lane and straightening up. The abnormal load will not overhang onto any of the verge on Hazelrigg Lane. It will not be possible for other vehicles to use this access while this movement is taking place.

Heavy goods vehicles will be restricted to using only the paved bituminous bell mouth section of the junction. Heavy goods vehicles will be able to freely pass each other on entering and exiting the junction with no conflicts between the passing vehicles observed.

2.5.6. Assumptions for Traffic Generation

12.5.6.1 Units of Traffic Generation and Key Definitions

- For the purposes of this assessment, a single trip will be a movement into or out of the site by any vehicle.
- A light goods vehicle is a vehicle under 7.5 tonnes in weight and can be anything from a car to a large panel van.
- A heavy goods vehicle is a vehicle over 7.5 tonnes in weight.
- An abnormal load vehicle is a vehicle which is over 40 tonnes in weight or over 18.75 metres in length.
- Monthly figures will be based on the assumption that there are 22 working days in a month and that there is no weekend working to take place.

12.5.6.2 Construction Vehicles for Site Access, Tracks and Crane Pads

The construction of the site access, the tracks to the turbine bases and the crane pads will require construction vehicles to clear and excavate the land and lay the materials needed to construct this infrastructure.

The following has been assumed in regards to construction vehicles:

- Construction plant once brought on site will remain on site until the scheme is concluded and that it will be only brought to site once during the construction period.
- The construction plant will be brought to site using a low loading heavy goods vehicle and taken away by this same size vehicle.
- Two mobile cranes will be brought to site. One being the main crane which will be of either a mobile telescopic or an assembled lattice boom type which will have a loading capacity capable of lifting the nacelle and hub to the top of the tower and an auxiliary crane which will be used to assemble the rotor and the blades. These vehicles will come in multiple sections which will need to be assembled on site.

12.5.6.3 New and Excavated Materials for Site Access, Tracks, Crane Pads and Assembly Areas

The construction of the access, the access tracks and the crane pads and turbine foundations will require material to be excavated and new material brought in to construct the road structure. In addition to this drainage will need to be constructed and the existing landform will likely need reprofiling to suit the longitudinal design of the access tracks. The construction of the access tracks is based on the Figure 12. below which is based on the recommended track construction provided by the turbine manufacturers.

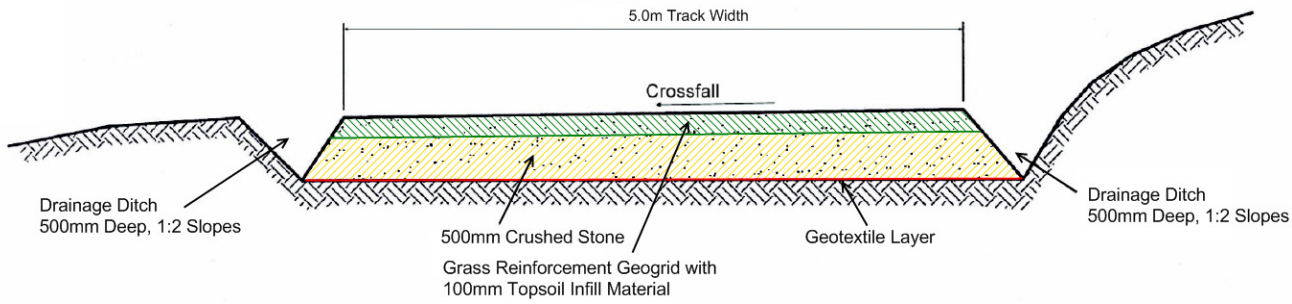

Figure 12.7 - Assumed Access Track Construction

The access track will require the excavation of a minimum of 500mm depth of topsoil, some of which can be re-used on site minimising tipping requirements. The ground underneath the access track will then be compacted and a geotextile material the full width of the access road will then be laid atop this compacted foundation. A top this textile a 500mm thickness later of Type 1 compacted granular material will be laid to a minimum of 5 metres in width, banked at either side to a minimum grade of 1 in 2 into the drainage ditch. A grass reinforcement geogrid will be used to provide a running surface for at least part of the access track. It will be compacted into a 100mm thickness layer of recycled topsoil with grass seed sown into its surface. At least one lay-by should be provided on the access track as a site compound will not be constructed, to allow for vehicles to pass by any transporter vehicles. These lay-bys should be minimum of 5 metres wide by 61 metres long.

The crane pads and loading areas will require deeper foundations and loading thicknesses due to the higher loads these areas will undergo during construction and likely future maintenance

and these areas will be constructed using up to 600mm of Type 1 granular material. This will be constructed in a similar manner to the access road utilising a 500mm excavation of the existing topsoil, compacting the foundation and laying a geotextile with 600mm of type 1 granular material laid atop this geotextile. In addition to this, surface water drainage will need to be laid around the perimeter of the crane pad and loading area. The crane pad and loading area is to be laid flat with a maximum gradient of 1% and constructed at a level of not less than 1.5m below the level of the top of the turbine foundations.

The site access will be constructed up to the entry gate of bituminous construction comprising of a minimum 150mm Type 1 sub-base, 90mm bituminous base course, 60mm bituminous binder course and 45mm bituminous surface course in accordance with Lancashire County Council's Estate Roads Standards for Industrial Use. This will be used to form the bell mouth used by the majority of the light and heavy goods traffic.

For the over-run areas for the abnormal load vehicles a construction of 300mm of type 1 sub-base and 100mm of grass reinforcement geogrid with topsoil infill will be used to reduce the visual impact of the access and provide a stable running surface for the abnormal load vehicles.

The grass reinforcement geogrid will be capable of carrying a load of 15 tons per square metre and has been specified in order to reduce the visual impact of the access and the tracks.

When decommissioning the site, 100mm of topsoil and geogrid material which overlays the crushed stone will be removed on the tracks. The crushed stone will remain in place and levelled. For the assembly area and crane pads, 100mm of crushed stone will be removed instead.

Based on the assumption that the maximum chosen size turbine will be used for this development, the crane pad and assembly guide, This is shown below:

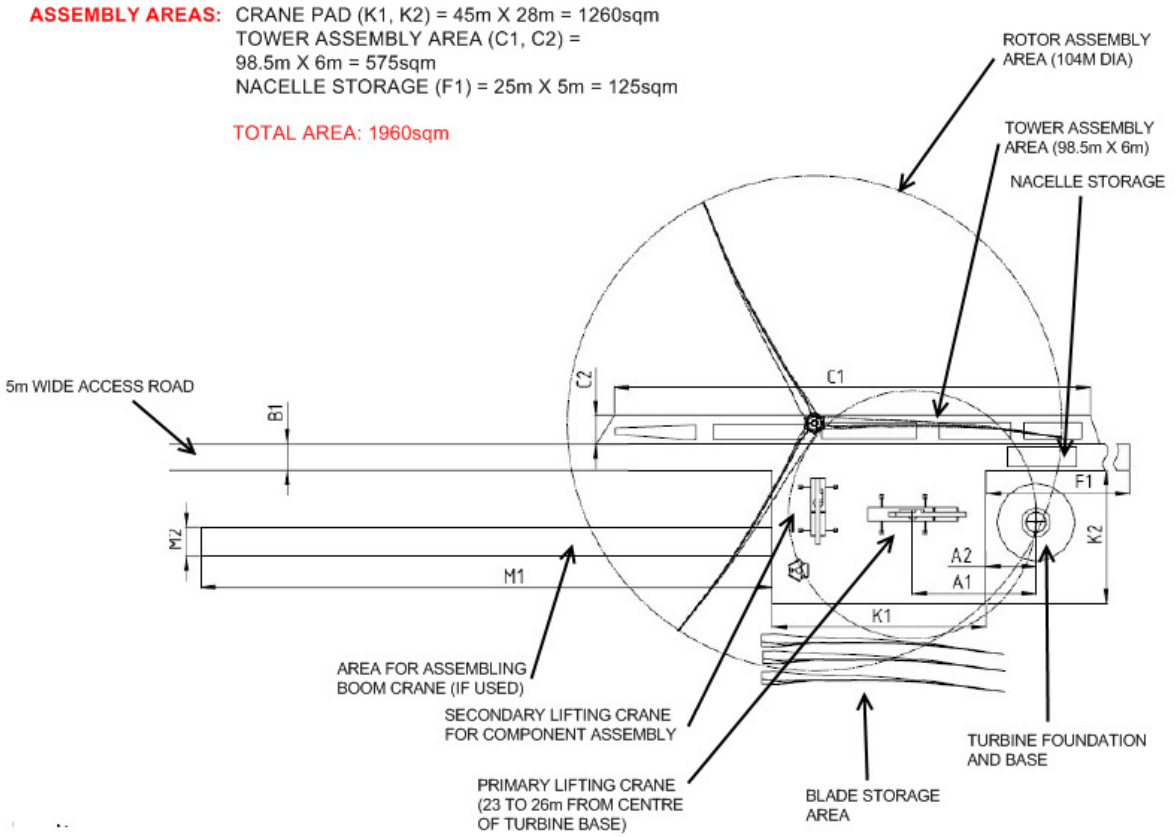

Figure 12.8 - Turbine Assembly Area and Crane Pad Requirements

The following assumptions apply for the construction phase:

- HGV vehicles carrying compacted stone will be able to carry 6.2m^3 of material per trip.
- HGV vehicles carrying excavated material (topsoil) will be able to carry 7.5m^3 of material per trip.
- All vegetation will be mulched, chipped and kept on site.
- Only topsoil which cannot be reused on site will be removed
- An assembly area for the boom crane and turbine rotor will need to be cleared of vegetation, but not surfaced. The others areas indicated in Figure 12. above will require excavation and construction.

12.5.6.4 Concrete for Foundations

The concrete for the turbine foundation will need to be mixed off-site and transported to the turbine foundations via the use of concrete transportation vehicles. Due to the time limitations of the premixed concrete, and the need to pour the foundation in one go, a significant number of deliveries will need to occur in a short amount of time. A single ready mix concrete lorry can carry approximately 6.75 m^3 of concrete and assuming that a turbine base consists of approximately 400m^3 of ready mix concrete of which 45 tonnes of this is steel reinforcement, the number of concrete deliveries required to pour the foundation can be calculated. These will likely occur in a single day during the construction period unless the foundation can be constructed in multiple pours.

12.5.6.5 Turbine Component Transport

The numbers of abnormal vehicles needed to complete the transportation of each turbine on site are as follows and are based on the turbine component information in Section 12.5.2.

- 4 No Abnormal Vehicles for the transportation of the tower sections, max width 4.9m wide,
- 3 No Abnormal Vehicles for the transportation of the turbine blades, max length 51m (57m),
- Max 3 No Abnormal Vehicles for the transportation of the nacelle, rotor hub and drive train.
- 4 No HGV Vehicles for miscellaneous internal and external equipment.

12.5.6.6 Miscellaneous Site Equipment

There will be an allowance for a further 20 heavy goods vehicles for the connection equipment into the national grid and the provision of a transformer and connection equipment. The exact nature of the additional grid equipment and cabling to be provided is not yet known, but it is felt that this figure will be sufficient to cover this.

12.5.6.7 Decommissioning and Site Clearance

For the decommissioning of the site the turbines will be dismantled into transportable sections, maintaining integrity of the individual components during the transportation of the components to their destination for dismantling and recycling. It is therefore assumed that the same number of abnormal vehicles will be required for the eventual removal of the components. In addition to this, construction vehicles will be required to dismantle the turbine foundations to 1m below ground level. The crane pads and loading areas will be left to grow over as is with no additional material taken offsite.

12.6 Information Gaps

Details of any gaps in information that have been identified when undertaking the traffic, transport and highways impact studies are documented and discussed in the relevant assessment sections within the chapter of the ES.

12.7 Assessment of Potential Effects

12.7.1 Potential Construction Effects

The construction of the turbines and associated work is expected to take approximately 5 months with the first three months consisting of the construction of the drainage system and enabling works which will allow access to the turbine locations, the third month consisting of the turbine assembly and foundation works and the final month consisting of final turbine assembly, commissioning works, reinstatement and mitigation works. The process of construction the turbines is detailed in Figure 12.9 below with the timetable and the forecast traffic generation shown in Figure 12.10.

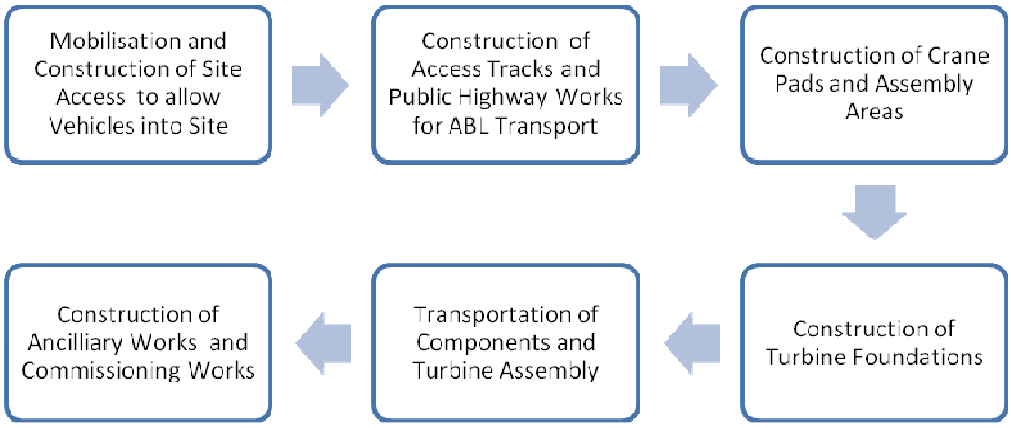

Figure 12.9 - Construction Process for the Wind Turbine Development

Traffic Generation (Movements In, Out)	Month					
Activity	1	2	3	4	Total	
Mobilisation to Site	50	0	0	0	50	HGV MOVEMENTS
Construction of Access	80	0	0	0	80	
Construction of Tracks	0	1428	0	0	1428	
Construction of Crane Pads and Assembly Areas	0	642	0	0	642	
Turbine Foundations	0	6	120	0	126	
Turbine Deliveries	0	0	18	0	18	
Turbine Assembly and Commissioning	0	0	0	0	0	
Ancillary Works	0	0	0	40	40	
Average Daily HGV per Month	**6**	**96**	**7**	**2**		
Monthly HGV Movements	**130**	**2076**	**138**	**40**	**2384**	TOTALS
Monthly ABL Movements	**8**	**0**	**10**	**0**	**18**	
Monthly Light Vehicle Movements	**1100**	**1100**	**880**	**440**	**3520**	
Total Monthly Vehicle Movements	**1238**	**3176**	**1028**	**480**	**5922**	

Table 12.10 - Construction Traffic Generation – All Movements

12.7.2 Potential Operation Effects

12.7.2.1 Introduction

This section looks at set back distance guidance and appraises the visual impact of the turbines from the motorway network. It does not appraise the impacts of shadow flicker, light reflection or adverse weather conditions. These impacts are assessed separately within chapters 8 and 13 of the ES.

Spatial Planning Advice Note SP 12/09 by The Highways Agency – 'Planning Applications for Wind Turbines Sited Near To Trunk Roads' gives guidance on the construction of wind turbines in proximity to a motorway or trunk road.

Point 13 of Highways Agency SP 12/09 states that "*Consideration of the risks associated with structural failure and 'icing' identifies the clear need to incorporate a safety margin in the offset between the trunk road boundary and the siting of a wind turbine. Therefore, it is appropriate to achieve a setback from the nearest highway boundary equal in distance to their height + 10% for micro and small turbines. Commercial turbines should be set back a distance equal to their height + 50 metres*"[1]

Point 15 of SP 12/09 states that *"any potential for visual distraction should be minimised, not by screening but rather by the provision of a clear, continuous view of the wind farm that develops over the maximum possible length of approach carriageway The potential for distraction may be greater than with other roadside features – advertisements, etc., do not generally rotate – but a clear view from distance will considerably reduce the temptation for drivers to turn their heads when passing the towers".*[1]

Point 53 of PPS22 Companion Guide states that "*Although a wind turbine erected in accordance with best engineering practice should be a stable structure, it may be advisable to achieve a set-back from roads and railways of at least fall over distance, so as to achieve maximum safety*[2]

Point 54 of PPS 22 Companion Guide states "*Concern is often expressed over the effects of wind turbines on car drivers, who may be distracted by the turbines and the movement of the blades. Drivers are faced with a number of varied and competing distractions during any normal journey, including advertising hoardings, which are deliberately designed to attract attention. At all times drivers are required to take reasonable care to ensure their own and others safety. Wind turbines should therefore not be treated any differently from other distractions a driver must face and should not be considered particularly hazardous. There are now a large number of wind farms adjoining or close to road networks and there has been no history of accidents at any of them".*[2]

12.7.2.2 Information Gathering and Methodology

The assessment has been carried out for two wind turbine with hub height of 59m and a ground to tip height of 101m. The grid references for the turbines are as follows; T1; 349175, 457789 and T2 349093, 457073.

Information regarding the land ownership boundary of the application site was provided by Lancaster University estates department.

A video was taken along the M6 northbound and southbound between Junctions 33 and 34. Photographs at points along the motorway have been extracted and the locations for the wind turbines superimposed on them, as indicated on the Location Plan for Photographs in shown below in Figure 12.11

[1] Highways Agency 2009, NETWORK SERVICES SPATIAL PLANNING ADVICE NOTE: SP 12/09 PLANNING APPLICATIONS FOR WIND TURBINES SITED NEAR TO TRUNK ROADS

[2] Planning for Renewable Energy A companion guide to PPS22 http://www.communities.gov.uk/documents/planningandbuilding/pdf/147447.pdf

12.7.2.3 Set Back

In accordance with Highways Agency SP 12/09 a setback from the M6 boundary equal in distance or greater than tip height plus + 50 metres is achieved for both turbines as detailed by the site layout plan Appendix B section B4

In accordance with PPS22 a setback of tip height plus 10% from all other roads, as detailed by the site layout plan Appendix B section B5, has been agreed with Lancashire County Highways department who were contacted during the scoping opinion stage of the project.

12.7.2.4 Visibility Assessment

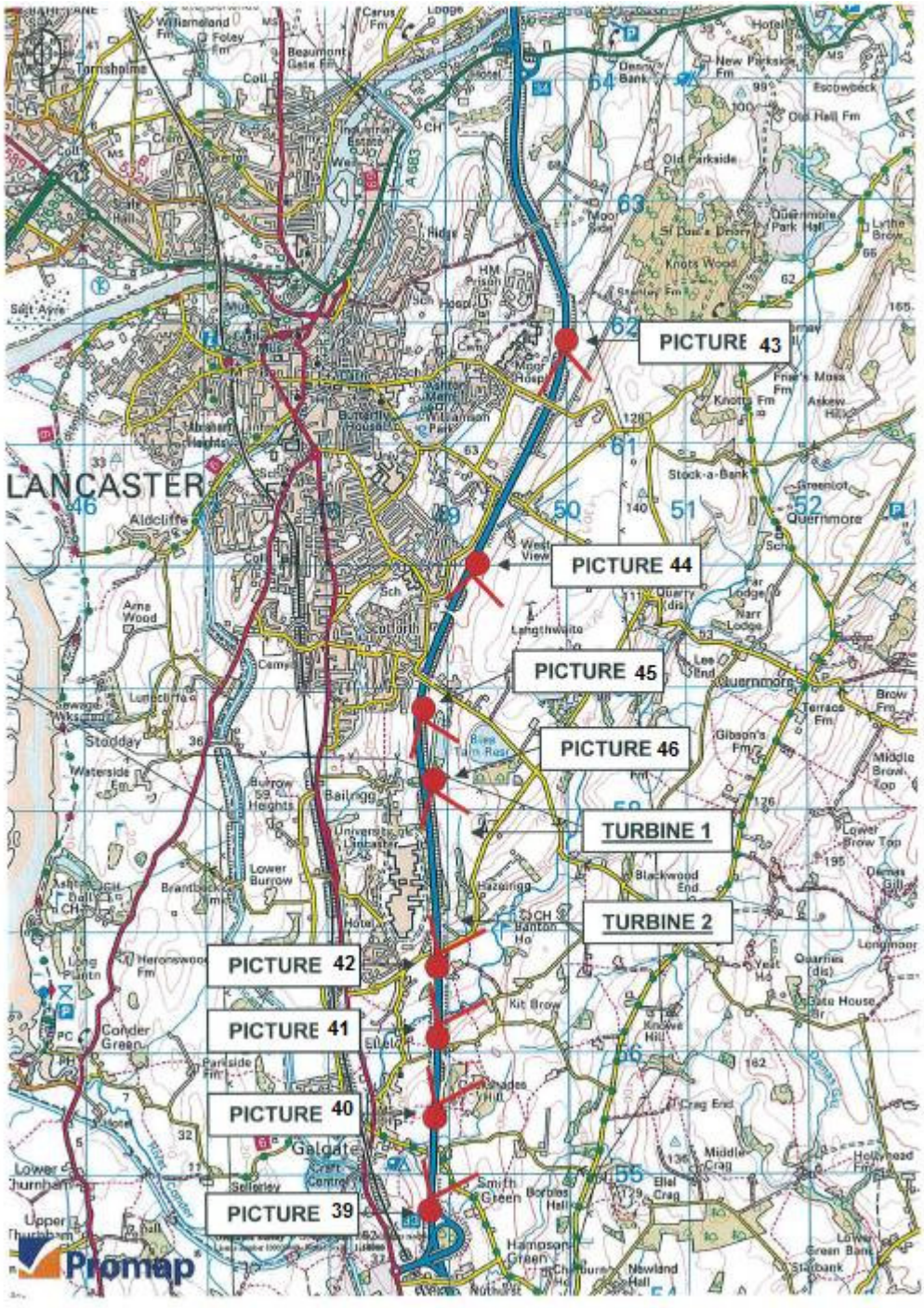

Figure 12.11 Map showing locations of reference Photographs used in the Motorway Impact Assessment

Full details of the Motorway Impact reference photographs are provided in Appendix L section 3

Photograph 39 in Appendix L section L3 is where a vehicle has just entered the motorway from the northbound slip road of Junction 33. Both turbines will be visible on the horizon, with the distance to Turbine 1 (the first turbine) being approximately 1.5 miles.

Photographs 40 to 42 Appendix L section L3 show that both turbines will be visible all the way along this section of the motorway.

The first time a turbine will be visible to a driver travelling southbound will be approximately 1.4 miles from Junction 34 and an approximate distance to Turbine 1 of 2.8 miles, Photograph 43, where the Turbine will be visible on the horizon above the bridge over the motorway. Prior to reaching the bridge the Turbine will not be visible as the motorway is in a tree lined cutting.

Due to the topography, vegetation and trees the next clear sighting of Turbine 1 will be approximately 2.8 miles from Junction 34 and approximately 1.4 miles from the Turbine, Photograph 44.

Beyond Photograph 45, Appendix L section L3 the motorway is again in a tree lined cutting and the next clear view of the Turbines will be after passing under the road bridge approximately 0.8 mile from Turbine 1, Photograph 46 Appendix L section L3 , which is taken approximately 3.6 miles from Junction 34 and 0.6 miles from Turbine 1.

The Turbines will then be visible to a driver above the trees lining the eastern side of the motorway, Photograph 8 taken approximately 4.0 miles from Junction 34 and 0.2 miles to Turbine 1.

For northbound traffic the proposed turbines will be visible from Junction 33 until traffic reaches the site, an approximate distance of 1.7 miles.

For southbound traffic the turbines will first be visible at approximately 1.4 miles from Junction 34 and an approximate distance to Turbine 2 of 2.8 miles. Due to the topography, vegetation and trees adjoining the motorway drivers will have intermittent sight of the turbines until approximately 0.8 miles from Turbine 1 where the turbines will be visible to drivers above the trees lining the eastern side of the motorway.

It is therefore considered that turbines will be sufficiently visible to drivers travelling south that they will not be a distraction and drivers will not need to turn their heads when passing the turbines.

The visibility of the wind turbine development by road users on the M6, A6, A588, A683 and B5272 is also discussed in Chapter 6 section 6.11.3 of the ES which demonstrates the turbines will be clearly visible from the M6.

12.7.2.5 Accident Data

Lancashire County Council were approached for the accident data along the M6 between Junctions 33 and 34 over a period of 3.5 years between March 2006 and September 2009, Appendix L sections L4 and L5.

Point 15 of SP 12/09 states that "*The existing accident record and type of accidents occurring near the proposed wind turbine should be analysed. Locations with a history of rear end shunt accidents should be treated with particular caution".*

A majority of the accidents occurred on or in the vicinity of Junctions 33 and 34. There are nine rear end shunts of which four were in darkness, and only three were adjacent to the site, these were 153225, 153892 and 179243. All three of these accidents were as a result of slow moving traffic.

From the accident data the rear end shunts in the vicinity of the site would appear to be attributed to slow moving traffic as a result of roadworks. Four of the other rear end shunts happened during darkness, therefore there does not appear to be any particular distractions in the area which could be a contributing factor to the accidents.

12.7.2.6 Operational Traffic Generation

During the 25 year operational lifetime for the scheme the turbine and the ancillary equipment will need to be inspected and maintained in order for the wind farm to be safe and operational. The assumed maintenance requirements for the site are as follows:

- Turbine Servicing – Every 6 months for 2 Days,
- Extended Turbine Servicing – One of the servicing periods every year will last for 4 days,
- Access Track and Site Maintenance – Once a year for 3 days,
- Five Yearly Servicing – Once every 5 years, for 2 days,
- Contingency Maintenance – Allowance for 2 days/year for emergency or unforeseen maintenance to turbines or site.

It is assumed that for each trip two LGVs and one HGV will be required on site with no equipment remaining in the site overnight and therefore, based on the above frequencies

	HGV Total	LGV Total	TOTAL
Turbine Servicing	4	8	12
Extended Turbine Servicing	8	16	24
Access Track and Site Maintenance	6	12	18
Five Yearly Servicing	1	2	3
Contingency Maintenance	4	8	12
Annual Number of Trips	**23**	**46**	**69**
Average Daily Trips per Year	**0.1**	**0.2**	**0.3**

Table 12.12 - Operational and Maintenance Traffic Generation

12.7.3 Potential Decommissioning Impacts

The decommissioning of the wind farm once the 25 year lifespan has been reached will take place over a maximum of three months. The first month will be spent mobilising the demolition contractor to site and the decommissioning of electrical and mechanical equipment ready for transport. The second month will consist of the removal of the turbine structure, components and the demolition of the foundations for the turbine. The final month will be spent returning the site to its previous condition by removing the top layers of the access tracks and crane pads and removing all the added material from site. This process is shown in figure 12.13 below and the forecast traffic generation in Table 12. below.

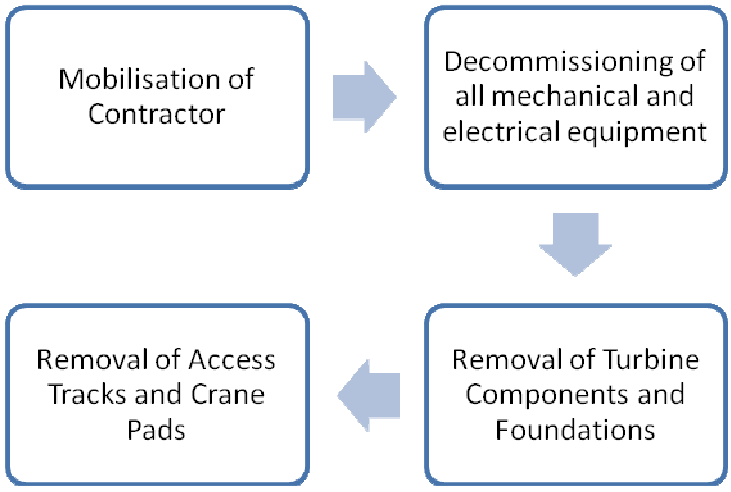

Figure 12.13 - Decommissioning Process for the Wind Farm Development

Traffic Generation (Movements In, Out)	Month				
Activity	1	2	3	Total	
Mobilisation to Site	50	0	0	50	HGV MOVEMENTS
Decommissioning of Equipment	40	0	0	40	
Turbine Removal	0	18	0	18	
Excavation of 1m of Foundations	0	58	0	58	
Excavation of Crane Pads and Assembly Areas	0	0	172	172	
Excavation of Tracks	0	0	64	64	
Average Daily HGV per Month	**6**	**4**	**12**	**0**	
Monthly HGV Movements	**90**	**76**	**236**	**402**	TOTALS
Monthly ABL Movements	**8**	**10**	**0**	**18**	
Monthly Light Vehicle Movements	**1100**	**880**	**660**	**2640**	
Total Monthly Vehicle Movements	**1198**	**966**	**896**	**3060**	

Table 12.14 - Decommissioning Traffic Generation – All Movements

12.8 Mitigation

12.8.1 Construction and Decommissioning

- The movements will be timed to occur outside of peak periods so that the impact of these movements on the local road network can be reduced.
- Vehicles will only be permitted to turn left in and right out of the site access in order to improve the safety of the access junction. This will also have the effect of reducing the traffic impact on Hazelrigg Lane east of the access junction.
- The management of vehicles will need to be detailed in a Traffic Management Plan prior to the site becoming operational. This plan will detail the methodology to be used to schedule the vehicles and to prevent the site from having an overly negative impact on the local and strategic road network.
- There is likely to be disruption to Hazelrigg Lane during the construction works for the site access due to the need for traffic management while excavation and construction occurs and this will be managed in accordance with Chapter 8 of the Traffic Signs Manual.[3]
- The construction of the access junction will require hedgerow removal. Compensatory replacement habitat will be replanted elsewhere on site. Vegetation will not be removed during breeding season (February to July inclusive) unless checked for checked for breeding birds by ecologist. Basic details of ecology mitigation measures are provided in Appendix F section F7.
- The current proposed route of the internal access tracks requires that a culvert structure be provided over an existing beck as described in Chapter 11 of the ES.

[3] Traffic Signs Manual Chapter 8 Traffic Safety Measures and Signs for Road Works and Temporary Situations http://www.dft.gov.uk/pgr/roads/tss/tsmanual/tsmchap8part1.pdf

12.8.2 Operation

- The proposal accords with guidance provided in PPS 22 and Spatial Planning Advice note SP 12/09 therefore no mitigation is required.

12.9 Residual Effects

Implementation of the identified mitigation will ensure that the road network and highway safety will not be adversely affected by the proposed turbines.

12.10 Statement of Significance

The turbines accord with setback guidance provided by the Highways Agency and County Highways Department and will be sufficiently visible to drivers travelling south that they will not be a distraction and drivers will not need to turn their heads when passing the turbines. Furthermore it does not appear to be any particular distractions in the area which could be a contributing factor to the accidents.

During the mobilisation of the contractor, when the sites first begin operating, there is likely to be a surge of heavy goods and light goods vehicle traffic as the construction plant and site equipment is transported. This is likely to occur within a very short timeframe and will occur during both the construction and decommissioning phases. The movements will be timed to occur outside of peak periods so that the impact of these movements on the local road network can be reduced. Due to the temporary nature and phasing of construction activity the overall impact is considered to be insignificant.

When the turbine components are transported to and from site there will be significant disruption in the vicinity of the site access as the loads cross the carriageway under escort from and into the site. Again this disturbance will be temporary in nature with abnormal movements occurring in a single or a couple of short periods to minimise the impact on the local road network.

The removal of waste materials and the importing of new materials for the construction and decommissioning of the access, access tracks, crane pads and assembly areas will use bulk transportation lorries which will be timed to make deliveries and removals outside of peak hours in order to minimise the impact on the local road network.

The transportation of concrete to site during the pouring of the turbine foundations is likely to cause some disruption as 60 concrete delivery vehicles will need to access and egress the site during the pour at a rate of 10 or more vehicles an hour outside of peak times. This level of impact will only occur once during the construction of the wind turbines and associated works.

The management of vehicles will be detailed in a Traffic Management Plan prior to the site becoming operational. This plan will detail the methodology to be used to schedule the vehicles and to prevent the site from having an overly negative impact on the local and strategic road network. This will ensure that the impact of all site traffic is minimised.

Chapter 13 : Miscellaneous Issues

13 Miscellaneous Issues

13.1 Introduction

This chapter of the ES describes and assesses the potential effects of the wind turbines on air quality, health and safety, waste management and weather conditions.

13.2 Consultations

General consultation has been carried out with BWEA, Lancaster City Council Environmental Health department and the Environment Agency. The advice received has been used to inform the following section of this ES chapter.

13.3 Guidance and Legislation

The relevant legislation and guidance that has been consulted to inform this section of the ES is listed within the relevant assessment sections below.

13.4 Assessment Methodology

For the purposes of this assessment significant effects on air quality are categorised as those which would result in a fundamental or material change to air quality. Significant effects on health and safety are categorised to arise if fundamental deviations to recognised health and safety procedures occur.

The relevant assessment methodologies that have informed this section of the ES are listed within the relevant assessment sections below.

13.5 Baseline Description

The relevant baseline descriptions that have informed this section of the ES are documented within the assessment topic sections below.

13.6 Information Gaps

Details of any gaps in information are documented and discussed in the relevant assessment sections below.

13.7 Assessment of Potential Effects

13.7.1 Potential Air Quality Effects

13.7.1.1 Construction

The movement of vehicles and plant on site would create exhaust emissions which in turn will have impacts on air quality. Details of the number of vehicles predicted during the construction, operation and decommissioning phases of the project can be found in Chapter 12.7 of this ES.

In addition to vehicle movements, certain construction activities could create dust in dry, windy conditions. The EIA has been undertaken during the design phases of the project and therefore some technical aspects of the construction phases have yet to be determined. Mitigation measures to limit the occurrence of dust would be incorporated into a Pollution Prevention Plan that will be designed and implemented following finalisation of the technical aspects of site construction.

Given the short term nature of the construction period effects of construction on local air quality are likely to be negligible.

13.7.1.2 Operation

Climate Change is a current serious environmental threat that has already been accepted on a global level. The Intergovernmental Panel on Climate Change (IPCC) has stated that warming of the climate system is unequivocal" following observations of "increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level".[1]

Carbon Dioxide (CO2), Methane and Nitrous Oxide are the most environmentally damaging greenhouse gases, which rapidly escalated to their highest ever recorded levels in the 1990s, which was also the warmest decade since pre-industrial times; Eleven of the last 12 years (1995-2006) rank among the warmest years ever recorded on the global surface temperature instrumental record [1] CO_2 emissions contribute approximately 70% of the potential global warming effect created by greenhouse gases (between 1970 and 2004, annual CO_2 emissions rose by approximately 80%. [1]

Electricity in the UK is currently generated from a range of sources including fossil fuels, nuclear fuel and renewable energy. The use of fossil fuel in the generation of electricity releases greenhouse gases, predominantly CO_2, as described above.

Wind turbines create no atmospheric pollution during operation. The Lancaster University Wind Turbines have the potential to displace electricity generated from fossil fuels and consequently prevent CO_2 from being released.

The actual amount of CO_2 released through electricity generation in the UK relates directly to the generating plant in use at any given time. This mix changes on a daily basis and will change in the future as UK generating plant is replaced and as a consequence it is not possible to predict exactly how much CO_2 release the wind turbine will prevent over its lifetime.

The Digest of United Kingdom Energy Statistics (DUKE Stats) 2007: Carbon Dioxide Emissions from Power Stations in 2006[2] assumes that when generating electricity from gas 370g of CO_2 are released each kilowatt hour (kWh); this is increased to 875g per kWh when generation is from coal. The typical UK electricity generation 'mix' for 2011 (the anticipated year of installation) is anticipated to be 533g of CO_2 per kilowatt-hour of electricity generated[2]. This has been used to calculate the Emission Reductions detailed in Appendix A Section A3.

Based on the estimates from the typical UK electricity generating mix the Lancaster University wind turbine with an installed capacity of 4.1MW, would displace **5743 tonnes of CO_2 emissions per annum**.

In addition the operation of the wind turbines could, based on the same assumptions detailed in Appendix A section A3, also displace other gases related to coal fired electricity generation including those associated with acid rain such as sulphur dioxide ($S0_2$) and Nitrogen Oxides (NOx). Based on a same installed capacity the Lancaster University Wind turbine would displace **107 tonnes of $S0_2$ emission per annum and 32 tonnes of NO_x emissions per annum**

1Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007) Solomon, S et al (eds.). Cambridge, United Kingdom.
http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm

2 BNXSO1: Carbon Dioxide Emissions Factors for UK Energy Use , Version 4.1, Market Transformation Programme 2009

The mix of generation sources is likely to change in the long term, which will affect the calculations presented. It is therefore difficult to quantify the lifetime effects of the wind turbines on emissions. The cumulative generation of power from wind turbines and other forms of renewable energy generation may allow more dated fossil fuel power stations to be decommissioned at the end of their of their design lives, reducing the national emissions of pollutants from electricity generation.

13.7.1.3 Decommissioning

Decommissioning impacts will be the same as those identified during the construction of the development. Given the short term nature of the decommissioning period effects of decommissioning on local air quality are likely to be negligible.

13.7.2. Potential Health and Safety Effects

The selected construction contractor will, in accordance with the UK Industry regulations carry out a comprehensive health and safety assessment prior to the construction of the Lancaster University Wind Turbines. The information presented within this ES provides an outline of the issues to be addressed.

The implementation of the construction, design and management principles (CDM) will result in a wind development, designed, built, operated and maintained to the highest safety standards.

The relevant guidance in the documents listed below has been used to assess the impact of the proposed development to public safety.

- Office of the Deputy Prime Minister: PPS22 Planning and Renewable Energy (2004) and its Companion Guide
- BWEA: Guidelines for Health and Safety in the Wind Energy Industry (2005) and the October 2008 Revision
- BWEA: Wind Turbine Safety Rules, March 2006
- BWEA: Best Practice Guidelines for Windfarm Owners and Operators, January 2009.

The construction of the development site would be managed in accordance with the Health and Safety at Work etc. Act 1974 and comply with the relevant Health and Safety Regulations including;

- The Management of Health and Safety at Work Regulations 1999
- The Construction (Health, Safety and Welfare) Regulations 1996, by Statutory Instruments 1996/1592, 1998/494, 1999/3242 and 2000/2380
- Construction (Design and Management) Regulations 2007
- Electricity Safety, Quality and Continuity Regulations 2002
- Electricity at Work Regulations 1989
- The Control of Noise at Work Regulations 2005
- Personal Protective Equipment at Work Regulations 1992
- Manual Handling Operations 1992
- The Lifting Operations and lifting Equipment Regulations 1998
- The Health and Safety (Safety Signs and Signals) Regulations 1996
- Work at Height Regulations 2005
- Personal Protective Equipment Regulations 2002
- Control of Substances Hazardous to Health (COSHH)

There are no residential properties within the boundaries of the proposed development however a number of temporary Lancaster University owned research buildings are present to the south of the site. Risk assessments of these building will take place prior to commencement of the development, if risk to these building is deemed high relocation of the temporary building will be considered.

13.7.2.1 Construction

Civil work and turbine construction is undertaken according to relevant CDM regulations, British Standards and the British Wind Energy Association (BWEA) guidance relating to the design and construction of foundations and the use of cranes.

The layout and design of the proposed wind farm takes into account the following considerations

- Location of existing services
- Public safety
- Existing structures on site
- Access
- Construction
- Maintenance/Inspection
- Emergencies
- Safe access to the wind farm has been assessed. The following issues have been addressed and are incorporated within the design of the proposed wind farm
- Vehicle size, weight and clearance distances
- Maintenance of public access requirements
- Stability of ground conditions
- Prevention of conflict with underground or overhead services
- Traffic control

During the construction and decommissioning phases, clear warning signs will be displayed notifying of the construction works and temporary restrictions on site.

13.7.2.2 Operation

The site would operate to the IBWEA (British Wind Energy Association) Guidelines for Health and Safety in the Wind Energy Industry.

Wind turbine technology is well proven with many years of experience in Europe and throughout the world. PPS22 states that “properly designed and maintained wind turbines are a safe technology”.

Although the actual wind turbine manufacturer has yet to be confirmed, they will be designed and manufactured in accordance with British and European Standards (listed below), and the relevant certification documentation can be provided on request:

- BS EN 50308:2004 Wind turbines - Protective measures - Requirements for design, operation and maintenance
- BS EN 61400-1:2004 Wind turbine generator systems - Part 1: Safety Requirements.

A Supervisory Control and Data Acquisition (SCADA) system will be installed to monitor the performance of the wind farm and should a fault occur a message is sent to automatically shut the effected turbine down preventing emergency situations from arising.

13.7.2.3 Decommissioning

Decommissioing impacts will be the same as those identified during the construction of the development

13.7.3 Potential Waste Management Effects

Waste management will be an integral part of the proposed project. The EIA has been undertaken during the design phases of the project and therefore some technical aspects of the construction phases have yet to be determined. As part of the construction phase of the development a Site Waste Management Plan will be designed. It is likely that this will have two principle objectives:

- To segregate waste that cannot be avoided and maximise recovery, reuse and recycling opportunities;
- To dispose of the waste in an environmentally sensitive manner where recovery options are impractical.

13.7.3.1 Construction

The construction of the wind turbines will lead to very low volumes of construction waste being generated. Onsite segregation will assist in minimising the quantity of material that is sent for offsite disposal in landfills.

As described in Chapter 2 and 11 of the ES storage of potentially polluting substances will be kept to a minimum, with only the necessary amount being kept on site. When potentially polluting substances are on site, they will be located in a sensible location where they are least likely to be interfered with and at a maximum distance away from watercourses and likely catchment areas.

It is anticipated that 'Portaloo' type toilets will be provided on site at the more frequently worked areas as these are able to be relocated. These will be serviced weekly by a licensed waste contractor. The construction compound will have integrated working toilets serviced by a septic tank arrangement.

13.7.3.2 Operation

Where it is unavoidable to store materials while the wind turbines are in operation, polluting substances will be locked in an impermeable container. This will reduce the risk of vandalism and contamination.

13.7.3.3 Decommissioning

Decommissioning impacts will be the same as those identified during the construction of the development

13.7.4 Potential Weather Condition Effects

Due to the exposed nature of wind farm sites, wind turbines are designed to withstand extreme weather conditions.

13.7.4.1 Extreme Winds

The turbines would be fitted with sensors which would automatically shut down and brake (or "park") the turbines should very high wind speeds occur which exceed safe operating limits. This prevents excessive wear on the gear box and damage to the turbines.

13.7.4.2 Lightning Strike

The turbines would also be equipped with lightning protection equipment. In the event of a lightning strike, the equipment will effectively and safely conduct the lighting strike into the earth.

13.7.4.3 Icing

In certain meteorological conditions, such as still, cold weather, it is possible for ice to form on the rotor blades. If this occurs, two types of risk may result ice fragments thrown from the rotor and ice fall from the turbines while shut down.

Ice throw has been noted as a higher risk in very cold climatic conditions for example in the high latitudes of Scandinavia or the very high altitudes in Europe. The most severe icing is due to in-cloud icing which is typical in mountainous regions.[3] this occurs when a super cooled cloud collides with a cold surface causing ice to accumulate. Ice fall may occur when ice accumulates on a turbine and then falls to the ground after temperatures begin to rise and the ice melts. This phenomenon is observed during times when the temperature warms following a period of extreme cold weather conditions.

Due to the more temperate climate of the United Kingdom, it is considered that suitable weather conditions for icing occur for less than seven days per year' within this area. Despite the low risk, the turbines would be fitted with vibration sensors which detect any imbalance such as that caused by icing, in which case the affected turbines would be shut down. Inherent in the design of the layout is a further mitigation provided by the spacing between turbines and public rights of way and residential properties, where a buffer of at least 101m, equivalent to the maximum tip height has been applied.

In wind farms in the particular locations and circumstances where ice fall has actually been observed the statistical maximum of occurrence is within 50m of a turbine base. The most frequent observation is ice simply falling straight down and not being thrown laterally. Beyond a 50m radius of the base the statistical risk decreases rapidly to negligible,

Operational procedures would, also be put in place to ensure the safety of both workers, the landowners and the public in relation to ice throw and ice fall. Procedures would include turbine shutdown and warning signage.

[3] http://ieawind.org/iea_wind_pdf/state_of_the_art.pdf

13.8 Mitigation

Potential Effect	Mitigation	Residual Effect
Construction		
Dust	Use of dampening techniques and good construction practice	No Significant Effect
Site Health and Safety	Relevant health and safety regulations and guidelines will be followed to ensure safe design and construction of the wind farm site	No Significant Effect
Operation		
Emissions Savings	None Necessary	Positive effect from emission saving of CO_2 during the operation life of the wind turbines
Site Health and Safety	Relevant Health and Safety regulations and guidelines will be followed to ensure safe operation of the wind turbines	No Significant Effect
Effects of Weather	Sensors and protection equipment fitted to turbines and operational procedures to mitigate any task	No Significant Effect
Decommissioning		
Site Health and Safety	Relevant Health and Safety regulations and guidelines will be followed to ensure safe decommissioning of the wind turbines	No Significant Effect

13.9 Residual Effects

The only residual effects of the development would be the positive effects of carbon saving of CO_2 during the operation lifetime of the development.

13.10 Statement of Significance

Lancaster University Wind Turbines will have a positive effect through the saving of greenhouse gas and other polluting emissions. During the course of every year of its 25 year operational life, the wind turbines will be displace approximately 5743 tonnes of CO_2 from entering the atmosphere.

Any health and safety risks will be addressed through mitigation measures and normal construction and operational procedures. All relevant legislation will be adhered to during all stages of development. The implementation of current best practice and technology will be used so as to minimise any health and safety risks that might be associated with this project.

The implementation of the construction design and management principles will result in a quality wind turbine development, built, operated and maintained to the highest standards of safety. Sensors and protection equipment will be fitted to turbines and operational procedures followed to mitigate any safety risks associated with extreme weather. As such there will be no significant effects in relation to health and safety.

Chapter 14 :
Community Consultation & Community Benefits

14. Community Consultation

14.1 Introduction

This section of the ES describes and explains the consultation which has taken place with the local communities prior to an application being submitted to Lancaster City Council and sets out the details the community benefits package which Lancaster University are offering to the community within the development area of the proposed turbines.

14.2 Guidance and Legislation

PPS22 and its Companion Guide sets out Community consultation as one of the key principles that should be adhered to when considering renewable energy developments. PPS 22 advises developers of renewable energy projects to engage in active consultation and discussions with local communities at an early stage in the planning process, and before any planning application is formally submitted. In line with this advice community consultation has informed the entire design phase of this project and the production of the ES.

PPS22 also advises Local planning authorities, regional stakeholders and Local Strategic Partnerships should foster community involvement in renewable energy projects and seek to promote knowledge of and greater acceptance by the public of prospective renewable energy developments that is appropriately located.

The Renewable Advisory Boards Advice note 'Delivering Community Benefits for Wind Energy Development- A Toolkit, 2009' provides advice to developers, communities and local planning authorities on community benefits packages.

This advice note explains that '*although community benefits packages are not a legitimate material consideration within the planning decision making process, as they do not relate to planning issues or directly to the proposed wind farm, developers should nevertheless be able to provide details of their general policy and overall approach to community benefits as part of the public consultation process.*[1]*….The offer of a community benefits package is a fully justifiable component of a wind energy development and its relationship with the host community*[1].

In line with this guidance details of the basic details of the proposed community benefits package are provided within this chapter of the ES however the offer of a community benefits package runs separately to the proposed planning application and any other mitigation that might be required as part of the planning process.

[1]The Renewable Advisory Boards Advice note 'Delivering Community Benefits for Wind Energy Development- A Toolkit, 2009'

14.3 Community Consultation

Extensive consultation with local authorities, communities, Parish Councils in the surrounding area of the windfarm proposal has take place throughout all stages of the development.

Initial pre-design community consultation involved the following steps;

- To date public consultation procedure has taken the form of;
- Detailed discussions with Lancaster University's wind farm public consultation researchers
- Community Plan and Stakeholder Identification
- Initial discussions on community benefits
- Parish, County and District Councillor Briefing
- Letter to nearby householders in Bailrigg, Ellel and Galgate
- Initial Press Release
- Question and Answer Summary
- Local and National Press Publicity
- Wind Development webpage www.lancs.ac.uk/windturbines
- Lancaster University Newsletter Articles
- Radio Announcements
- Update for Times Newspaper

Appendix M section M1 contains examples of community consultation letters sent to 100 local residents and press notices advertising public exhibitions.

Following this the initial baseline assessments were undertaken and public exhibitions were held to provide an opportunity for local communities to view and make comment on the wind turbine proposal, the feedback from these exhibitions then helped to inform the final design of the wind turbines.

Public exhibitions were held in December 2009 in convenient locations in the local wards and parishes as detailed below:

- 14th December 2009 12.00-15.00 Lancaster University, University House Reception
- 14th December 2009 17:30- 20:00 Ellel War Memorial Insitiute, Stoney Lane, Galgate
- 15th December 2009 14.00- 19.00 St Pauls Parish Hall, Scotforth Road, Lancaster
- 16th December 2009 16.00- 20.00 Quernmore Methodist Church Hall, Quernmore TBC
- 17th December 2009 10:30- 16:00 Lancaster Central Library, Market Street, Lancaster

Photographs 1 and 2 show some of the exhibition stands present at the public exhibitions.

Photograph 1: Ellel War Memorial Institute, Public Exhibition

Photograph 2: Lancaster Library Public Exhibition

The majority of people attending the consultation events were very interested in the proposal and many had positive attitudes and comments, in particular, towards the wind turbines, in particular the community benefits being proposed. Where direct concerns or questions were raised conscientious efforts were made to respond directly to these. An example public consultation feedback document is contained within Appendix M section M2 outlining people's opinions on the proposal and the community benefits package.

In line with Lancaster City Council's Sustainability Policy and to ensure continued public awareness copies of the ES and its Non Technical Summary will be made publically available at the following locations detailed below;

- Lancaster City Council Office, Palatine Hall, Dalton Square, Lancaster, LA1 1PW
- Lancaster Library, Market Square, Lancaster, LA1 1HY
- www.lancs.ac.uk/windturbines

14.4 Community Benefits

The Lancaster University wind turbines would generate clean, green, electricity predominantly for use on the University Campus, however the proposal would benefit the wider community through its contributions to Lancashire's targets for renewable electricity generated by onshore Wind turbines. The University recognise that this development will have an effect on the local community through alteration of "their" landscape. In response to this and in accordance with guidelines produced by the Renewables Advisory Board (RAB) in May 2007, Lancaster University propose to provide a Community Benefits Package (CBP) to support the wind turbine development.

The RAB Advice note 'Delivering Community Benefits for Wind Energy Development- a Toolkit, July 2009' states that it is good practice for wind turbine proposals of all scales to incorporate some form of community benefit. However it acknowledges that smaller projects (particularly below 5MW) are less likely to be able to afford community benefits because the fixed costs of development and operation take up a greater proportion of the income. This leaves less 'spare' for returns to shareholders and payments to community funds (or other community benefits).

Although this development falls below the 5MW threshold Lancaster University recognise that the provision of meaningful benefits to those communities is one of the key ways to achieve sustained public support for wind energy in general. Therefore Lancaster University intend to offer a community benefits package that is proportional to the scale of the proposed wind turbines.

By definition, the concept of community benefits is principally about providing gain for the community as a whole, rather than enriching individual members within it. Having reviewed the best practice advice currently available, the public consultation feedback and taking into account the scale of the development proposed in this instance the most appropriate way to administer a community benefits package is through the provision of a Community Fund which would include: A lump sum payment paid in to a Community Fund followed by an annual contribution of £2,000 per MW of installed generating capacity for the lifetime of the project (around 25 years). The fund would be available for environmental and eco- friendly projects in the local area. The exact boundaries of these and the scope/nature of which would be finalised following detailed analysis of the community consultation feedback.

It is proposed that this fund would be managed by a Steering Group comprising of elected local representatives, as well as, a university representative who would act as an impartial advisor to the group.

Chapter 2: Project Description

2. Project Description

2.1 Introduction

This chapter of the ES outlines the extent of the development works proposed including the indicative construction and decommissioning methodologies. It also reviews the site selection process and the iterative design stages undertaken prior to selection of the final turbine locations and scale.

2.2 Project Description

Lancaster University is seeking to install and operate two wind turbines with an output of approximately 4.1MW. The precise turbine make and model have not been finalised as this is dependent upon the technology available at the time of install and statutory requirements for tendering. However, the EIA and the ES assumes a worst case scenario opting for a candidate turbine with the largest dimensions. An elevational drawing of the proposed wind turbines is shown in Appendix B figure B1i- vi.

The turbines will be three bladed, horizontal axis machines with a hub height of approximately 59m, a blade length of approximately 41m and a rotor diameter of approximately 82m, giving a ground to tip height of 101m. The turbine rotor and nacelle will be mounted on a tapered steel tower, colour to be agreed with the Local Planning Authority. The turbines will be supported on reinforced concrete foundations. The foundation will be approximately 15m x 15m with an overall depth of approximately 3m.

Further to the wind turbine, ancillary development will comprise a crane hard standing approximately 20m wide by 40m long, an access track leading to the site and between the turbines, Underground electrical cables and a temporary construction compound. There is no requirement for any associated standalone control building at the site as it is proposed to house the new transformer unit and switch gear within the base of the turbine towers.

The wind turbines will connect from the transformer unit in the base of the tower to the grid via a cable running to an existing electricity substation on the main University Campus. The location of this substation is shown on Appendix B figure B2. The grid connection itself is the subject of a separate application to the District Network Operator who will ensure that the additional load from the turbine can be suitably incorporated into the network.

The main entrance to the site will require some alterations to enable turbine component delivery. This will comprise the creation of a new access onto site and temporary improvements of verges and visibility splays to enable long vehicles to access and egress the site. Details of the access arrangements are shown in Appendix B and L and explained in Chapter 12 of the ES.

2.3 Site Description

The University Campus lies between the M6 and the A6 to the south of Lancaster. The application site is situated to the east of the M6 adjacent to the University campus on agricultural land accessed from Hazelrigg Lane.

The general character of the landscape around the site comprises rolling farmland with hills in the distance. To the north of the site is grazing land and a line of electricity pylons and wires. To the west is the M6 motorway and the main university campus beyond, separated from the site by a mature trees belt which extends in to a mature area of woodland. To the east is the University field station which comprises grassland and research plots, a small building, a number of atmosphere controlled greenhouses, permanent meteorological mast and a

telecommunications mast. There is also an area of coppice to the south east separating the site from the sporadic residential properties located on Hazelrigg Lane. To the south is additional agricultural land and the existing site access off Hazelrigg Lane.

The total ground area covered by the planning application is approximately 23 hectares. However, it is important to note that the total land take of the turbines is in reality much smaller comprising only part of the wider study area and land holding. For example, the total land taken of the turbines comprises the turbine foundations, site access track and crane pad hardstandings which total approximately 1.5 hectares.

2.4 Iterative Design and Micro-siting

2.4.1 Site Selection

PPS22 confirms that 'As most renewable energy resources can only be developed where the resource exists and where economically feasible, local planning authorities should not use a sequential approach in the consideration of renewable technology projects. 'Government policy is to develop such acceptable sites wherever they occur.' [1]

The optimum layout of turbines depends upon a range of criteria. These vary depending on the type and size of turbine. In general, technical considerations prescribe that the turbines be spaced at least four rotor diameters apart with a distance of at least five rotor diameters separation. These requirements, along with other constraints, such as topple distance set backs from road networks, limits the number of turbines which can be accommodated on the site.

2.4.2 Iterative Design Process

At project feasibility stage a variety of design solutions were presented and from these four options which best met the client brief were then developed, these being:

- Two turbines maximum tip height 125m
- Two turbines maximum tip height 100m
- Single turbine maximum tip height 130m
- Multiple turbines maximum tip height 85m

These options were then assessed against the following project drivers identified below:

- Funding Criteria
- Required Energy Generation
- Carbon Reduction Targets
- Wind Resource
- Environmental Impact
- Land Take
- Site Access
- Grid Connection
- Aesthetic Considerations

Following this assessment procedure the multiple smaller turbine option was discounted from consideration because the turbine land take needed to meet the required energy generation and carbon reduction thresholds exceeded the amount of usable land available for development within the site boundaries.

[1] Planning Policy Statement 22 Renewable Energy

2.4.3 Screening Layout

The turbine project was then screened on the basis of worst case scenarios which would allow the development of any of the remaining three options. This being a maximum of two turbines and a maximum generating capacity of 5MW.

The Council's screening and subsequent scoping responses and the initial consultations response were then used to refine turbine options. As were the findings of preliminary studies for Access, Electromagnetic Interference, Noise, Hydrology, Archaeology and Ecology Studies.

Consultation responses from the Lancaster City Council and the Forest of Bowland AONB office identified that the landscape and visual impacts of the proposal would be a key consideration during the determination of the planning application. The AONB office expressed some reservation about the scale of turbines with 125m and plus tip heights. The Highways Agency also specified required set back distances which would precluded the development of two 125m tip height turbines.

Having regard to these responses and the findings of preliminary study work the two turbine options with tip heights of 125m and single turbine options with a tip height of 130m were discounted in favour of a two turbine option with reduced tip heights of 101m.

2.4.4 Constraint Mapping

Constraint mapping was then carried out for the 101m tip height option based on the findings of preliminary study work and consultation responses. This enabled possible turbine location to be pinpointed in order that indicative site layouts could be developed for further consultation and review. The following sections describe each of the constraints in further detail, thus providing potential scope for turbine locations. Detailed constraint maps depicting each constraint overlay are also provided in Appendix B Figures B4-B19.

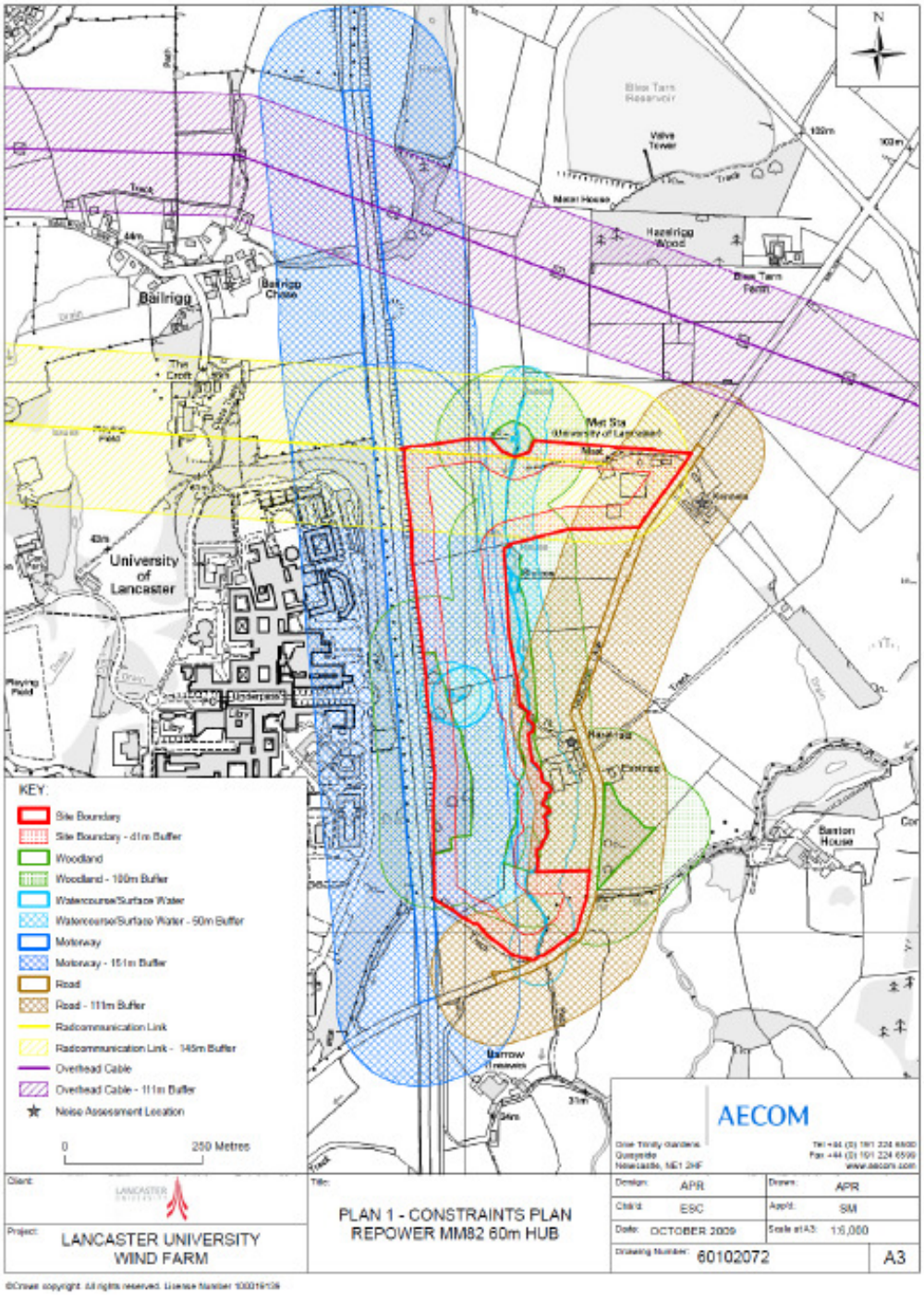

Figure 2.1 Site Constraints Plan (101m tip height, 82m rotor)

2.4.4.1 Turbine over-sail of land boundary

This constraint is illustrated on the constraints plan as the site boundary with a 41m buffer. To ensure that no part of the turbine oversails adjacent land a separation distance of the rotor radius is required between the turbine tower and the site boundary. This is illustrated on the Figure 2.1 as a shaded red area.

2.4.4.2 Road Network Stand-off distance

These constraints and associated stand-off distances are illustrated on the constraints plan as the road and motorway, in brown and blue respectively. The motorway Highways Authority Guidance HA Spatial Planning Note 12/09 requires a stand-off distance of tip height + 50m.
The guidance, which has been published in January 2009 states:

'Consideration of the risks associated with structural failure and 'icing' identifies the clear need to incorporate a safety margin in the offset between the trunk road boundary and the siting of a wind turbine. Therefore, it is appropriate to achieve a setback from the nearest highway boundary equal in distance to their height + 10% for micro and small turbines. Commercial turbines should be set back a distance equal to their height + 50 metres.[2]

The guidance also requests a stand-off distance of tip height + 10% from minor roads. This stand-off distance is required to be applied to Hazelrigg Lane. Both stand-off distances are required to be applied to the highway's land holding boundary, providing for road expansion.

2.4.4.3 Ecological Stand-off distance - Woodlands

The constraints plan illustrates that a 100m stand-off distance has been applied to woodlands. This equates to a buffer of approximately 50m from the blade tip to the trees. This is beneficial for wind yield and also for ecological reasons. Birds and bats are likely to roost in the trees, and use them as foraging areas. The application of the 100m stand-off distance is consistent with the initial ecological assessments. The initial assessments have identified areas which are 'safe areas', and can accommodate the swept path of the turbine's blades and roughly equate to the 100m stand-off distance to the turbine base.

The potential mitigation measure which could be applied to provide areas for potential turbine development is the application of habitat improvement plans. If habitat needs to be removed then the habitat improvement plan may compensate for this.

2.4.4.4 Ecological/Construction Stand-off distance – Watercourses / Surface Water

The constraints plan illustrates that a 50m buffer has been applied to all watercourse and surface water features. This is for ecological and construction reasons. The water features that are located within the site boundary will require protection during the construction of the proposed wind farm and its subsequent operation. There are a range of mitigation measures that should be capable of providing this protection. This may enable the separation distances to be reduced.

2.4.4.5 Construction Stand-off distance

Photograph 1 shows an aerial view of the construction area of a turbine at the point of installation. This shows the location of the edge of the excavation (shown in a black line) in relation to the turbine location.

2.4.4.6 Radio communications link and Aviation

The standard stand-off distance from a BT radcom link is145m; this is to ensure that the swept area of the turbine blades does not interfere with the link.

N.B Chapter 6 of the ES quantifies the significance of the chosen turbine positions and provides confirmation that BT does not object to the chosen locations despite Turbine 1 being located within this buffer zone.

2.4.4.7 Overhead Line Stand-off distance

Turbines cannot be located closer than tip height +10% from overhead lines of a voltage of up to 275kV. The overhead line to the north of the site is a 132kV line. A buffer distance of 111m has therefore been applied.

[2] Guidance HA Spatial Planning Note 12/09, January 2009

2.4.4.8 Turbine noise

Paragraph 51 of PPS 22 Companion Guide states the minimum desirable distance between wind turbines and occupied buildings calculated on the basis of expected noise levels and visual impact will often be greater than that necessary to meet safety requirements. Fall over distance (i.e. the height of the turbine to the tip of the blade) plus 10% is often used as a safe separation distance.[3]

It is not usually possible to overlay the constraint that is presented by noise due to the complex set of variables that influences this. These variables are:

- Background noise measurements, day and night
- Number of turbines
- Location of turbines
- Model of turbine.

It is therefore normal to identify turbine locations that are consistent with the constraints identified in sections 2.4.4.1- 2.4.4.7 and then model them with an indicative turbine type.

This modelling will identify if the location is compliant or non-compliant. If non compliance is identified noise effects can be mitigated by either restricting the output, or turning the turbine off at specific wind speeds or directions, or at specific times of the day.

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2.4.4.9 Constraint Mitigation, Difficulty Summary

The figure below presents an assessment of the relative difficulty of implementing the various mitigation actions discussed in sections 2.4.4.1- 2.4.4.7.

Constraint	Mitigation	Difficulty (1=easy, 10 difficult)
Boundary oversail	Wayleave or lease with neighbour	8
Highways Stand-off	Negotiation with Highways	10
Ecology Woodlands	Felling trees on own land Felling trees on neighbours land	4 8
Ecology Watercourses	Habitat enhancements	5
Construction moves into neighbours land	Lease or land purchase with neighbour	8
Radcoms	Reduce envelop of exclusion area De-commission and move radio link	3 5
Noise	Restrict output at particular wind speed, direction, time	2 – 4
Overhead line	Move overhead line	10
Landscape and Visual	Relocate turbine	10
Shadow Flicker	Relocate turbine Restrict turbine	10 2-4

Figure 2.2: Constraint Mitigation, Difficulty Summary

[3] Planning for Renewable Energy: A Companion Guide to PPS22

2.4.5 Turbine Location Options

Having regard to the constraints map and mitigation difficulty summary potential locations were identified and seven of these are plotted refer to Figure 2.3 shown below. For each of these locations the constraints are outlined and the resulting mitigations are described.

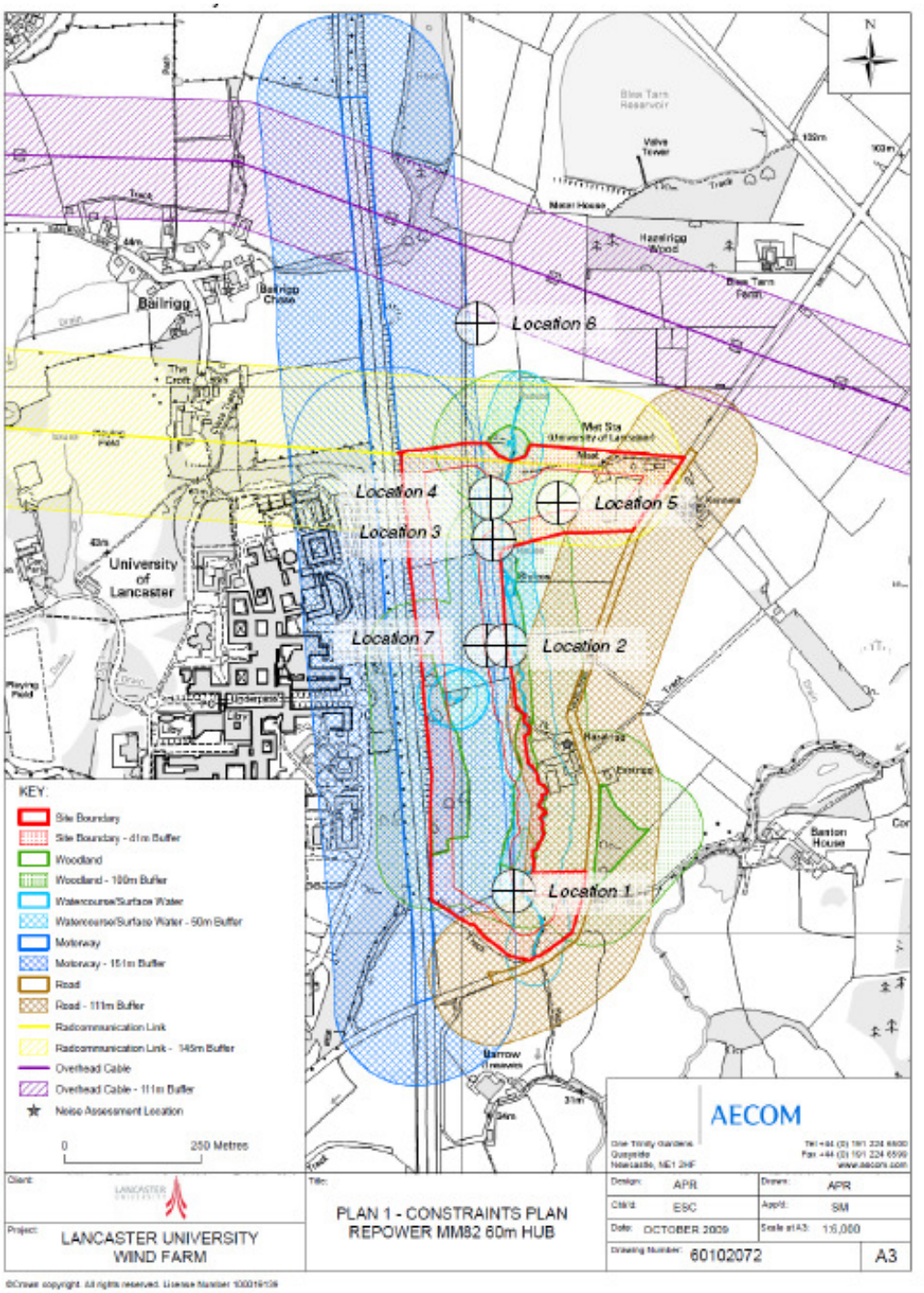

Figure 2.3: Layout Options (101m tip height, 82m rotor)

2.4.5.1 Turbine Location 1

This turbine location is to the south of the site at Grid ref. [349093.3, 457073.4]. This location complies with the M6 stand-off distance of tip height +50m, and the Hazelrigg lane distance of tip height +10%. If installed at this location its blade would not oversail the neighbouring property.

It is not expected that this location will offer significant challenges from a noise perspective due to the high background noise from the M6. It is approximately 40m from the woodland that is on the University land, these trees would have to be felled to a distance of 100m from the turbine tower to provide a safe area for an ecological perspective and to reduce turbulence at the base of the turbine. The location of the tower is approximately 20m form the watercourse. In order to construct at this location the watercourse may have to be temporarily diverted to be outside the turbine foundation construction area.

2.4.5.2 Turbine Location 2

This turbine location is to the north of Hazelrigg farm, as far west as the Highway stand-off distance will allow. It position would be defined by ensuring that the chosen turbine did not present a noise issue at Grid ref. [349080.3 457528.2].This location complies with the M6 stand-off distance of tip +50m. This location does not prevent oversail of neighbours land, it would therefore be necessary to obtain a wayleave to allow this. This location is almost on the boundary would require the purchase or lease of the some neighbouring land to enable the construction works to be completed. This location lies on the boundary of the woodland to the east of the University's landholding, it would therefore be necessary to fell up to at least 100m of this woodland to facilitate construction at this location.

2.4.5.3 Turbine Location 3

This turbine is located as far north on the site restricted by the M6 stand-off distance to the west and the BT radcom stand-off distance to the north at Grid ref. [349056.3, 457721.6].

This location complies with the M6 stand-off distance of tip +50m. This location complies with BT radcom stand-off distance. This location would oversail the neighbours land by about 30m, which would require a wayleave. This location would be about 10m from the woodland and would therefore require up to at least 90m of trees to be felled to enable the turbine to be located here. These trees are on the neighbouring land. This location is approximately 10m from the stream which would present a challenging construction situation and a potentially significant ecological issues.

2.4.5.4 Turbine Location 4

This turbine is located as far north on the site restricted by the M6 stand-off distance to the west and the oversail stand-off distance at Grid ref. [349050.1 457798.2]. This location complies with the M6 stand-off distance of tip +50m and does not oversail the neighbours land.

This location is approximately 80m from the woodland to the north of the site. It is likely that the some trees will need to be felled to allow a turbine to be sited here. These trees are not on land owned by the university. This location is approximately 30m from the stream. This location is within the BT radcom safe zone and therefore it would be necessary to remove the BT link mast to site a turbine here.

2.4.5.5 Turbine Location 5

This turbine is located in the area of the site that is only constrained by the BT radcom link. It is at Grid ref. [349175.7 457789.2]. The most significant constraint at this location apart from the Radcom link is noise at the Valley Views Kennels. A noise model has been constructed to establish the safe locations when a residence is considered at the entrance to the kennels. It has been shown that location 5 is acceptable. Figure 2.4 shows the noise constraint area shaded in.

In order to site the turbine at this location negotiation with BT will be required to ensure that the impact on the BT link remains within acceptable limits. It should also be noted that long term University studies/experiments ongoing in this location that may be affected and may have to be relocated.

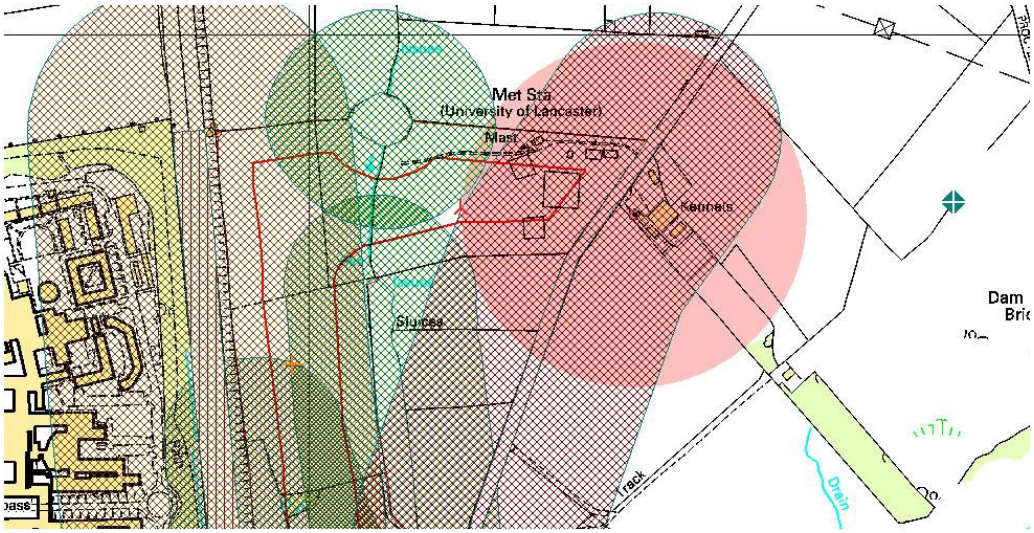

Figure 2.4 Noise Constraints for Location 5

2.4.5.6 Turbine Location 6

This turbine is located in the land adjoining the universities to the north. This land is closer to the urban area of Lancaster and is more elevated. The land is not within the Lancaster University Ownership or within the development site boundaries

This location Grid ref. [349026.7 458118.4].complies with the M6 tip +50m stand-off distance. This location complies with the tip +10% stand-off distance for the 132kV overheadline. There is no woodland within 150m of this location.

2.4.5.7 Turbine Location 7

This turbine is located 111m from the western boundary of the Universities land at Grid ref. [349042.5, 457526.3]. It is not expected to cause a noise issue. It is not constrained by ecology – watercourses but would still require the felling of trees. This turbine does not comply with the highways stand-off distance.

2.4.6 Ranking of locations

Figure 2.5 shown below provides a summary of the combinations of turbine locations that can be considered. The total constraint score takes account of the turbine spacing, potential carbon savings, and installed capacity. Constraints scores range from 1- least constrained to 20 most constrained.

Loc	Highways	Ecology	Legal	Noise*	Radcom	Landscape	Total
1	OK	NOK6	OK	OK	OK	Tbc	8
2	OK	NOK6	NOK6	OK	OK	Tbc	16
3	OK	NOK6	NOK6	OK	NOK3	Tbc	19
4	OK	NOK5	OK	OK	NOK5	Tbc	9
5	OK	OK	OK	OK	NOK5	Tbc	5
6	OK	OK*	NOK 6	tbc	OK	Tbc	8
7	NOK10	NOK6	OK	OK	OK	Tbc	18

Where OK – Acceptable
Where NOK- Not acceptable
Where TBC- To be confimed

Figure 2.5: Ranking Summary

2.4.7 Final Layout

A review of the turbine location ranking method identified sites 1, 5 and 6 as preferential, with sites 1 and 5 being carried forward as these are within Lancaster University's identified development area. A plan of final turbine positions is provided in Appendix B figure B10.

2.4.8 Micro-siting

In addition to the above, the continual refinement of the scheme will extend into the construction phase. Therefore it is established practice to seek agreement for the micrositing of the turbines and other wind farm infrastructure within 50m of the approved centre point. The eventual turbine positions would remain within the planning application boundary and would avoid blade over sailing of land outside the defined development area.

2.5 Turbine Specification

2.5.1 Rotor

Maximum Diameter	82m
Maximum Swept area	5281 m^2
Rotational speed, rotor	8.5-17.1 rpm
Direction of rotation	Clockwise
Rotor position	Up-wind

2.5.2 Blades

Length	41 m
Height	5 m
Type	GRP Sandwich construction manufactured in infusion-process

2.5.3 Tower

Type	Steel Tube
Hub Height	59m

2.5.4 Foundation and Construction

The form of the wind turbine foundations would depend on;

- Site geology
- Turbine location
- Turbine manufacturer and type
- Turbine manufacturer's foundation stiffness criteria

The anticipated geology of the area consists of Roburndale Formation which is mainly Sandstone and Interbedded Siltstone and Sandstone.

Based on the indicative turbine specification and preliminary site investigations it is anticipated that the turbine foundations would take the form of reinforced concrete foundations

approximately 15m x 15m and 3m deep, with a central plinth into which the turbine is anchored. The foundation detail is shown in Appendix B figure B11.

Trial pits have been carried out at each of the proposed turbine locations to ascertain whether the geology will bear the foundations as proposed. The trial pits indicate that the turbines are likely to be viable in the current positions, subject to detailed site Investigation which would be carried out prior to construction, to determine whether micrositing was required.

2.5.5 Hardstanding

Each turbine requires an area of hard-standing to be built adjacent to the turbine foundation in order to provide a stable base of the cranes and to lay down the turbine components ready for assembly. The turbine crane pads would be left in place following construction in order to allow for use of similar plant should major components need replacing during the course of the wind turbines operational life.

The total area of hard-standing at each turbine location, including the turbine base and the turbine erection area would be approximately 2200m^2

A typical crane pad is illustrated in Appendix B figure B12 - B14.

Approximately 13,500 tonnes of stone would be required during the construction of the access track, turbine base and other infrastructure. Stone would be sourced from local quarries. These quarries would be selected prior to construction following a competitive tendering process.

Importing stone for construction, while increasing traffic for a short period, would prevent the additional visual and potentially polluting effects of digging borrow pits on site. Indicative vehicle movements for all development phases are provided in chapter 12 of the ES.

Photograph 2.1: Construction Areas at Turbine Installation

2.5.6 Electricity and Grid Connection

The wind turbines will connect from the transformer unit in the base of the tower to the grid via a cable running to an existing electricity substation on the main University Campus. The location of this substation is shown on Appendix B figure B2. The grid connection itself is the subject of a separate application to the District Network Operator who will ensure that the additional load from the turbine can be suitably incorporated into the network.

2.5.7 Cabling Route

Underground cabling would link the turbines to each other and to the existing electricity substation on the main University Campus.

Appendixes B figure B2 details the indicative cable route. This route is approximately 1.3km in length. From the University intake substation the route follows the existing Green Lane through the Campus and then along the public Hazelrigg Lane, before the route turns sharply off the public road and runs across University owned land to the proposed wind turbine site(s).This route includes cable install in a section of footway under the existing Motorway bridge on Hazelrigg Lane. The route may require a Section 50 closure of Hazelrigg Lane after agreement with Lancashire County Council. The cable route along Hazelrigg Lane has been walked with Lancashire County Council as draft agreement on cable placement within the verge/roadway and footway.

Detailed construction and trenching specifications would depend on ground conditions encountered. Typically cables would be laid in a trench approximately 1100mm deep and 610mm wide. To minimise ground disturbance cables would be along the side of the access tracks where practicable.

2.5.8 Storage Compounds

A temporary construction compound with approximate area 3500m^2 would be provide at site, the location of this temporary compound is provided in Appendix B figure B10.

The compound will house the following items;

- temporary portable buildings needed for site offices and welfare facilities
- containers used for tool and equipment storage
- parking for construction vehicles
- secure storage of components and materials

The location of the site compound has been selected to minimise environmental impacts, particularly areas of ecological, archaeological and hydrological interest, and on visibility grounds.

The compound will be constructed, in order to facilitate removal and reinstatement following the wind farm becoming operational. The compound would be designed so that any, contaminated run-off would be directed to a central point and disposed of at an appropriate waste management facility. All portable buildings, machinery and equipment will be removed and the area fully restored in accordance with an approved method statement.

At the end of the construction period, all equipment will be removed and the hardstandings will be covered over with stored topsoil, this would then be re-seeded.

2.5.9 Access Tracks

The main site access would be taken from Hazelrigg Lane as shown in Appendix B figure B3. The access would be constructed typically as shown below in Figure 2.6. An estimated 1.1km of site access tracks would required for the wind turbines. The tracks would have a nominal width of 5m and may have temporary passing places as required in order to facilitate traffic movement. At bends the track would be widened as appropriate depending on bend radius. Bends would be kept free from obstruction to allow a swept area for traversing by long loads

Access tracks will comprise a geotextile base layer with crushed stone on top, to a depth appropriate for the ground conditions. A grass reinforced geo grid with 100mm top soil infill will then be provided over the most visually prominent section of the access track to enable grass to reseed. It is anticipated that tracks will have minimum thickness of 500mm. A turning area will be located at each turbine to allow the safe movement of vehicles in forward gear across the site. The turning areas will be constructed in the same way as tracks. A geotextile separator would be used between the surface of the stone and the topsoil to minimise cross contamination between soil fines and stone.

Various constraints have influenced the site track layout design these include;

- track length is kept to a minimum
- gradients are to be kept to a minimum where possible to accommodate the requirements of delivery vehicles and to allow construction plant to move safely around the site
- track layout is designed to reflect contours, to avoid cross slopes and deep cut and fill sections into existing terrain

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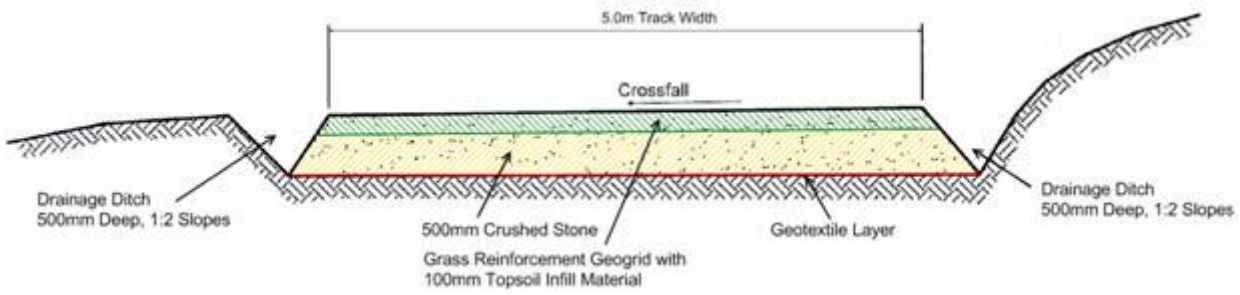

Figure 2.6: Typical Access Track Section

2.5.10 Earthworks

Localised differences between required construction levels for turbine infrastructure and existing sloping ground levels will dictate that some earthworks are required on the site. In order to minimise the amount of groundwork's, the orientation of the hard standing, roads and foundation will be adjusted, where possible, to parallel land contours.

It is anticipated that approximately 6800m ^{3} or 10,000 tonnes of material will be excavated during the construction of the turbine bases and associated infrastructure. As far as is practical this stone or soil will be reused on-site, primarily for restoration of disturbed ground and during implementation of the habitat mitigation strategy described in Appendix F7 of the ES.

Topsoil would be removed from the surface of proposed construction locations around the site to a defined storage area located a safe distance away from the watercourse at the eastern boundary of the site. Topsoil would then be reused as necessary for land reinstatement following construction. Any excess would be either be used by the landowner elsewhere or removed to a licensed waste disposal site. Other materials removed from site would also be disposed of in the same manner in accordance with duty of care procedures.

It is anticipated that materials for use in cut and fill operations will be balanced on site. No additional material is expected to be imported or exported from site, as a result of these operations.

To control this process, prior to commencement of development on site a Site Waste Management plan will be produced as described in Chapter 13 of this ES. The appointed Site Manager will be responsible for the enforcement of this plan during the construction phases of the development.

2.5.11 Stream Culverting

Construction of the proposed access tracks will involve crossing the stream at one location where a culvert will be constructed. Chapter 5 of the ES also outlines that culverting of approximately 100m of the stream will be necessary near the base of turbine at the southern end of the site in order to deter birds and bats from nesting or foraging around the turbine base. To compensate for this replacement wetland habitat will be provided elsewhere on site, further details of this are shown on the site layout plan Appendix F Section F7.

2.5.12 Hedgerow and Woodland Clearance

The construction of turbines and their associated infrastructure will result in the need to remove approximately 606 metres of hedgerow across the site and 0.36 hectares of woodland. The significance of this impact is quantified in chapters 4, 5, 6 and 11 of the ES.

To compensate for this loss replacement habitat comprising approximately 0.79 hectares of planted woodland, 1.74 hectares of woodland and scrub provided by natural regeneration and approximately 1090m of hedgerow is proposed, further details of which are provided in Appendix F Section F7.

2.6 Wind Turbine Construction

The timescales below are estimates and should be viewed as indicative only, although they are based on projects of similar value and complexity in the design team has been involved.

Construction would take place over a period of 5 months subject to the final details of the scheme, weather and ground conditions. The construction process would comprise the following principal activities.

- site survey and preparation
- construction of access tracks and passing places
- remedial works to lengths of the public highway to facilitate turbine delivery
- construction of the contractors compound including temporary site office facilities
- construction of the crane pads
- construction of the turbine foundations
- construction of the site control building
- excavation of the cable trenches and cable laying
- delivery and erection of wind turbines and permanent meteorological mast
- testing and commissioning of the wind farm
- site restoration and implementation of necessary mitigation measures

Most of these operations would be carried out concurrently in order to minimise the overall length of the construction programme. In addition, development would be phased so that the civil engineering works would be continuing in some parts of the site whilst wind turbines are being erected elsewhere. Site restoration would be programmed and carried out to allow restoration of disturbed areas as early as possible and in a progressive manner.

2.7 Wind Turbine Operation

The windfarm will operate all year round, with the majority of operation being automatic. The turbines being considered would begin generating electricity when wind the speed reaches an average of approximately 3.5 metres per second (m/s), rising to their maximum output at around 13 m/s (about 30mph). They would continue to generate their maximum (rated) output until the wind conditions become too strong, which is typically around 25m/s (about 56mph).

2.6.1 Routine Maintenance

Wind turbine operation will be overseen by a suitably qualified contractor who would visit the site regularly to carry out maintenance. The following turbine maintenance would be carried out along with any other maintenance required by the manufacturer's specifications;

- initial service
- routine maintenance and servicing
- gearbox oil changes
- blade inspections

Routine servicing would take place twice per year with a main service at twelve monthly intervals and a minor service at six months. Servicing would include the performance of tasks such as maintaining bolts to the required tightness, adjustment of blades, inspection of blade tip brakes and inspection of welds in the tower. In addition oil sampling and testing from the main gearbox would be required and oil and components replaced at regular intervals. Other visits to the site would take place approximately once per month to ensure that the turbines are operating at their maximum efficiency. In the event of any unexpected failure of a generator or gearbox, appropriate maintenance works would be carried out.

2.6.2 Shutdown

If the average wind speeds exceed the maximum operational limit specified above, the wind turbine shuts down with the rotor blades orientated 90 degrees to the wind direction. The turbine would automatically begin operation once average wind speeds reduce to safe levels.

Under other causes of shutdown through malfunction or instability, the turbine would remain shut down and in a safe condition until manually restarted by the maintenance provider following satisfactory inspection and/or repair. If the sensors within the nacelle identify any abnormal readings then the turbine will automatically shut down and ‘park’ securely. Depending on the nature of the shutdown, the turbine will either automatically restart or will need to be manually restarted. A manual restart can be initiated remotely by the wind turbine developer.

2.7 Decommissioning

Prior to commencement of decommissioning a schedule of works will be agreed with the Local Planning Authority. In a similar manner to construction, decommissioning would take place over a period of 5 months subject to the final details of the scheme, weather and ground conditions. Decommissioning will include of the steps detailed within the construction process but in reverse, excluding habitat improvement mitigation measures which would remain in place following removal of the turbines.

Chapter 3: Planning Policy Context

3. Energy and Planning Policy Review

3.1 Overview

This chapter of the ES sets out the policy framework associated with the proposed wind turbine development at Lancaster University. The aim of this chapter is to provide an overview of current energy and planning policies that will be used in the determination of this planning application.

This chapter will comprise the following:

- Legislative drivers at a national and international level
- Overview of national policies associated with this application
- Regional and local policy which cover the issues associated with this application

In order to maintain the objectivity of this ES this chapter does not assess the acceptability of the proposed wind turbines in planning policy terms, more it presents a balance of the policies which will be used by decision makers to determine the application.

A separate document in the form of an application covering letter will investigate and provide developer opinions on the schemes compliance with the policies identified within this chapter.

3.2 Legislative drivers

3.2.1 International and European drivers

The United Nations (UN) has played a central role in agreeing actions to tackle climate change. These actions have largely been focused on the United Nations Framework Convention on Climate Change (UNFCCC), agreed at the Earth Summit in Rio de Janeiro, Brazil in 1992 and signed by 189 countries. At this summit, Agenda 21 was formulated. Agenda 21 is a comprehensive plan of action covering all spatial scales in every area in which human's impact on the environment. In addition to Agenda 21, more than 178 Governments adopted the Rio Declaration on the Environment and Development and the Statement of Principles for Sustainable Management of Forests. Agenda 21 and the Rio Principles were strongly reaffirmed at the World Summit on Sustainable Development held in Johannesburg in 2002.The aim of the UNFCCC is to, "stabilize greenhouse gases in the atmosphere at a level that would avoid dangerous climate change". (DEFRA, 2008) Additionally, it placed a voluntary commitment on developed countries to reduce their greenhouse gas emissions to 1990 levels by 2000[1].

On 22 September 2009, nearly 100 leaders met in New York for the historic UN Summit on Climate Change. The aim of this summit was "*to mobilize the political will and vision needed to reach an ambitious agreed outcome based on science at the UN climate talks in Copenhagen*." (UN Secretary-General, Ban Ki-Moon) In his opening address to the leaders, Moon said that "*there is little time left. The opportunity and responsibility to avoid catastrophic climate change is in your hands.*[2]"

[1] Department for Environment, Food and Rural Affairs (DEFRA) (2008) 'International Action – The UN and the Kyoto Protocol', http://www.defra.gov.uk/environment/climatechange/internat/un-kyoto.htm - accessed on 16 March 2008

[2] UN Summit on Climate Change http://un.org/wcm/content/site/climatechange/lang/en/pages/2009summit

The **Kyoto Protocol**, agreed in 1997, takes forward the international response constructed by the UNFCCC. It has been ratified by over 166 countries and became legally binding in February 2005. It is the first ever international treaty to set legally binding emissions reduction targets. Developed countries agreed to a target that will reduce their overall emissions of six greenhouse gases, including carbon dioxide, by 5.2% below 1990 levels over the period 2008 – 2012[3]

The **Intergovernmental Panel on Climate Change** (IPCC) was set up in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) to assess the scientific aspects of climate change. It is widely considered to be the foremost authoritative source of material on climate change. Its review process is long, open and peer assessed and consequently its recommendations shape much of climate change policy. In this way, the IPCC assessments have fully informed the development of domestic climate policy and the UK position in international climate negotiations. Currently working its Fifth Assessment Report, the IPCC's Forth Assessment Report 2007 stated that "*Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels*."[4]

At a European scale, the member states of the **European Union (EU)** have collectively agreed to a target of reducing greenhouse gas emissions by 8% of 1990 levels by 2012. The 'bubble policy' mechanism allows the redistribution between member states of the EU's target, which caters for differing national circumstances, requirements for economic growth and the scope for further emissions reductions. The European Climate Change Programme was set up to help EU member states to meet this shared target. The UK's legally binding target was to reduce greenhouse gas emissions by 12.5% of 1990 levels by 2012. It is predicted that UK emissions in 2010 are to be 23.6% below 1990 levels, 11.1% lower than that required by the Kyoto Protocol.[5]

The EU Directive 2001/77/EC relates to the portion of electricity produced from renewable energy sources. The directive, issued in September 2001, commits Member States to the setting of national targets from renewable sources in terms of a proportion of total energy consumption. The UK's target is set at 10%, meaning that by 2010, at least 10% of the total electricity produced should be from renewable resources.[6]

3.2.2 UK Drivers

The British Government have taken the threat climate change poses very seriously and consider it to be one of the biggest challenges currently facing the country. Over the last few years several frameworks and groups have been formed and much policy and guidance has emerged, largely directed at the planning profession, which the government sees as an important facilitator in tackling climate change.

The 2006 **UK Climate Change Programme** is the UK's key strategy for tackling climate change. The Programme sets out Government policies and priorities as well as looking at how existing policies are performing and the possible range of policies that could be implemented in the future. In addition to this, **The Office of Climate Change** (OCC) works across Government departments to support analytical work on climate change and the development of climate change policy and strategy[7].

The Government has introduced two new bills, the **UK Climate Change Bill** and the **Energy Bill**, both of which aim to tackle climate change, principally through a reduction in carbon emissions. The

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[3] See Footnote 1
[4] Department for Environment, Food and Rural Affairs (DEFRA) (2008) 'International Action – The Intergovernmental Panel on Climate Change (IPCC), http://www.defra.gov.uk/environment/climatechange/internat/ipcc/index.htm
[5] Department for Environment, Food and Rural Affairs (DEFRA) (2008) 'International Action – The UN and the Kyoto Protocol', http://www.defra.gov.uk/environment/climatechange/internat/un-kyoto.htm
[6] *Directive 2001/77/EC* of the *European* Parliament and of the Council of 27 September 2001 http://www.ec.europa.**eu**/energy/.../ms_report_**directive**_2001_77_en.htm
[7] Office of Climate Change (OCC) (2008)

UK Climate Change Bill aims to address both the causes and consequences of climate change. The Energy Bill was introduced in early 2008 and alongside the Climate Change Bill will ensure legislation underpins the long-term delivery of the national energy and climate change strategy. One of the key components of the Energy Bill include Carbon Capture and Storage (CCS), creating a regulatory framework to enable private sector investment in CCS projects, which have the potential to reduce the carbon emissions from fossil fuel power stations by up to 90%, and renewable energy; principally strengthening the Renewables Obligation to drive greater and more rapid deployment of renewables in the UK. This will increase the diversity of the UK's electricity mix, thereby improving the reliability of energy supplies and help lower the carbon emissions from the electricity sector[8]. (BERR, 2008)

In addition to these Bills, a **Committee on Climate Change** will advise Government on how best to meet the 2050 targets. The draft Climate Change Bill proposes that the Committee on Climate Change should advise Government on the level of each five year carbon budget, consistent with the optimal trajectory towards the statutory 2050 and 2020 limits and how much effort should be made by the part of the economy covered by cap and trade schemes, and by the rest of the economy.

The UK Government has a target of 10% of the UK's electricity supply to come from renewable sources by 2010, with an aspiration for 20% renewable energy generation by 2020. In 2008 electricity generated from renewable resources Renewables accounted for 5.5% of all electricity generated, up from 4.9% in 2007 and 2.6% in 2000[9].

At a Regional level the **North West Sustainable Energy Strategy (2006)** explains that the need for sustainable energy generation, supply and use has never been more acute. Stating that the serious and undisputable threats that we face in relation to climate change, energy security and affordability tell us clearly that the economic prosperity, social equity and environmental quality of the North West depend on this vital issue[10].

The strategy aims to make the North West a leading region for sustainable energy by meeting the following goals:

- Improving energy efficiency and eliminating energy wastage in all areas of activity across the region.
- Accelerating the transition to sustainable forms of energy and achieving regional renewable energy deployment targets.
- Setting the region on a course to reduce greenhouse gas emissions by at least 60% by 2050.
- Eliminating fuel poverty by ensuring that all householders have access to affordable warmth and decent housing.
- Contributing to the region's economy by harnessing business innovation and employment opportunities arising from sustainable energy practices.
- Communicating views, experiences and examples from the region to improve national and international policy frameworks.

In support of this strategy the **Climate Change Action Plan (2006)** aims to stimulate and measure the progress of the region towards a low carbon economy, preparing it for the challenges of a changing climate and future energy demands, whilst protecting and enhancing our quality of life and rich environment[11]. The Action Plan provides a focussed mechanism through which the North West Sustainable Energy Strategy can be implemented. It is intended that the Action Plan will be reviewed every three years

[8] Climate Change and Sustainable Energy Bill 2008 *http://www.*.berr.gov.uk/files/file29620
[9] UK Energy in Brief 2008, Department of Energy and Climate Change, http://www.decc.gov.uk/en/content/cms/statistics/publications/brief/brief.aspx
[10] North West Sustainable Energy Strategy Summary, 2006 www.nwrpb.org.uk/.../nwra_1156410969_North_West_Sustainable_Energy_.pdf
[11] The Climate Change Action Plan September 2006. www.nwda.co.uk/climatechange

3.3 National Policy Overview

3.3.1 Planning Policy Framework

Planning in England is guided by the department of Communities and Local Government (CLG), which determines national policies on different aspects of planning, and the rules that govern the operation of the system. National planning policies are set out in new-style Planning Policy Statements (PPS), which are gradually replacing Planning Policy Guidance Notes (PPG). These statements set out the Government's objectives in respect of planning for a whole range of issues and are used by Local Planning Authorities in formulating development plans and determining planning applications.

In preparing the detailed EIA the scheme design was guided by all relevant national planning policies, regional spatial strategies and local plans. Relevant national planning policies consulted for this proposal include:

- PPS1: Delivering Sustainable Development;
- PPS1 Supplement: Planning and Climate Change;
- PPS7: Sustainable Development in Rural Areas;
- PPG8: Telecommunications;
- PPS9: Biodiversity and Geological Conservation;
- PSS 11: Regional Guidance
- PPS 12: Local Spatial Strategies
- PPG15: Planning and the Historic Environment;
- PPG16: Archaeology and Planning;
- PPG17: Planning for Open Space, Sport and Recreation;
- PPS23: Planning and Pollution Control;
- PPS25: Development and Flood Risk;
- PPG 24: Planning and Noise.
- PPS22: Renewable Energy;
- A Companion Guide to PPS22 Renewable Energy;

3.3.2. PPS1: Delivering Sustainable Development

PPS1 sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system and is of relevance to all development proposals. It explicitly states that development plan policies should take account of issues such as mitigation of the effects of, and adaptation to, climate change through the reduction of greenhouse gas emissions and the use of renewable energy.

Sustainable development is the core principle underpinning planning. At the heart of sustainable development is the simple idea of ensuring a better quality of life for everyone, now and for future generations. A widely used definition was drawn up by the World Commission on Environment and Development in 1987: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The Government set out four aims for sustainable development in its 1999 strategy. These are:
- social progress which recognises the needs of everyone;
- effective protection of the environment;
- the prudent use of natural resources; and,
- the maintenance of high and stable levels of economic growth and employment.

One of the aims cited in PPS1 is that the prudent use of natural resources should be encouraged. This includes the promotion rather than restriction of the use of renewable resources by, for example, the development of renewable energy.

PPS1 encourages regional planning bodies and local planning authorities should ensure that development plans contribute to global sustainability by addressing the causes and potential impacts of climate change - through policies which reduce energy use, reduce promote the development of renewable energy resources, and take climate change impacts into account in the location and design of development. '

When determining planning applications, PPS1 states Planning Authorities should adhere to 'controls under the planning, building control and other regulatory regimes'. Information sought from applicants should be 'proportionate to the scale of the proposed development, its likely impact on and vulnerability to climate change and be consistent with that needed to demonstrate conformity with the development plan and PPS1'.

In addition, if the Regional Spatial Strategy or Development Plan Documents have not been updated to reflect this PPS Supplement, then 'planning authorities should have regard to this PPS as a material consideration which may supersede the policies in the development plan'.

Local Development Documents should 'promote and encourage renewable and low-carbon energy generation' and not restrict these proposals and their associated infrastructure.

3.3.3 PPS: Planning and Climate Change – Supplement to PPS 1

This PPS on climate change supplements PPS1 by setting out how planning should contribute to reducing emissions and stabilising climate change and take into account the unavoidable consequences. The document states that planning has a key role to play in tackling climate change and that *"when used positively, planning can help to create an attractive environment for innovation and for the private sector to bring forward investment, including in renewable and low-carbon technologies and supporting infrastructure."*

With specific regard to renewable energy, this supplement states that planning authorities should provide a framework that promotes and encourages renewable and low carbon energy generation. Policies should be designed to promote and not restrict renewable and low-carbon energy and supporting infrastructure. In particular, planning authorities should:

- not require applicants for energy development to demonstrate either the overall need for renewable energy and its distribution, nor question the energy justification for why a proposal for such development must be sited in a particular location;
- ensure any local approach to protecting landscape and townscape is consistent with PPS22 and does not preclude the supply of any type of renewable energy other than in the most exceptional circumstances;
- alongside any criteria-based policy developed in line with PPS22, consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources, but in doing so take care to avoid stifling innovation including by rejecting proposals solely because they are outside areas identified for energy generation.
- Expect a proportion of the energy supply of new development to be secured from decentralised and renewable or low-carbon energy sources.

The PPS1 supplement also states that development proposals which will 'contribute to the delivery of the Key Planning Objectives should expect expeditious and sympathetic handling' by the Planning Authority.

3.3.4 PPS7: Sustainable Development in Rural Areas

The policies in PPS7 relate to rural areas, including country towns and villages and the wider largely undeveloped countryside up to the fringes of larger urban areas. Amongst the Government

objectives for rural areas are to raise the quality of life and the environment and to promote more sustainable patterns of development.

PPS7 states that development within the countryside should be good quality, carefully sited and accessible. The Government's overall aim is to protect the countryside for the sake of its intrinsic character and beauty, the diversity of its landscapes, heritage and wildlife, the wealth of its natural resources and so it may be enjoyed by all. In addition all development in rural areas should be well designed and inclusive, in keeping and scale with its location, and sensitive to the character of the countryside and local distinctiveness

In terms of development in the countryside, PPS7 states that when determining planning applications for development in the countryside, local authorities should take account of the need to protect natural resources and they should provide for the sensitive exploitation of the of renewable energy sources in accordance with policies set out in PPS22.

3.3.5 PPS22: Renewable Energy

PPS 22 sets out the Government's stance on renewable energy development in England. In line with current Government targets to cut the UK's carbon emissions the increased development of renewable energy resources is vital.

PPS22 states that positive planning which facilitates renewable energy developments can contribute to all four elements of the Government's sustainable development strategy:

- social progress which recognises the needs of everyone – by contributing to the nation's energy needs, ensuring all homes are adequately and affordably heated; and providing new sources of energy in remote areas;
- effective protection of the environment – by reductions in emissions of greenhouse gases and thereby reducing the potential for the environment to be affected by climate change;
- prudent use of natural resources – by reducing the nation's reliance on ever diminishing supplies of fossil fuels; and,
- maintenance of high and stable levels of economic growth and employment – through the creation of jobs directly related to renewable energy developments, but also in the development of new technologies. In rural areas, renewable energy projects have the potential to play an increasingly important role in the diversification of rural economies.

PPS22 sets out a number of key principles that planning authorites should adhere to when considering applications for renewable energy developments. These include:

- Renewable energy developments should be capable of being accommodated throughout England in locations where the technology is viable and environmental, economic, and social impacts can be addressed satisfactorily.
- The wider environmental and economic benefits of all proposals for renewable energy projects, whatever their scale, are material considerations that should be given significant weight in determining whether proposals should be granted planning permission.
- Regional planning bodies and local planning authorities should not make assumptions about the technical and commercial feasibility of renewable energy projects (e.g. identifying generalised locations for development based on mean wind speeds). Technological change can mean that sites currently excluded as locations for particular types of renewable energy development may in future be suitable.
- Local planning authorities, regional stakeholders and Local Strategic Partnerships should foster community involvement in renewable energy projects and seek to

promote knowledge of and greater acceptance by the public of prospective renewable energy developments that is appropriately located. Developers of renewable energy projects should engage in active consultation and discussion with local communities at an early stage in the planning process and before any planning application is formally submitted.

- Developments should be capable of being accommodated throughout England...where the technology is viable, and environmental, economic and social impacts can be addressed satisfactorily';
- Policies should be designed to 'promote and encourage' the development of renewable energy resources, subject to appropriate environmental safeguards;
- Local Planning Authorities should define criteria within development documents which will be applied in the assessment of renewable energy projects planning applications;
- 'The wider environmental and economic benefits of all proposals for renewable energy projects...are material considerations that should be given significant weight in determining whether proposals should be granted';
- 'Local Authorities should not make assumptions about the technical and commercial feasibility of renewable energy projects';
- Development proposals should demonstrate any environmental, economic and social benefits as well as how any environmental and social impacts have been minimised through careful consideration of location, scale, design and other measures.

3.3.6 Planning for Renewable Energy: A Companion Guide to PPS22

Whilst PPS22 sets out the policy context for renewable energy planning, this Companion Guide offers practical advice as to how these policies can be implemented on the ground, whilst the Technical Annex at the back of the document includes specific advice on the range of renewable energy technologies covered by PPS22.

The Guide should be read in conjunction with PPS22 and offers much needed assistance to decision makers who might be unsure about the technicalities of emerging renewable energy technologies. The Guide expands on issues such as the wider social, environmental and economic benefits of renewable energy technologies. It looks at community involvement, landscape issues, local and regional policy formulation and issues associated with development control decisions, including information regarding EIAs, what should be included in a renewable energy development planning application, and consultation.

3.3.7 Additional Relevant National Planning Policy

In addition to the planning policy statements set out above, there are a number of additional PPS's & PPG's that have relevance to this proposal, as follows;

PPG8: Telecommunications states that the construction of new buildings or other structures, such as wind turbines, can interfere with broadcast and other telecommunications services, and the possibility of such interference can be a material planning consideration.

PPS9: Biodiversity and Geological Conservation complements but does not override other national policy and should be read in conjunction with other relevant PPS. PPS9 states that development proposals where the principal objective is to conserve or enhance biodiversity and geological conservation interests should be permitted. The aim of planning decisions should be to prevent harm to biodiversity and geological conservation interests. Where granting planning permission would result in significant harm to those interests, local planning authorities will need to be satisfied that the development cannot reasonably be located on any alternative sites that would result in less or no harm

PPG15: Planning and the Historic Environment from 1994 states that the Government has committed itself to the concept of sustainable development - of not sacrificing what future generations will value for the sake of short-term and often illusory gains. Though choices sometimes have to be made, conservation and sustainable economic growth are complementary objectives and should not generally be seen as in opposition to one another. This guidance provides a full statement of Government proposals for the identification and protection of historic buildings, conservation areas and other elements of the historic environment.

PPG16: Archaeology and Planning should be read I conjunction with PPG15 and sets out the Government's policy on archaeological remains on land and how they should be preserved or recorded. The desirability of preserving an ancient monument and its setting is a material consideration in determining planning applications whether that monument is scheduled or unscheduled**.** Developers and local authorities should take into account archaeological considerations and deal with them from the beginning of the development control process.

PPS23: Planning and Pollution Control states that any consideration of the quality of land, air or water and potential effects arising from development is capable of being a material planning consideration. Through its commitment to sustainable development, the Government attaches great importance to controlling and minimizing pollution.

PPG24: Planning and Noise guides local authority planners to use their planning powers to minimise the adverse effects of noise. The guidance outlines what considerations should be taken into account when determining applications for both noise-sensitive developments and for activities which might generate noise. It explains the concept of noise exposure categories for residential development and recommends appropriate levels for exposure to different sources of noise. It also advises on the use of conditions to minimise the impact of noise.

PPS25: Development and Flood Risk suggests that flood risk is taken into account at all stages of development to ensure that inappropriate development in at risk areas does not take place. In exceptional circumstances where development in 'at risk' areas is deemed necessary, policies are in place to make this development is safe and ensure increased flood risk elsewhere does not occur as a result.

3.4 Regional Policy Issues

3.4.1 Regional Policy Overview

The North West Regional Spatial Strategy, herein referred to as the NW Plan, was adopted in July 2008 and sets out a vision for the North West up to 2021. It provides a framework for development in the region and sets priorities for dealing with environmental issues, transport and infrastructure.

The Plan states that *"From an environmental point of view, it is important that the North West is a better place to live…that it makes substantial contributions to national and global environmental targets and initiatives. Particularly critical is the need to adapt to, as far as possible, reduce the effects of climate change; including by planning for the efficient use of energy and by developing renewable sources."*

This section will look at the overarching policies associated with this application. It will explore the issues associated with this proposal and identify the key regional policies which deal with these issues.

3.4.2 Overarching Regional Policies

Several general policies in the RSS have relevance to this proposal. These include; **DP1: Spatial Principles** details the principles which underpin the RSS. One of the key points identified is the need to reduce emissions and adapt to climate change. **DP2: Promote Sustainable Communities** reflects central Government advice on the main concepts of sustainable development. **DP9: Reduce Emissions and Adapt to Climate Change** looks at the key point identified in DP1 in more detail. This policy reinforces the Government target to reduce carbon emissions by 60% below 1990 levels by 2050. The policy also cites increasing renewable energy capacity as a key component in reaching this target.

3.4.3 Land Use/Countryside Issues

Since the proposal falls within an area of countryside, the following policies from the RSS are considered relevant:

RDF2: Rural Areas states that in general new development should be located in local and key service centres. However, exceptionally, development will be permitted in the open countryside where it has an essential requirement for a rural location which cannot be accommodated elsewhere.

EM1:Integrated Enhancement and Protection of the Region's Environmental Assets states that the region's environmental assets should be identified, protected, enhanced and managed. With regards to specific elements of the suggested approach, **EM1 (A): Landscape** suggests that plans, strategies, proposals and schemes should identify, protect, maintain and enhance natural, historic and other distinctive features that contribute to the character of the landscape. The importance of nationally designated areas, such as National Parks and AONBs should be recognised. **EM1 (B): Natural Environment**, **EM1 (C): Historic Environment** and **EM1 (D): Trees, Woodlands and Forests** may also have some relevance to this application.

3.4.4 Economic, Social and Environmental Issues

PPS22 states that the economic, social and environmental benefits of renewable energy installations should be regarded as material considerations during the application process. The following policies from the RSS are therefore relevant to this application:

DP2: Promote Sustainable Communities suggests that sustainable communities should meet the diverse needs of existing and future residents, which includes being sensitive to the environment. It also states that the economic, social and environmental implications to communities of development and investment decisions should be taken into account.

DP3: Promote Sustainable Economic Development states that one of the key aims of the RSS is to to improve productivity, and to close the gap in economic performance between the North West and other parts of the UK. Sustainable economic growth should be supported and promoted, and so should reductions of economic, environmental, education, health and other social inequalities between different parts of the North West, within the sub-regions, and at local level.

DP7: Promote Environmental Quality states that environmental quality should be protected and enhanced.

DP9: Reduce Emissions and Adapt to Climate Change suggests that schemes should contribute to a reduction in carbon dioxide and other greenhouse gas emissions. Measures should be identified, assessed and applied to ensure effective adaptation to likely environmental, social and economic impacts of climate change. As stated earlier, this policy advocates the installation of renewable technologies as a key component in the reduction of carbon emissions.

W1: Strengthening the Regional Economy advocates the promotion of opportunities for economic development.

EM1: Integrated Enhancement and Protection of the Region's Environmental Assets as stated above is also relevant in this case.

3.4.5 Ecology/Nature Conservation

EM1 (B): Natural Environment states that Plans, strategies, proposals and schemes should secure a 'step-change' increase in the region's biodiversity resources by contributing to the delivery of national, regional and local biodiversity objectives and targets for maintaining extent, achieving condition, restoring and expanding habitats and species populations. This should be done through protecting, enhancing, expanding and linking areas for wildlife within and between the locations of highest biodiversity resources, including statutory and local wildlife sites, and encouraging the conservation and expansion of the ecological fabric elsewhere.

EM1 (D): Trees, Woodlands and Forests suggests that Plans, strategies, proposals and schemes should support the aims and priorities of the North West Regional Forestry Framework and sub-regional forestry strategies. Included in this, schemes should aim to identify and protect ancient semi-natural woodland and veteran trees.

3.4.6 Visual Impact

EM17: Renewable Energy (see below) states that a key criteria in relation to renewable energy applications is visual impact. Acceptability of the location/scale of the proposal and its visual impact in relation to the character and sensitivity of the surrounding landscape, including cumulative impact are key material considerations. Stringent requirements for minimising impact on landscape and townscape would not be appropriate if these effectively preclude the supply of certain types of renewable energy, other than in the most exceptional circumstances such as within nationally recognised designations as set out in PPS22 paragraph 11.

3.4.7 Cultural Heritage

EM1 (C): Historic Environment states that Plans, strategies, proposals and schemes should protect, conserve and enhance the historic environment supporting conservation-led regeneration in areas rich in historic interest, and in particular exploiting their regeneration potential.

3.4.8 Hydrology/Geology

EM1 (B): Natural Environment (as above) states that Plans, strategies, proposals and schemes should protect and enhance the region's geological and geomorphological resources including statutory and local sites by contributing to the delivery of national, regional and local geodiversity objectives and targets.

3.4.9 Renewable Energy

EM15: A Framework for Sustainable Energy in the North West suggests that Plans and strategies should promote sustainable energy production and consumption in accordance with the principles of the Energy Hierarchy and within the Sustainable Energy Strategy.

EM17: Renewable Energy states that In line with the North West Sustainable Energy Strategy, by 2010 at least 10% (rising to at least 15% by 2015 and at least 20% by 2020) of the electricity which is supplied within the Region should be provided from renewable energy sources. To achieve this new renewable energy capacity should be developed which will contribute towards the delivery of indicative capacity targets In accordance with PPS22, meeting these targets is not a reason to refuse otherwise acceptable development proposals.

The Policy goes on to state that opportunities should be sought to identify proposals and schemes for renewable energy and that developers must engage with local communities at an early stage of the development process prior to submission of any proposals and schemes for approval under the appropriate legislation. A number of criteria should be taken into account, but not be used to rule out or place constraints on the development of renewable technologies:

- anticipated effects on local amenity resulting from development, construction and operation of schemes (e.g. air quality, atmospheric emissions, noise, odour, water pollution and disposal of waste). Measures to mitigate these impacts should be employed where possible and necessary to make them acceptable;
- acceptability of the location/scale of the proposal and its visual impact in relation to the character and sensitivity of the surrounding landscape, including cumulative impact. Stringent requirements for minimising impact on landscape and townscape would not be appropriate if these effectively preclude the supply of certain types of renewable energy, other than in the most exceptional circumstances such as within nationally recognised designations as set out in PPS22 paragraph 11;
- effect on the region's World Heritage Sites and other national and internationally designated sites or areas, and their settings but avoiding the creation of buffer zones and noting that small scale developments may be permitted in such areas provided there is no significant environmental detriment;
- effect of development on nature conservation features, biodiversity and geodiversity, including sites, habitats and species, and which avoid significant adverse effects on sites of international nature conservation importance by assessment under the Habitats Regulations;
- maintenance of the openness of the Region's Green Belt;
- potential benefits of development to the local economy and the local community;
- accessibility (where necessary) by the local transport network;
- effect on agriculture and other land based industries;
- ability to make connections to the electricity distribution network which takes account of visual impact (as qualified above);
- integration of the proposal with existing or new development where appropriate;
- proximity to the renewable fuel source where relevant – e.g. wood-fuel biomass processing plants within or in close proximity to the region's major woodlands and forests.

Policy EM18: Decentralised Energy Supply states that plans and strategies should encourage the use of decentralised and renewable or low-carbon energy in new development in order to contribute to the achievement of the targets set out in Table 9.6 and 9.7a-c. In particular, local authorities should, in their Development Plan Documents, set out:

- targets for the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources, based on appropriate evidence and viability assessments; and
- the type and size of development to which the target will be applied.

Appendix C section C1 and C2 details the tables noted in Policy EM 17 from the NWRSS

3.5 Sub Regional Policy Issues

3.5.1 Sub Regional Policy Overview

The Joint Lancashire Structure Plan 2001 – 2016 was adopted in March 2005 by Lancashire County Council, Blackburn with Darwen Borough Council and Blackpool Borough Council. However, this document and its saved policies are no longer relevant as the Joint Structure Plan has been replaced by the North West of England Plan Regional Spatial Strategy to2021. Therefore guidance for development proposals within Lancashire should be taken from the North West RSS, as detailed in Section 3.4

3.5.2 Landscape and Heritage Supplementary Planning Guidance (2004)

This policy document referred to in Lancaster City Council Scoping Response provides a strategic good practice guide for development in rural and urban environments. It explains the application of national and regional plan policies on landscape, biodiversity and heritage assets in a Lancashire context. Its purpose is to inform the production of District Local Plans/Local Development Frameworks, the operation of the Development Control process, developers and land use managers about the general principles of heritage conservation, and how heritage resources may be protected and enhanced through the planning process.

3.5.3 Landscape sensitivity to wind energy developments in Lancashire (2005)

This study commissioned by Lancashire County Council together with Blackpool and Blackburn with Darwen Borough Councils in November 2004. It addresses landscape parameters only and excludes consideration of other issues (e.g. impacts on ecology, hydrological regimes, soil resources, grid connections etc) which also merit careful consideration when seeking to locate wind energy developments.

The study reveals that generally, the central portion of the county displays generally High and Moderate-High sensitivity to wind energy development includes the areas of both AONBs. The south eastern part of the county includes areas with Moderate and Moderate-Low. The western margin of the county includes areas which exhibit Moderate-Low and Low sensitivity to wind energy development.

It should be noted that this is a broad scale study, undertaken at County level to provide strategic guidance. An identification of high sensitivity to wind energy development does not necessarily rule out all wind energy development in the denoted area. Similarly a finding of low sensitivity does not imply that all of the LCA concerned will be equally appropriate for wind energy development. This study does not replace a comprehensive on-site investigation and analysis in respect of any specific development proposal.

3.6 Local Policy Issues

3.6.1 Local Policy Overview

The Lancaster District Local Plan was adopted in April 2006. The policies in this document are gradually being replaced by policies in the new raft of Development Plan Documents, including the Lancaster District Core Strategy, adopted in 2008. This section of the policy review includes many Core Strategy policies with some relevant Local Plan policies. For clarity, where policies are included form the Local Plan, this is stated in the text.

3.6.2 Overarching Local Policy

SC1: Sustainable Development reinforces the ideas presented in Planning Policy Statement 1 and in the North West Plan. The purpose of this policy is to *ensure that "new development proposals are as sustainable as possible, minimise greenhouse gas emissions and are adaptable to the likely effects of Climate Change".* In assessing whether a development proposal or allocation is

as sustainable as possible, the Council will apply the principles of location, design construction and use in order to make proposal decisions.

3.6.3 Land Use/Countryside Issues

SC3: Rural Communities aims to build healthy sustainable communities. The policy states that in rural areas, development outside of the defined settlements which have five basic services will require exceptional justification.

E3 (Lancaster District Local Plan) states that development both within and adjacent to the Forest of Bowland or Arnside/Silverdale areas of outstanding natural beauty or the Yorkshire Dales National Park which would either directly or indirectly have a significant adverse effect upon their character or harm the landscape quality, nature conservation interests or features of geological importance will not be permitted. Any development must be of an appropriate scale and use materials which are appropriate to the area.

E4 (Lancaster District Local Plan) states that within the area identified as countryside on the Local Plan Proposals Map, development will Only be permitted where it:

- Is in scale and keeping with the character and natural beauty of the landscape;
- Is appropriate to its surroundings in terms of siting, scale, design, materials, external appearance and landscaping;
- Would not result in significant adverse Effect on nature Conservation or Geological interests;
- And makes satisfactory arrangements for access, servicing, cycle and car parking.

3.6.4 Economic, Social and Environmental Issues

ER1: Higher and Further Education aims to maximise the regeneration benefits to Lancaster District of growth at Lancaster University and the University of Cumbria. Lancaster University is the most important economic asset in the District and is of continued importance to both Lancaster and the North West region. The Council will seek to maximise the economic benefits of the Higher Education sector and seek to spread its impact to areas of deprivation by:

- Supporting the continued expansion of Lancaster University within the existing built-up part of the campus and, outside this area, where special justification is demonstrated;
- Developing the Lancaster Science Park as a high quality location for knowledge based industries and with functional and physical linkages between the Park and Lancaster University;

ER7: Renewable Energy aims to maximise the proportion of energy generated in the District from renewable resources where compatible with other sustainability objectives. This policy is explored in more detail below.

E1: Environmental Capital looks to improve the District's Environment. The Council are committed to safeguarding and enhancing the District's Environmental Capital by applying national and regional policies. The policy states that the Council will aim to encourage development which makes the minimum and most efficient use of finite natural resources including land, buildings soil, non-renewable energy, water and raw materials. The policy also aims to conserve and enhance existing landscapes.

SC1: Sustainable Development is also relevant to this issue.

3.6.5 Ecology and Nature Conservation

E1: Environmental Capital (as above) states that protecting and enhancing nature conservation sites, urban greenspaces, landscapes of special importance, listed buildings, conservation areas and archaeological sites is key to enhancing and protecting the local environment. This policy states that the Council will identify how habitats in urban and rural areas will be protected and, where possible, enhanced in extent and in their diversity of wildlife species when deciding planning applications. The conservation and enhancement of landscape is a key component of this policy.

E12 (Lancaster District Local Plan) states that in determining development proposals, The council will ensure That any impacts upon wildlife, wildlife habitats, protected species and important geological features are taken into full account. Where development is permitted, developers will be required to minimise any adverse Impact and/or create and provide for the appropriate management of compensatory wildlife habitats.

E13 (Lancaster District Local Plan) states that development which would result in a significant adverse effect on, or involve the loss of, any significant area of woodland; significant trees; or any area of ancient woodland, will not be permitted.

3.6.6 Visual impact

SC5: Achieving Quality in Design aims to ensure that development proposals achieve the Core Strategy Vision of leading the North West in terms of design. The policy states that the Council will work with developers, local and national stakeholders and communities to maintain and improve the quality of development by seeking to ensure that throughout the District and particularly in a number of landscapes, including the countryside, new development is of a quality which reflects and enhances the positive characteristics of its surroundings including the quality of the landscape, results in an improved appearance where conditions are unsatisfactory, complements and enhances the public realm and, in high profile locations, creates landmark buildings of genuine and lasting architectural merit.

3.6.7 Cultural Heritage

Elements of other policies within the Core Strategy are relevant to this issue, including **SC5** and **EM1.**

Policy E35 (Lancaster District Local Plan) states development proposals which would adversely affect important views into and across a conservation area or lead to an unacceptable erosion of its historic form and layout, open spaces and townscape setting will not be permitted.

Policy E44 (Lancaster District Local Plan) states in determining applications for development, the City Council will take into account archaeological considerations and the need to safeguard important sites from damage or destruction. Development proposals which would have an adverse impact on the site or setting of a scheduled ancient monument or other monument of national importance will not be permitted.

Policy E45 (Lancaster District Local Plan) states the City Council will protect other sites of archaeological significance. When development affecting such sites is acceptable in principle, the council will seek to ensure mitigation of damage through preservation of the remains in situ as a preferred option.
When in situ preservation is not justified, the developer will be required by planning condition or Legal agreement to make adequate provision for investigation and recording before or during development.

Policy E46 (Lancaster District Local Plan) states where development proposals affect sites of known or possible archaeological interest, the city council will require an archaeological assessment and/or evaluation to be submitted as part of the planning application. Planning

permission will not be granted without adequate assessment of the nature, extent and significance of the remains present and the degree to which the proposed development is likely to affect them.

3.6.8 Renewable Energy

ER7: Renewable Energy (as above) aims to maximise the proportion of energy generated in the District from renewable resources where compatible with other sustainability objectives. The policy states that the Council will promote renewable energy in the District by:

- Promoting and encouraging the development of renewable energy resources across the District including, but not limited to, the promotion of South Heysham as a key focus for renewable energy generation including wind and biomass technology whilst ensuring the protection of Natura 2000 sites including the Morecambe Bay, Bowland Fells and Leighton Moss Special Protection Areas from adverse effects;
- Promoting micro-renewables through its Development Control policies;
- Promoting energy efficiency through Building Control;
- Participating in a study of the economic potential of environmental technologies in the District.

E22* (Lancaster District Local Plan) is specific to wind turbine installation. The policy states those proposals for the development of wind turbines will be assessed against their impact on; the character of the landscape, including the cumulative impact on a number of sites; nature conservation interests, historic buildings and areas and archaeological sites; nearby dwellings including the effect of electromagnetic disturbance. Within the Arnside/Silverdale and Forest of Bowland Areas of Outstanding Natural Beauty, wind turbines will only be permitted where the applicant can demonstrate that no alternative suitable site exists elsewhere, that the economic benefits of the proposal clearly outweigh any adverse impact on the area and that any such impact is minimised.

(*This policy is partly superseded by policies in the Core Strategy but should still be taken into account).

3.6.9 Hydrology and Geology

SC7: Development and Risk of Flooding aims to build sustainable communities by ensuring that new homes, workplaces and public spaces are not exposed to unacceptable levels of flood risk, in line with PPS25.

Policy E7 (Lancaster District Local Plan) states that development proposals which would affect an existing watercourse will only be permitted where:

- Water quality would be maintained or improved;
- Water flow would not be reduced to a point which would have a significant adverse impact on water quality, public amenity or public health; and
- There would be no significant adverse impact on the landscape, nature conservation, recreation and amenity importance of the watercourse.

Policy E8 (Lancaster District Local Plan) states within areas of groundwater vulnerability, development which would have a significant adverse effect on the purity of ground water supplies will not be permitted.

Chapter 4: Socio-Economics, Land Use and Tourism

4. Socio- Economics, Land Use and Tourism

4.1 Introduction

This chapter of the ES is split into three assessment sections; the effect of the development on the local economy of Lancaster, the effect of the proposed development on local tourist attractions and recreation facilities and finally the effect of the development on land use within 0.5km of the development site.

4.2 Consultation

As part of the Pre Application Consultation process and Scoping process, relevant organisations were contacted with regard to the proposal. These being;

- Lancaster City Council
- Bridleways Association
- Lancashire County Council Public Rights Of Way
- Ramblers Association
- Natural England
- The Forest of Bowland AONB Board

There responses are outlined in Appendix A section A5

4.3 Guidance and Legislation

The baseline description has been prepared after referencing a number of different sources and materials, including the following:

- Guidelines for Environmental Impact Assessment (2004) IEMA
- A Handbook for Environmental Impact Assessment (2005) Scottish Natural Heritage
- Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 6
- North West of England Plan Regional Spatial Strategy to 2021 (RSS);
- Lancaster Core Strategy (2003 – 2021);
- Lancashire Partnership – Ambition Lancashire 2005-2025;
- Lancashire Local Transport Plan
- Lancaster District Development Plan 2001-2016 'saved policies'.
- National Statistics online (www.statistics.gov.uk)
- Lancaster University Website (www.lancs.ac.uk)
- Forest of Bowland AONB Management Plan (www.forestofbowland.com)
- Morecambe Bay Partnership (www.morecambebay.org.uk)
- DTI, GfK NOP Social Research Renewable Energy Awareness and Attitudes Research, Management Summary (2006).
- GfK NOP WIND FARMS TELEBUS Fieldwork conducted : 28th – 30th July 2006

4.4 Assessment Methodology

There is no set procedure for the assessment of socio-economic, recreation and land-use effects. Therefore this chapter of the ES has been produced in line with the general guidelines produced by IEMA (2004) and by Scottish Natural Heritage (2005) and draws upon additional guidance and legislation listed within section 4.4.

For the purposes of this assessment, in terms of socio-economic factors significant effects are classed as occurring if the proposal were to result in any fundamental or material changes in population, structure of the local community, or local economic activity during the different construction, operation or decommissioning phases.

When assessing impact on tourism and recreation, consultations with the local authority and other consultees such as the Rambler Association, Public Rights of Way Office and Forest of Bowland AONB Board have provided baseline data for the area. Significant effects are classed as occurring if the proposal were to result in permanent effects to facilities or public access to recreational resources.

Land use has been assessed within a 0.5km boundary around the development site. This assessment involved a number of site visits to establish the physical effects of the proposed development on existing land use, considering the effect of the wind turbines and associated infrastructure. This aspect of the assessment considers[1];

- Effects on private property and associated land take;
- Effects on land used by the community, for example Registered Common Land, field allotments and registered public open space;
- Effects on development land; and
- Effects on agricultural land.

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Significant effects are classed as occurring if the development were to result in a fundamental change in the predominant land use of the site.

Potential effects on Land Use and Recreation outside this study area would relate predominantly to visual or noise effects. These issues are discussed further in Chapter 6: Landscape and Visual Impact and Chapter 9: Noise and Vibration respectively. To some extent the visual impact of the proposal on these matters is subjective and relates to public perception of the wind turbines within the landscape. A number of papers have been published on this topic and are referred to in the relevant subsection of this chapter. This information is also supplemented with additional commentary within ES Chapter 6, as well as, details of the public consultation process and response in ES Chapter 14 and Appendix M.

4.5 Baseline Description

4.5.1 Socio-Economic Impacts

Population statistics for the Lancaster District demonstrates significant growth between the periods of 2001 -2006. As recorded at the time of the 2001 Census, Lancaster District had a population of 133,914[2]. This increased by 7% over 5 years, to 143,000 by 2006. According to the North West of England Plan Regional Spatial Strategy to 2021, the population of the region is continuing to rise, as a result of an improving economy[3].This figure not only takes into account natural rates of change due to births and deaths, but also the predicted net migration patterns between this period.

Approximately 90% of the district is rural in character with around 34,000 people living in villages and the countryside[4]. The rural areas have the lowest levels of deprivation, the best health and education and the highest incomes. The wind turbine project is situated in the Ellel ward. For the purposes of the Census population **figures for Ellel and the University are combined**. Population figures for this area are 8146, which is 82.5% lower than the main urban area of Lancaster which has a population density of 47159.[1]

In terms of age structure, the median age of the population in the county of Lancashire is 38. In Lancaster District the majority of the population are aged between 45-65 years. In the Ellel and

1 Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 6

2 Lancaster University Website (www.lancs.ac.uk)

3 North West of England Plan Regional Spatial Strategy to 2021

4 Lancaster Core Strategy (2003 – 2021)

University ward where the turbines are located, the majority are aged between 20-29 years. This is likely to be because of the high student population at the University which when combined with the Ellel ward population skews the data.

Population statistics at parish level were being recalculated at the time of writing therefore no information is available regarding this.

At the time of the 2001 census there was a high working age population in Lancaster of approximately 62%. Of these 54% were in full time employment. The unemployment rate for Lancaster stood at 6% for the same period, slightly above the British average of 5.3%.

Excluding the farm complex which currently grazed the pasture, there are two businesses within 0.5km of the development site, these are Valley View Boarding Kennels and Forest Hills Golf Course.

4.5.2 Recreation and Tourism

There is no evidence to suggest that wind turbines adversely affect tourism. In fact the UK's first commercial wind farm at Delabole received 350,000 visitors in its first ten years of operation. A MORI poll in Scotland showed that 80% of tourists would be interested in visiting a wind farm. Furthermore, wind farm developers are often asked to provide a visitor centre, viewing platforms and rights of way to their sites.[5]

The Lancaster University lies within a countryside area approximately 2km west of the boundary of the Forest of Bowland AONB and 2.5km east of the Morecambe Bay special area of conservation, as shown in Appendix D section D1.

The AONB's population of just over 16,000 live mostly in its historic villages[4].The Forest of Bowland AONB attracts over 30,000 visits per year, based on the most up to date publicly available information'. The highest frequency of visitors occurs in the 35 to 54 age group followed by 55 + age groups. There are fewer visitors between the ages of 11 and 34. Furthermore a considerable number of people pass though the area on their way to the Lake District. According to the AONB board's visitor surveys the main reason for visiting the AONB was for walking (accounting for 62% of people surveyed) followed by pleasure visit/general sightseeing (49%), cycling (17%) and bird watching (12%)[6].Within the AONB Visitor's favourite places to visit are Dunsop Bridge, Slaidburn, the Trough and Beacon Fell[7].

Morecambe Bay lies to the west of the application site and covers an area of approximately 310sqkm which consist mainly of intertidal sandflats and mudflats. Up to 200,000 people live and work in the bay area.

Although there are no public rights of way within the confines of the development site, there are a number of public rights of way around the site. The closest public footpath is to the southeast of the site, approximately 145m from Turbine 2 across Hazelrigg Lane. There is also a golf course to the southeast of the site, approximately 220m from Turbine 2. Horse riding is a popular recreational activity in the area. The closest public bridleway (see Appendix D section D1) is approximately 2.2km to the east of the site. The British Horse Society has confirmed that a number of minor roads around the site are also utilised by riders however consultation responses with the bridleways office have not resulted in any negative responses. The operational impact turbines are assessed in detail in chapters 6, 8 and 9. Overall the Lancaster University wind turbines are considered to create a gateway to Lancaster and an attraction for people using walking, cycling and riding routes.

There are several well recognised local historic attractions around the area from which the wind turbine project will be visible. These include views from Lancaster Castle, Ashton Memorial and Jubilee Tower. The historic attributes of these attractions and the visual impact of the proposal on these historic assets are assessed within Chapter 7 section 7.5.5 of this ES.

The operational impact of the turbines is assessed in detail in ES chapters 6: Landscape and Visual, 8: Shadow Flicker and 9: Noise and Vibration.

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[5] http://www.bwea.com/pdf/tourism.pdf, 2009
[6] http://www.forestofbowland.com/files/uploads/pdfs/strategies/visitor_survey08_report.pdf, 2009
[7] Forest of Bowland Visitor Survey 2008 www.forestofbowland.com

4.5.3 Land Use

The development site totals approximately 23 hectares and comprises mainly of agricultural improved pasture boarded by woodland, used predominantly for grazing of sheep and cows. To the north east of the site lies the University Environmental Science field station. There is no development land or community owned land within the site.

Ellel ward and neighbouring areas is a mixed urban and agricultural area. The closest settlements around the site are Galgate, located approximately 1km to the south of the development site, Bailrigg village located approximately 0.5 km to the north west of the development site, and Quernmore village approximately 2.5km to the northeast. The agricultural land at site is catagorised as poorer quality, grades 4 and 5 land. These poorer grades of land are best suited to grass crops or rough grazing[8].

The M6 motorway runs along the western boundary of the development site. Vehicular access will be via a new entrance at the south of the site onto Hazelrigg Lane which runs along the southern and western boundaries of the development site.

4.5.4 Public perception of wind turbines

PPS22 advises Local planning authorities, regional stakeholders and Local Strategic Partnerships to “seek to promote knowledge of and greater acceptance by the public of prospective renewable energy developments that are appropriately located.”[9]

In the United Kingdom there have been a number of studies undertaken to evaluate the public's attitudes to wind turbines. This section of the ES examines a number of these studies as a means of predicting the public's response to the proposed development.

The 'Wind Tracker' is a survey of public attitudes to wind energy in the UK, conducted by leading independent research company GfK NOP, and governed by MRS Codes of Conduct[10]. The tracker was first undertaken in August 2004, and has subsequently been repeated four times. The results of each wave of the tracker show that the majority of the population - some three-quarters - agree that wind farms are necessary to help us meet current and future energy needs in the UK[10].

The results of the latest wave, based on telephone research conducted among 973 adults 16+ between 28-30 July 2006 showed that:

- 76% of people in Great Britain agreed that wind farms are necessary so that we can produce renewable energy to help us meet current and future energy needs in the UK.
- 52% of people disagreed that wind farms are ugly or would be a blot on the landscape with 21% having no strong views.
- 60% of people think that what they look like is unimportant, because wind farms are necessary.
- 56% said they would be happy to have a wind farm in their local area, with 21% having no strong views.

A study carried out by GfK NOP Social Research in 2006 also looked at Renewable Energy Awareness and Attitudes to wind farms. The study appraised people’s attitudes to renewable technologies and wind development and investigates whether people’s attitudes to wind turbines change the closer they live to a wind development.

[8] http://www.lancashire.gov.uk/office_of_the_chief_executive/lancashireprofile/sectors/agricult.asp, 2009
[9] Planning for Renewable Energy: A Companion Guide to PPS22
[10] DTI, Renewable Energy Awareness and Attitudes Research, Management Summary (2006). GfK NOP Social Research http://www.bwea.com/ref/windtracker.html

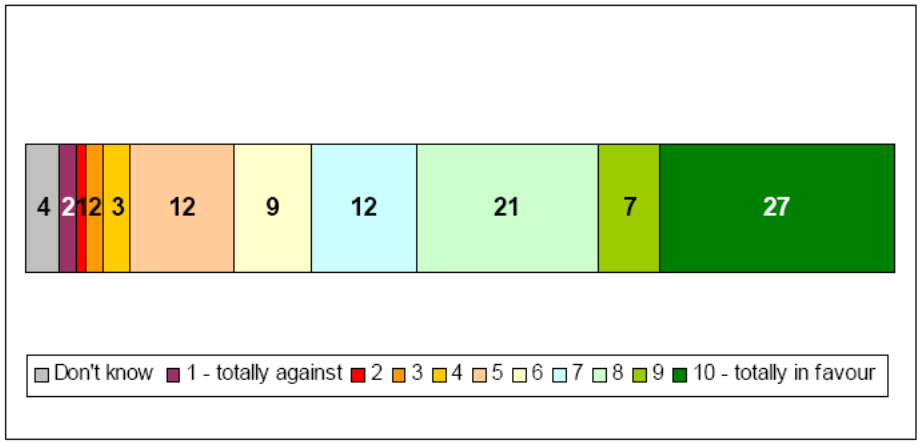

Figure 4.1: Overall opinion of renewable energy (%, base = 2032) [9]

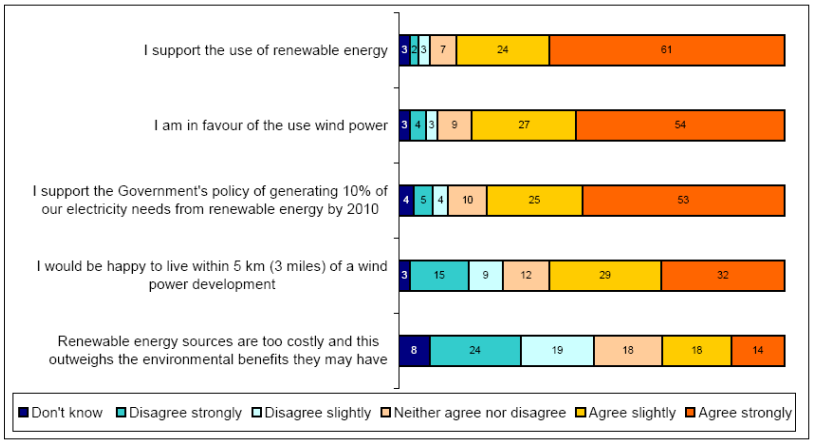

Figure 4.2: Level of agreement to attitude statements about renewable energy (%, base = 2032) [9]

The results shown in Figures 4.1 and 4.2 show that overall, people are in favour of renewable energy and that the majority are in favour of wind development and support the government's objectives to increase energy generation from renewable energy. The results also show that the majority of people would be happy to live within 5km of a wind turbine development.

Further studies undertaken echo these findings, for example by GfK NOP Social Research in 2006[11] also appraised people's opinions on the appearance of wind turbine development and whether they would be happy to have a wind development within their local area. The results are shown below.

Figure 4.3 details the responses to the statement "Wind farms are, or would be, ugly and a blot on the landscape". The results of the study show that the majority disagree with this statement. Whilst there is no significant difference by age, gender and social grade subgroups, there are some regional differences. Level of disagreement with this statement is higher in the North, and level of agreement is lower.[10]

[11] GfK NOP WIND FARMS TELEBUS Fieldwork conducted : 28th – 30th July 2006 (http://www.bwea.com/pdf/Wind%20Tracker%20Executive%20Summary%20Aug%202006.pdf)

	Total	Seen working wind farm	Not seen working wind farm
AUG 04	*(1000)*	*(421)*	*(579)*
AGREE	27%	26%	27%
DISAGREE	50%	58%	44%
JAN 05	*(999)*	*(470)*	*(529)*
AGREE	30%	28%	32%
DISAGREE	52%	60%	45%
MAY 05	*(1000)*	*(439)*	*(561)*
AGREE	28%	27%	29%
DISAGREE	51%	57%	47%
SEP 05	*(935)*	*(452)*	*(483)*
AGREE	27%	23%	30%
DISAGREE	50%	57%	43%

Figure 4.3: GfK NOP FARMS TELEBUS Fieldwork, 2006 Q. Wind farms are, or would be, ugly and a blot on the landscape?[10]

Figure 4.4 details the responses to the question, "Would you be happy to have a wind farm in your local area?" (by which I mean within 5km/ c.3 miles from where you live). The responses indicate that more than half of the sample claim that they would be happy to have a wind farm 'in their own back yard'.[10] Of the remainder, almost half are neutral about the issue. Interestingly, there are no differences at all between those who have seen a wind farm and those who haven't. There are also no differences by region.

	JULY 06	Seen working wind farm	Not seen working wind farm
(base)	**(972)**	**(499)**	**(473)**
Very/ Quite Happy	56%	56%	56%
Not very/ Not at all Happy	22%	22%	22%
Neutral/ don't know	22%	22%	21%

Figure 4.4: GfK NOP FARMS TELEBUS Fieldwork, 2006. Q Would you be happy to have a wind farm in your local area?[10]

A MORI poll commissioned by the Scottish Renewables Forum and the British Wind Energy Association in 2002 determined public attitudes towards wind farms in Argyll, which has the highest concentration of such developments in Scotland. The survey, which was based on detailed interviews with some 300 visitors over two September weekends, found that over 90% of visitors would return to Scotland for a holiday whether or not there were wind farms in the area. Of those that had actually seen wind farms whilst on holiday only 8% had come away with a negative impression. Eight out of ten said that they would go to a wind farm visitor or information centre

[10] DTI, Renewable Energy Awareness and Attitudes Research, Management Summary (2006). GfK NOP Social Research http://www.bwea.com/ref/windtracker.html

during their stay[12]. The conclusions that may be drawn from the research are that there is no evidence that wind farms detract from the tourist experience of an area.

A MORI survey commissioned in 2003 by the Scottish Executive which examined the views of locals living within 20km of Scotland's ten largest wind farms'[13] also revealed that 20% of the residents felt that their local wind farm has a broadly positive effect on the area, compared to just 7% who said it was negative, whilst 73% felt it had neither a positive or negative effect or expressed no opinion. When asked what the shortcomings of the area in which they lived, most commonly mentioned lack of amenities (20%) and poor public transport (18%), whilst only 0.3% of people specifically mentioned wind farms as a negative aspect of their area.

Furthermore the 2003 study also found that people living closest to wind farms tend to be more positive about them (44% of those living 5km say that a wind farm has had a positive effect compared to 16% of those living 10-20km away). People living closest to wind farms are also more supportive of expansion of the sites (65% of those within the 5km zone support 50% expansion compared with 53% of those in the 10-20km zone). The same study also found that before construction 27% of people surveyed thought that adverse landscape impacts might occur as a result of wind farm development. Following construction only 12% indicated that the landscape had been spoiled.

Research also indicates that the media has a strong influence over public perception of wind energy, perhaps because many people don't have firsthand experience of wind energy development in their local area and therefore have to rely on different media to inform them. In general the national media, on the whole, is considered to be more favourable than local media, particularly amongst those people who already view renewable energy most positively, i.e. are positively engaged in the subject.[9] Where as there is a wide variation in the level of favourability of local media across different GB regions. There is probably a bigger role for local media to play, in terms of reassuring and educating the local population of the benefits surrounding renewable energy.[9]

4.6 Information Gaps

Population statistics at parish level were being recalculated at the time of writing therefore no information is available regarding this.

4.7 Assessment of Potential Effects

4.7.1 Socio - Economic Effects

Social and economic effects can categorised as direct, indirect or induced.

- Direct effects, include employment opportunities in the construction, operation and maintenance and decommissioning of the wind farm
- Indirect effects, include employment opportunities created down the supply chain by those companies providing services to the development during construction, operation and de-commissioning
- Induced effects: for instance employment created by the additional spend of wages into the local economy and the purchasing of basic materials, equipment and office space for staff

The proposed Lancaster University wind turbines have the potential to generate a range of economic and social effects and opportunities for local businesses, most notably employment opportunities and local spending. Known and predicted financial spending which will occur at each stage of the development process is detailed in the following sections.

9 DTI, Renewable Energy Awareness and Attitudes Research, Management Summary (2006). GfK NOP Social Research http://www.bwea.com/ref/windtracker.html

12 MORI Scotland, 'Tourist Attitudes towards Wind Farms", 2002. sample: 307 Tourists.

13 Scottish Executive, MORI, "Public Attitudes to Wind Farms: A survey of Local Residents in Scotland", 2003. Sample: 1,800 residents.

4.7.1.1 Pre Construction Investment;

The wind turbine proposal has resulted in contract opportunities for a variety of specialists and useful Services. Preference has been given to local or regional companies, as detailed in figure 4.5.

Company	Service
Segen Ltd, Lancaster	Planning Consultancy Service
Oxford Archaeology, Lancaster	Archaeology and Cultural Heritage Assessment
Thomas Consulting, Lancaster	Highways Impact Assessment
Stephenson Halliday, Kendal	Landscape and Visual Impact Assessment
ACIA Engineering Acoustics Ltd, Stockport	Noise Assessment
CSC Associates, Preston	Ecology Surveys
Roger Cartwright, Silverdale	Tree Surveys
ADTI, Sussex	Aviation and Electromagnetic Interference Assessment
Aecom, Manchester	Site Design and Specification, Civils, Grid Connection
Aecom, Newcastle- Upon- Tyne	Hydrology Assessment
SDA, Salford	Project Management
Aegis, Preston	Safety, Environmental and Risk Management
Ellel War Memorial Institute, Stoney Lane, Galgate St Pauls Parish Hall, Scotforth Road, Lancaster Quernmore Methodist Church Hall, Quernmore TBC Lancaster Central Library, Market Street, Lancaster	Hire of community facilities for public consultation

Figure 4.5: Pre Construction Investment

4.7.1.2 Construction

During construction phases there will be a significant amount of capital spent on supply and construction contracts. Preference will be given to North West companies for these contracts and associated employment opportunities will be made available for local people.

Examples of direct opportunities for local contractors would include;

- haulage
- turbine base and access track construction
- the supply of building materials such as fencing, concrete, cement, stone, etc.
- mechanical, electrical and supervisory services

All stone and ready mixed cement used for the construction of the project would be sourced from local quarries providing an additional, indirect economic benefit to the area.

Construction workers not living locally would stay in local accommodation during the construction period providing modest economic opportunities for local accommodation and other local services.

Overall, construction of the wind turbines would not result in any fundamental or long term changes in population, structure of the local community, local services or employment, but would bring about

a moderate short term beneficial effect through increases in employment and business opportunities.

4.7.1.3 Operation

Once the wind turbine project is complete and operational, investment into the local economy will continue for the lifetime of the project, annual investments will go towards:

- Rates to Lancaster City Council;
- Electrical connection to the electric distribution network;
- Funding for community benefits;
- General site maintenance;
- Wind Turbine servicing and maintenance.

The financial saving from the direct reduction in energy bills will also help to sustain continued growth and investment by the University itself which directly employs 2500 people and contributes significantly to the economy of Lancaster with over £125 Million turn over related to student spending into local area each year.[14]

Lancaster University is currently engaged in a £200 million building programme which will in turn provides local jobs.[15] The financial saving provided by of the wind turbines will be reinvested at site helping to support this programme and safeguarding the long term future growth and development of Lancaster University.

4.7.1.4 Decommissioning

Employment opportunities would also arise during the de-commissioning process. Decommissioning effects are anticipated to be of a similar nature and scale as construction effects, with employment opportunities arising during this process.

4.6.1.5 Impact of Existing Businesses

There are two businesses within 0.5km of the development site, see Appendix D section D1.

- Valley View Kennels;
- Forest Hill Golf Course;

(N.B This excludes the farm complex which currently uses the site pasture for grazing, impacts associated with loss of agricultural land are discussed in 4.7.3).

An assessment of the noise and air quality impacts of the construction and decommissioning phases of the development are provided in ES Chapter 9: Noise and Vibration and Chapter 13: Miscellaneous Issues. An assessment of the operational impacts turbines are provided in ES Chapters 6: Landscape and Visual, 8: Shadow Flicker and 9: Noise and Vibration.

There is no reason to believe that the wind turbine development will have an adverse impact on either the golf course or the kennels. Indeed the reverse may be the case, with people being attracted into the area, increasing public awareness of local businesses and passing trade.

There is no legislation or guidance currently available regarding the impact of wind turbines on domestic animals. In response to the question ‘do wind turbines frighten animals”, the BWEA responds “Wind farming is popular with farmers, because their land can continue to be used for growing crops or grazing livestock. Sheep, cows and horses are not disturbed by wind turbines.”[16]

Regarding possible impacts on dogs and cats which are sensitive to high frequency tonal noise, Chapter 9 of the ES explains that modern large turbine designs emit noise primarily of aerodynamic

[14] www.lancs.ac.uk/vc/key_facts.htm, 2009
[15] www.lancs.ac.uk/vc/key_facts.htm, 2009
[16] http://www.bwea.com/ref/faq.html#scare, 2009

origin, and that tonal noise has been virtually eliminated. In fact based on ACIA's (Figure 4.5) experience of other similar large turbines, the noise profile of these machines contains no tonal noise components. As such the noise regime of the turbines would not be within the sensitive range of high frequency tonal noise (4kHz- 45kHz[17]) which could adversely affect dogs and cats. Furthermore, Paragraph 46 of the Companion guide to PPS 22 explains that tones above 3 kHz are found to attenuate rapidly with distance – the higher frequencies attenuating at a progressively increasing rate[18]. This means that in the unlikely event that small amounts of tonal noise were experienced these would be attenuated out by air absorption within a short distance of the turbine base.

4.7.2 Recreational and Tourism Effects

4.7.2.1 Construction

There are a number of public rights of way (as shown in Appendix D section D1) in the vicinity of the site. Although the Public Rights of Way Office for Lancashire County Council has not responded directly to pre-planning consultation requests or the Scoping Opinion. The Ramblers Association has responded requesting that view points from Glasson Dock, Quernmore Village and Clough Pike be taken in to consideration during the assessment phase of the development. Assessment of these viewpoints is provided in Chapter 6 of the ES. The British Horse Society has raised no objections to the proposal.

There will be no direct effects on recreational routes around the site. During construction there may be indirect intermittent effects on noise levels and air quality. These will be minimised by following best practice guidance for construction.

4.7.2.2 Operation

There will be no direct effects on recreational routes around the site. Surveys of public attitudes to wind farms provide no clear evidence that the presence of turbines in an area has any adverse impact on local tourism. In fact, the Lancaster University wind turbines (situated directly adjacent to the M6 and the AONB) are likely to create a tourist attraction for walkers, cyclists and horse riders that use the public right of way networks and minor roads in the area.

The visual impacts of the proposal having regard to tourism and recreation are discussed further in Chapter 6 of the ES.

4.7.2.3 De-commissioning

Decommissioning effects will be similar to construction effects as described above. The wind farm is a temporary feature which after its 25 year operational life would be removed and the development site restored. No significant effects are predicted.

4.7.3 Land Use

4.7.3.1 Construction

The total ground area covered by the planning application is approximately 23 hectares. However, it is important to note that the total land take of the turbines is much smaller than this and comprises only part of the wider land holding, for example the total land taken of the turbines comprises the turbine foundations, site access track, crane pad hardstanding which total approximately 1.5 hectares and only 6.5% of the wider site area.

The majority of the development site consists of improved grazing fields with woodland at the boundaries. There is also a research field station comprising grassland and research plots, a small building, a number of atmosphere controlled greenhouses, permanent meteorological mast and a

[17] http://www.lsu.edu/deafness/HearingRange.html, 2009

[18] Planning for Renewable Energy A Companion Guide to PPS 22

telecommunications mast. In total approximately 1.5 hectares of the grassland and research plots at field station area would be given over to develop the turbines and their associated infrastructure. These research plots will be relocated elsewhere on site therefore there would only be a minor negative effect that would be temporary in nature.

An area of woodland (approximately 0.36 hectares) and an area of hedgerow (approximately 606m) will require clearance to construct the turbine 2 and the site access tracks. Details of this are provided in ES Chapters 5 and 6 and in appendices B and F. A habitat mitigation strategy is currently being developed which will include measures to enhance the habitat quality and the biodiversity value of the site as a compensatory measure. The mitigation plan will cover approximately 2.5 hectares and is considered sufficient to alleviate any residual impacts.

There is currently14.5 hectares of land used for grazing, it will be necessary to ensure the safety of livestock during construction by either restricting part or the entire site during the 5 month construction period. Construction is due to take place over the autumn and winter months, therefore the temporary loss of the site for grazing is considered negligible having regard to the context of the similar available land locally.

Cumulatively construction of the turbines and implementation of the mitigation plan will result in a permanent loss of 2.3 hectares of grade 4/5 agricultural land. This would be a minor negative effect and would be considered as a limited loss to the grazing/agricultural land that would have no adverse impact having regard to the context of the similar available land locally.

4.7.3.2 Operation

Following installation of the ecology mitigation measures at site and replacement of the Field Station research area elsewhere on site, the only land that will be directly affected by the operation of the wind turbine development would be the land used for the wind turbines themselves, the access tracks, compound and hard standings. No other land outside the development site would be affected during operation. It is envisaged that both the wider site and the areas around the turbine bases can continue to be used for farming and research throughout the operational life of the wind turbines.

4.7.3.3 Decommissioning

The proposal is a temporary feature which after its 25 year operational life would be removed and the development site restored, or the life of the project extended subject to the granting of further planning permission and related consents. The covered access tracks would be retained for use in land management following de-commissioning.

4.7.4 Cumulative Effects

Cumulative visual effects on the Forest of Bowland AONB and Morecambe Bay are assessed in Chapter 6

4.8 Mitigation

Potential Effect	Mitigation	Residual Effect
Loss of 1.5 hectares of grassland and field station research space	Replacement facilities to be provided elsewhere on site.	No Significant Effect
Loss of field station met mast	Replacement met mast to be provided on mutually agreeable site	No Significant Effect
Temporary loss of part or all on site	Reinstatement of grazing land	Temporary loss of the site for grazing is considered

pasture for grazing during the 5 month construction phase.	around turbine bases following completion of construction phases.	negligible having regard to the context of the similar available land locally.
Loss of agricultural land to turbine bases, replacement field station research space and tree planting required as part of ecology mitigation detailed in Chapter 5 and Appendix F7.	Provision of replacement land to be made available for grazing within the former Field Station research area.	Following construction and implementation of mitigation measures there will be approximately 12.2 hectares of available pasture remaining resulting in the overall loss of improved approximately 2.3 hectares of semi-improved grassland. This loss is assessed as negligible and not significant in the context of the similar available land locally.

Figure 4.6: Mitigation requirements

4.9 Residual Impacts

Following implementation of the mitigation measures detailed in Figure 4.6, the only expected residual impact would be the loss of approximately 2.3 hectares of semi-improved grassland during the operational phase of the wind turbine development; however this is assessed as negligible and not significant in the context of the similar available land locally.

4.10 Statement of Significance

Socio-economic effects would occur at a local and regional level and are deemed to be minor and short term and not significant in terms of the EIA regulations.

The development of the proposed Lancaster University Wind Turbines will bring financial investment to the local area, both directly through opportunities for local and regional companies and for construction and through the supply chain and indirectly for the financial savings it offers to Lancaster University which will in turn be reinvested back in to the University enabling its further growth and sustaining its position as a key investor and employer in Lancaster.

Through continuous further funding for community projects throughout the 25 year lifetime of the wind turbine project, it will also contribute positively towards improvements in the social-economic profile of the surrounding villages.

It is anticipated that there would be no negative impacts on local businesses or households in the local communities as a result of the development of Lancaster University wind turbines.

No public rights of way will be directly impacted by the turbine development. The effects on tourism and recreation are dependent upon the attitude of the viewer. Studies undertaken by a range of professional bodies have shown that the majority of the public are in favour of generating energy from renewable sources and although local people can be concerned about wind turbine proposals in their area, these fears are generally allayed when the equipment becomes operational.

The loss of improved and semi-improved grassland is assessed as not significant in the context of the similar available land locally. The loss of the field station facilities will be compensated by on site replacement. The loss of a relatively small area of woodland will also be compensated by replacement planting and through the introduction of a habitat mitigation strategy which will improve biodiversity in the un-developed areas of the site.

Chapter 5: Ecology

5. Ecology

5.1 Introduction

This chapter of the ES describes the findings of the ecological assessment carried out by CSC Associates at the Lancaster University wind turbine site.

The ecological assessment comprised of a desktop survey and a series of ecological surveys, site appraisal and impact assessment carried out at the site of the proposed development at Hazelrigg, including Lancaster University Metrological & Field Station with the following aims:

- To establish the presence or absence of protected species and evaluate the overall nature conservation status of the site
- To assess the likely impact of proposed works to develop the site upon any protected species that may occur on or adjacent to the area of land concerned, and the integrity of nature conservation interest of any other sites of ecological or nature conservation importance within the vicinity
- To provide outline mitigation and habitat aftercare proposals, as appropriate

For the remainder of this ES chapter the term *site* will be used in to refer to the area of land proposed for development as shown on the final version of site layout plan, unless otherwise indicated within the text.

5.2 Consultation

To inform and supplement field work, existing data including field records and known sites of biological importance, were sought from the following:

- MAGIC
- Lancashire County Council Environment Directorate
- North Lancashire Bat Group
- North Lancashire Bat Group and Lancaster & District Bird watching Society
- Lancashire Wildlife Trust, Heysham Nature Reserve
- Natural England, Regional Office

Resultant data is provided within Appendix E

At pre application and scoping stages consultation has been carried out with the following organisations,

Consultee	**Summary**
Natural England	Ecology assessment requirements and procedures agreed, site visit carried out, suitability of turbine locations discussed, principle of tree / hedgerow removal and stream culverting discussed and advice provided on suitable mitigation strategies
Lancashire County Council Ecologist	Ecology assessment requirements and procedures agreed, site visit carried out, suitability of turbine locations discussed, principle of tree / hedgerow removal and stream culverting discussed and advice

	provided on suitable mitigation strategies
RSPB	Advice about bird survey requirements provided and bid flight path maps for the local area provided.
Wildlife Trust	No response received
Lancaster City Council	Discussions regarding site constraints, ecology assessment requirements, principle of tree removal, turbine locations and mitigation requirements

Figure 5.1 Consultation Feedback

5.3 Guidance and Legislation

The assessment has been prepared after referencing a number of different sources and materials, including the following:

- Baerwald, E.F., D'Amours, G.H., Klug, B. J., and Barclay, R., (2008) *Barotrauma is a significant cause of bat fatalities at wind turbines.* Current Biology
- Bibby, C.J., Burgess, N.D. and Hill, D.A. (1992). *Bird Census Techniques*. Poyser. London.
- Byron H. (2000). Biodiversity and Environmental Impact Assessment: A good practice guide for road schemes. RSPB, WWF-UK, English Nature and The Wildlife Trusts, Sandy.
- British Government (1992). Protection of Badgers Act 1992. HMSO.
- British Government (1994). *Conservation (Natural Habitats, &c.) Regulations 1994.* Statutory Instrument 1994 No 2716 Wildlife, Countryside. HMSO
- British Government (1981). *Wildlife and Countryside Act* 1981 with Amendments. HMSO
- English Nature (2001). *Great Crested Newt Mitigation Guidelines*. English Nature, Peterborough.
- Gent, T. and Gibson, S., (eds) (1998). *Herpetofauna Workers' Manual.* JNCC.
- Harris, S., Cresswell, P. and Jefferies, D.J. (1989). *Surveying Badgers.* The Mammal Society.
- IEA (1995). *Guidelines for Baseline Ecological Assessment.* Institute of Environmental Assessment. E & FN Spon.
- Kirkby, K.J. (1988). *A Woodland Survey Handbook.* Research and Survey in Nature Conservation No. 11. NCC, Peterborough.
- Kunz, T.H., Arnett, E.B., Erickson, W.P., Hoar, A.R., Johnson, G.D., Larkin, R.P., Strickland, M.D., Thresher, R.W., and Tuttle, M.D. ((2007). *Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses*. Front. Ecol. Environ. *5*, 315–324.
- Matthews, J., Mitchell-Jones, A.J., and Raynor, R. (2009) Natural England Technical Information Note TIN059 *Bats and single large wind turbines: Joint Agencies interim guidance*
- Mitchell-Jones, A. J., (2004). *Bat Mitigation Guidelines.* English Nature.
- Mitchell-Jones, A.J. and Carlin, C. (2009) Natural England Technical Information Note TIN051 Bats and onshore wind turbines
- NCC (1990). *Handbook for Phase 1 Habitat Survey*: *A Technique for Environmental Audit.* Nature Conservancy Council.
- Rodwell, J. (1991). British Plant Communities: Vol 1, *Woodlands and Scrub.* Cambridge University Press.
- Rodwell, J. (1992). British Plant Communities: Vol 3, *Grasslands and Montane Comnunities*. Cambridge University Press.
- Rodwell, J. (1995). British Plant Communities: Vol 4, *Aquatic Communities and Tall-Herb Fens.* Cambridge University Press.
- Rodwell, J. (2000). British Plant Communities: Vol 5, *Maritime Communities and Vegetation of Open Habitats*. Cambridge University Press.
- SNH (2006) *Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas*
- Stewart, A., Pearman, D.A. and Preston (1994). *Scarce Plants in Britain*. JNCC, Peterborough.
- Wigginton M.J., (ed) (1999). *British Red Data Book: Vascular Plants*, 3rd Edition. JNCC. Peterborough.

5.4 Assessment Methodology

5.4.1 General Ecological and Botanical Survey

This comprised primarily an Extended Phase 1 Habitat Survey carried out in May, August and November 2009 with any evidence of mammals, birds, amphibians, reptiles and invertebrates noted during the survey. The survey methodology for the Extended Phase 1 Habitat Survey comprised a modified version of that described in NCC (1990) and IEA (1995) and where appropriate, with particular respect to the Phase 2 Habitat Survey, incorporating the methodology outlined in Rodwell (1991, 1992, 1995 & 2000) for determination of National Vegetation Classification plant communities.

This was supplemented by a full vascular plant species survey using the 'walkabout method' as described in Kirkby (1988) and a generalised assessment of the site for suitability of habitat for animals, in particular protected species such as badger, bats, breeding birds, water voles and great crested newts. The results from the initial Phase 1 Habitat survey were used to guide the requirements and level of detail of the more specific surveys outlined below.

5.4.2 Badgers

This part of the survey was carried out in May and November 2009 using standard badger survey methodology as described in Harris *et al* (1989). In practice, this comprised a generalised search of the whole site where suitable habitat was found, to a distance of 30m from the site boundary, to check for feeding signs, habitual runs and footprints, hairs, droppings and latrines, scratching posts and actual setts.

5.4.3 Bats

This comprised a daytime survey in May 2009 and a series of night-time surveys carried out between the second week in May and the third week in June 2009. This included two dusk emergence and activity surveys and one dawn activity and roost return survey. All surveys including both static and transect monitoring of activity carried out by three workers using ultrasonic bat detectors (both heterodyne and frequency modulation). Dusk surveys commenced at 15 minutes prior to sunset continuing until 1.5 hours after sunset. The dawn survey commenced at 1.5 hours before dawn and continued until sunrise. The location of surveyors and area of coverage are shown on the Bat Survey Coverage map provided in Appendix E Section E1 Bat activity recorded is also shown on the relevant site plan. All survey work was carried out during optimal survey conditions where mean wind-speed was less the 10kmh, Relative Humidity at least 70% and no rain.

5.4.4 Water Voles

This was carried out in May 2009 and comprised a detailed inspection of all suitable water courses occurring within 15m of each site boundary following the methodology described in Strachan (1998). In practice, the water courses were examined for evidence of water vole usage including field signs such as latrines (piles of droppings used to mark territories), feeding remains, footprints, burrows, 'vole lawns' and actual sightings or the sound of animals diving into the water.

5.4.5 Bird (Breeding and Overwintering)

This part of the survey followed a modified, scaled-down version of the methodology described in Bibby et al (1992) carried out in May and June 2009 with further visits in November, December 2009 and January 2010. Six site visits (each of at least six surveyor-hours) were made during the spring/summer period and six visits have been carried out during the winter period (with two more to be completed in February). All potential bird nesting habitat such as trees, shrubs, grassland and other rough vegetation, was checked for suitability for use by breeding birds or signs of bird breeding activity such as territorial behaviour. Birds were observed from vantage points allowing adequate visual coverage of the whole site, concentrating on the proposed location of turbines. For the winter survey, observations were made of any birds overflying the site as well as use of the site for roosting, foraging or shelter. The results of the survey have been tabulated within the relevant section below according to the perceived breeding potential of each species or overwintering activity.

5.4.6 Amphibian & Reptiles

The survey for amphibians followed the methodology outlined in British Herpetological Society (1990) and was carried out between early May and mid June 2009 in full accordance with the *Great Crested Newt Mitigation Guidelines* (English Nature, 2001). The surveys comprised four rounds of torch-light survey, egg-search and bottle-trapping of the all ponds within 250m of the site boundaries. Only suitable water bodies which were considered to hold water long enough for breeding to take place and that were not effectively isolated from the site by rivers, major roads, buildings, hard-standing or other inhospitable habitat, were surveyed.

Each torch-light survey commenced 30 minutes after sunset and continued for a minimum of three surveyor-hours to check for aquatic phase crested newts and other amphibia. A 1 million candle power spotlight was used for this part of the survey. Particular attention was given to open parts of the water bodies near to marginal vegetation and to the bankside. The periphery of the water, where accessible, was netted, especially around the edges of dense marginal vegetation to check for newts which may have been hidden. This was undertaken prior to the torch-light survey due to the amount of disturbance and turbidity caused.

Newt egg searches were carried out in daylight, comprising a detailed inspection of all suitable aquatic foliage within the water bodies, especially submerged foliage of broad-leaved species such as willow-herb and water mint, to check for any crested newt eggs folded into leaf blades.

Bottle-trapping was carried out using 2 litre plastic bottles with inverted lids, secured by canes, sited at an average of 2m intervals within each suitable water body. Bottle-traps were set one to two hours prior to sunset and checked by 11am at the latest the following morning. Any amphibians or other fauna such as fish and invertebrates were recorded.

In addition, terrestrial surveys were carried out across each survey area where suitable habitat was found, for terrestrial phase great crested newts, checking all potential refugia such as plastic sheeting, wooden sheeting, hardcore, concrete, brick rubble and other debris which was found at various points across the survey area. All potential refugia were closely examined, turning over as many loose materials as possible to check beneath and all cracks and crevices within the soil or hard-standing were examined with a high powered torch.

All the survey elements listed above were carried out during suitable weather conditions; i.e. air temperature above 5 degrees centigrade with no rain and little or no wind (less than Force 3 on the Beaufort Scale).

With respect to reptiles, any potential refugia such as metal, wooden or plastic sheeting or any potential egg-laying sites such as piles of sawdust were inspected for signs of sloughed skins

5.5 Baseline Description

The part of the site proposed for wind turbine location comprises an extensive area of agricultural land dominated by improved grassland currently used for grazing. The site is partly bounded by mature broadleaved woodland and hedgerows to the east and west with individual fields separated by a combination of both intact and defunct hedges, post and wire fences and drainage ditches. There are occasional individual trees across the site with a notable copse of mixed broadleaved and coniferous mature trees to the north. There is a small stream to the south and another along the northern part of the western boundary to the agricultural land. The stream also passes through the woodland to the east of the site. Three small on-site ponds occur, each of which is located within woodland. To the north-east of the agricultural land is the existing Lancaster University Field Station which comprises grassland, experimental plots, hard standing, a large telephone mast and associated equipment, glasshouses, and buildings and equipment associated with the Meteorological Station. One turbine is to be located to the south of the existing agricultural land, a second within the existing Field Station.

5.5.1 Habitats and Flora

The habitats recorded during the Phase 1 Habitat Survey are summarised below and shown graphically on the Phase 1 habitat map shown in Appendix E Sections E2

NCC/RSNC[1] Habitat	NVC[2] Communities
Woodland	W2 *Salix cinerea-Betula pubescens* woodland W6 *Alnus glutinosa-Urtica dioica* woodland W10 *Quercus robur-Pteridium aquilinum-Rubus fruticosus* Woodland
Scrub: dense continuous Scrub: scattered	W21 *Crataegus monogyna-Hedera helix* scrub W22 *Prunus spinosa-Rubus fruticosus* scrub W23 *Ulex europeaus-Rubus fruticosus* scrub W24 *Rubus fruticosus-Holcus lanatus* underscrub community W25 *Pteridium aquilinum*-Rubus *fruticosus* underscrub
Grassland: acid, semi-improved	U1 *Festuca ovina-Agrostis capillaris* grassland U2 *Deschampsia flexuosa* grassland
Grassland: neutral, semi-improved	MG1 *Arrhenatherum elatius* grassland MG5 *Cynosurus cristatus-Centaurea nigra* grassland MG6 *Lolium perenne-Cynosurus cristatus* grassland MG9 *Holcus lanatus-Deschampsia cespitosa* grassland MG10 *Holcus lanatus-Juncus effusus* rush pasture MG11 *Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland MG13 *Agrostis stolonifera-Alopecurus geniculatus* grassland OV23 *Lolium perenne-Dactylis glomeratus* community
Improved Grassland Amenity Grassland	MG6 *Lolium perenne-Cynosurus cristatus* grassland MG7 *Lolium perenne* leys and related grasslands
Marsh/Marshy Grassland	MG10 *Holcus lanatus-Juncus effusus* rush pasture M23 *Juncus effusus/acutiflorus-Galium palustre* rush-pasture
Tall herb and fern: tall ruderal	OV24 *Urtica dioica-Galium aparine* community OV25 *Urtica dioica-Cirsium arvense* community OV26 *Epilobium hirsutum* community OV27 *Epilobium angustifolium* community OV28 *Agrostis stolonifera-Ranunculus repens* community
Cultivated/disturbed land: ephemeral/short perennial	OV10 *Poa annua-Senecio vulgaris* community OV21 *Poa annua-Plantago major* community OV22 *Poa annua-Taraxacum officinale* community OV28 *Agrostis stolonifera-Ranunculus repens* community
Swamp, marginal and inundation	S22 *Glyceria fluitans* water-margin vegetation S23 Other water-margin vegetation S28 *Phalaris arundinacea* tall-herb fen
Open Water	A2 *Lemna minor* community A16 *Callitriche stagnalis* community
[1] Nature Conservancy Council and Royal Society for Nature Conservation habitat classification (NCC, 1990) [2] National Vegetation Classification communities (Rodwell, 1991)	

Figure 5.2 Recorded Habitats

A full list of vascular plant species recorded within each of the habitats listed above as well as within each of the sub-sites, is provided within Appendix E Section E3 and E4

5.5.1.1 Significance of Habitats and Flora

With the exception of those listed below, all habitats and vegetation communities recorded on site are relatively common and widespread throughout Lancashire and Britain. The exceptions are as follows: semi-natural broadleaved woodland, and ponds and streams, all of which are listed as local Biodiversity Action Plan habitats. However, with the exception to the woodland blocks to the east and west of the site, all the habitats listed have been modified by disturbance, cultivation or introduction of non-native species, so are not particularly good examples of the habitats listed within the Lancashire BAP.

To quantify the impact of the proposal on woodland present at the site an Arboricultural Assessment has been undertaken, a copy of this report is provided in Appendix E Section E5. This report shows that the woodland block to the west is the best example of broadleaved woodland but this will not be directly affected. The woodland block to the east will be affected to a limited degree (the loss of a small section to the south to accommodate one of the turbines – see Appendix F section F7, but this has had a greater degree of modification and is therefore of lesser (though still significant) nature conservation value.

5.5.2. Mammals

5.5.2.1 Mammals (Badgers)

Habitat Suitability: Most of the habitat on site provides suitable foraging potential for badgers, especially the areas of grassland and scrub. The woodland and hedge banks also provide habitat for the establishment of setts.

Presence/Absence: For the majority of the site, an inspection of all suitable habitat to a distance of at least 30m from the site boundaries, revealed no conclusive signs of any badger activity.

5.5.2.2 Mammals (Bats)

Habitat Suitability: There is a wide diversity of habitat on site suitable for bat foraging and commuting purposes, the most important habitat occurring along the margins of the site, along the above the woodland, and over the water bodies. Some trees on site provide potential for roosting but none were found to be exceptional. No buildings occur on the main part of the site proposed for the wind turbine and the buildings on the meteorological station provide very low potential for roosting. North Lancashire Bat Group records search results are provided in Appendix E section E 6i.

Roosting: There were no positive signs of roosting found anywhere on or closely adjacent to the site proposed for the wind turbines.

Activity: Bat activity was recorded during each of the site surveys as indicated on the activity map to the rear of this report but none of this activity was associated with roost emergence or roost return. Generally, activity was found to comprise commuting or foraging and was confined mainly to the margins of the site, especially alongside mature trees and scrub, including hedgerows. Little activity was recorded over the more open parts of the site such as the central parts of the fields used for grazing. The majority of bats were noted to fly at a height of lower than 20m (gauged by adjacent trees). The exception was the noctule which was recorded at an approximate height of 25-30m (again gauged by adjacent mature trees). The indicative flight path of this bat species is shown on the Bat Activity Map Appendix E Section E6ii.

5.5.2.3 Mammals (Brown Hare)

Habitat Suitability: The pasture which accounts for most of the agricultural land is suitable for brown hare (*Lepus europeaus*), a species known to be relatively common in the wider area.

Activity: No specific survey for this species was carried out. However, during the Extended Phase 1 Habitat Survey, the existing pasture which runs north to south was found to be used extensively by brown hare with a small number of individuals recorded (approx. 8-10) spread across the site. The site is used for grazing and several forms were noted, the latter mainly towards the southern part of the site where sheep grazing was apparently less intense.

5.5.2.4 Mammals (Deer)

Habitat Suitability: The site provides a number of niches for deer, in particular the two extensive blocks of mature woodland, hedgerows, a wooded copse and extensive areas of pasture with direct habitat links to open countryside and moorland.

Activity: The site is used to a limited extent by deer. During the various survey visits, several sightings of adult Sika deer (*Cervus nippon*) were made, primarily within the woodland block to the east of the site and the small wooded copse to the north. Indications are that the deer on site also graze within the pasture and browse some of the hedgerows though this has not been observed. Only two individuals were noted at any one time, both of which being mature female or possibly large immature males. Roe deer (*Capreolus capreolus*) are known to occur in the area but no sightings were made during any of the surveys.

5.5.3 Birds

Habitat Suitability: The site provides a wide diversity of habitat for a number of bird species, including species which are both rural and urban. The most important habitat, and that where most birds were recorded, is the mature woodland, mature scrub (including hedgerows), wetland, and rough grassland on closely adjacent sites.

A number of common bird species were recorded on site in close by (seen flying over or in adjacent habitat, or heard calling). In addition, some less common species such as lapwing, curlew and oystercatcher were also recorded although these were mostly found on adjacent sites. Important bird habitat in relation to habitat suitability is shown on the bird habitat map provided in Appendix E Section E7 Bird species considered to be breeding on or closely adjacent to the site are highlighted in bold type within the table below with a qualifier in the third column as to certainty.

Species Name	Common Name	Breeding Status	Winter Presence	Notes
Accipiter nisus	Sparrowhawk	NoB	Yes	Seen hunting in woodlands and alongside hedgerows across site
Aegithalos caudatus	Long-tailed Tit	PoB	No	Foraging within woodland
Anas platyrhynchos	Mallard	PoB	No	Occasionally seen overflying. Breeding in pond to north
Apus apus	Swift	NoB	No	Occasionally feeding over site
Ardea cinerea	Heron	NoB	No	Occasional sightings at streams north and south
Buteo buteo	Buzzard	NoB	No	Occasionally seen hunting across site
Carduelis carduelis	**Goldfinch**	**PrB**	No	Frequent along hedgerows
Carduelis chloris	**Greenfinch**	**PrB**	No	Frequent along hedgerows
Columba livia	Rock Dove (street pigeon)	NoB	Yes	Occasionally seen flying over site or feeding in pasture
Columba palumbus	**Wood Pigeon**	**CoB**	Yes	Occasional sightings in woodland blocks and flying over site
Corvus corone	**Carrion Crow**	**CoB**	Yes	Frequent sightings across site in both woodland and

				pasture
Corvus monedula	Jackdaw	PoB	No	Occasional sightings flying over site
Dendrocopus major	**Great-spotted Woodpecker**	**CoB**	No	Heard and seen in woodland block to east and copse to the north of site
Erithacus rubecula	**Robin**	**CoB**	Yes	Seen frequently across the site
Falco tinnunculus	Kestrel	NoB	Yes	Occasionally seen hunting adjacent to rough grassland near hedgerows
Fringilla coelebs	**Chaffinch**	**CoB**	No	Occasional sightings and heard singing in woodland blocks
Fulica atra	**Coot**	**CoB**	No	Within pond to west of site (in woodland)
Gallinula chloropus	**Moorhen**	**CoB**	No	Within pond to north of site
Garrulus glandarius	**Jay**	**CoB**	Yes	Occasional sightings in woodland blocks and flying across site
Haematopus ostralegus	Oystercatcher	PoB	No	Frequent sightings around site, in particular over Field Station
Hirundo rustica	Swallow	NoB	No	Frequently recorded feeding over pasture across site
Larus argentus	Herring Gull	NoB	Yes (ov)	Frequently seen flying over site
Larus canus	Common Gull	NoB	Yes (ov)	Frequently seen flying over site
Larus ridibundus	Black-headed Gull	NoB	Yes (ov)	Frequently seen flying over site
Numenius arquata	**Curlew**	**CoB***	No (tbc)	Infrequent records of a single pair to the north of the site (breeding off-site)
Parus caeruleus	**Blue Tit**	**CoB**	Yes	Frequently recorded in woodland and hedgerows across site
Parus domesticus	House Sparrow	PoB	Yes	Frequently recorded in woodland and hedgerows across site
Parus major	Great Tit	CoB	Yes	Frequently recorded in woodland and hedgerows across

				site
Phasianus colchicus	**Pheasant**	**PrB**	Yes	Occasional sightings or calls heard within woodland blocks
Phylloscopus collybita	Chiffchaff	PoB	No	Occasional recordings in woodland and hedgerows in late spring across site
Phylloscopus trochilus	Willow Warbler	PoB	No	Occasional recordings in woodland and hedgerows in late spring across site
Pica pica	Magpie	CoB	Yes	Frequent sightings across whole site
Scolopax rusticola	Woodcock	PoB	Yes	Rare sighting (flushed from hedgerow) to north of site
Stryx aluco	**Tawny owl**	**PrB**	Yes	Occasionally heard calling in copse to north of site and woodland block to east
Sturnus vulgaris	**Starling**	**CoB**	Yes	Occasional sightings in pasture and hedgerows to north of site
Sylvia atricapilla	Blackcap	PoB	No	Occasional recordings in woodland and hedgerows in late spring across site
Turdus merula	**Blackbird**	**CoB**	Yes	Frequent in hedgerows and woodland across the site
Turdus viscivorus	**Mistle Thrush**	**CoB**	Yes	Occasional in woodland blocks
Vanellus vanellus	**Lapwing**	**CoB**	Yes (os)	Occasional sightings (one pair) to the north of the site, though primarily seen off-site within the field immediately to the south of Field Station, or to the north, beyond the site boundaries
Key to Breeding Qualifiers: CoBr - Confirmed Breeding; NoB – Not Breeding; PrNB – Probably Not Breeding; PrB – Probably Breeding; PoB – Possibly Breeding; * breeding activity off-site only Key to Winter Presence Qualifiers: ov – overflying site only; os – off-site only; tbc – to be confirmed				

Figure 5.3 Recorded Bird Species

The majority of species recorded as likely to breed close to the site proposed for the wind turbine location are common, urban species. No signs of any Schedule 1 species (i.e. species fully protected under the Wildlife & Countryside act) such as barn owl were found during the survey. However, of the species recorded, the following are listed UK Priority species: starling, curlew and lapwing and as such, are also listed as local and UK BAP species. Of those species, curlew is particularly susceptible to impact from wind turbines and so activity must be monitored over winter before final location of turbines is determined. In addition, the site falls within 1km of a designated Important Bird Area and within 5km of two major SSSIs which have been designated for their important bird assemblages (see Appendix E Section E8 for details). It is possible therefore that other species may use the site during different parts of the year.

5.5.4 Great Crested Newts

During the amphibian survey, three ponds were surveyed. All ponds were considered to be of very low potential for great crested newt breeding and this was confirmed by the detailed surveys as none were recorded. The ponds are used to a very limited extent by smooth newt and common frog, but populations are very low and the ponds will not be directly affected by development proposals.

5.5.4.1 Reptiles

Habitat Suitability: The site provides very little potential for this group of species.

An inspection of all suitable habitats within the site boundaries revealed no conclusive evidence of use by reptiles and the site was found to be generally sub-optimal for this group of species. It is reasonable to assume therefore that reptiles are unlikely to be present on site.

5.5.4.2 Terrestrial Invertebrates

Habitat Suitability: Most of the site is cultivated and disturbed providing little in the way of suitable niches for terrestrial invertebrates. However, the woodland and mature trees do provide a significant number of niches, in particular for species associated with long-established habitat or deadwood.

Species Recorded: No specific invertebrate survey was carried out as the site overall is not considered important for this group of species and there will be relatively little impact upon any good quality invertebrate habitat. However, as part of the general ecological surveys, in particular the Phase 1 Habitat Survey, incidental records of invertebrates were made with particular emphasis placed upon those species belonging to the larger invertebrate groups.

The site provides numerous niches for a variety of species, in particular representative species of the beetles, hoverflies and butterflies groups. As a result of the presence of mature trees and scrub, invertebrates associated with dead-wood habitat may be expected to be well represented. However, in practice, the level of disturbance and limited amount of deadwood habitat actually present within the site, has resulted in only limited diversity of such species being recorded, the vast majority of species being locally common within their respective habitats and widespread or typical of disturbed, cultivated (agricultural) habitat.

With respect to butterflies (and moths), the most abundant species were meadow brown and orange tip with other species recorded including small white, large white, red admiral, peacock, small copper, orange tip, small tortoiseshell, green-veined white, common blue, magpie moth, large yellow underwing, burnet moth and large skipper.

Ground beetles were found to be well represented including *Carabus violaceus, Harpalus latus, Pterostichus madidus,* and *Leistus ferrugineus.* Other beetle species included *Cantharis livida, Coccinella 7-punctata, Adalia bipunctata, A. 10-punctata, Phyllodecta vitellinae, Leperisinsus varius, Lathridius minutus, Omalium rivulare, Cerlyon histeroides, Polydrusus mollis,* and *Magdalis ruficornis.*

Hoverflies recorded included *Eristalis tenax, E. horticola, E. pertinax, Helophilus pendulus, Episyrphus balteatus, Platycheirus albimanus, Rhingia campestris, Syrphus ribesii,* and *Scaeva pyrastri.*

Other invertebrate species in addition to the target groups include true flies such as the greenbottle and bluebottle, the cleg fly (*Heamatopota pluvialis*), blackfly (*Similium sp.*) and midges (*Cuculoides sp.* and *Chironomus sp.*), crane flies such as *Tipula maxima* and *T. olearacea*; grasshoppers, including *Chorthippus brunneus* and *C. parallelus*; shield bugs, including *Elasmucha grisea* and *Palomena prasina*; wasps, including *Vespula vulgaris*; bees including *Bombus terrestris, B. hortorum, B. agrorum,* and *Apis mellifera;* and finally, dragonflies and damselflies including *Coenagrion puella, Ischnura elegans, Aeshna grandis* and *Libellula quadrimaculata.*

None of the invertebrate species recorded are listed within the national red data book or nationally scarce register, nor within the Lancashire Red data book.

5.5.4.3 Aquatic Invertebrates

Habitat Suitability: The water bodies on site comprise three ponds and a stream. The ponds are all located within woodland and are heavily eutrophic with little or no aquatic vegetation. The stream is narrow (<1m) for the most part and relatively shallow (<.0.5m) and has a sandy/gravelly substrate with occasional clayey areas. The most botanically-rich part of the stream is the section to the north but here, it is relatively species-poor comprising mainly terrestrial species, the only true aquatic species being occasional brook-lime, fools water-cress and water starwort. Overall, the water bodies provide limited habitat for aquatic invertebrates.

Species Recorded: Due to the relative low ecological value of the site, no specific survey was carried out other than an ad-hoc netting of selected areas of water or incidental observations during other surveys. Only a limited number of aquatic invertebrates were recorded, nearly all of which were found to be common and widespread species such as chironomid midge larvae and occasional aquatic bugs such as common pond skater, water boatman and freshwater shrimp with no particular group of species being well represented. The limited number of species present reflects the eutrophic nature of the ponds and the low botanical diversity of the stream. Within the stream, few invertebrates were recorded other than an indeterminate species of caddis fly (an empty shell), a small number of mayfly nymphs (Ephemeroptera, probably *Ephemera* sp.) and freshwater shrimp (*Gammarus pulex*), the latter mostly beneath overhanging trees and shrubs.

5.5.5 Significance of Fauna

With the exception of breeding birds and bats, no protected or otherwise important species were recorded during any of the surveys and for the reasons outlined above none are reasonably expected to occur on site.

Whilst no bird species listed under Schedule 1 of the Wildlife & Countryside act were recorded breeding on the development site, a number of important species (UK Priority and BAP) were recorded and all breeding birds (with a small few exceptions) are protected in general terms under the Wildlife & Countryside act. Therefore, site design, mitigation and the programme of site operations, where applicable, must take this into account. The most important habitats for bird breeding are the semi-mature trees and shrubs, wetland and other rough vegetation that occur adjacent to the development site boundaries and at various points across the site as indicated on the site plan.

With respect to the UK Priority and Lancashire BAP species, proposals are less likely to affect these as the wind turbines will be located away from recognised breeding and foraging areas or any known migration routes, but precautions must still be taken.

Little habitat suitable for bat roosting was found on site and no conclusive signs of roosting activity were found at the time of survey.

The site is used for foraging and commuting by bats and where avoidable turbines should not be sited within 50m of hedge-lines, trees, water courses or known flight-paths of bats (in particular Noctule).
In this case the former is unavoidable due to the constraints identified in Figure 2.1 Chapter 2 of the ES. Therefore hedgerows and trees within 50m of the blade sweep area (approximately 100m from the turbine base) should be removed and water courses realigned or culverted. Where culverting is required a compensatory wetland habitat should be provided elsewhere on site to ensure that the proposed development is less likely to result in a significant adverse impact to bats.

5.6 Information Gaps

All species groups and habitats likely to occur within the vicinity of the proposed turbines or likely to be indirectly affected have been allowed for in the assessment and, with one exception, survey work has been carried out using currently accepted best practice methodology at an optimal time of year for the species or habitat concerned. The exception is overwintering birds which to date, have only been partially covered due to the time of year. This work is due for completion in mid February 2010. Until then, all data and impacts in this respect must be treated as provisional. Natural England, the RSPB and the County Ecologist have been informed of this and have agreed that the ES can be submitted with the level of data currently collected on the presumption that an addendum to this report will be provided upon completion of bird overwintering work.

With respect to desk-top data, all the main ecological data holders for the area concerned have been consulted either directly of via the internet. However, to date no response has been returned from the Morecambe and Lancaster Bird Club. As an alternative source of data, the Lancashire Wildlife Trust Warden at Heysham has been recently consulted and data is expected soon.

There are no other known significant gaps in ecological data.

5.7 Assessment of Potential Effects

5.7.1 Potential Effects

The likely impact of the proposed site works is evaluated against the criteria laid out in the table below which is based on NATA (New Approach to Appraisal) as described in Byron H. (2000). This evaluation is based on the assumption that no mitigation works will be implemented.

5.7.2 Impact Assessment Table

Impact Magnitude	**Nature Conservation Importance**				
	Negligible	***Local***	***County***	***National***	***European***
Beneficial Effects	Non Significant	Non Significant	Non Significant	Non Significant	Non Significant
Nil Effect	Non Significant	Non Significant	Non Significant	Non Significant	Non Significant
Minor (short term or reversible effects)	Non Significant	Non Significant	Slight	Moderate	Moderate
Moderate (deterioration of feature	Non Significant	Slight	Moderate	Severe	Severe
High (loss of feature)	Non Significant	Slight	Moderate	Severe	Severe

Figure 5.4 Impact Assessment Criteria

The evaluation criteria for nature conservation importance are as follows:

5.7.2.1 European

Habitats which are listed in Annexe 1 of the Habitats Directive and are included as candidate or proposed Special Areas of Conservation (cSAC, pSAC)

Species which are listed under Schedule 2 of the Habitats Directive and form a population which would qualify the site for consideration as a Special Protection Area (SPA) or Special Area of Conservation

5.7.2.2 National

Habitats which meet the criteria for designation of, or occur within, a Site of Special Scientific Interest (SSSI)

Species which are protected under national wildlife legislation such as the Wildlife & Countryside act, are listed in a national Red Data Book, or that are part of a population or assemblage of species that would meet the criteria for the site being designated a site of Special Scientific Interest (SSSI)

5.7.2.3 County

Habitats which are rare or uncommon in the County would meet the criteria for inclusion or are included within a second tier nature conservation site (SINC), or which form part of a local Biodiversity Action Plan (BAP) or Habitat Action Plan (HAP)

Species which are rare or uncommon within the County, form part of a population or assemblage of species which would meet the criteria for inclusion or are included as part of a Site of Importance for Nature Conservation (SINC)

5.7.2.4 Local

Habitats which are uncommon or threatened within the Lancaster area

Species which are uncommon or threatened within the Lancaster area

5.7.2.5 Negligible

Habitats or Species that fit into none of the above categories

5.8 Mitigation

The current ecological impacts resulting from the proposed sites development works, based on the criteria outlined above and mitigation required to negate any impacts are summarised within the following table:

Ecological Issues (receptors)	Details	Likely Impacts	Required Mitigation and Residual Impact
Turbine 1 – Main Agricultural Site			
Bats	Bats forage alongside trees and scrub at the margins of the site as shown on the activity site plan. Commuting routes follow linear features such as lines of trees. No roost sites found in any of the larger trees buildings occur on this part of the site proposed for the wind turbines or will be otherwise affected.	Removal of trees may result in severance of commuting routes, and/or loss of foraging areas. Wind turbines located within 50m of known flight-lines or foraging areas may result in bat death or injury due to direct impact from blade strike or through indirect effects of turbulence (barotraumas).	Maintain and enhance existing flight-lines such as woodland and hedgerows wherever possible to provide clear commuting routes and high quality foraging areas and encourage bats to stay clear of turbine areas. Where avoidable turbines should not to be sited within 50m of hedge-lines, trees, water courses or known flight-paths of bats (in particular Noctule). Where the former is unavoidable, hedgerows and trees within 50m of the blade sweep area (approximately 100m from the turbine base) should be removed and water courses realigned or culverted. Where culverting is required

			a compensatory wetland habitat should be provided elsewhere on site. Carry out specific bat survey to check any mature trees for bat roosts of any large trees planned for removal nearer to time of development
	Nature Conservation Importance: **European**	Impact Magnitude: **Moderate** Overall Impact: (Minor: European) **Moderate**	Residual Impact Magnitude: **Nil Effect-Moderate*** Overall Impact: **Non significant-Moderate*** * following confirmation by post-construction monitoring. If deaths of bats are found to be high, consideration to be given to feathering turbines at certain times of day/year
Badgers	No badger setts found but badgers may occur in nearby site	No significant impact likely unless new setts established in the interim.	Check for signs of new setts being established prior to any site works taking place. Retain mature vegetation along periphery of site as commuting routes. If new setts found, situation to be reassessed. If no setts found
	Nature Conservation Importance: **National**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: National) **Non Significant**	Residual Impact: **Nil Effect** Impact Magnitude: **Non significant**
Water Voles	No conclusive signs of water vole found in either of the streams or ponds	No impact likely	No mitigation required
	Nature Conservation Importance: **National**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: National) **Non Significant**	Residual Impact: **Nil Effect** Impact Magnitude: **Non significant**
Breeding and Overwintering Birds	Moderate to high levels of bird breeding potential particularly within mature trees and shrubs and on closely adjacent sites. The site is little used by overwintering birds and survey work undertaken up to January 2010 indicates that there are no significant migration routes over the site and no important birds using the site in the vicinity of proposed turbine locations	Removal of trees, shrubs or other dense vegetation will result in disturbance of breeding birds. Possibility of death or injury to birds from turbine blades. Overwintering birds, in particular large species such as geese, overflying site may be impacted by turbines.	Retain as much existing mature vegetation as possible, especially mature trees and shrubs. No vegetation to be removed during breeding season (February to July inclusive) unless checked for checked for breeding birds by ecologist.

	Nature Conservation Importance: **National**	Impact Magnitude: **Moderate-High** Overall Impact: (Minor: National) **Severe**	Residual Impact: **Nil effect-Moderate*** Impact Magnitude: **Non significant-Severe*** * Potential impact upon curlew (and other potential species such as pink-footed geese) requires winter survey work to be completed to determine usage of site.
Great Crested Newts	None recorded in any of the ponds within 250m of site boundaries	No likely impact.	No mitigation required.
	Nature Conservation Importance: **European**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: European) **Non Significant**	Residual Impact: **Nil Effect** Impact Magnitude: **Non significant**
Reptiles	No suitable habitat recorded. No signs of any reptile species on site.	No likely impact.	No mitigation required
	Nature Conservation Importance: **National**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: National) **Non Significant**	Residual Impact: **Nil Effect** Impact Magnitude: **Non significant**
Botanical & Habitats	Majority of habitat where turbines to be located is of low ecological value (improved grassland). However, mature woodland, trees and scrub (including hedgerows) which have moderate to high ecological importance, and a section of the stream which has moderate ecological importance, will also be affected	There will be a direct loss or deterioration of significant areas of existing vegetation in the vicinity of turbine 1, including sections of hedgerow, some mature trees, an 0.36 hectares of mature woodland, and a section (~100m) of stream which will require culverting to deter use by bats and birds near to the base of the turbine. Whilst most of the habitat and vegetation that will be affected is of low ecological value, hedgerows, broadleaved woodland and streams are Lancashire BAP	Retain mature vegetation wherever possible. Protect trees and other retained vegetation during development works. Where tree and hedgerow removal is required any loss of habitat to be compensated by creation of new habitat, in particular broadleaved woodland and wetland. Where culverting to be provide compensatory wetland habitat to be provided elsewhere on site .

		habitats	
	Nature Conservation Importance: **Moderate**	Impact Magnitude: **High** Overall Impact: (High: Local) **Moderate**	Residual Impact: **Minor** Impact Magnitude: **Non Significant**
Turbine 2 – Existing Experimental Research/Meteorological Station			
Bats	Bats forage around trees and shrubs along parts of Commuting routes follow linear features such as line of trees. No roost sites found in any of the larger trees. Buildings on site not affected.	Removal of trees and sections of hedgerow for access etc. may result in severance of commuting routes, and/or loss of foraging areas.	Maintain flight-lines wherever possible. Carry out specific bat survey to check any mature trees for bat roosts of any large trees planned for removal nearer to time of development
	Nature Conservation Importance: **European**	Impact Magnitude: **Minor** Overall Impact: (Minor: European) **Moderate**	Residual Impact: **Nil Effect** Impact Magnitude: **Non significant**
Badgers	No badger setts found but badgers may occur in adjacent site	No significant impact likely unless new setts established in the interim.	Check for signs of new setts being established prior to site works taking place. Retain mature vegetation along periphery of site as commuting routes and avoid blocking access for foraging
	Nature Conservation Importance: **National**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: National) **Non Significant**	Residual Impact: **Nil Effect** Impact Magnitude: **Non significant**
Water Voles	One water body (a stream) suitable for this species runs along the western boundary of the sub-site. However, no conclusive signs found.	Stream unlikely to be affected so no impact likely	No specific mitigation required but retains and enhance water body to encourage colonisation if possible. Carry out resurvey if more than 18 months delay to development, especially if works to encroach within 10m of stream.
	Nature Conservation Importance: **National**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: National) **Non Significant**	Residual Impact: **Nil Effect** Impact Magnitude: **Non Significant**

Breeding Birds	Bird breeding within mature trees, shrubs and rough grassland areas highly likely	Removal of trees, shrubs or other dense vegetation will result in disturbance of breeding birds.	Retain as much existing mature vegetation as possible, especially mature trees and shrubs. No vegetation to be removed during breeding season (February to July inclusive) unless checked for checked for breeding birds by ecologist.
	Nature Conservation Importance: **National**	Impact Magnitude: **Minor** Overall Impact: (Minor: National) **Moderate**	Residual Impact: **Nil Effect** Impact Magnitude: **Non Significant**
Great Crested Newts	None recorded in any of the ponds within 250m of site boundaries	No likely impact.	No mitigation required.
	Nature Conservation Importance: **European**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: European) **Non Significant**	Residual Impact: **Nil Effect**
Reptiles	No suitable habitat recorded. No signs of any reptile species on site.	No likely impact.	No mitigation required
	Nature Conservation Importance: **National**	Impact Magnitude: **Nil Effect** Overall Impact: (Nil effect: National) **Non Significant**	Residual Impact: **Nil Effect**
Botanical/Habitat	Majority of habitat where turbines to be located is of low ecological value (improved grassland). However, mature woodland, trees and scrub (including hedgerows) have moderate to high ecological importance	There will be a direct loss or deterioration of significant areas of the existing vegetation, including hedgerow, mature trees and woodland within this sub-site. Whilst most of the vegetation that will be affected is of low ecological value, hedgerows and broadleaved woodland are Lancashire BAP habitats.	Retain mature vegetation wherever possible. Protect trees and other retained vegetation during development works. Any loss of habitat to be compensated by creation of new habitat, in particular broadleaved woodland.
	Nature Conservation Importance: **Moderate**	Impact Magnitude: **High** Overall Impact: (High: Local) **Moderate**	Residual Impact: **Minor** Impact Magnitude: **Non Significant**

Figure 5.5 Mitigation Measures

To complement the mitigation measures described above a habitat mitigation strategy is currently being created in order to compensate for habitat loss required as part of construction and operation of the turbines. Basic details of this strategy are provided in Appendix F section F7. Full details of the compensatory measures to be provided within this mitigation strategy will be provided as an addendum to this chapter following submission of the EIA. Both Natural England and the Lancashire County

Ecologist have agreed that the habitat mitigation strategy addedum can be provided following completion of the site Bird Overwintering Study.

5.9 Residual Impacts

Following implementation of mitigation, there will be residual impacts upon bats, breeding birds and overwintering birds. The magnitude of impact cannot be fully quantified as future behaviour of birds and bats cannot be reliably predicted. However, the removal of habitat which is used by the respective species concerned coupled with the creation of new, optimal habitat (see basic habitat mitigation strategy details Appendix F section F7) will minimise the risk by encouraging the species concerned to use other parts of the site. Monitoring of the active wind turbines, once installed, will provide data as to effectiveness of mitigation and allow for additional measures to be implemented should impacts be unacceptably large. These will include measures such as modifications to existing habitat around turbines (reduction in attractiveness to bird and bat species) and improvement of replacement habitats. Other measures may include feathering one or both turbines at certain times of day or year to avoid periods where birds or bats are more likely to be impacted. The extent of this can only be fully determined following monitoring works and assessment of any kills that may have occurred although the based on survey data, the overall impact is expected to be low if not negligible.

5.10 Statement of Significance

With the exception of breeding birds and bats, no protected or otherwise important species were recorded during any of the surveys and for the reasons outlined above none are reasonably expected to occur on site.

It should be noted that to date, overwintering birds studies have only been partially covered due to the time of year. This work is due for completion in mid February 2010. Until then, all data and impacts in this respect must be treated as provisional. An addendum providing Febrary bird overwintering results will be provided as an addendum to this ES chapter as soon as it it available.

Following implementation of mitigation measures outline above, there will be residual impacts upon bats, breeding birds and overwintering birds. The magnitude of impact cannot be fully quantified as future behaviour of birds and bats cannot be reliably predicted. However, the removal of habitat which is used by the respective species concerned coupled with the creation of new, optimal habitat will minimise the risk by encouraging the species concerned to use other parts of the site. Monitoring of the active wind turbines, once installed, will provide data as to effectiveness of mitigation and allow for additional measures to be implemented should impacts be unacceptably large.

Chapter 6: Landscape and Visual Impact Assessment

6. Landscape and Visual Assessment

6.1 Introduction

6.1.1 Introduction

This chapter of the ES is based on the findings of a Landscape and Visual Impact Assessment (LVIA) carried out by Stephenson Halliday. The purpose of this chapter of the ES is to identify, and where possible quantify, the likely significant effects of the Lancaster University Wind Development on the existing landscape and visual amenity within 30km of the development site.

A full description of the development is provided in Chapter 2 of this document. The main elements of the development considered by this section of the ES are as follows:

- Two 2.05 MW wind turbines which will comprise three bladed, horizontal axis machines with a hub height of approximately 59m, a blade length of approximately 41m and a rotor diameter of approximately 82m, giving a ground to tip height of 101m.
- 1.1km of access tracks
- Underground cable route
- A temporary construction compound and topsoil storage compound

Landscape impacts and visual impacts are separate, but related. Landscape impacts are changes in the fabric, character and quality of the landscape. Visual impacts relate solely to changes in available views of the landscape, and the effects that those changes have on people. Landscape and visual impacts do not necessarily coincide. Impacts can be beneficial as well as adverse.

There are three main objectives to the Landscape and Visual Impact Assessment. Firstly to identify the effects of the development on the visual amenity of the area. This includes views from nearby properties and settlements and any areas of public access. This process requires the identification of the intrinsic visual characteristics of the existing landscape, its quality, and value. An impact of the development on views relates to the changes that arise in the composition of views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity.

The second objective is to identify the effects of the development on the landscape character of the area. This will involve the identification of the landscape characteristics of the site and its surrounds at a national, regional and local level, and an assessment of how the development will change the fabric, character and quality of the landscape.

Thirdly, this assessment will identify any cumulative effects the development will have on visual amenity. A cumulative appraisal has been undertaken to take account of any wind farm developments within a 10km radius which are either in operation, under construction, have planning permission, or which are due to be submitted to local planning authorities for planning permission in the near future. This includes the existing wind farm development at Caton Moor, and its possible extension. This wind farm is located 10km from the development site and currently comprises eight 2MW turbines.

Guidance provided in The Companion Guide to PPS22 'Planning for Renewable Energy'[1] identifies cumulative effects as "the degree to which renewable energy development becomes a feature in particular views (or sequence of views), and the effect this has upon the people who experience those views". The Guidance for Landscape and Visual Impact Assessment[2] defines cumulative effects as additional changes to visual amenity caused by the proposed development in conjunction with other developments, or actions that occurred in the past, present or are likely to occur in the foreseeable future. Cumulative effects consist of combined visibility and sequential visibility. Combined visibility occurs where the observer is able to see two or more developments from one viewpoint. Sequential effects occur when the observer has to move to another viewpoint to see a different development.

6.1.2 Chapter Structure

The potential landscape and visual effects of the proposed development are regarded as a key issue. The appraisal and consideration of these effects is set out in the following sections:

- Consultation - summary of consultation and responses received.
- Guidance and Legislation – Summary of guidance and legislation followed during the assessment.
- Assessment Methodology – an outline of general methodology, with reference to established guidance;
- Baseline description – to identify/confirm the fabric, character and quality of the landscape which would be affected by the proposal, including a review of the extent, purposes and special characteristics of landscape planning designations within the study area;
- Landscape Capacity – summary of relevant guidance contained within the Landscape Sensitivity to Wind Energy Development in Lancashire' report.
- Information Gaps- Summary of any gaps in information identified during the assessment
- Project Description and Mitigation – a description of the aspects of the proposed wind turbine development which have the potential to cause a landscape and/or visual effect, and the measures which have been incorporated into the project design to mitigate these potential effects;
- Visual Analysis – comprising an assessment of the visual effects of the proposed development with reference to computer generated Visibility Maps to ascertain from where the development could be visible and those potential receptors that could be affected by changes in views, together with a viewpoint analysis to determine the magnitude and significance of the changes in the view from a selection of viewpoint locations that represent the main landscape and visual receptors in the study area;
- Assessment of Landscape Effects – an assessment of the significance of effects arising from the proposed wind turbines on the landscape fabric, landscape character and quality of the landscape types and designated areas within the study area;
- Assessment of Visual Effects – an assessment of the significance of effects arising from the proposed wind turbine on the visual amenity, receptors and viewpoints in the study area;
- Residual Effects and Statement of Significance– a summary of the assessment results and concluding discussion on the acceptability of the proposed turbine in landscape and visual terms.

Following consultation with the Local Planning Authority, the landscape assessment is based on a 10km radius (see Appendix F section F6, Figure 6.01 to 6.03 and 6.06) and the visual assessment is based on a 15km radius study area (see Appendix F section F6, Figure 6.04 & 6.05). The assessment of landscape and visual effects is illustrated with reference to existing photographs, wireframes and photomontages (Visualisations 1-12).

[1] The Companion Guide to PPS22 'Planning for renewable Energy' (ODPM, 2004)
[2] The Guidance for Landscape and Visual Impact Assessment (GLVIA) 2nd Edition (2002)

6.2 Consultation

Consultation forms an important part of the assessment process. As described in Chapter 1 of this ES, during the scoping stage of this development, consultation with relevant stakeholders and interested parties was carried out. The aim of this consultation was to provide them with information on the development proposal and what technically appear to be the key issues and to find out what their key concerns are regarding the location and the development itself. Consultation responses were as follows:

6.2.1 Forest of Bowland AONB and Lancashire County Council

Following an initial consultation request, the AONB Office deferred comments on Landscape and Visual Impacts to Lancashire County Council who expressed some reservations on the following aspects of the development;

- The site as identified within Lancashire's Landscape Sensitivity to Wind Energy Development document is within an area of ***moderate - high sensitivity***.
- Location.
- The turbines would be situated on a narrow ridge that has quite a complex and relatively small scale landscape pattern. This would increase the likelihood that the turbines would be out of scale with the surroundings.
- Impacts on landscape value - the wind turbines would be visible from within much of the Forest of Bowland AONB.
- The presence of features nearby which would act as scale comparators emphasising the height of the turbines.
- The overall proposed height of the turbines which at 123.7m would be inappropriate for the areas topography.
- The relative scale of the proposed turbines in relation to the average height of the ridge that they would be located on. The turbines at 123.7m high would exceed the average height of the ridge which has a maximum height of only 144m, by a ***considerable*** margin.
- Likely significant adverse visual impacts on nearby residences and the M6 corridor.
- Cumulative impacts with the Caton Moor wind farm.

6.2.2 Lancaster Council

Detailed consultation regarding landscape and visual impact has been undertaken with Lancaster City Council who has been generally supportive of the principle of the development. The scope of the assessment criteria including the radius (km) of the Landscape and Visual Assessment studies, the scope of the cumulative assessment and the general locations of the photomontage have been agreed prior to commencement of the study.

6.2.3 English Heritage

English Heritage has been consulted at pre application and scoping stages, they have provided only procedural advice to date.

6.2.4 Natural England

In response to initial pre applications consultation and a Scoping Opinion Request Natural England with the following advice.

"The proposed wind farm site is not within a designated landscape. The Forest of Bowland Area of Outstanding Natural Beauty (AONB) is less than 2Km to the East of the proposed development site. However Natural England is of the opinion that the adverse effects on the

special qualities of this part of the AONB, including the sense of wildness and remoteness, will not be of sufficient significance for an objection to be made on landscape grounds given that the proposed development will be within the M6 motorway corridor and against a background of the Lancaster university buildings.

The landscape and visual impact assessment should follow the standard methodology as set out in the Landscape Institute/IEMA Guidelines for Landscape and Visual Impact Assessment 2nd edition 2002. As the wind turbines may be seen from coastal locations and from viewpoints across Morecambe Bay, the methodology for seascape assessment (CCW/Brady Martin Shipman 'Guide to Best Practice in Seascape Assessment 2001) is also relevant, as are offshore wind energy developments in assessing cumulative effects."

In addition to the national Character Areas (also known as Joint Character Areas), there are strategies and Supplementary Planning Documents which are relevant, including landscape sensitivity in relation to wind energy studies. Information on these and on Historic Landscape Character assessments can be obtained from the local authorities affected.

6.3 Guidance and Legislation

The assessment has been prepared after referencing a number of different sources and materials, including the following:

6.3.1 Guidance and Legislation

The assessment has been based on the following best practice guidance:

- Guidelines for Landscape and Visual Assessment (Landscape Institute and Institute of Environmental Management and Assessment 2002); and
- Landscape Character Assessment: Guidance for England and Scotland (The Countryside Agency and Scottish Natural Heritage 2002).

It also takes account of advice within the following documents
:

- Environmental Impact Assessment Regulations 1999;
- Guidelines on the Environmental Impact of Windfarms and Small Scale Hydro Electric Schemes (SNH 2001);
- Visual Representation of Windfarms: Good Practice Guidance (SNH 2006); and
- Cumulative Effect of Windfarms (SNH 2005).
- "A Landscape Strategy for Lancashire" (2000)
- 'Landscape Sensitivity to Wind Energy Development in Lancashire' SPD (2005).

6.3.2 Policy Framework

A number of national planning policy statements consider landscape character as set out below:

6.3.2.1 PPS1 - Delivering Sustainable Development: PPS1 sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system. It states that one of the Government's objectives for the planning system is that planning should facilitate and promote sustainable urban and rural development by protecting and enhancing the natural and historic environment and the quality and character of the countryside (Para 5).

In its key principles, PPS1 states that "a spatial planning approach should be at the heart of planning for sustainable development" (Para 13.iii) and "design which fails to take the

opportunities for improving the character and quality of an area should not be accepted" (Para 13.iv). When preparing development plans, "planning authorities should seek to enhance as well as protect biodiversity, natural habitats, the historic environment and landscape and townscape character" (Para 27).

6.3.2.2 PPS7 - Sustainable Development in Rural Areas: Landscape Character Assessment, along with Village or Town Design Statements and Village or Parish Plans, is recommended as a tool to assist Local Authorities in the preparation of policies and guidance that encourage good quality design throughout rural areas (Para 13).

Landscape Character Assessment is recommended as a tool for creating carefully drafted, criteria-based policies in Local Development Documents to protect valued landscapes outside nationally designated areas without the need for rigid local designations, which may restrict sustainable development and the economic vitality of rural areas. Local landscape designations should only be maintained or, exceptionally, extended where it can be clearly shown that criteria-based policies cannot provide the necessary protection (Paras 24 and 25).

6.3.2.3 PPS22 – Renewable Energy: The Companion Guide to PPS22 makes clear endorsements of the landscape character approach when planning for renewable energy at the regional level. It states that the "intrinsic qualities of each landscape character area", as expressed in either the Character of England Countryside Character volumes or more recent Landscape Character Assessments, should be considered when addressing broader landscape issues at the regional planning level: these 'intrinsic qualities' should be set down in writing, and all parties involved or interested in development for renewable energy should be encouraged to consult this supporting information before making reference to a particular landscape character area (Para 3.29).

It also states that regional planning authorities should identify the sensitivity of any landscape character areas referred to in plans for renewable energy development to particular types of change/development at a broad scale, and that "landscape character areas may be described in relation to their suitability as a location for particular types and scales of renewable energy development" (Para 3.29). It goes on to state that "applying LCA at the regional level is recommended to inform strategic planning for renewables" (Para 3.33).

The Companion Guide to PPS22 also makes specific endorsements of the Countryside Character Network, the former name of the Landscape Character Network, as "the main forum for ongoing discussion on landscape issues", and LCA Topic Paper 6: Techniques and Criteria for Judging Capacity and Sensitivity (Further Information, p41).

6.4 Assessment Methodology

6.4.1 General Approach

The assessment has utilised information in the Countryside Character publication for the North West in addition to the county landscape character assessment: "A Landscape Strategy for Lancashire" (2000) and the 'Landscape Sensitivity to Wind Energy Development in Lancashire' SPD (2005). It has been assisted by consultations with Lancaster City Council, Lancashire County Council and Natural England.

6.4.2 Significance Criteria

The aim of the landscape and visual assessment is to identify, predict and evaluate potential key effects arising from the proposed development. Wherever possible identified effects are quantified, but the nature of landscape and visual assessment requires interpretation by professional judgement. In order to provide a level of consistency to the assessment, the

prediction of magnitude and assessment of significance of the residual landscape and visual effects have been based on pre-defined criteria.

6.4.3 Landscape Sensitivity

The sensitivity of the landscape to change is not absolute and varies according to the existing landscape, the nature of the proposed development and the type of change being proposed. Accordingly, the concept of 'sensitivity to change' is not part of the baseline description of the landscape of the study area, but is considered in relation to the assessment of the effects of the proposed development. In general terms, areas of high landscape quality and value are more sensitive to change than areas of lesser quality and value, and general guidance on the evaluation of sensitivity is provided in Table 6.1. However, the actual sensitivity would depend on the attributes of the landscape receiving the proposals, and the nature of those proposals.

The assessment of sensitivity is based on consideration of the following parameters, together with the nature of the proposals, during the course of the assessment:

Landscape value: the importance attached to a landscape, often as a basis for designation or recognition which expresses national or regional consensus, because of its quality, cultural associations, scenic or aesthetic qualities;

Landscape quality: the state of repair or condition of elements of a particular landscape, its integrity and intactness and the extent to which its distinctive character is apparent;

Landscape capacity: the capacity of a particular type of landscape to accommodate change brought about by wind farm development without unacceptable negative effects on its character, reflecting key aspects of landscape character including scale and complexity of the landscape and degree of 'wildness' or 'remoteness'.

Parameters	***Sensitivity of Landscape***		
	High	***Medium***	***Low***
Landscape value (designations)	National (e.g. National Parks and AONBs)	Regional (e.g. Area of Great/High Landscape Value)	No designation
Landscape quality	A landscape in good condition, predominantly intact and with a clearly apparent distinctive character	A landscape in moderate condition, reasonable intact, retaining a distinctive character	A landscape in poor condition, lacking in integrity, where landscape character has been adversely affected
Landscape capacity	Landscapes of distinctive character susceptible to relatively small changes	Landscapes reasonably tolerant of changes	Landscapes potentially tolerant of substantial change

Figure 6.1: Landscape Sensitivity

Visual Sensitivity - The sensitivity of potential visual receptors will vary depending on the location and context of the viewpoint, the activity of the receptor and importance of the view. Visual receptor sensitivity is defined as high, medium, or low in accordance with the criteria in Table 6.2

High sensitivity	Residents experiencing principal views from dwellings, users of outdoor recreational facilities including strategic recreational footpaths and cycle ways, people experiencing views from important landscape features of physical, cultural or historic interest, beauty spots and picnic areas.
Medium sensitivity	Road users and travellers on trains experiencing views from transport routes. In addition, residents experiencing secondary views from dwellings, users of secondary footpaths experiencing views, and people engaged in outdoor sport (other than appreciation of the landscape) or recreation i.e. hunting, shooting, golf and water based activities.
Low sensitivity	Workers, users of facilities and commercial buildings (indoors) experiencing views from buildings.

Figure 6.2: Visual sensitivity criteria

Those receptors living within view of the scheme are usually regarded as the highest sensitivity group along with those engaged in outdoor pursuits for whom landscape experience is the primary objective. The threshold for significance of visual effects relies to a great extent on professional judgement. Criteria and local circumstances require close study and careful consideration to decide if the effect on a single property will warrant classification as a highly significant issue. Generally it will be rare for the impact on a single dwelling to be categorised as of high significance for the development overall. However it may combine with similar impacts on many properties to give rise to a more general impact of high significance.

The magnitude of change arising from the proposed development at any particular viewpoint is described as substantial, moderate, slight or negligible based on the interpretation of a combination of largely quantifiable parameters, as follows:

- distance of the viewpoint from the development;
- duration of effect;
- extent of the development in the view;
- angle of view in relation to main receptor activity;
- proportion of the field of view occupied by the development;
- background to the development;
- extent of other built development visible, particularly vertical elements.

In order to differentiate between different levels of magnitude the following definitions are provided:

- **Substantial** - total loss or major alteration to key landscape elements/features/characteristics such that post development the baseline landscape character or composition of the view will be fundamentally changed;
- **Moderate** - partial loss or alteration to one or more key landscape elements/ features or characteristics such that post development the baseline landscape character or composition of the view will be partially changed;
- **Slight** - minor loss or alteration to one or more key landscape elements/features or characteristics such that post development the change/loss will be discernible but the underlying landscape character or composition of the view will be similar to the baseline;
- **Negligible** - very minor loss or alteration to one or more key landscape elements / features/ characteristics of the baseline conditions. Change will be barely distinguishable approximating to no change.

The significance of any identified landscape or visual effect has been assessed in terms of major, moderate, minor or none. These categories are based on the juxtaposition of viewpoint or landscape sensitivity with the predicted magnitude of change. This matrix should not be used as a prescriptive tool but must allow for the exercise of professional judgement. These categories have been based on combining viewpoint or landscape sensitivity and predicted magnitude of change, to determine significance of effects:

LANDSCAPE AND VISUAL SENSITIVITY	***Magnitude of Change***				
		Substantial	Moderate	Slight	Negligible
	High	**Major**	**Major/ Moderate**	Moderate	Moderate/ Minor
	Medium	**Major/ Moderate**	Moderate	Moderate / Minor	Minor
	Low	Moderate	Moderate/ Minor	Minor	Minor/ negligible

Figure 6.3 Significance of landscape and visual impact

The measure of significance of effects must not be taken to imply that they are necessarily adverse or should warrant refusal. As with many aspects of landscape and visual assessment, significance of effect also needs to be qualified with respect to the scale over which it is felt. An effect may be locally significant, or significant with respect to a small number of receptors, but not significant when judged in a wider context.

Any effect may be described as temporary or permanent, direct or indirect, positive or negative and these various types of effect have a bearing on the acceptability or otherwise of the type of effect. The various types of effect are described as follows:

6.4.4 Temporary/ Permanent Effects -If a proposal would result in an alteration to an environment whose attributes can be quickly recovered then judgements concerning the significance of effects should be tempered in that light. The wind energy application is for a 25 year operational period, and while this is not permanent it can properly be described as long term. Landscape and visual effects can be reversed and following decommissioning there would be no residual landscape and visual effects. A wind turbine should therefore be regarded as a long term reversible addition to the landscape preserving the choice for future generations whether or not to retain what might be regarded as the landscape fabric of today.

6.4.5 Direct and Indirect Effects - Direct and Indirect landscape and visual effects are defined in Guidelines for Landscape and Visual Impact Assessment (GLVIA 2002). Direct effects may be *defined "… as an effect that is directly attributable to a defined element or characteristic of the proposed development, for example the loss or removal of an element or feature such as a hedgerow or a prominent group of trees…".* 'An indirect (or secondary) effect is an effect that is not a direct result of the proposed development but is often produced away from the site of the proposed development or as a result of a complex pathway or secondary association'. The direct or physical effects are generally limited to an area around the base of the proposed turbine and cable trenches to an existing substation building on the Lancaster University Campus. The main effects are often concerned with the visual effects (occasionally referred to as indirect effects) and relate to effects associated with the introduction of the wind turbine as seen in the context of the existing landscape and visual character of the view.

6.4.6 Positive/Negative (Beneficial and Adverse) - Positive effects upon landscape receptors may result from changes to a view involving positive enhancement measures or through the addition of well-designed elements, which add to the landscape experience or sense of place in a complementary manner. In the case of wind turbine development it is not a clear cut matter to determine whether or not a change in the view should necessarily be regarded as an adverse or positive effect, because of the widely varying responses of individuals to this form of development. The perception of the viewer influences whether a significant visual effect would constitute acceptable change to the landscape. As described in Chapter 4 of the ES public attitude surveys in the vicinity of existing operational wind farms in England, Scotland and Wales have consistently found that more people view wind farms positively than negatively and it appears to be the case that this proportion tends to increase post construction compared to pre-construction. The most recent study is the *'Public Attitude to Wind farms'* survey carried out for the Scottish Executive by MORI (August 2003). The factors influencing acceptability are considered in the conclusions of this chapter.

The assessment has been carried out in a systematic manner based on a neutral perspective in relation to the beneficial or adverse nature of effects.

6.4.7 Illustrative Tools

6.4.7.1 Visibility Maps - Computer generated Zone of Theoretical Visibility (ZTV) Maps have been prepared to assist in viewpoint selection and to indicate the potential influence of the development in the wider landscape. They have been prepared to indicate the extent of potential visibility on the basis of 'bare ground' only not taking the screening effects of the built form of settlements and main areas of woodland into account.

Visibility Maps to turbine blade tip and hub height have been prepared to a radius of 15km from the proposed turbine. Visibility Maps illustrate potential visibility on the basis of 'bare ground'.
The Visibility Maps indicate areas from which it might be possible to secure views of part, or parts, of the proposed turbine. However, use of the Visibility Maps needs to be qualified on the following basis:

- there are a number of areas within the Visibility Maps from which there is potential to view parts of the proposal, but which comprise open agricultural, or other land where the general public do not appear to exercise regular access;
- the Visibility Maps can indicate visibility in areas of significant tree and woodland cover where the landcover obscures the majority of views out with the vegetated area;
- the Visibility Maps do not account for the effects of screening and filtering of views as a result of intervening features, such as buildings, dense settlement, trees and hedgerows;
- the Visibility Maps do not account for the likely orientation of a viewer – for example when travelling in a vehicle.

6.4.7.2 Viewpoint Assessment and Visualisations - The combined effect of these limitations means that the Visibility Maps tend to over-estimate the extent of visibility – both in terms of the land area from which the turbine is visible and also possibly the extent of visibility of the turbine from a particular viewpoint.

In addition, the accuracy of the Visibility Maps has to be considered. In particular, the Visibility Maps are generated from Ordnance Survey (OS) Landform Panorama digital data based on a gridded terrain model with 50m cell sizes. The resolution of this model cannot accurately represent small-scale terrain features, which can therefore give rise to inaccuracy in the predicted visibility. This can lead to either underestimation of visibility – e.g. a raised area of ground permitting views over an intervening obstruction – or can lead to overestimation of visibility – such as where a roadside embankment obscures a view. These effects are said to be 'random' and over the extents of the Visibility Maps are unlikely to present a significant error.

The use of this type of Visibility Map is considered good practice and should be considered as a tool to assist in assessing the visibility of the project. The Visibility Maps do not present an absolute measure of visibility and do not represent the 'visual impact' of the proposed wind turbine.

The assessment of landscape and visual effects is carried out from an agreed representative selection of viewpoints. Following consultation with Lancaster City Council a total of 12 viewpoints were chosen at a range of locations throughout the 15km study area. The selected viewpoints are representative of the views experienced at different distances and directions from the site, as well as from the various landscape character types identified in the study area from which the proposed wind turbines would be visible. Detailed analysis of the viewpoints includes description of the existing and predicted view, analysis of magnitude of change and the effects on landscape character and visual amenity.

The viewpoint analysis is illustrated with reference illustrative material, comprising photographs and photomontages, both of which have been undertaken in line with guidance provided in the SNH document 'Visual Representation of Windfarms' which recommends a "minimum viewing distance of 300mm and the use of a 50mm equivalent camera lens". Photography was undertaken on behalf of Segen and by Stephenson Halliday (Viewpoints 1-12) taken as part of the viewpoint refinement process was taken with a digital SLR camera with full size (35mm) sensor, using a 50mm focal length lens, mounted on a level panoramic head tripod.

All of the photographs and photomontages have been produced to record a 65.5 degree angle of view, illustrating the view experienced at the viewpoint, and provides an indication of the visual context of the development. In this assessment the visualisations have been presented with a comfortable viewing distance of 350mm.

6.5 Baseline Description

The aim of the baseline analysis is to document, classify and appraise the existing landscape features in the vicinity of the development site. It also establishes the extent of the visibility of the site. Through this process, a better understanding of the key components or characteristics of the study area is gained, which is critical in identifying valued and potentially sensitive landscape and visual receptors against which the predicted landscape and visual impacts of the development can be assessed.

6.5.1 Landscape Context

The site is located adjacent to the M6 motorway corridor south of Lancaster within the rolling lowland landscape of the Bowland Fringe and Pendle Hill character areas. The proposed turbines would be located within agricultural land and the immediate character close to the site includes the predominantly developed M6 corridor to the west with more rural character to the east including narrow lanes, hedgerows and scattered dwellings. It was agreed with the Local Planning Authority that the Study of Landscape Character should be limited to a 10km radius of the proposed development site.

6.5.2 Landscape Character – National Character Areas

A description of the wider landscape surrounding the development is given here to provide context to the visual qualities of the landscape within which the development would be located. The description is based on Natural England's 'National Character Areas', (NCA) of which there are 159 in England. The descriptions given for each character area highlight the influences which determine the character of the landscape, for example land cover, buildings and settlements. Appendix F Figure 6.01 – Landscape Character, illustrates the location of the NCA's and also the Local Landscape Character types within a 10km radius of the development, as agreed with the Local Planning Authority.

The NCA in which the development site falls is No.33 – Bowland Fringe and Pendle Hill, close to the boundary with No. 31 - Morecambe Coast and Lune Estuary . The Bowland Fringe and Pendle Hill is a transitional landscape which wraps around the dramatic upland core of the Bowland Fells. It extends from the Lune Valley in the north around the slopes of the Bowland massif before merging imperceptibly eastward into the landscape of the Ribble Valley. The eastern boundary links with the Yorkshire Dales while to the south lie the Lancashire Valleys.

Bowland Fringe and Pendle Hill (NCA 33)

This is a diverse landscape of undulating pasture, broadleaved woodland, parkland and water bodies. Fields are small to medium-sized and are enclosed by well maintained hedgerows with large mature hedgerow trees. The sycamore of the Lancashire and Amounderness Plain is replaced by oak, ash and alder. This is a relatively wellwooded landscape, predominantly associated with the myriad of streams and valleys which cascade off the Bowland Fells and support large areas of semi-natural riparian woodland. This includes several areas of ancient woodland along the Brock and Calder and between Dolphinholme and Abbeystead.

To the south of Bowland the moorland outliers of Pendle Hill, Beacon Fell and Longridge Fell enclose the Ribble Valley and reinforce its affinity with the Forest of Bowland. The combination of topography, tree cover and field enclosure creates a sense of intimacy in contrast to the expanse of the coastal plain and exposed moorland heights. To the north of Bowland is the Lune Valley which separates the Fringe from Morecambe Bay. It has a pastoral character with fields enclosed by well-maintained hedgerows containing mature hedgerow trees. Due to soil conditions and a favourable microclimate, vegetation is generally larger and more vigorous than in other areas. Deciduous woodland, including some areas of ancient woodland, is concentrated on valley sides and is most prominent in the Roeburn, Wenning, Greta and Hindburn valleys.

The key characteristic of the *Bowland Fringe and Pendle Hill* landscape area are as follows:

- Undulating rolling landscape with local variation created by both the numerous river valleys and outlying upland features of Beacon Fell, Longridge Fell and Pendle Hill.
- Strong outcrops of 'reef knolls' and limestone form distinct landscape features to the Ribble and Hodder Valleys.
- Meandering, commonly tree-fringed rivers with oxbow lakes form prominent features within the predominantly pastoral landscape.
- Predominantly Grade 3 agricultural land supporting permanent pasture, mostly improved, for dairy and livestock farming.
- Intensively managed landscape, with lush hay meadows in small- to medium-scale fields defined by well maintained hedgerows with mature hedgerow trees. Some rough grazing at higher elevations.
- Extensive semi-natural woodland, much of which is ancient, on both main valley bottoms, side valleys and ridges.
- Dense north - south communication corridor, comprising the M6, A6, the railway line and the Lancaster Canal, defining the western boundary and providing a physical and psychological barrier.
- Numerous water courses and bodies including the rivers Ribble, Hodder, Calder, Wyre, a number of reservoirs, and field ponds north of Preston.
- Small villages, hamlets and scattered farmsteads mostly in local stone are well integrated into the landscape and connected by a network of winding hedge-lined country lanes.
- Bowland Fells provide a dramatic backdrop to the east and north with extensive views possible from high ground across the Lancashire and Amounderness Plain and across open valley bottoms.

The key characteristics of the other National Character Areas within the Study Area are set out at Appendix F 1.

6.5.3 Lancashire Landscape Character Assessment

All of the NCA's, including the Bowland Fringe and Pendle Hill area have been subdivided further by the Lancashire County Council's Landscape Character Assessment 'A Landscape Strategy for Lancashire' (2000).

The development site predominantly falls within the **7c – Langthwaite Ridge**, landscape character type (LCT) which is within the Farmed Ridges Landscape Character Area (LCA). The southern tip of the site is located in **12a – Carnforth-Galgate-Cockerham** LCT within the Low Coastal Drumlins LCA. Both landscape character types are described in more detail below.

In the area around the development site, in addition to type 7c – Langthwaite Ridge, the following landscape character types also fall within the 10km study area (see Appendix F2 for full descriptions):

1b – High Bowland Plateau
2b – Central Bowland Fells
4d – Bowland Gritstone Fringes
5i – West Bowland Fringes
10a – Wyre Valley
10b – North Bowland Valleys
11d – Lune Valley
12c – Heysham - Overton
13c – Docker-Kellet-Lancaster
15e – Forton-Garstang-Catterall
16a – North Flyde Mosses
16f – Heysham Moss
17b – Cockerham Coast
18d – Lune Marshes
18e – Pilling and Cockerham Marshes

7c Langthwaite Ridge

The development site falls within the landscape character area of Langthwaite Ridge as shown on the map below and is part of a group of 'Farmed Ridges' which includes 7a – Mellor Ridge and 7B - Upholland Ridge. These gritstone outcrops are relatively low in comparison to the Bowland Fells and outliers, their distinctive ridge profiles set them apart from the adjacent lowland agricultural landscapes. Wooded sides, which rise sometimes dramatically from the farmed plains, are visible for miles around and provide a sense of orientation when in the lowlands. The ridges themselves support a mosaic of mixed farmland and woodland which provides a textural backdrop to the surrounding lowlands. The landscape character one side of the ridge may be totally different from the character on the other, despite their proximity to each other.

The local vernacular is clustered stone built villages with scattered outlying cottages and farmsteads strung out along local roads, but more recent ribbon development and new houses display an incongruous mix of materials. There is a good network of footpaths, parking and picnic spots with views over the surrounding lowlands. The ridges also support some forestry and provide ideal sites for reservoirs and communication masts.

The ridges are formed from high areas of Millstone Grit which rise dramatically from the surrounding landscape to elevations of between 140 and 230 metres. The Millstone Grit outcrops in places, but is largely overlain by Boulder clay. The Langthwaite Ridge is orientated

north south and is separated from the Bowland Hills by low lying land of glacial sands and boulder clay drift. To the west lie low drumlins.

The relative height and views from the ridges have more recently attracted communication masts, housing developments and recreational activities. The ridges continue to be resources for agriculture, stone and water to supply nearby urban populations. Intensive farming in recent history threatens to remove traces of early enclosure, although the early origin of field patterns is still discernible in the landscape.

Relating to the Langthwaite Ridge in particular, this gritstone outcrop forms a prominent rounded ridge which forms a southern extension to the Docker-Kellet-Lancaster Drumlin Field. It separates the city of Lancaster and developed coastal drumlin landscape from the rural landscapes of the Bowland Fells.

It is distinguished from the adjacent drumlin field by its smooth rounded form. It is typical of a farmed ridge with a rich mosaic of pasture, woodland and parkland. It forms a setting for the city of Lancaster and scattered built development takes advantage of views from the ridge. It provides suitable location for reservoirs and communication masts which stand out against the skyline. Mixed woodlands are a feature of this area, associated with the Quernmore estate and the reservoirs. The largest block is Knots Wood, managed by Forest Enterprise.

12a – Carnforth-Galgate-Cockerham

The Low Coastal Drumlins, on or near which Lancaster and Morecambe are built, extend along the coast behind Morecambe Bay from Cockerham in the south to Carnforth in the north. This landscape supports an extremely high proportion of built development including the large settlements of Lancaster and Morecambe and recent built development along the A6.The Low Coastal Drumlins provide a convenient transport corridor; the Lancaster Canal, M6, A6 and mainline railway run side-by-side in a north-south orientation. The canal, which weaves through the drumlins, is an important reminder of the area's industrial heritage; a branch emerges into the Lune at Glasson Dock.

To the west of Cockerham settlement is sparse and dominated by scattered large scale farmsteads in contrast to the towns and large villages further north. Fields are largely of post medieval pattern, however there are areas of older enclosure and settlement, notably at Cockersand Abbey. The drumlins provide elevated points from which there are views over the salt marshes to Morecambe Bay. Near Thurnham there is a significant area of mossland lying between the drumlins, allowing long distant views towards the coast. Traditional farmsteads and older settlement cores are built of stone but the modern development is often built using red brick. Buildings on top of the drumlin hills are particularly visible. Woodland is limited to small plantations, woods associated with former estates and rarely, fragments of ancient woodland in unusual hilltop or hillside settings.

6.5.4 Greenbelts

Approximately 25% of the total area of Lancashire is designated as Greenbelt. The purposes of the Greenbelt designation are as follows:

- to check the unrestricted sprawl of large built-up areas;
- to prevent neighbouring towns from merging into one another;
- to assist in safeguarding the countryside from encroachment;
- to preserve the setting and special character of historic towns;

- to assist in urban regeneration by encouraging the recycling of derelict and other urban land.

The extend of the Greenbelt designation in Lancashire is shown on the Map in Appendix F section F3. Greenbelt policy in England is guided by PPS2: Greenbelts. This planning policy statement is detailed in Chapter 3 of this ES. The closest Greenbelt designation to the development site is to the north of Lancaster, located approximately 6km from the proposals. The designation separates the city of Lancaster from the settlements of Slyne, Hest Bank, Bolton le Sands and Carnforth to the north (see Appendix F section F6, Figure 6.02 – Landscape Designations).

6.5.5 Development Site Designation

The development site falls within an area designated as countryside by the Lancaster District Local Plan, covered by policy E4. This designation is described in more detail in Chapter 3 of this ES.

6.6 Landscape Capacity

6.6.1 Lancashire Landscape Capacity Guidance

In 2004 'Landscape Sensitivity to Wind Energy Development in Lancashire' was produced to provide strategic guidance on the sensitivity of Lancashire's landscapes to wind energy developments. The study addresses landscape parameters only and excludes the consideration of other others, such as potential impacts on ecology, hydrology and soils.

The document looks at the landscape character areas as defined in the Lancashire Landscape Character Assessment. A desk top review was undertaken referring to the written LCA descriptions and ceash LCA was considered in respect of the selected sensitivity criteria.

These criteria included scale, openness, landform, landcover, complexity and patterns, built environment , sense of remoteness/wildness, perception of change, views, landscape form/setting/backdrop/focal points, rarity of landscape,designation, cultural associations and amenity and recreation

The out-put in respect of each LCA is expressed as High, Moderate-High, Moderate, Moderate-Low and Low sensitivity to wind energy development. The assessment process integrated the different components of sensitivity and the findings were tested on a sample of LCAs in the field.

In general it was found that Lancashire as a whole has a generally High and Moderate-High sensitivity to wind energy development as shown in the Appendix F section F4. This sensitivity includes the areas of both AONBs.

6.6.2 Sensitivity of Langthwaite Ridge

The development site is located in 7c – Langthwaite Ridge, which was found to have a Moderate-High level of sensitivity to wind energy development. It is stated that this particular landscape rises above the surrounding lowland, forming a prominent ridge, although in close proximity to the more elevated landscape of the Forest of Bowland. There are no attributes of scale or landform that lead to particular sensitivity.

The area has a long established settlement pattern, including designated landscapes and country houses with a distinctive architecture, all of which tend to elevate the sensitivity. In addition there is an extensive footpath network and the area is used extensively for recreation. There are however some detractors within this area that reduce the sensitivity.

Whilst not forming elevated backdrops to adjacent areas this area is an important component of local and some wider views and this tends to elevate the sensitivity, with these areas perceived as part of the setting of adjacent areas. This is particularly the case with this area forming the setting of the western edge of Lancaster.

The document points out that since this is a broad scale study carried out at County level to provide strategic guidance, an identification of high sensitivity to wind energy development does not necessarily rule out all wind development in the denoted area. It is possible that in limited parts of these LCAs, exceptional circumstances of characteristics, or the absence of them, may lead to opportunities for wind energy development.

A further consideration of the study was undertaken in order to identify the appropriate scale of wind energy developments that may be appropriate within each LCA, notwithstanding the findings of sensitivity. In this context the following typology for scales of wind energy development was prepared to address four scales of development:

- Small scale clusters (2-5 1.3MW+ turbines)
- Medium scale clusters (6-10 1.3MW+ turbines)
- Large scale clusters (11-25 1.3MW+ turbines)
- Very large scale clusters (26+ 1.3MW+ turbines)

Langthwaite Ridge is identified as being appropriate for small and possibly medium scale clusters. This is shown on the map in Appendix F section F5.

6. 7 Information Gaps

Details of any gaps in information are documented and discussed in the relevant assessment sections of this chapter.

6.8 Project Description and Mitigation

6.8.1 The Proposed Development

The proposed development would comprise three distinct phases; a temporary construction phase, an operational phase and a temporary decommissioning phase. A description of these phases of development is contained in Chapter 2 of the ES. Those elements of the development with the potential to cause an effect on landscape character and visual amenity are described in the paragraphs below.

The construction phase is expected to last for approximately 5 months. The activities and temporary features with the potential to cause an effect on the landscape and visual amenity include:

- Construction of crane hard-standing;
- Excavations and construction of turbine base foundation;
- Excavations for underground cables;
- Temporary site compound;
- HGV deliveries to site and movement of vehicles on site;
- Erection of turbine;
- Reinstatement works, including mitigation measures and the removal of the temporary accommodation.

These works will be confined to the immediate surroundings of the site within agricultural land and include delivery movements as well as construction machinery in the immediate vicinity. The visual effects of the construction phase are considered below.

The proposed 2 wind turbines are the only element of this development with the potential to affect the landscape and visual amenity of the study area during the operational phase.

The precise turbine make and model have not been finalised as this is dependent upon the technology available at the time of install and statutory requirements for tendering. However the turbine will have a nominal hub height of 59 metres and 41 metre rotor length, giving a maximum blade tip height of 101 metres in the vertical position. The turbine would be three bladed with a tubular tower as illustrated in Appendix B Section B1i. An electrical transformer would be accommodated within the tower. The colour of this structure would be pale grey, with a semi-matt surface that minimises surface reflectance, subject to agreement with the local planning authority.

6.8.2 Potential Effects of Operational and Decommissioning Phase

The access tracks and underground grid connection are not anticipated to have any significant residual effects on the landscape and visual amenity of the area, as a result of appropriate siting and design, and thus have not been considered in any further detail in this assessment. The assessment which follows has therefore been based on the potential residual effect of the wind turbines.

The expected operational life of the turbines is approximately 25 years from the date of commissioning. When the wind turbines are decommissioned the turbine components would be removed. It is envisaged that conditions attached to any planning consent for the turbine would stipulate the work required for the reinstatement of the site. The turbines can be decommissioned easily, rapidly dismantled and the land restored.

There would be a short term temporary impact associated with the removal of structures during the decommissioning stage of the project; however this would have a minimal effect on the locality and has not been considered further as part of this assessment.

In the circumstances that a development would result in an alteration to an environment whose attributes can be quickly recovered, then judgements concerning the significance of effects should be tempered in that light. Landscape and visual effects, whether regarded as positive or adverse, can be reversed and following decommissioning there would be no residual effects.

6.8.3 Mitigation Measures

By their nature, the proposed turbines would result in significant visual effects which it would not be feasible to mitigate by adjusting the siting, or providing screening. The design of the turbines comprise simple tubular towers with nacelle and three blades which provides a smoother sense of movement and more efficient power generation than two blades. The proposed colour of the upper parts of the turbines has been selected to blend with the predominant colour of the sky and have a semi matte finish to minimise reflectance.

6.8.4 Landscape Proposals

The landscape proposals are illustrated on the Landscape Master Plan at Appendix F Section F7. The new woodland would comprise planted areas of native species in 10m wide belts along the southern and south western perimeter of the site to reinforce the structural planting framework of this part of the site which currently only comprises a clipped hedgerow. The growth of the woodland, over time, will help to partially screen the base of the turbines and associated access road infrastructure, from parts of Hazlerigg Lane, dwellings to the south of the Site and also views from vehicles travelling north along the M6. The southern end of the access track is specified as reinforced grass to assist in blending the track

into the surrounding pasture, which would be retained and expanded to cover the area of felled woodland. The regarding of the landform to the west of the road with excess soil material generated from the construction process will also assist in subtly enclosing the route, reinforcing the pattern of the local ridge that already exists in this area.

The incorporation of riffle pools to the stream and the creation of a new wetland area is proposed as ecological mitigation for the necessary culverting of the stream in the vicinity of the turbine. New species rich native hedgerows are proposed to replace those lost as part of the construction process. A short section of hedgerow along the Lane adjacent to the southern boundary would be removed to accommodate the new access road visibility splay, whilst the hedgerow in the vicinity of turbine 2 would be removed for ecological reasons (see Chapter 5 of the ES). A further length of hedgerow would need to be lost to accommodate the relocated research area. In total the removal of 606m of existing hedgerow would be replaced by 1090m of new species rich native hedgerow incorporating standard trees. In addition, the structure of existing hedgerows would be improved by the planting of native standard trees in the locations illustrated on Habitat Mitigation Plan Appendix F section F7.

The removal of 0.36ha of the semi-natural woodland to accommodate turbine 2 would be partially offset by the planting of 0.79ha of species rich woodland, however further mitigation is provided by fencing off an additional 1.74 ha to allow the natural regeneration of woodland adjacent to the existing semi natural woodland where this will have the greatest potential ecological and landscape fabric benefits. The proposals would still maintain 12.21 ha of pasture across the site, which would allow the majority of the remain available for grazing.

6.9 Visual Analysis

This section comprises the assessment of visual effects arising from the proposed wind turbines during the operational period. The potential landscape and visual effects arising during the operational phase of the turbines have been assessed in two ways:

- Analysis of the zone of theoretical visibility (ZTV) maps to provide a general overview of the visibility of the turbine from different distances within the study area;
- Assessment of the potential landscape and visual effects at the 12 representative LVIA viewpoints illustrated in the visualisations.

6.9.1 Visibility Map Analysis

Visibility Mapping to turbine blade tip and hub height has been prepared to a radius of 15km from the proposed turbines, as illustrated in Zone of Theoretical Visibility (ZTV) plan shown in Appendix F Section 6 **Figures 6.04 & 6.05**. This ZTV analysis has been prepared on the basis of 'bare ground'; not taking into account the screening effects of the built form of settlements or vegetation.

The Visibility Mapping (Appendix F Section F6 **Figures 6.04 & 6.05**) illustrates the maximum overall visibility of the proposed turbine to the upper blade tip height of 100 metres. An indication of areas where only blades would be visible can be gained through direct comparison of the colour coded theoretical visibility zones which distinguish between the Blade Tip and Hub Height.

Blade Tip Visibility
The visibility would be widespread within 5km with only small pockets of land in the north and south east not experiencing any visibility. Beyond 5km the visibility would predominantly be concentrated on in the west, south west and south east with more dispersed visibility in the east and north. The wider views out to 15km would also be predominantly in the west with limited visibility in the east (Bowland Fringe and Bowland Fells).

Hub Height Visibility
The hub height is broadly similar to blade tip visibility with reduced visibility in the north beyond 5km and in the south east between 5km and 10km.

6.9.2 Receptors

Settlement

Potential visibility may be experienced by residents of settlements at the following locations:

- Scattered isolated dwellings and settlement within 5 km of the proposed turbines, including Bailrigg, Galgate, Ellel, parts of Lancaster, Quernmore, Dolphinholme, Conder Green, Lower Green Bank and Brow Top.
- Parts of towns and villages within 5 -10 km radius of the site including Lancaster, Crossgill, Caton, Brookhouse, Heysham, Middleton, Overton, Cockerham, Forlon and Thurnham.
- There would be limited theoretical opportunity for visibility from settlement at 15 -30 km radius from the site, given the screening effect of intervening topography.

Road Users

Potential visibility may be experienced by motorists on A, B and minor roads including:

- M6 Motorway
- A6 Lancaster to Garstang
- A588 Lancaster to Cockerham
- A683 Morecambe to Hornby
- B5272

Railways

The London to Glasgow west coast line runs parallel with the A6 road to the west of the site (approx 1.5km at the closest point).

6.9.3 Recreational Receptors Tourist Destinations

It is considered that all the main road routes through the study area are likely to have tourist, visitor and recreational usage and the above analysis of visibility for the road network would apply to these receptors. Recreation and visitor interest focuses on the natural and historic environment with walking, cycling and bird watching representing the key activities.

The study area contains national and regional footpaths that may be subject to views of the proposed development, including:

- Lancashire Coastal Way – 137 mile footpath following the coastline between Mersey side and Cumbria. At the closest location to the turbines are approximately 3 km distance to west near Ashton on the River Lune ;
- Wyre Way – Connects Fleetwood on Lancashire coast to Tarnbrook in Forest of Bowland. At the closest location the turbines are approximately 4.5 km distance at Dolphinholme to south east.
- Lune Valley Ramble – Extends north east from the centre of Lancaster along River Lune to Kirby Lonsdale. At the closest location to the turbines are approximately 5 km distance within the centre of Lancaster;
- Forest of Bowland – Series of local walks located within approx 10 km to the north east including Caton and Littledale Walks.

In addition to these long range footpaths, pedestrian, cycle and horse riding access within the study area is provided by an extensive network of local footpaths, tracks and minor roads.

The Study Area contains several national cycle and regional routes including:

- National Cycle Route 6 – Is routed through the 15km study area from Catteral in the south to Carnforth in north west, broadly following the route of the Lancashire Coastal Way;
- Regional Route 90 – The Northern loop of this cycle routes is routed through the 15km study area near Fleetwood on Lancashire coast to Carnforth in north west via western parts of the Forest of Bowland. At the closest location the turbines are approximately 1 km distance to the east.
- National Cycle Route 69 – Is routed through the study area between Morecambe and Caton.

6.9.4 Viewpoint Analysis

A viewpoint assessment has been carried out on a selection of key viewpoint locations to assess the likely magnitude and significance of landscape and visual effects arising as a result of the two proposed turbines. A total of 12 were selected following consultation with Lancaster City Council. The viewpoints are considered representative of the main landscape and visual receptors in the study area. These 12 viewpoints are listed in Table 6.4 below and their locations are shown in Appendix F section F6 **Figures 6.11** to **6.32**.

Vp Ref	Viewpoint Name	Distance from nearest turbine	Grid reference	Sensitive receptors	Landscape Character types
1	Bailrigg	0.7 km	348492 458243	Residents	Low Coastal Drumlins
2	Galgate	1.6 km	348361 455694	Residents Road users	Low Coastal Drumlins
3	Bay Horse Road	1.9k m	351095 457047	Residents Road users in AONB	Moorland Fringe
4	Quernmore	2.3 km	352047 459026	Residents Road users in AONB	Moorland Fringe
5	Greyhound Bridge	4.5 km	347716 462102	Road users	Urban
6	M6 South	5.0 km	349827 452739	Road users	Moorland Fringe
7	Jubilee Tower	5.0 km	354215 457316	Leisure users	Moorland Plateaux
8	Sunderland Point	6.5 km	342640 455886	Footpath users Leisure users	Open Coastal Marsh
9	Torrisholme	7.2 km	345975 464243	Leisure users	Low Coastal Drumlins
10	M6 North	7.4 km	349645 465167	Road users	Drumlin Field
11	Cockerham	9.1 km	343597 449790	Bridleway users	Mosslands
12	South west of Grange Over Sands	21.0 km	336484 473996	Strategic Footpath users	Open Farmland and Pavements

Table 6.4: Viewpoints included in this assessment

The existing and predicted views from these locations are shown in the Visualisations 1-12. On the basis of fieldwork observations and a number of measured parameters for each viewpoint, the sensitivity of the location for each of the landscape and visual receptors and magnitude of change has been assessed. These have been combined in accordance with the matrix in Table 6.3 in the methodology to establish an overall effect and determine whether or not the effect is likely to be significant. The viewpoint assessment is presented in Table 6.5 below.

View point No.	Viewpoint	Distance from nearest turbine	No. of turbines theoretically visible	Landscape Effects				Visual Effects			
				Landscape Sensitvity*	Magnitude of change	Effect on landscape character	Significant Yes/no	Receptor sensitivity	Magnitude of change	Effect on visual amenity	Significant Yes/no
1	Bailrigg	0.7 km	2	Medium/ High	Substantial	Major	**yes**	High	Substantial	Major	**yes**
2	Galgate	1.6 km	2	Medium/ High	Substantial	Major/ Moderate	**yes**	High (residents) Medium (highway)	Substantial	Major	**yes**
3	Bay Horse Road	1.9k m	2	High	Substantial	Major	**yes**	High	Substantial	Major	**yes**
4	Quernmore	2.3 km	2	High	Substantial/ Moderate	Major	**yes**	High	Substantial/ Moderate	Major	**yes**
5	Greyhound Bridge	4.5 km	0	Low	None	None	no	Medium	None	None	no
6	M6 South	5.0 km	2	High	Moderate	Major/ Moderate	no	Medium	Moderate	Moderate	no
7	Jubilee Tower	5.0 km	2	High	Moderate	Major/ Moderate	**yes**	High	Moderate	Major/ Moderate	**yes**
8	Sunderland Point	6.5 km	2	Medium/ High	Moderate/ Slight	Moderate	no	Medium	Moderate/ Slight	Moderate/ minor	no
9	Torrisholme	7.2 km	2	Medium/ High	Slight	Moderate	no	High	Slight	Moderate	no
10	M6 North	7.4 km	1	Medium/ High	Slight/ Negligible	Moderate/ Minor	no	Medium	Slight/ Negligible	Minor	no
11	Cockerham	9.1 km	2	Low	Slight	Minor	no	Medium	Slight	Moderate/ Minor	no
12	South west of Grange Over Sands	21.0 km	2	High	Negligible	Moderate/ Minor	no	High	Negligible	Moderate/ Minor	no

*Landscape Sensitivity – values derived from the 2004 publication by Lancashire County Council 'Landscape Sensitivity to Wind Energy Development in Lancashire

Table 6.5: Viewpoint Assessment

6.10 Assessment of Landscape Effects

6.10.1 Introduction

Landscape Effects defined by the Landscape Institute "*Change in the elements, characteristics, character, and qualities of the landscape as a result of development.*" These effects are assessed by considering the landscape sensitivity against the magnitude of change. The type of effect may also be described as temporary or permanent, direct or indirect, cumulative and positive, neutral, or negative.

6.10.2 Landscape Effect during Construction

Whilst it is the operational stage of the wind turbines which would give rise to prolonged landscape and visual effects, temporary effects at the construction stage would occur and these are considered below. Construction of the wind turbines would involve the following operations:

- Construction of crane hard-standing;
- Excavation and construction of turbine base foundation;
- Excavations for underground cables;
- Temporary site compound;
- HGV deliveries to site and movement of vehicles on site;
- Erection of turbine;
- Reinstatement and mitigation works, including the removal of the temporary accommodation.

The works detailed above would give rise to some landscape and visual effects. These effects would however be temporary and would mainly arise through the erection of the turbines. The effects arising from other operations, including the vehicle movement, excavation of turbine foundations, cable runs and the construction compound would be localised, and would not be prominent in views from the surrounding areas. Construction operations would take place over a period of approximately 5 months. These effects would be limited in extent and duration and are not considered to be significant.

During the construction period many of the potential construction mitigation measures would involve small-scale site management issues regarding the detailed location of construction activities. Individually these may have only minor effects, but cumulatively these could have an influence upon the intrusiveness of the construction activities. The key measures that can be implemented in order to avoid or reduce potential construction effects include:

- the selective and sensitive location of temporary storage of materials and plant and security fencing;
- using designated routes around the site for construction vehicles and operation of construction plant such as cranes;
- implementation and monitoring of site management procedures including regular litter sweeps of immediate environs for litter arising from the construction site; and
- The protection of key landscape resources such as existing boundary vegetation and on-site hedgerows that are to be retained. Contractors will be required to prepare methodologies for working close to such features.

6.10.2.1 Potential Construction Effects on Landscape (Fabric and Character*)*

The construction of the two turbines would take place on a limited part of the existing agricultural land adjacent to the M6. The wind turbines are located at the intersection of two landscapes with one turbine located within the Langthwaite Ridge and other within Carnforth-Galgate-Cockerham. Direct landscape effects on these landscapes would be localised and indirect effects are assessed in the Landscape Effects Section below.

The main site access would be taken from Hazelrigg Lane as shown in Appendix B Section B3. An estimated 1.1km of site access tracks would be required for the wind turbines. The tracks would have a nominal width of 5m and may have temporary passing places as required in order to facilitate traffic movement.

Any disturbance of existing grassland areas to be retained on completion of construction would be reinstated accordingly. The effects of the construction phase of the turbine development on the fabric of the landscape are considered to be minor and not significant.

6.10.2.2 Potential Construction Effects on Visual Amenity

The visual effects of the activities during the construction phase would be temporary and intermittent and slight in magnitude. The visual effects of the limited number of turbine delivery vehicle movements would be of minor significance.

Having regard to the assessment set out above and the temporary nature of the construction effects, it is considered that the proposal would result in landscape and visual effects of minor significance during the construction stage, not considered to be significant.

6.10.3 Landscape Effects during Operation

Post construction the wind turbine site would gain a 'cleaner' and more 'settled' appearance as the construction areas would be restored and the wind turbines operational stage would have commenced.
The wind turbines and to a lesser extent the meteorological mast would be visible over a wider area and potentially capable of indirect effects on the surrounding landscape resource. These effects have been assessed under the operational effects as they would occur incrementally over the construction period, but would not exceed the final operational magnitude of effect.

Direct Effects upon Landscape Fabric of the Site
In total the removal of 606m of existing hedgerow would be replaced by 1090m of new species rich native hedgerow incorporating standard trees. In addition, the structure of existing hedgerows would be improved by the planting of native standard trees in the locations illustrated on the Habitat Mitigation Plan (see Appendix F section F7).

The removal of 0.36ha of the semi-natural woodland to accommodate turbine 2 would be partially offset by the planting of 0.79ha of species rich woodland, however further mitigation is provided by fencing off an additional 1.74 ha to allow the natural regeneration of woodland adjacent to the existing semi natural woodland where this will have the greatest potential ecological and landscape fabric benefits. The proposals would still maintain 12.21 ha of pasture across the site, which would allow the tenant farmer to continuing utilising the majority of the land for sheep grazing.

It is assessed that the sensitivity of landscape fabric in the local context is medium to high and the magnitude of change is moderate resulting in Major/Moderate and significant effects in the short term, which would be mitigated over time by the establishment of new hedgerows, woodland planting and woodland regeneration.

Effects on Bowland Fringe and Pendle Hill NCA
A large proportion of this landscape is designated within the Forest of Bowland Area of Outstanding Natural Beauty and contains large areas natural woodland and distinct limestone features within the Ribble and Hodder Valleys. Overall the landscape sensitivity is considered to be high, reducing to medium in outer fringe areas. Overall the wind turbines would contribute to a negligible magnitude of change and the overall level of landscape effect on the Bowland Fringe and Pendle Hill would be Moderate/Minor and not significant.

Effects on the Langthwaite Ridge 7c (Farmed Ridges)
This landscape extends 7km north east from the wind turbine site and is made of ridge profiles made up of mixed farmland and woodland. The landscape is located out with the AONB and would be of medium to high sensitivity. ZTV coverage within the landscape would be concentrated on areas up to 4km, after which visibility becomes more dispersed. Overall the wind turbines would contribute to a Substantial magnitude of change and the overall level of landscape effect on the Langthwaite Ridge would be Substantial and significant.

Effects on the Galgate - Cockerham - Carnforth 12a (Low Coast Drumlins)
This landscape extends approx 8km from the M6 corridor to west and south west of the site to the River Lune and Cockerham Sands. The landscape supports an extremely high proportion of built development including the large settlements of Lancaster and Morecambe and recent built development along the A6. Woodland is limited to small plantations, woods associated with former estates and rarely, fragments of ancient woodland in unusual hilltop or hillside settings. The overall sensitivity of this landscape is Medium to High. The magnitude of change in relation to views within 5km would be Moderate leading to a Major / Moderate level of indirect effect. The overall magnitude of change would be Moderate leading to a combination Major / Moderate and Moderate levels of effect.

6.10.3.1 Indirect Effects on Adjacent Areas of Landscape Character

Moving beyond the Langthwaite Ridge and Galgate/Cockerham/Carnforth local landscapes, the wind turbines would have an indirect effect on the visual and perceptual characteristics of other or adjacent areas of landscape character. None of these landscapes would be directly affected by operation of the proposed development, as there would be no direct effects on their key physical characteristics. However, the wind turbines may be visible from these areas and as such could indirectly affect the landscape character where particular views or scenic qualities are noted as key characteristics of the landscape. The wind turbines could be frequently visible in the landscape, or alternatively, would also be cumulatively visible with other operational wind farms. Appendix F Section F6 **Figure 6a** illustrates the ZTV in relation to the landscape character areas.

Effects on the West Bowland 5i (Undulating Lowland Farmland)
This landscape runs parallel to the Langthwaite Ridge to the west at distances of between 0.5km and 15km (north east and south) from the wind turbine site. This is a transitional landscape between the Bowland Fells and coastal plain with some unique landscape features including wooded ridges, valleys and drumlin fields. The landscape is partially located within the Forest of Bowland AONB and sensitivity of this landscape is high. The visibility of the wind turbines would predominantly be concentrated on areas within 5km of the wind turbine site. **Viewpoint 3** is representative of close range views from within this landscape and the magnitude would be substantial. The magnitude of change in relation to views within 5km would be Moderate leading to a Major / Moderate level of indirect effect. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

Effects on Bowland Gritstone Fringes 4d (Moorland Fringe)
There are four pockets of this landscape type within the study area and are located at distances of between 3km and 15km from the wind turbine site. They are transitional landscapes between the uplands of the Bowland Fells and lower wooded fringes. The landscapes are predominantly located within the AONB and are of High sensitivity. The visibility of the wind turbines would predominantly apply to the landscape within 5km to the east of the site, with some smaller patches of visibility in relation to areas in the south east at distances between 6kmand 12km. **Viewpoint 4** is representative of from within this landscape up to 5km distance and the magnitude would be substantial. The magnitude of change in relation to views within 5km would be Moderate leading to a Major / Moderate level of indirect effect. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

Central Bowland Fells 2b (Moorland Hills)
This landscape is located between 4km and 15km to the east of wind turbine site, and extends beyond this distance to include a large proportion of the fells. It encompasses the smooth heather clad profiles

of the escarpment slopes on the western limit of the fells, the wide undulating areas of open craggy moorland, and the deep upland valleys within the core of the Fells. The majority of the landscape is designated within the Forest of Bowland AONB and is of High sensitivity. The visibility of the wind turbines would apply to areas to the north east (between 4km and 6km) at Hare Appletree Fell and at further distance to the south east (between 7km and 12km) at Catshaw Fell and Blaze Moss. A large proportion of these landscapes in the north east and south east would not experience any visibility. **Viewpoint 7** is representative of views from within this landscape up to 5km distance and the magnitude would be Moderate. The magnitude of change in relation to views within 5km would be Moderate leading to a Major / Moderate level of indirect effect. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

Wyre Valley 10a (Wooded Rural Valleys)
This landscape is located between 3.5km and 12km to the south and east of wind turbine site at the western edge of the Bowland Fells. The landscape follows the River Wyre from the M6 corridor to Abbeystead and is partially located within the AONB designation. The landscape contains some unique features particularly in the east including mosaics of open water and woodland, generally the landscape is of High Sensitivity. Visibility would be predominantly restricted to areas beyond 5km in the south east and the overall Magnitude of change would be Slight and level of effect Moderate and not significant.

Docker-Kellet-Lancaster 13c (Drumlin Field)
This landscape is located between 1km and 15km from the wind turbines and extends as a thin strip from the university to the north and north east of the study area towards Cumbria forming a large expanse of undulating ground north of the River Lune. The landscape is of Medium to High sensitivity and visibility would include close range views around the Lancaster University area to views out to 5km in area to east of Lancaster. At longer distances visibility would be intermittent and concentrated on areas to north and north east of Halton at distances of between 7km and 14km. Viewpoint 10 is located within in this landscape and the overall effects have been adjudged to be Moderate / Minor. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

High Bowland Plateau 1b (Moorland Plateau)
These landscapes are located between 5km and 15km to east and south east of the wind turbine site. These are large scale landscapes reaching 561m AOD are located within the Forest of Bowland AONB and are of High sensitivity. Visibility would be intermittent and range between 5.5km at Clougha Scar to 12km in south east at Bleasdale Moor with turbines viewed in the context of expansive panoramic views over Lowland areas. **Viewpoint 7** is representative of views from closer area at Clougha the magnitude would be Moderate. The magnitude of change in relation to views within approx 6km would be Moderate leading to a Major / Moderate level of indirect effect. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

Lune Marshes 18d (Open Coastal Marsh)
This landscape is located between 4km and 7km to west, north west and south west of the wind turbine site following the River Lune between Lancaster and the coast. The landscape is of Medium to High sensitivity with a high accessibility to the public including the Lancashire Coastal Way. The visibility would be relatively widespread with views consisting of upper turbines against the background landscape. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

Heysham – Overton 12c (Low Coast Drumlins)
This landscape is located between 5km and 9km to the west of the wind turbines between the River Lune and the coast. The overall sensitivity of this landscape is Medium to High with visibility being relatively widespread and consisting of upper turbines viewed against the background landscape. The overall magnitude of change would be Slight and level of effect Moderate and not significant.

Forton – Garstang – Catteral 15e (Coastal Plain)
This landscape is located between 4km and 15km to the south and south west of the wind turbine site. This is a transitional landscape between the Bowland Fells and raised bog at Winnmarleigh and is a

gently undulating landscape with areas of improved pasture and scattered woodland. In addition there are large areas of urban development and the sensitivity of this landscape is Medium. Visibility would be widespread with turbines taking up a small proportion of the views and being predominantly viewed against the background sky. The overall magnitude of change would be Moderate and level of effect Moderate and not significant.

North Fyde Mosses 16a (Mosslands)
This landscape is located between 7km and 15km to the south west of the wind turbine site and includes large areas of moss including Winmarleigh and Stalmine. Vertical elements such as telegraph poles and pylons are prominent in this landscape and there are distant views to Blackpool Tower, the Pleasure Beach rides and industrial development on the outskirts of Blackpool. The overall landscape sensitivity is Low and the visibility would be widespread with turbines appearing against a combination of the background landscape and sky. The overall magnitude of change would be Slight and level of effect Minor and not significant.

Heysham Moss 16 f (Mosslands)
This landscape is located between 6km and 9km to the north west of the site between the Lune Valley and Morecambe. The proximity of the city of Lancaster influences the character of the mossland in the north of the character area where trading estates, residential estates and caravan parks spill out onto the mosslands, obscuring the landscape pattern and eroding the rural nature of the landscape. The overall landscape sensitivity is Low and the visibility coverage would be relatively widespread and the overall magnitude of change would be Slight and level of effect Minor and not significant.

Cockerham Coast 17b (Enclosed Coastal Marsh)
This landscape is located between 7km and 14km to the south west at Cockerham Sands are flat expansive areas coastal land and marsh which have been reclaimed by drainage. Improved pasture predominates and is used for cattle or sheep grazing, although arable crops grow in well drained areas and the landscape is of Medium sensitivity. The visibility coverage would be relatively widespread and the overall magnitude of change would be Slight and level of effect Minor and not significant.

Lune Valley 11d (Valley Floodplains)
This landscape is located between 8km and 15km to the north east following the River Lune and includes areas of pasture and flood plain surrounded drumlins and hills. There are remnant features of previous industry and the overall sensitivity of this landscape is Medium. Visibility of the wind turbines would be confined to areas around Aughton (between 10km and 13km) and the magnitude of change would be negligible leading to Minor visual effect.

6.10.3.2 Effects on Landscape Designations

Landscape effects would therefore be limited to indirect effects, such as those on the views and visual character experienced from within landscape designated areas as a consequence of the presence of the operation of the proposed Lancaster Wind Turbines. The assessment below considers the indirect effect on the integrity of landscape planning designations within the study area with particular emphasis on the potential effects on valued features and characteristics for which these areas are designated. The assessment of potential effects upon landscape planning designations only includes those designated areas within the blade tip ZTV.

Forest of Bowland Area of Outstanding Natural Beauty
The Forest of Bowland Area of Outstanding Natural Beauty is an extensive designation located to the east of the wind turbines, approx 1km at closest point, extending approx. 25km to the east and north east (North Yorkshire) and approx 25km to south east towards Clitheroe. This designation relates to scenic quality with many parts of the landscape offering expansive views over the fells and valleys. It is also a popular destination for various recreational activities including walking, cycling, fishing and bird watching. The overall sensitivity of the landscape is high.

Areas of potential visibility within the AONB are predominantly concentrated within western and southern parts of the designation, predominantly within 10km with some dispersed visibility between 10km and 15km. Visibility within 10km includes parts of Hare Appletree Fell, Littedale, Caton Moor, Calshaw Fell and Hawthornthwaite Fell. **Viewpoints 3, 4 and 7** are located within the AONB (within 5km) and magnitude of change would range from Moderate to Substantial. The overall magnitude in relation to the composite designation would be Slight leading to a Moderate indirect effect which would not be significant.

6.10.3.3 Effects on Registered Parks and Gardens

Registered Parks and Gardens are designated due to their historical, horticultural, architectural and scenic qualities. Registered Parks and Gardens are assessed below and their sensitivity is considered to be high.

Ashton Memorial Gardens and Williamson Park

These gardens are located approx. 3.5km to the north of the site at the eastern edge of Lancaster and include a memorial feature, Public Park, woodland garden, butterfly house and lakes. Views would be intermittent and subject to screening by mature woodland features within the park and intervening buildings within Lancaster. Considering the park as a whole, the magnitude of change is considered to be slight, leading to a moderate level of effect that would not be significant.

6.10.4 Decommissioning Effects

The details regarding the decommissioning are provided in Chapter 2 of the ES. Decommissioning would entail the removal of all above-ground structures including the wind turbines, crane hard standings, substation and grid connection, and the control building. The wind turbine foundations, site tracks, and underground cables would be left in situ, but in the case of wind turbine foundations and cables, no visible part of these components would remain above ground.

There would be a short term temporary impact associated with the removal of structures during the decommissioning stage of the project, however this would have a minimal landscape and visual effect on the locality and has not been considered further as part of this assessment.

6.11 Assessment of Visual Effects

6.11.1 Introduction

Visual effects are recognised by the Landscape Institute as a subset of landscape effects and are concerned wholly with the effect of the development on views, and the general visual amenity as experienced by people.

Visual effects are assessed by considering the sensitivity of the receptor (people) against the proposed magnitude of change to determine a level of visual effect. In professional landscape terms, the acceptability of this effect largely relates to the activity and the experience of the viewer and the visual composition, character, context, and the overall ability of the landscape in that view to accommodate the development in design terms. Visual effects are assessed in relation to the agreed viewpoints, properties and settlements, tourist and recreational destinations and transport routes.

This section draws on the results of the landscape context, review of the development proposal, viewpoint assessment and field work observations. It considers the potential effects of the proposal on the visual amenity of the following groups of potential receptors:

- Residents and workers - in towns, villages and isolated dwellings;
- Motorists and other road users on A class, B class and minor roads;
- Recreational Receptors and tourist destinations.

6.11.2 Residents – Settlements

The following section of the assessment considers changes and consequent visual effects upon the views available to the residents residing in settlements**.** In accordance with the GLVIA residential receptors in settlements are all considered to be of high visual sensitivity.

For residents of urban areas and scattered villages, the most likely places for visibility would be from the edges of the settlements nearest the proposed turbine. Within these settlements, most views would be partially screened by adjacent dwellings and intervening buildings combined with the screening effect of field boundary trees and woodland cover. There may however be places within these settlements where glimpsed views of the turbines may occur beyond intervening buildings. It is important to note that the magnitude of visual effects arising from the presence of the turbines in views from within the built up areas would be greatly reduced in comparison with those experienced in open views from the edges of settlements, as illustrated in the visualisations.

6.11.2.1 Settlements within 5km

Views of the proposed development would be experienced from individual dwellings and farmsteads in the surrounding area. Due to extreme adverse weather conditions at the time of survey the assessment of individual dwellings, out with settlements and within 2km of the turbines could not be completed and will be submitted in due course as an Addendum to the Environmental Statement. It has been observed that the orientation of dwellings, local topography and intervening vegetation/ structures combine to reduce the potential visibility of the wind turbines. Furthermore initial field survey observations have confirmed that the total number of individual properties where a significant visual effect may be experienced is relatively small compared to the overall population in the surrounding area. Whilst acknowledging that significant effects may arise in the private context, it is considered that the overall change in visual amenity would not be unacceptable, given the separation distance from the proposed turbines and the restricted nature of views from many dwellings.

Lancaster is located approx 1.3km from the wind turbine site and extends approx 5km to the north west. There would be views of the wind turbines at distances of between 1.3km and 4km subject to screening by intervening buildings and woodland within the settlement. Visibility would predominantly be concentrated on the southern and eastern edges of the settlement with turbines visible against the background landscape and sky. **Viewpoint 5** is located at Greyhound Bridge within the centre of Lancaster where there would be no visibility. There would be a Moderate and Substantial magnitude of change from parts of the southern and eastern edges but in terms of the whole settlement the overall magnitude of change would be Slight leading to Moderate level of effect which would not be significant.

Bailrigg is a small hamlet, located approximately 700m north west of the proposals and separated from it by the M6 corridor. There would be views of Turbine 1 from the majority of dwellings in the hamlet, particularly from properties on the northern edge of the settlement in elevated locations (see **Viewpoint 1**). Turbine 1 would be screened from the majority of dwellings by intervening woodland and buildings. The overall magnitude of change would be Substantial and level of effect would be Major and significant.

Galgate is located approx 1.4km to the south west and the village is centred on the A6 and spreads west towards the Lancaster Canal. There would be views of the wind turbines at distances of between 1.4km and 1.6km, with turbines being viewed against the background landscape. **Viewpoint 2** is located at the eastern edge of the settlement and the magnitude change has been adjudged to be Substantial. The overall magnitude of change would be Moderate and level of effect would be Major / Moderate and significant.

Glasson is located approx 4.5km to the south west at the end of Lancaster Canal on the Lune estuary. Views of the wind turbines would consist of two upper turbines visible against the background landscape.

Viewpoint 8 is located at Sunderland Point to west where magnitude of change has been adjudged to be Moderate / Slight. The overall magnitude of change for the settlement would be Slight and level of effect would be Moderate and not significant.

Overton is located approx 5km to the west of the site near the Lune estuary and views would vary from blade tips to upper turbines and viewed against the background landscape due to intervening landform screening. The overall magnitude of change for the settlement would be Slight and level of effect would be Moderate and not significant.

6.11.2.2 Settlements between 5km-10km

Morecambe is situated between 6km and 9km to the north west of the wind turbines between the River Lune and the Lancashire coast. Views would be subject to screening by buildings and vegetation within the settlement and mainly concentrated on southern and eastern edges. The overall magnitude of change for the settlement would be Slight and level of effect would be Moderate and not significant.

Heysham is a coastal town located approx 8km to the north west adjoining Morecambe. Views would be restricted to eastern and southern edges and the overall magnitude of change for the settlement would be Slight and level of effect would be Moderate and not significant.

Middleton is located approx 7km to west of the wind turbines and is located between Overton and Heysham. Views would be subject to intervening screening within farmland and the overall magnitude of change for the settlement would be Slight and level of effect would be Moderate and not significant.

Halton is located to the north east of Lancaster adjacent to the River Lune and there would be views of the wind turbines at 8km distance. Views would be subject to screening by buildings and vegetation within the settlement and mainly concentrated on southern edges. The overall magnitude of change for the settlement would be Negligible and level of effect would be Moderate / Minor and not significant

6.11.2.3 Settlements between 10km - 15km

The visual effects in relation settlements between 10km and 15km would be limited to settlements in the south and south west of the study area including Garstang and Stake Pool. The effects in relation these settlements would be Moderate / Minor and not significant.

6.11.3 Motorists and other road users

The potential significance of visual effects experienced by those travelling on the road network has been considered with reference to the viewpoint analysis and visual survey of key routes. The views from these routes would be experienced transiently by road users and the sensitivity of all of these receptors is considered to be medium. All visibility from roads would be subject to screening levels along routes and within intervening farmland.

6.11.3.1 M6

The M6 is routed through the study area between Catteral in the south and Wharton in the north. Visibility would be predominantly concentrated on the section of motorway between Catteral in the south to Lancaster, with visibility becoming more dispersed between Lancaster and the northern edge of study area. There would be close range views as the motorway runs adjacent to the wind turbines and visibility within 5km would predominantly apply to the section of motorway near the River Wyre in the south and junction 34 near Lancaster. **Viewpoint 6** is located on this route and the magnitude of change has been adjudged to be Moderate. The magnitude of change within the study area would vary between substantial and negligible and the overall magnitude would be slight and level of effect would be Moderate/Minor and not significant

6.11.3.2 A6

The A6 is routed through the study area between Catteral in the south to Bolton Le Sands in the north west. There would be close range views as the route passes the university and widespread visibility within 5km between Brook in the south and southern edge of Lancaster. The visual effects would be broadly contiguous with views from the M6 with the magnitude of change ranging between substantial and negligible. the overall magnitude would be Slight and level of effect would be Moderate/Minor and not significant

6.11.3.3 A588

The A588 is routed through the study area between Knott End on Sea in the south west and Lancaster. Visibility of the wind turbines would predominantly apply to entire section of the route with greatest visibility applying to section of route between Lancaster and Cockerham within 5km. The magnitude of change within the study area would vary between substantial and negligible and the overall magnitude would be Slight and level of effect would be Moderate/Minor and not significant

6.11.3.4 A683

The A683 is routed through the study area between Morecambe in the north west and Hornby in the north east. Visibility would be extremely minimal and apply to section of the route within the settlement Morecambe. The magnitude of change would be Negligible and level of effect would be Minor and not significant.

6.11.3.5 B5272

The B5272 is route through the study area between Cockerham and Garstang to the south west of the wind turbine site. Visibility of the wind turbines would be at distances of between 6km and 11km and the overall magnitude of change would be Slight and level of effect would be Moderate and not significant.

6.11.4 Recreational Receptors Tourist Destinations

There are several long distance footpaths and Sustrans cycle routes within the study area. The visual changes and their consequent effects that would be sustained by the walkers, riders. The assessment of the potential effects on these routes has been assisted by the use of sequential wireframes and ZTV maps.

6.11.4.1 Lancashire Coastal Way

This nationally designated route is a coast to coast long distance footpath between Merseyside and Cumbria which is routed through the study area between Pilling in south west to Carnforth in the north west. The sensitivity of receptors using this route would be high.

Visibility of the wind turbines from this route would be concentrated on the section of the route between Pilling and Ashton Hall at distances between 3km and 15km. The visibility between Aston Hall and Lancaster would be intermittent and subject to potential screening by built features. To north west of Lancaster and Morecambe the visibility would be extremely limited and confined to a small section of the route between Hest Bank and Morecambe at 9km distance. Although there could be significant effects from parts of the route within 5km the overall magnitude of change would be *Slight leading to a Moderate visual effect.*

6.11.4.2 The Wyre Way

This long distance footpath is routed through the study area between Knott End and Abbeystead Reservoir in the south east. The sensitivity of receptors using this route would be high.

Visibility would be concentrated on section of route between Knott End and Garstang at distances of between 15km and Garstang 12km. There would also be visibility on the section of route between Garstang and Scorton (8km). The overall magnitude of change would be Slight *and level of effect would be Moderate and not significant.*

6.11.4.3 Lune Valley Ramble

This extends north east from the centre of Lancaster along River Lune to Kirby Lonsdale. At the closest location to the turbines are approximately 5 km distance within the centre of Lancaster and the overall sensitivity of receptors using this route would be Medium. Visibility would extremely limited within the study area and the overall magnitude of change would be Negligible and level of effect would be Minor.

6.11.4.4 National Cycle Route 6

Is routed through the 15km study area from Catteral in the south to Carnforth in north west, broadly following the route of the Lancashire Coastal Way and the sensitivity of receptors using the route is High. The visibility would be consistent with views from the Lancashire Coastal Way and although there could be significant effects from parts of the route within 5km the overall magnitude of change would be *Slight leading to an Moderate visual effect.*

6.11.4.5 Regional Route 90

The Northern loop of this cycle route is routed through the 15km study area near Fleetwood on Lancashire coast to Carnforth in north west via western parts of the Forest of Bowland. At the closest location the turbines are approximately 1 km distance to the east. The sensitivity of the receptors would predominantly be Medium except within the section of route within the Forest of Bowland AONB where receptor sensitivity would be high. Visibility would be generally concentrated on section route between Piling and Quernmore to the north east of the site. Although there could be significant effects from parts of the route within 5km the overall magnitude of change would be *Slight leading to a Moderate visual effect.*

6.11.4.6 National Cycle Route 69

This path is routed through the study area between Morecambe in the north west to Caton in the north east and receptors are of High sensitivity. Visibility would be concentrated on the section of route within Morecambe where views would screened by built features, the remainder of route would have no visibility coverage. The overall magnitude of change would be Negligible *leading to a Moderate / Minor visual effect.*

6.12 Cumulative Landscape and Visual Effects

6.12.1 Introduction

The cumulative assessment has considered existing, consented and proposed projects where planning applications have been submitted within 20 km of the proposed turbines at Lancaster (See Table 6.6 below and Appendix F, Section 6 Figure 6.08). The Study Area and schemes assessed were agreed in advance with the Local Planning Authority.

Ref	Wind Farm	No. of turbines	Blade tip height (m)	Approx distance from Lancaster Wind Turbines	Landscape Character Area
Operation schemes					
A	Caton Moor	8	100	9 km	Central Bowland Fells (2b)
Consented schemes					

B	Dewlay Cheese	1	126	13 km	Forton-Garstang-Catterall (15e)
In Planning					
C	BT Heysham (Withdrawn Planning Application)	2	110	6.5 km	Heysham Moss (16f)
D	Eagland Hill (Refused Planning Permission)	2	125	12.5 km	North Fyde Mosses (16a)
E	Claughton Moor (Current Undetermined Planning Application)	20	126	9 km	Central Bowland Fells (2b)

Table 6.6 Schemes included in the Cumulative Assessment

The potential composite cumulative effects arising from the construction of Lancaster against a baseline situation consisting of all operational and consented projects. In addition, potential cumulative effects arising from Lancaster are considered assuming that all the projects where applications have been submitted are constructed.

6.12.2 Potential Cumulative Landscape Character Effects

The baseline situation comprises the existing turbines at Caton Moor which are located some 9km north east of the Lancaster site within the Central Bowland Fells LCA. The other baseline project is the consented Dewlay Cheese turbine which lies 13km south of the Lancaster Site within the Forton-Garstang-Catterall LCA. Excluding the Lancaster scheme from consideration it is assessed that there is sufficient distance between Caton Moor and Dewlay Cheese sites for there to be no conjoining of wind farm landscapes and also no conjoining of sub-types. Bringing Lancaster into the equation would not change the overall judgement just expressed and it is considered there is the potential for all sites to co-exist without transformation of landscape type and coalescence of character whether this be at the local or regional scale.

Assuming the prior presence of the other proposals of Heysham, Eagland Hill and Claughton Moor, which are all located within different landscape character types, it is assessed that each wind farm would create a wind farm landscape within approximately 800m of the turbines and a wind farm sub-type of each character area extending approximately 3km from the turbines. It is considered that Lancaster is sufficiently distant from the other proposed schemes and would not give rise to coalescence of sub-types into broader unified sub-types or lead to the establishment of new landscape types over an extensive area so as to cumulatively transform local and regional landscape character. A threshold of change would not be crossed with the addition of the two Lancaster turbines that would transform perceptions to those of a wind farm landscape across the area of the Langthwaite Ridge (7c) and Carnforth-Galgate-Cockerham (12a) LCT's that cover the proposed site and immediate surroundings.

6.12.3 Potential Cumulative Visual Effects

6.12.3.1 Residents

Given the separation distance between Lancaster and Caton Moor and the distribution of settlement it is considered that there is limited potential for significant cumulative effects upon residential amenity. Reference to the combined baseline cumulative ZTV (Appendix F Section B6 Figure 6.09) indicates that potential combined visibility may be available from the western edge of Quernmore on Wyresdale Road and scattered dwellings between the village and Littledale Road to the north east which may give rise to significant cumulative effects from the front and rear of the same dwelling.

Assuming the prior presence of the other proposals of Heysham, Eagland Hill and Claughton Moor, potentially significant cumulative effects on residents would not occur due to the distances between the schemes, however the introduction of the Lancaster turbines would potentially result in cumulative effects with the Heysham scheme from scattered dwellings to the south of Stodday, however the effects would be restricted by the presence of intervening vegetation. Dwellings at Condor Green, Glasson and Overton may also experience views of Heysham or Lancaster, however due to the orientation of dwellings within these settlements views of both proposals are unlikely to be available from the same dwelling.

6.12.3.2 Road Users

Visibility of the baseline schemes of Caton Moor and Dewlay Cheese are experienced from the M6 travelling north and south, however field verification indicates the principal stretch of visibility of the Caton Moor scheme is restricted to a short section of the route in the vicinity of Junction 34. The Dewlay Cheese proposal is potentially visible for longer stretches of the M6 travelling in both directions however the principal cumulative effect with Caton would be sequential. The addition of the Lancaster proposals would reinforce the sequential cumulative effect experienced from the M6 and would increase the magnitude of turbine presence resulting in a significant cumulative effect. It should be noted that combined visibility of Lancaster and the baseline schemes is not predicted apart from the stretch of the M6 within approximately 1km of the site, where the visual effect resulting from the Lancaster turbines would already be significant.

Assuming the prior presence of all other proposals the magnitude of turbine presence would be increased slightly from the M6 with Eagland Hill being seen in combined views with Dewlay Cheese and Claughton Moor seen with the nearby Caton Moor. As described for the baseline situation the addition of the Lancaster turbines would reinforce the sequential cumulative effect experienced from the M6 and would increase the magnitude of turbine presence, resulting in a significant cumulative effect.

Cumulative baseline visual effects from the A6 would be restricted in extent, as whilst the Dewlay Cheese scheme would be visible from parts of the route, visibility of Caton Moor is extremely limited due to intervening landform, vegetation and buildings. Due to the separation distance between Dewlay Cheese and the proposals it is predicted that the addition of the Lancaster turbines, over 13km to the north would not result in any significant sequential cumulative effects and it is predicted that drivers passing Dewlay Cheese would generally not be aware of the Lancaster scheme until the approach to Junction 33, due to intervening vegetation and buildings alongside the route.

Assuming the prior presence of all other proposals the addition of Heysham may result in a slight increase in turbine magnitude in oblique views from the road corridor between Galgate and Lancaster, however the significant visual effects from the route between Junction 33 and the southern edge of Lancaster would primarily arise from the presence of the Lancaster scheme alone and no significant cumulative effects are predicted.

Intermittent visibility of the Heysham scheme and the proposals are predicted to be available from the A683 between Lancaster and Upper Thurnham. Assuming prior presence of all proposals, the primary effect would be oblique views of the Heysham scheme (c.5km W) with the addition of the Lancaster turbines (c.2.5km E) raising the magnitude of turbine presence to a level where significant cumulative effects would occur. These effects would be limited to sections of the route where views to both proposals would not be screened by local woodland cover and it should be noted that due to the orientation of the schemes, combined visibility is not likely to be perceived by motorists or their passengers.

6.12.3.3 Tourism and recreation

Visibility of the baseline schemes would be not be significant cumulatively from the Lune Valley Ramble, National Cycle Route 6, National Cycle Route 69, The Wyre Way and The Lancashire Coastal Way due to intervening landform, vegetation and the location of the routes relative to these schemes. The addition of the Lancaster proposals would not significantly increase the magnitude of turbine presence from these routes and therefore no significant cumulative effects are predicted. Assuming the prior presence of all schemes, cumulative effects are predicted to occur from a limited section of the Lancashire Coastal Way/National Cycle Route 6 in the vicinity of Stodday where the addition of the Lancaster proposals in combination with the Heysham scheme could potentially result in significant cumulative effects for a limited section of the route. Further north on the edge of Lancaster, more extensive views of the Heysham scheme would be available that are predicted to be significant, regardless of the Lancaster proposals.

Visibility of the Caton Moor and Dewlay Cheese proposals from Regional Cycle Route 90 within 5km of the Lancaster Proposals is extremely limited. The addition of the Lancaster proposals whilst resulting in significant visual effects from the route within a radius of approximately 5km, would not result in a significant combined cumulative effect. It is predicted however that sequential cumulative effects would occur between Caton village and the crossing over the M6 to the south. Assuming the prior presence of all proposals, the addition of the Lancaster scheme would reinforce the sequential cumulative effect between Caton and the M6, where the overall magnitude of turbine presence would be increased by the addition of Claughton Moor.

6.13 Residual Effects

In the circumstances that a development would result in an alteration to an environment whose attributes can be quickly recovered, then judgements concerning the significance of effects should be tempered in that light. Landscape and visual effects whether regarded as positive or adverse can be reversed, and following decommissioning there would be no residual effects. A wind turbine proposal should therefore be regarded as a long term reversible addition to the landscape, preserving the choice for future generations as to whether or not to recover what might be regarded as the landscape fabric of today, or continue with clean renewable energy generation.

6.14 Statement of Significance

6.14.1 Introduction

The proposed wind turbines at Lancaster have been designed following the design objectives and principles set out within Chapter 1 and 2 of the ES. The design has been optimised, taking account of the technical, economic and environmental constraints, and has achieved a turbine layout which relates to the scale and landform of the site and its surroundings. The effects on landscape and visual amenity within the surrounding area have been minimised as a result.

6.14.2 Landscape Effects

The turbines are located within two areas of landscape character namely the Langthwaite Ridge (7c) and Cockerham-Galgate-Carnforth 12a landscape areas. There would be no significant direct effects on these landscapes as a result of the wind turbine development. However due to their proximity to the site and associated ZTV coverage there would be significant indirect effects in relation to the Langthwaite Ridge (7c) and Cockerham-Galgate-Carnforth (12a) landscapes.

In respect of other neighbouring landscapes, significant landscapes effects would apply to areas within approx 5km to West Bowland (5i), Bowland Gritstone Fringes (4d), Central Bowland Fells (2b), and High Bowland Plateau (1b) although the composite effects for each of these would not be significant.

The indirect landscape effects in relation to the Forest of Bowland AONB would be similar to effects on some of the landscapes with significant effects associated to areas within 5km and with overall composite effects being Moderate.

6.14.3 Visual Effects

Significant effects would apply to some receptors within the settlements at Bailrigg and Galgate subject to intervening screening levels. In terms of roads significant visual effects would apply to short sections of the M6 and A6 routes where the wind turbines could be viewed at close range, although the overall visual effects in relation to these routes and others within the study area would not be significant.

In terms of recreational routes and footpaths significant effects would apply to parts of Lancashire Coastal Way, National Cycle Route 6 and Regional Route 90 at locations within 5km, although the overall effects on these routes would not be significant.

6.14.4 Cumulative Landscape and Visual Effects

Significant cumulative effects would potentially apply to residents on the western edge of Quernmore on Wyresdale Road and scattered dwellings between the village and Littledale Road to the north east as a

result of the addition of the Lancaster proposals. The Lancaster scheme would reinforce the sequential cumulative effects already experienced from the M6 resulting in significant effects.

Assuming the prior presence of all schemes, cumulative effects are predicted to occur from a limited section of the Lancashire Coastal Way/National Cycle Route 6 in the vicinity of Stodday where the addition of the Lancaster proposals in combination with the Heysham scheme could potentially result in significant cumulative effects for a limited section of the route. Sequential cumulative effects would also occur as a result of the Lancaster proposals from the Regional Cycle Route 90 between Caton village and the M6.

Chapter 7:
Archaeology & Cultural Heritage

7. Archaeology and Cultural Heritage

7.1 Introduction

7.1.1 Introduction

This chapter of the ES quantifies the impact of the development on the historic environment looking specifically at archaeology. Although no listed buildings or scheduled monuments are directly affected by the development the visual impact of the proposal on important listed buildings and scheduled monuments within the surrounding landscape is also appraised.

The desk-based assessment carried out by Oxford Archaeology (OA) North comprised a search of both published and unpublished records held by the Lancashire Historic Environment Record (HER) in Preston, the Lancashire Record Office (LRO) in Preston, and the archives and library held at OA North. In addition to this, a site visit was undertaken on Thursday 24th September 2009, to relate the existing topography and land use with the results of the desk-based assessment (Plates 1-9, in Appendix G section G2). The visit also allowed an understanding of areas of impact by the proposed development, as well as areas of more recent disturbance that may affect the potential for the survival of archaeological deposits

The desk-based assessment was carried out in accordance with the relevant IFA and English Heritage guidelines (Institute for Archaeologists 2008, *Standard and Guidance for Archaeological Desk-based Assessments*; English Heritage 2006, *Management of Research Projects in the Historic Environment* (MoRPHE).

7.1.2 Location Topography and Geology

The study area (centred on NGR SD 4904 5742) is situated to the south of Lancaster, within the parish of Scotforth. Lancaster University's South West Campus lies a short distance to the west, separated from the proposed development area by the north/south aligned M6 motorway, which forms the western boundary of the site. Hazelrigg Lane, which crosses under the motorway, forms the southern boundary of the proposed development area. This lane then curves round to head northwards towards Lancaster, and, to the east of the proposed development area, Hazelrigg Farm is located on the west side of the lane immediately outwith the boundary of the site. A thick band of trees separates the proposed development area from the farm, and further north the area is bounded by farm fields. The north-east portion of the proposed development area is occupied by the University of Lancaster's Meteorological Station (Appendix G, section G3, figure G.1). Blea Tarn reservoir is located a short distance to the north of the proposed site. The river Conder, aligned in this area approximately south-west/north-east is located a short distance to the south of Hazelrigg Lane, and a small stream runs through the eastern side of the proposed site. The area of the proposed site gradually slopes from c 50m AOD at its south end to c 70m AOD at its north end (OS 1974). The fields that occupy the proposed site are currently in use as pasture.

The solid geology of the area consists of mudstones, probably of the Crossdale Mudstone Formation, of the Upper Carboniferous Millstone Grit series, dating to the Namurian geological era, 250 million years ago (Crofts 1992). Overlying the solid geology, the drift geology is essentially boulder clays, laid down approximately 10,000 years ago at the retreat of the last glaciers. The soils of the area belong to the Brickfield Association, which are cambic stagnogleys (Jarvis et al 1984). The resulting landscape is one of mixed arable and pastoral agricultural land.

7.2 Consultation

Lancashire Historic Environment Record (HER): the HER (known formerly as the Sites and Monuments Record), maintained by Lancashire County Council in Preston, holds records of archaeological sites within the county, and is held as both paper and digital information (database and GIS combined). A record, including grid reference and description, was

obtained for the various sites within the defined study area which were then added to a gazetteer (Appendix G Section G1).

Lancashire County Record Office, Preston (LRO): the LRO in Preston was visited to consult historic maps of the study area, including the tithe map and relevant Ordnance Survey (OS) maps. A search was also made for any relevant historical documentation. Several secondary sources and archaeological or historical journals were also consulted, and the results of this have been incorporated into the historical background (Appendix G Section G4).

Oxford Archaeology North: OA North has an extensive archive of secondary sources relevant to the study area, as well as numerous unpublished client reports on work carried out both as OA North and in its former guise of Lancaster University Archaeological Unit (LUAU). These were consulted where necessary.

7.3 Guidance and Legislation

7.3.1 Planning Policy Framework

In order to be able to consider the archaeological potential of the site and the resultant restrictions or requirements for the proposed development, it is necessary to understand the relevant policies, both at a national and local level. For archaeologically and historically significant sites, planning policy at a national level is provided by Planning Policy Guidance Notes (PPGs), the principal national policy guidance being PPG 15: Planning and the Historic Environment, and PPG16: Planning and Archaeology. County level planning policy is provided by the Replacement Joint Lancashire Structure Plan 2001-2016, and local planning policy by the Lancaster District Core Strategy (adopted July 2008) and the Lancaster District Local Plan (adopted 2004). These plans contain specific policies, in accordance with PPG15 and PPG16, with regard to the protection of archaeological and cultural heritage resources.

National Planning Policy: PPG15 (1994) provides a full statement of Government policies for the identification and protection of historic buildings, Conservation Areas and other elements of the historic environment. Developers are encouraged to consult with the local planning authority and other statutory bodies at any early stage for development proposals that may affect historic sites or the built heritage resource, particularly those affecting statutory designated sites (Conservation Areas and Listed Buildings). Sections of particular relevance to the proposed development site are 2.16-2.17 (settings of Listed Buildings). The document provides a range of guidelines to be considered when a proposed development has the potential to affect the built heritage resource.

PPG16 (1990) provides guidance on the protection and preservation of the archaeological resource, in order to secure its long term management. It sees archaeological remains as a “finite and non-renewable resource...vulnerable to damage or destruction”, and sets out the desirability or preservation of archaeological remains and their setting as a material consideration within the planning process. In considering the impact of a proposed development proposal, priority should be paid to any Scheduled sites, though any other unscheduled archaeological remains deemed to be of significance should also be considered. Preservation of the archaeological evidence *in situ* is the preferred solution, or if this is not justified, adequate provision is made for excavation and recording before and during development. It sets out advice on the appropriate management of archaeological matters in the planning process.

7.3.2 Legislative framework

Archaeological sites, including historic buildings, possessing a statutory designation are protected under a legal framework, depending on their category. There are a number of statutory designations used for sites of architectural or historic significance in the UK, which are made depending upon the importance of the site in a local, regional, national or international context. These are detailed below for those relevant to sites in England:

- **World Heritage Sites (WHS):** these are international designations under the UNESCO Convention for the Protection of the World Cultural and Natural Heritage. A site will be

nominated in a list submitted by each country, which is party to the Convention. Although there is no statutory designation in its own right for a World Heritage Site, it is often a combination of other designations that validate the designation. The body responsible for World Heritage Sites is the Department of National Heritage. There are no WHSs within the study area or wider 10km search area.

- **Scheduled Monuments (SM):** the Secretary of State can schedule any building, structure or other work below or above ground which appears to be of national importance due to its historic, architectural, traditional, artistic or archaeological interest, under the Ancient Monuments and Archaeological Areas Act 1979. Any private sector development that may affect it requires consent from the Secretary of State, undertaken through English Heritage (EH) as the responsible body. The schedule differs from Listed Buildings but Scheduled Monuments are equivalent to Grade I and II* Listed Buildings. There are 13 Scheduled Monuments within a 10km radius of the proposed development area, which have been considered in terms of the visual impact of the proposed scheme (Sites **35**-**40**, **43**, **46 48**-**50** and **52**-**53**; Table 7 section 7.5.5). None of these Scheduled Monuments are within the 500m study area.

- **Listed Buildings (LB):** under section I of the Planning (Listed Buildings and Conservation Areas) Act 1990 the Secretary of State for National Heritage is required to compile lists of buildings of special architectural or historic interest on advice from EH. Listed Buildings are classified in grades according to their importance and are afforded protection as a means of planning control. Therefore, such buildings cannot be demolished, altered or extended in a way that would affect its architectural or historic character unless Listed Building Consent has been obtained from the local planning authority. Similarly, unlisted buildings in Conservation Areas are also protected from demolition without consent. The local planning authority would consult EH prior to granting permission for Listed Building Consent or Conservation Area Consent. There are two Grade II Listed Buildings within the 500m study area (Sites **14** and **15**). There are also numerous Listed Buildings within 10km of the proposed development area. Of these, a number have been considered in terms of the visual impact of the proposed scheme (Sites **28**-**32**, **34**, **37**, **39**, **41**-**42**, **44**-**45**, **47** and **50**-**55**; Table 7 section 7.5.5).

- **Conservation Areas:** the local planning authority may designate a section of land or buildings with special architectural or historic interest as a Conservation Area. This is designed to enhance or preserve the character or appearance under section 72 (I) of the Planning (Listed Buildings and Conservation Areas) Act 1990. Although a local designation, a Conservation Area may be of national importance and significant developments may be referred to EH. There are 17 Conservation Areas within 10km of the proposed development area, (Section 7.5.5), but none within the 500m study area.

- **Parks and Gardens of Special Historic Interest (RP):** EH compiles a non-statutory Register of Parks and Gardens of Special Historic Interest to highlight the existence of such areas to highway and planning authorities, and developers, in order that they can be considered for safeguarding during the planning for developments. The grading system used for Listed Buildings applies to parks and gardens. There are two Registered Parks within 10km of the proposed development area (Sites **32** and **33**; Table 7 section 7.7.5), but none within the 500m study area.

- **Historic Battlefield sites:** EH published a non-statutory Register of Historic Battlefields in 1995, in which 43 sites were listed. The sites are not graded, as with parks and gardens, but only those sites that are both important and sufficiently documented to be located on the ground are recorded. In a similar way to the parks and gardens register, the Register of Historic Battlefields is a planning document to highlight sites during the planning process. There are no Historic Battlefield sites within the study area or wider 10km search area.

7.4 Assessment Methodology

The aim of the desk-based assessment is not only to give consideration to the potential for archaeological remains on the development site, but also to put the site into its archaeological and historical context. All statutory and non-statutory sites within a 500m radius of the development site were identified and collated into a gazetteer (Appendix G section G1) and their location plotted on Figure G.2 in Appendix G section G3. The principal sources of information consulted were historical and modern maps of the study area, although published

and unpublished secondary sources were also reviewed. The study has focused on the proposed development area, although information from the immediate environs has been summarised in order to place the results of the assessment into context.

In addition to the 500m study area, a search was also made for Scheduled Monuments, Grade I and Grade II* Listed Buildings, Registered Historic Parks and Gardens, and Conservation Areas within 10km of the proposed scheme (Section 7.5.5). The purpose of this search was to identify sites that may be visually impacted upon by the installation of the wind turbines.

The results of the assessment will identify the significance or potential of the environmental impacts for archaeology, in accordance with the legislative framework. In order to assess adequately the potential impact and resulting residual impacts of the development, a comparative approach to other environmental factors has been employed. These have been adapted from those set out in Guidance on the Methodology for Multi-Modal Studies, DETR (2001) as they prove to be most effective, and increasingly widely accepted, although they were compiled for transport developments. The method of assessment is limited to:

- assessing in detail any impact and the significance of the effects arising from the proposals;
- reviewing the evidence for past impacts that may have affected an archaeological or historical site;
- outlining suitable mitigation measures to avoid, reduce or remedy adverse impacts, including operational impacts.

Such impacts on the identified archaeological or historical sites may be:

- positive or negative;
- short, medium or long term;
- direct or indirect;
- reversible or irreversible.

Key impacts have been identified as those that would potentially lead to a change to the archaeological or historical site significantly outside the existing range of environmental baseline conditions. Each potential impact has been determined as the predicted deviation from the baseline conditions during both the construction and operational phases of the development, in accordance with current knowledge of the site and development.

The impact is assessed in terms of the sensitivity or importance of the site and the magnitude of change or scale of impact during the development. Table 7.1, below, shows the sensitivity of the site scaled in accordance with its relative importance using the following terms for the archaeological or historical issues. However, the magnitude (scale) of an impact is often difficult to define, but will be termed as large, medium, small, and negligible as shown in Table 7.2, below. The methodologies employed for determining the importance of sites and the scale of impact can be summarised as follows:

Importance	Examples of receptor
High	World Heritage Site, Sites of International importance. Scheduled Monuments (SMs), Grade I, II*, and II Listed Buildings, Sites of National importance.
Medium	Conservation Areas, Registered Parks and Gardens (Statutory Designated Sites), Sites of Regional/County importance.
Low	Sites with a local or borough interest. Sites with a borough value or interest for education or cultural appreciation. Sites that are so badly damaged that too little remains to justify inclusion into a higher grade.
Negligible	Sites or features with no significant value or interest. Sites which are so badly damaged that too little remains to justify inclusion into a higher grade.

Table 7.1: Criteria used to determine Importance of Receptors or Sites of Archaeological or Historical Significance.

Magnitude of Impact	Description of Change
Large	Significant change in environmental factors. Complete destruction of the site or feature. Change to the site or feature resulting in a fundamental change in ability to understand and appreciate the resource and its cultural heritage value/historical context and setting, or causing statutory objectives to be exceeded.
Medium	Significant change in environmental factors. Change to the site or feature resulting in an appreciable change in ability to understand and appreciate the resource and its cultural heritage value/historical context and setting.
Small	Change to the site or feature resulting in a small change in our ability to understand and appreciate the resource and its cultural heritage value/historical setting.
Negligible	Negligible change or no material change to the site or feature. No real change in our ability to understand and appreciate the resource and its cultural heritage value/historical context and setting.

Table 7.2: Criteria used to determine Scale of Impact

The interaction of the scale of impact (Table 7.2) and the importance of the receptor (Table 7.1) produce the impact significance (Table 7.3). This is calculated by using the matrix table as shown below:

Magnitude of Change	**Importance of Receptor**			
	High	**Medium**	**Low**	**Negligible**
Large	Large/ Very Large	Moderate/ Large	Moderate/ Slight	Slight
Medium	Moderate/ Large	Moderate	Slight	Slight/ Neutral
Small	Slight/ Moderate	Slight	Slight/ Neutral	Slight/ Neutral
Negligible	Slight	Slight/Neutral	Neutral	None

Table 7.3: Impact Significance Matrix

The effects are categorised according to the established seven-point scale and terminology of Major, Intermediate and Minor Beneficial and Adverse and Neutral effects set out below (Table 7.4).

Nature of Impact
Large beneficial (positive) effect
Moderate beneficial (positive) effect
Slight beneficial (positive) effect
Neutral effect
Slight adverse (negative) effect
Moderate adverse (negative) effect
Large adverse (negative) effect

Table 7.4: Impact Significance Category

The impact significance category for each identified site or feature will also be qualified, providing that recommended mitigation measures will be implemented. Any measures to reduce any impact will be promoted in the report. It is also normal practice to state that impacts above moderate significance are regarded as significant impacts. It is very important that the residual impact assessment takes into consideration the ability of the mitigation to reduce the impact, its likely success and the developer's commitment to this.

It is considered important to attribute a level of confidence by which the predicted impact has been assessed. For the purpose of this assessment, the criteria for these definitions are set out in the table below.

Confidence Level	Description
High	The predicted impact is either certain, i.e. a direct impact, or believed to be very likely to occur, based on reliable information or previous experience.
Low	The predicted impact and its levels are best estimates, generally derived from the experience of the assessor. More information may be needed to improve the level of confidence.

Table 7.5: Impact Prediction Confidence

7.5 Baseline Description

The following section presents a summary of the historical and archaeological background of the general area. This is presented by historical period, and has been compiled in order to place the study area into a wider archaeological context.

Period	Date Range
Palaeolithic	30,000 – 10,000 BC
Mesolithic	10,000 – 4,000 BC
Neolithic	4,000 – 2,200 BC
Bronze Age	2,200 – 700 BC
Iron Age	700 BC – AD 43
Romano-British	AD 43 – AD 410
Early Medieval	AD 410 – AD 1066
Late Medieval	AD 1066 – AD 1540
Post-medieval	AD 1540 – *c*1750
Industrial Period	*c*AD1750 – 1901
Modern	Post-1901

Table 7.6: Summary of British archaeological periods and date ranges

7.5.1 Historical Periods

Prehistoric Period: There is relatively little information about prehistoric activity in North Lancashire which, in part, reflects the minimal amount of work carried out, and partially the paucity of known remains from this period (Middleton et al 1995). Bronze Age cemeteries might be expected to be found in the area, since place-names such as Barrow Greaves (in the southern portion of the study area) and Burrow Heights (c 700m to the west of the study area) are found nearby; however, the latter has produced only finds of Roman date. More substantial evidence comes from a flint scatter revealed at Galgate Allotments in 1978, which is thought to represent Bronze Age occupation (HER 2759), and the discovery of a Bronze Age log boat, found during the construction of Blea Tarn Reservoir (HER 13705). Prehistoric activity has also been recorded in Lancaster, the earliest being a Neolithic Mortlake type bowl at 65 Church Street (Jones and Shotter 1988 207). A Bronze Age palstave was found on Castle Hill and a group of Bronze Age urns were recovered from Lancaster Moor in the mid- to late nineteenth century development of the area (Shotter and White 1990, 5). There is one known site of Bronze

Age date within the study area, the findspot of a bronze axe (Site 12 Appendix G section G1).

In the Iron Age, the area seems to have come under the aegis of the Brigantes (Cunliffe 1991); there are no known remains dating to the Iron Age within the environs of the study area but it is notoriously difficult to identify such sites, in part due to a lack of a distinct material culture (Haselgrove 1996, 64).

Romano-British Period: To the south of the study area, in the vicinity of Galgate, two Roman roads are believed to have met and continued north towards the fort and extramural settlement at Lancaster; one heading north from the industrial site at Walton-le-Dale, and the other heading north-west from the fort at Ribchester (identified by Margary (1973) as 70d and 704 respectively). The road between Galgate and Lancaster has been recorded in two places: at the former Royal Albert Hospital (c 2km north-west of the study area), where an earthwork appears to have survived, although excavations in the area produced ambiguous results (LUAU 2000; 2001); and at Highland Brow (c 800m south-west of the study area and west of the A6), where aerial photographs appear to show a linear mark consistent with a Roman road (Neil 1995b, 16). Burrow Heights has produced Romano-British stone heads, milestones, and a third century AD coin of Claudius II (Shotter 1997).

The finding of a Roman milestone near Caton points to the existence of a road (identified by Margary (1973) as 705) along the south side of the river Lune, and it is presumed that this would connect the main route from Walton-le-Dale (Margary 70d) with the fort at Overburrow to the north-east of Lancaster. This road is thought to have branched off from the main route north in the Scotforth area and followed the high ground to the east of the town before passing to the west of Quernmore and on to Caton (http://www.lancashire.gov.uk/environment/historichighways/roman3.asp). The HER puts the putative route of the Roman road to the east of the proposed development area (Site 13 Appendix G section G1).

In 2003 an archaeological excavation was carried out on land to the south of Barker House Farm (centred at SD 4836 5694, c 580m to the west of the south end of the proposed development area) in advance of the development of Lancaster University's South West Campus access road (OA North 2004). The main focus of the excavation comprised a group of features located on top of a low promontory in the east of the site at 42m AOD, overlooking the river Conder, identified as a late prehistoric/Romano-British farmstead. A combination of a few cultural indicators and radiocarbon dating identified this site as being active in the first to early fourth centuries AD. The main elements comprised the remains of a roundhouse, a circular enclosure, and associated linear arrangements of postholes interpreted as fence lines. The farmstead was bounded by a ditch to the west, beyond which a large water hole was identified. Evaluation trenching identified further apparently Romano-British activity to the north, suggesting the settlement extended northwards beyond the limits of the excavation (ibid).

Medieval period: The majority of the study area lies within Scotforth township, with a small portion in the Ellel township to the south. These areas are mentioned in the Domesday Survey of 1086 as the manors of Scozforde and Ellhale and were adjacent to the manor of Estun (Ashton) (Faull and Stinson 1986). After the Norman Conquest much of the land in Lancashire, including Scozforde and Ellhale was given to Roger de Poitou by William the Conqueror, the lands passing to the Lancaster family some time later (Baines 1891; Farrer and Brownbill 1914, 56-8). Two plough-lands in the manor of Scotforth were subsequently granted by William de Lancaster I (d. c 1170) to Hugh le Norreys, to be held by knight's service. Hugh's daughter, Alice, had a son, Roger, who was a benefactor of Lancaster Priory and Cockersand Abbey. Hugh or Alice also seems to have granted part of the manor to Hugh de Letwell, William de Meluer and Anabil his wife, and others. Parts of these lands were repurchased by Gilbert Fitz Reinfred, the lord of the manor in 1204, but following this the manor appears to have become increasingly divided (ibid).

Documentary sources indicate that 'Long Lands', the name given to a number of the fields in and around the proposed development area on the tithe of 1841 (LRO DRB 1/173), may have been derived from Laundlands, mentioned in the Cockersand

Chartulary, and therefore direct abbey ownership can be traced in the study area (OA North 2004; Farrer and Brownbill 1914, 99).

In addition, Bailrigg, a hamlet within Scotforth, also belonged, at least in part, to Cockersand Abbey. Burrow, Hazelrigg and Hallatrice are mentioned in the abbey records and charters, with Hazelrigg mentioned in 1450, when a William Cave gave four acres of land to a Lambert Stodagh (Farrer and Brownbill 1914, 56-8).

The place-names in the study area provide a topographical rather than historical insight into the area, with Hazelrigg being derived from the Old Norse hesli meaning hazel and hryggr meaning ridge. Bailrigg also has the ridge element, with 'Bail-' being derived from the Old Norse bali, meaning a gentle slope. Ekwall states that the name 'Big Forth' given to a farm to the west of the development area, probably evolved from 'Bigthwaite', which was derived from the Old Norse bygg meaning barley, and thwaite meaning clearing (Ekwall 1922, 173-4).

There are two sites of possible medieval date within the study area: a field system (Site 04 Appendix G section G1); and a field boundary and an area of ridge and furrow (Site **18** Appendix G section G1). In addition, two further sites, a second area of ridge and furrow (Site **17** Appendix G section G1), and the township boundary between Scotforth and Ellel (Site **23** Appendix G section G1) may be medieval in date.

Post-medieval and Industrial Period: an Enclosure Act for Scotforth Moor and Bailrigg Moor was passed in 1806. This was part of the large-scale Parliamentary Enclosure Acts, which took place across Britain in the eighteenth and nineteenth centuries, involving the intake of all available lands around the peripheries of the medieval enclosures. The resultant enclosure map of 1809 (LRO AE/5/11) shows the study area, depicted largely as an area of open moor on Yates' map of 1786 (Appendix G, section G3, figure G3), as partially divided into fields, with new, straight roads crossing it.

The proposed development area appears to have been excluded from the 1806 enclosure, however, as this area is labelled 'The Duke of Hamilton and Brandon' on the map (ibid). The Duke of Hamilton and Brandon held the Ashton Estate at this time, until it was sold to Le Gendre Nicholas Starkie in 1853 (http://www.nationalarchives.gov.uk /a2a/advanced-search.aspx?tab=1). The proposed development area appears to have been sold off before this, however, as on the tithe of 1841 the owner of the now enclosed land is named as 'TA and W Dewhurst' (LRO DRB 1/173).

From the nineteenth century onwards, the principal communication route through the area has been the A6 road, which was part of the Garstang and Heron Syke Trust and was operated as a turnpike. The road dates from after 1786 (Yates 1786), and was shown on a plan of 1815 (Lancaster Library Pl 13/42), indicating that it was in place by that date. The turnpike superseded a medieval road slightly to the east, the 'road to Scotland', shown on Yates' map. This road gave Galgate its name, with 'Gal' deriving from 'Galloway' and 'Gate' from 'gata' meaning ' road', hence 'the road to Scotland' (OA North 2004).

Eighteen sites of probable post-medieval date were identified within the study area and predominantly comprise agricultural features, such as relict boundaries and tracks (Sites **11**, **16**, **20**-**22** and **27** Appendix G section G1), former pits and ponds (Sites **08** and **24**-**25** Appendix G section G1), a ditch and bank (Sites **05** and **06** Appendix G section G1), a cropmark (Site **07** Appendix G section G1), and a former woodland enclosure bank (Site **19**). In addition, a number of settlement sites were identified, including houses and farmhouses (Sites **09**, **14**-**15** and **26** Appendix G section G1), and a former settlement identified as an earthwork and confirmed through documentary research to be post-medieval in date (Site **10** Appendix G section G1). A number of these sites are discussed below in the map regression, which traces the development of the study area over the past 200 years (Section 7.5.2).

Undated and modern: there is one site of modern date within the study area, (Site **01** Appendix G section G1), an unspecified cropmark in the vicinity of the university. Site **03** Appendix G section G1) is an undated earthwork at Barrow Greaves, comprising low earthen banks and Site **02** Appendix G section G1) is an undated former watercourse near Banton House.

7.5.2 Map Regression Analysis

A number of cartographic sources were examined at the LRO, together with some held at OA North's offices. **All Map Extracts are shown in Appendix G section G3 and all sites referenced in this section are shown in Appendix G section G1.**

William Yates' map, 1786 (Fig G.3)

This county map is small scale, and therefore contains a limited amount of information about the area at this time. An area of open moorland is depicted on the north side of the river Conder, and appears to run along a north-east/south-west aligned ridge. To the south of this, a winding road (named 'Bailrigg Road' on the enclosure map of 1809, Fig G.4) is shown from 'Borrough' in the west, to the river Conder in the east. North of this road is a long, narrow clearing, within which is a wood in its south-western portion and an unnamed building, which is likely to be Hazelrigg (Site **26**), on its eastern boundary. The road, which now runs a northward on the east side of Hazelrigg is not depicted. To the south-east of the clearing, 'Bantons' (later Banton House) is depicted, along with an unnamed building to its south-west (Site **10**). To the west of the northern end of the clearing, 'Bigg Ford' (later Big Forth) farm is named, and further to the west the small settlement of Bailrigg is depicted. Ashton Hall is marked a short distance to the west of the study area, with Archibald Hamilton named as the land owner.

Scotforth Moor and Bailrigg Moor Enclosure Award, 1809 (LRO AE/5/11) (Fig G.4):

An Enclosure Act for Scotforth Moor and Bailrigg Moor was passed in 1806. The resultant enclosure map of 1809 shows the former area of moorland now partially divided into fields, with new, straight roads crossing it. Bailrigg Road (shown on Yates' 1786 map) is clearly the boundary (Site **23**) between Scotforth township and the township of Ellel, which is marked to its south. A road, named Galgate Road, heads north from Bailrigg Road, passes to the east of Hazelrigg (Site **26**), and then heads north-eastwards. This road meets a north-west/south-east aligned road to the north of the study area named Scotforth Road. Blea Tarn is depicted to the south-west of this road, with a short stretch of road named Blea Tarn Road depicted on its north-west side. The rectangular clearing shown on Yates' map of 1786 is still depicted on this map, and is labelled 'Hazelrigg. The Duke of Hamilton and Brandon'. This therefore indicates that the proposed development area, which is mostly contained within this clearing, was part of the lands owned by the Duke of Hamilton and Brandon of Ashton Hall. As such, it appears to have been excluded from the parliamentary enclosure. Two buildings are depicted in the area of Hazelrigg (Site **26**) on the eastern boundary of the clearing.

Hennet's map, 1830 (Fig 5): as with Yates' 1786 map, this map is a small-scale county map and is limited in detail. It has less detail than the enclosure map of 1809, as it does not show field boundaries. However, it does show two bands of north/south aligned woodland, which are still largely extant today. Hazelrigg (Site **26**) is named, and as with the enclosure map of 1809, is depicted as two buildings.

Scotforth Tithe Map, 1841 (LRO DRB 1/173) (Fig G.6): this map shows that the proposed development area had been divided into fields by this time. The majority of these field boundaries are still extant, but four field boundaries which have subsequently been removed were added to the gazetteer as a result of consulting the tithe map (Sites **20**-**22** and **27**). The owners of the land are listed as 'TA and W Dewhurst', indicating that it was no longer part of the Duke of Hamilton and Brandon's land. The occupier of the land is listed as 'WJ Redmayne'. The names of the fields are all variations on 'Old Lands' or 'Long Lands'. The use of the fields (e.g. pasture, arable) was not given. Hazelrigg (Site **26**) is depicted as a group of three buildings, and a track heads north-westwards from the farm through the woodland to these fields. A group of three ponds or pits (Site **25**) is shown within the proposed development area, immediately east of the western band of woodland. A pond or pit (Site **24**) is also shown in the north-eastern corner of the proposed development area and there is a further pond or pit to the north of the proposed development area (Site **08**).

Ordnance Survey, First Edition, 6" to 1 mile, 1847 (Fig G.7): this map is fairly similar to the tithe map. Some changes have taken place at Hazelrigg, with modifications and additions to the buildings depicted on the tithe and two new buildings depicted on the opposite side of the road. The group of three ponds within the proposed development area (Site **25**) is not depicted on this map, but the pond or pit in the north-east corner of the proposed development area (Site **24**) is depicted, and that to the north is labelled 'pit' (Site **08**).

Ordnance Survey First Edition, 25" to 1 mile, 1895 (Fig G.8): this map shows few changes from the 1847 OS map. The buildings at the farm at Hazelrigg (Site **26**) have again been altered. The pit to the north of the proposed development area (Site **08**) is labelled 'old clay pit' and is surrounded by trees. Trees are also shown within hollows in the area of the three ponds or pits (Site **25**) depicted on the tithe map of 1841.

Ordnance Survey, 25" to 1 mile, 1912 (Fig G.9): some further changes to the ponds/pits in the vicinity of the proposed development area had taken place by the time of this mapping. The old clay pit (Site **08**) is depicted as further planted with trees, and enclosed within a boundary. The pond/pit (Site **24**) in the north-east corner of the proposed development area has also been enclosed within a circular boundary, and planted with trees. The three pits/ponds shown on the tithe of 1841 (Site **25**) and depicted as planted with trees on the 1895 OS map, are again cleared and shown as hollows or possibly ponds.

Ordnance Survey, 25" to 1 mile, 1932 (Fig G.10): this map is very similar to the 1912 map. The northernmost two ponds within the group of three (Site **25**) are now shown as enclosed, and this area adjoins the wood to its west.

Ordnance Survey, 6" to 1 mile, 1955 (Fig G.11): no significant changes to the proposed development area since the 1932 map are shown on this mapping.

Ordnance Survey, 6" to 1 mile, 1973 (Fig G.12): the M6 had been constructed by the time of this mapping, and is shown cutting through the woodland on the west side of the proposed development area. The route of the Bailrigg road to the south of the proposed development area was changed as a result. A new stretch of road, which takes a direct route under the motorway is shown to the south of a portion of the original road, and forms the southern boundary of the proposed development area. The original road (Site **23**) is depicted as a short stretch of track leading into the fields on either side of it. The buildings at Hazelrigg (Site **26**) have been further altered, and a new building to the south-west on the opposite side of the road is labelled Eastrigg. In the north-east portion of the proposed development area a track leads to a construction which is labelled 'Met Station (University of Lancaster)', and the field boundary shown in this area from the 1841 tithe onwards (Site **27**) has been removed. There are no significant changes within the proposed development area.

7.5.3 Aerial Photographs

1960s and recent aerial photograph coverage (http://www.mario. lancashire.gov.uk/ and Google Earth): vertical black and white photographs from the 1960s, that covered the whole of the proposed development area, were consulted along with present day photographs available from Google Earth. No features were added to the gazetteer as a result of consulting the aerial photographs.

7.5.4 Previous Archaeological Work

LUAU 1993: the North Western Ethylene Pipeline was constructed to the immediate east of the proposed development area in 1991. A programme of archaeological works was carried out in advance of the pipeline, and four of the sites in the study area gazetteer are a result of this work (Sites 10 and 16-18 Appendix G section G1). Site 10 is the site of a post-medieval settlement; Site 16 is a cobbled track and former field boundary; and Sites 17 and 18 are areas of medieval/post-medieval ridge and furrow.

Neil 1995a: three sites in the gazetteer were identified during the assessment phase of the archaeological work in advance of the University extension (Sites 04-06 Appendix G section G1). Site 04 is a medieval field system, Site 05 is a ditch or culvert and Site 06 is an embankment associated with Site 05.

OA North 2004: in 2003 an archaeological excavation was carried out on land to the south of Barker House Farm (centred at SD 4836 5694) in advance of the development of Lancaster University's South West Campus access road. The work was informed by an archaeological desk-based assessment of the overall site, undertaken by Nigel Neil in December 1995 (Neil 1995a; 1995b), followed by a programme of trial trenching in June and July 2002 (OA North 2002), across the extent of the proposed South West Campus development area. Further evaluation work was carried out by OA North in November 2002 in the south-west of the development area, targeting apparent Romano-British activity revealed in the initial trial trenching, which culminated in the final evaluation stage in March 2003 (OA North 2003), centred on a ring ditch initially highlighted by a geophysical survey undertaken by GSB

Prospection (GSB 2002). The western end of the proposed South West Campus access road was scheduled to cross these remains, and thus a programme of full excavation was instigated within its boundaries, carried out by OA North between July and August 2003.

The main focus of the excavation comprised a group of features located on top of a low promontory in the east of the site at 42m AOD, overlooking the river Conder, identified as a late prehistoric/Romano-British farmstead. A combination of a few cultural indicators and radiocarbon dating identified this site as being active in the first to early fourth centuries AD. The main elements comprised the remains of a roundhouse, a circular enclosure, and associated linear arrangements of postholes interpreted as fence lines. The farmstead was bound by a ditch to the west, beyond which a large water hole was identified. The evaluation identified further apparently Romano-British activity to the north, suggesting the settlement extended northwards beyond the limits of the excavation.

7.5.5 Designation

Full details of the Landscape and Visual Impact Assessment are provided in Chapter 6 of the ES. This assessment established a Zone of Theoretical Visibility (ZTV) within a 15km radius of the proposed site. This ZTV only takes ground level and topography into account and, therefore, existing screening from features, such as bands of trees or the built environment, is not considered; as such, the ZTV presents a worst-case scenario.

In order to consider the visual impact of the proposed scheme on statutorily protected cultural heritage sites, a list was compiled during initial stages of the desk-based assessment of potentially impacted sites within 10km of the scheme (Sites **28**-**55** Appendix G section G1 and Table 7.7 below), in order to enable their inclusion in the landscape and visual impact assessment. This included all Scheduled Monuments and Registered Historic Parks, and a selection of Grade I and II* Listed Buildings. Two Grade II Listed Buildings that were included in the gazetteer of sites for the study area (Appendix G section G1) were also included (Sites **14** and **15**). The consideration of these sites at this early stage also allowed for the cultural heritage site locations to be a factor in deciding representative viewpoints within a 10km radius area for photomontages; a photomontage being a superimposition of a rendered, photorealistic, computer generated model of the wind turbines onto a baseline photograph. This provides a predicted impact of the proposed scheme on the viewpoint in terms of the scale of change of the baseline view.

The results of the a landscape and visual impact assessment on the cultural heritage sites within a 10km radius is provided in Table 7.7, and shown in Appendix G, section G3, figure G.13 (reference is made to Appendix F section F6 of the landscape and visual assessment). In addition, the cumulative impact of the proposed scheme, when considered alongside other wind farm sites in the area, has also been assessed and is discussed in Section 7.9.2

Scheduled Monuments (SM)/Listed Buildings (LB)/Registered Parks (RP)					
Site no	**Type/ Ref no**	**NGR**	**Brief description**	**Approx. distance from T sites**	**Assessment of impact on setting (Figs. in Appendix F)**
14	LB II 16370	348610 458215	Bailrigg Farmhouse, Bailrigg	0.4km to NW	Within the ZTV for the blade tips and nacelle of Turbine 1 (see Fig 6.04, 6.05 and Viewpoint 1 - Figs 6.11 and 6.12)
15	LB II 25752	348494 457936	Bailrigg House, Bailrigg Lane	0.4km to W	Within the ZTV for the blade tips and nacelle of Turbine 1 (see Fig 6.04, 6.05 and Viewpoint 1 - Figs 6.11 and 6.12)
28	LB II* 182149	348611 455801	Church of St Mary, Ellel	4km to SSW	Within the ZTV for the blade tips and nacelle (see Fig 6.04, 6.05 and Viewpoint 2 - Figs

					6.13 and 6.14)
29	LB II* 383042	347660 460082	Royal Albert Hospital, Lancaster	2.5km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
30	LB I 182256 LB II* 182257	346130 457290	Ashton Hall, Lancaster Ashton Hall Gatehouse	2.75km to W	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
31	LB II* 383038	347670 460701	Chapel at Ripley St Thomas School, Ashton Road, Lancaster	3km to NNW	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
32	LB I 383350 RP II 1939	348894 461318	Ashton Memorial, Williamson Park, Lancaster Williamson Park	3.5km to N	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
33	RP II 5008	349200 461876	Lancaster Cemetery	3.6km to N	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
34	LB II* 383289	349253 461512	Moor Hospital, Quernmore Road	3.6km to N	Within the ZTV for the blade tips and possibly also for the nacelle (see Fig 6.04 and 6.05)
35	SM LA168	352100 459300	Roman kilns, 20m north-east of Fairyhill Cottage, Lancaster	4km to NE	Within the ZTV for the blade tips and nacelle (see Fig 6.04, 6.05 and Viewpoint 4 - Figs 6.17 and 6.18)
36	SM 34978	347480 461779	Glass melting and annealing workshop, part of Shrigley and Hunt's stained glass manufacturing workshop, Lancaster	4.1km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
37	SM 34987 LB I 383260 LB I 383090	347400 462000	Part of Roman fort and *vicus* and remains of a pre-Conquest monastery and Benedictine Priory on Castle Hill, Lancaster Priory Castle	4.3km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
38	SM LA169	344300 456200	Glasson Dock	4.5km to WSW	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
39	SM LA43 LBII*	347900 462300	Skerton Bridge, Lancaster	4.5km to NNW	No impact - the wind turbines will not be visible from this area (see Viewpoint 5 - Fig 6.19)
40	SM 13463	352048 453621	Castle Hill Motte, Dolphinhome	5km to SE	No impact - the wind turbines will not be visible from this area
41	LB II* 182195	344046 457576	Church of St Helen, Overton	5km to W	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
42	LB II* 182240	351652	Quernmore Park, Lancaster	5.5km to NE	No impact - the wind turbines will not be

		462767			visible from this area
43	SM 23760	352723 462390	Askew Heights univallate prehistoric defended enclosure and holloway	5.8km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
44	LB II* 182131	346257 451863	Church of St Michael, Cockerham	6km to SW	Within the ZTV for the blade tips and possibly also for the nacelle (see Fig 6.04 and 6.05)
45	LB I 181858	348417 463917	Lune Aqueduct, Caton Road	6km to N	The northern part of this area is within the ZTV for the blade tips and nacelle (see Fig 6.04 and 6.05)
46	SM 23742	349800 464700	High Cross in St Wilfred's Church, Halton	6.8km to NNE	No impact - the wind turbines will not be visible from this area (see Viewpoint 10 - Figs 6.28 and 6.29)
47	LB II* 182080	353253 463324	Gresgarth Hall, Caton with Littledale	6.8km to NE	No impact - the wind turbines will not be visible from this area
48	SM 13410	349966 464816	Castle Hill Motte and Bailey, Halton	7km to NNE	Within the ZTV for the blade tips (see Fig 6.04 and 6.05)
49	SM 23715	345968 464250	Torrisholme Bowl Barrow	7km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04, 6.05 and Viewpoint 9 - Figs 6.26 and 6.27)
50	SM 27844 LB I 182270	342713 453754	Cockersand Premonstratensian Abbey The Chapter House, Cockersand Abbey	7km to SW	Within the ZTV for the blade tips and nacelle (see Fig 6.04,6.05)
51	LB II* 182077	354217 464607	Church of St Paul, Caton Green Road	8.5km to NE	No impact - the wind turbines will not be visible from this area
52	SM 23760 LB I 391836	341057 461616	High Cross in St Peter's Church, Heysham St Peter's Church	8.6km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04,6.05)
53	SM 34983/ LB 391833 LB I 391834	340900 461600	St Patrick's Chapel and Cemetery, Heysham Rock-cut tombs	8.8km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04,6.05)
54	LB II* 391854	342815 464380	Midland Hotel, Morecambe	8.8km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04,6.05)
55	LB II* 391842	343098 464383	Winter Gardens, Morecambe	8.8km to NW	Within the ZTV for the blade tips and nacelle (see Fig 6.04,6.05

Table 7.7: Designated sites considered for visual impact

In addition to the Scheduled Monuments, Listed Buildings and Registered Parks there are numerous Conservation Areas within a 10km radius of the proposed development area. The city of Lancaster has six Conservation Areas, comprising Lancaster Castle, Williamson Park, Westfield Memorial Village, Lancaster City Centre, Aldcliffe Road and Greaves Road. Greaves Road is the nearest Conservation Area to the proposed development area, being located *c* 2.6km to the north-north-west. Each of these areas is within the ZTV for the turbines' blade tips and nacelle (Appendix F section F6, Fig 6.04 and 6.05).

In the surrounding areas there are a further eleven Conservation Areas, comprising Slyne with Hest, Halton, Brookhouse, Morecambe, Overton, West End Morecambe, Heysham, Sunderland Point, Glasson Dock, Dolphinholme and Scorton. The turbines would not be at all visible from Dolphinholme or Brookhouse, and only some areas of the Heysham and Halton Conservation Areas are within the ZTV for the turbines' blade tips and nacelle (Appendix F section F6 Fig 6.04 and 6.05). There are numerous Listed Buildings located within these Conservation Areas, including some of the buildings listed in Table 7.

Overall, the assessment found that, of the 30 sites considered, 24 may be visually impacted by the proposed scheme and, of the 17 Conservation Areas, 15 may be visually impacted. This is based on a worst-case scenario (see Appendix F section F6), however, and there may be additional screening between some of the sites and the proposed wind turbines, such as buildings and bands of trees (particularly in the summer months). With the exception of the two Grade II Listed Buildings within the study area (Sites **14** and **15** Appendix G section G1), none of the sites or Conservation Areas are closer than 2.5km to the proposed scheme. This suggests that the presence of the wind turbines in the landscape will be part of a wider view from these areas, rather than being a dominant feature (e.g. see Viewpoint 9, 2.3km from the proposed scheme, - Appendix F, section F6 Figs 6.17 and 6.18).

7.5.6 Site Visit

All Plates and Sites referred to below are contained within Appendix G sections G2 andG3.

A site visit was undertaken on Thursday 24th September 2009 (Plates 1-9, Appendix G section G2). For ease of reference the fields within the proposed development area were labelled A-E (Appendix G section G3, figure G2). Field A (Plate 1) is located on the south side of the former Bailrigg Road, which is now a track with access to Fields A, B and D. Field B (Plate 2) was located on the east side of this track, and further east was Field C (Plate 3), separated from Field B by a narrow stream (Plate 4). The southern portion of the stream marked the boundary between the townships of Scotforth to the north and Ellel to the south on the enclosure map of 1809 (Site **23**). This stream continues northwards, and marks the eastern side of the proposed development area. Field D (Plate 5), to the north of Field B, is bounded to the west and east by woodland. On the west side of the wood, at its southern end, the south and east sides of an enclosure were noted (Site **19**) (Plates 6 and 7). The enclosure comprises low earthen mounds, *c* 0.4m in height and *c* 1m in width. The southern bank measures *c* 30m in length and the eastern boundary *c* 20m. The present-day southern extent of the woodland is now bounded *c* 20m to the north of this enclosure by a post and wire fence. The mature tree located along the banks, and within the area they enclose suggests that the wood once extended as far as these banks. Towards the northern extent of Field D an area of woodland projects eastwards into the field. This is the area of two of the three former ponds noted on the 1841 tithe map (Site **25**). No sign of the third pond was noted. The northern part of the proposed development area is occupied by Field E (Plate 8), although two parallel post and wire fences demarcate a separate area in the north-east corner of this field (Plate 9). This double fence follows the line of the eastern portion of former field boundary Site **20** and the northern portion of the former field boundary Site **21**, and pairs of gateposts were noted in the south-west corner of this fenced-off area, and further north along the line of the north/south fence.

7.6 Information Gaps

7.6.1 Data source limitation:

The limitations of data have been considered during this assessment, which comprises a desk-based assessment supported by a site visit. Generally, information held by public data sources is usually considered to be reliable. Certain limitations should, however, be borne in mind:

- The HER can be limited because it depends on random opportunities for research, fieldwork and discovery. There can often be a lack of dating evidence for sites;
- The usefulness of aerial photographs depends upon geology, land use and weather conditions when the photographs were taken. Some types of remains do not produce crop, soil or vegetation marks. Aerial photographs necessarily involve some subjective interpretation of the nature of sites;
- Documentary sources are rare prior to the medieval period, and many historic documents are inherently biased; and primary sources, especially older records, often fail to accurately locate sites and can be subjective in any interpretation;
- The conditions and circumstances of the visual inspection were governed by the weather, access restrictions, and health and safety concerns that meant not all sites listed on the HER or identified during the desk-based assessment were visited and that potential previously unknown sites were not identified.

7.6.2 Limitations of the Impact Assessment:

Due to the nature of the data sources' limitations identified above (it is possible that previously unrecorded archaeological sites will survive within the study area. There is, therefore, an element of uncertainty over the nature, frequency and extent of the archaeological resource surviving within the study area that may be impacted upon by the installation of the wind turbines. Grading of archaeological sensitivity and significance of impact may therefore be revised following further evaluation and assessment.

7.7 Assessment of Potential Effects

7.7.1 Introduction

Twenty-seven sites have been identified within the study area, these are identified in Appendix G section G1. Sites 01-18 were identified from the HER, two of which were Grade II Listed (Sites 14 and 15). One site was identified during the site visit (Site 19), and the remaining eight sites (Sites 20-27) were identified during the map regression.

Period	No of Sites	Site Type
Prehistoric	1	Bronze axe findspot (**12**)
Romano-British	1	Road (**13**)
Medieval	4	Field system (**04**), ridge and furrow and a field boundary (**18**). Possible medieval or post-medieval sites: ridge and furrow (**17**), township boundary (**23**)
Post-medieval / Industrial Period	18	Ponds/pits (**08** and **24**-**25**), former field boundaries and tracks (**16**, **20**-**22** and **27**), a ditch/culvert and associated embankment (**05** and **06**), a cropmark (**07**), two farmsteads (**09** and **26**), a former settlement site (**10**), a former orchard boundary (**11**), a Listed farmhouse (**14**), a Listed house (**15**), and a banked enclosure (**19**)
Modern	1	Cropmark (**01**)
Undated	2	Watercourse (**02**), enclosure (**03**)

Table 7.8: Number of sites by period

7.7.2. Importance of Gazetteer Sites

Using the criteria outlined in Table 7.1, each of the sites listed in the gazetteer, Appendix G section G1 has been assessed for importance as a site of archaeological interest. Sites 14, and 15 are considered to be of *high importance*, due to their Grade II listed status. Sites 03-04, 09-10, 12-13, 17–18 and 26 are rated as being of *medium importance*, as they are or have the potential to be of county or regional interest. The remaining sites (Sites 01-02, 05-08, 11, 16, 19-25 and 27) comprise features related to the post-medieval local agricultural use and land management of the area and, therefore, are considered to be of *low* importance.

Site name	Site no.	Importance
Cropmark, Lancaster University	01	Low
Watercourse, near Banton House, Hazelrigg Lane	02	Low
Enclosure, Barrow Greaves, Ellel	03	Medium
Field system, Thorney Fall	04	Medium
Ditch/culvert, Green Lane and Thorney Fall	05	Low
Embankment, Green Lane	06	Low
Cropmark, Blea Tarn Farm, Hazelrigg Lane	07	Low
Pit, Bailrigg	08	Low
Farmstead and well, near Banton House, Hazelrigg Lane	09	Medium
Building platform, south of Eastrigg, off Hazelrigg Lane	10	Medium
Boundary, Banton House, Hazelrigg Lane	11	Low
Findspot, Banton House Farm, Hazelrigg Lane	12	Medium
Lancaster to Overburrow Roman road	13	Medium
Bailrigg Farmhouse	14	High
Bailrigg House, Bailrigg Lane	15	High
Cobbled trackway and field boundary, south-west of Blea Tarn	16	Low
Ridge and furrow, between Barrow Greave and Higher Kit Brow	17	Medium
Field boundary and ridge and furrow, west of Higher Kit Brow	18	Medium
Banked enclosure, south-west of Hazelrigg	19	Low
Former Field Boundary, north-west of Hazelrigg	20	Low
Former Field Boundary, north-west of Hazelrigg	21	Low
Former Field Boundary, south of Hazelrigg	22	Low

Boundary between Scotforth and Ellel townships	23	Low
Former Pit/Pond, north of Hazelrigg	24	Low
Three Former Pits/Ponds, west of Hazelrigg	25	Low
Hazelrigg Farm	26	Medium
Former Field Boundary, north of Hazelrigg	27	Low

Table 7.9: Assessment of the importance of each site identified in the gazetteer

7.7.3 Potential Effects

Following on from the assessment of the importance of sites of archaeological interest detailed in Section 7.7.2, the significance of impact during construction has been determined, based on the knowledge of the proposed development and the present condition of the archaeologically and historically significant sites. If proposed activities and processes are to change in the future, then the table will be further review. This assessment of impact is dependent upon adherence to the recommendations for mitigation (Section 7.8).

The proposed development consists of two wind turbines that will have a mast height of 59m, and a maximum ground to tip height of 101m. Turbine 1 would be located at NGR 349175 457789, and Turbine 2 at NGR 349093 457073. Ancillary development will comprise a crane hard standing; an access track leading to the site and between the turbines; underground electrical cables; and a temporary construction compound. It is currently proposed to house the new transformer unit and switch gear within the base of the turbine towers, removing the need for a standalone control building at the site.

The turbines will be supported on reinforced concrete foundations measuring approximately 15m by 15m, with an overall depth of 3m. The crane hard standings will be approximately 20m wide by 40m long. A temporary site compound will be required during the construction phase of the project. The location of this compound is shown in Appendix B Section G2 and will provide site offices, welfare facilities, a materials storage compound, and a parking area. The compound will be removed and the land reinstated to its former condition once the construction phase has been completed.

The scheme is designed with an operational life of 25 years. When the scheme ceases operation, all major equipment would be removed from site. The upper sections of the foundation structures would be removed to below ground level and the area would be reinstated to pasture. Underground cables would be left in place as removing them would cause unnecessary environmental disturbance.

Construction Phase - Direct Impacts: five of the archaeological sites identified within the study area could be impacted by the groundworks during the construction of the wind turbines (Sites 13, 20, 22, 23 and 27 Appendix G section G1). Sites 20 and 22 and 27, former field boundaries, and Site 23 the route of a township boundary, are considered to be of *low importance*. As these sites are linear in nature it is likely that any impact on them would be partial, and therefore the magnitude of impact has been considered to be *small*. Site 13 is the putative route of a Roman road and is considered to be of *medium importance*. The route of the road through this area is unknown, and therefore the potential impact of the proposed development remains uncertain. In addition, excavations to the immediate west of the study area uncovered the remains of a Romano-British settlement site in 2003. The proximity of this site to the proposed development area, and the similarities in topography (e.g. low lying and between 300-400m from the north bank of the river Conder) of the two sites suggests that there is some potential for further Romano-British archaeological remains to be uncovered at the proposed development area.

Construction Phase - Indirect Impacts: two Grade II Listed Buildings within the study area will be visually impacted by the installation of the wind turbines (Sites 14 and 15 Appendix G section G1). In addition, of 28 statutorily protected sites within a 10km radius of the proposed scheme sites considered, 22 may be visually impacted and of the 17 Conservation Areas within a 10km radius of the proposed scheme, 15 may be visually impacted (Section 7.5.5, Table 7.7). These sites are all considered to be of high importance, but as the impact of the proposed scheme on them would be indirect and temporary, the magnitude of impact has been considered to be *small*.

Operational Phase - Direct Impacts: no further direct impacts during the operational phase of the scheme are anticipated.

Operational Phase - Indirect Impacts: the indirect impacts of the proposed scheme during its operational phase are considered to be the same as for the construction phase.

Decommissioning Stage - Direct Impacts: unless groundworks are required in previously undisturbed areas, no further direct impacts during the decommissioning phase of the scheme are anticipated.

Decommissioning Stage - Indirect Impacts: no further indirect impacts during the decommissioning phase of the scheme are anticipated.

7.7.4 Table of predicted direct and indirect impact.

Site no	Nature of Impact	Importance	Magnitude of Impact	Significance of Impact	Confidence Level
01	No impact	Low	Negligible	Neutral	High
02	No impact	Low	Negligible	Neutral	High
03	No impact	Medium	Negligible	Neutral	High
04	No impact	Medium	Negligible	Neutral	High
05	No impact	Low	Negligible	Neutral	High
06	No impact	Low	Negligible	Neutral	High
07	No impact	Low	Negligible	Neutral	High
08	No impact	Low	Negligible	Neutral	High
09	No impact	Medium	Negligible	Neutral	High
10	No impact	Medium	Negligible	Neutral	High
11	No impact	Low	Negligible	Neutral	High
12	No impact	Medium	Negligible	Neutral	High
13	The route of the Roman road is uncertain. There is therefore a possibility that it lies within the proposed development area, and could be impacted by groundworks.	Medium	Uncertain	Uncertain	Low
14	Possible visual impact	High	Small	Slight/ Moderate	High
15	Possible visual impact	High	Small	Slight/ Moderate	High
16	No impact	Low	Negligible	Neutral	High
17	No impact	Medium	Negligible	Neutral	High
18	No impact	Medium	Negligible	Neutral	High

Site no	Nature of Impact	Importance	Magnitude of Impact	Significance of Impact	Confidence Level
19	No impact	Low	Negligible	None	High
20	Possible impact by groundworks	Low	Small	Slight/ neutral	High
21	No impact	Low	Negligible	None	High
22	Possible impact by groundworks	Low	Small	Slight/ neutral	High
23	Possible impact by groundworks	Low	Small	Slight/ neutral	High
24	No impact	Low	Negligible	None	High
25	No impact	Low	Negligible	None	High
26	No impact	Medium	Negligible	Neutral	High
27	Possible impact by groundworks	Low	Small	Slight/ neutral	High

Table 7.10: Assessment of the impact significance on each gazetteer site during construction

7.8 Mitigation

In terms of the requirement for further archaeological investigation and mitigation, it is necessary to consider only those sites that will be directly affected by the proposed development. Current legislation draws a distinction between archaeological remains of national importance and other remains considered to be of lesser significance. Those perceived to be of national importance may require preservation *in situ*, whilst those of lesser significance may undergo preservation by record.

Given the potential for Romano-British remains within the proposed development area, and the possibility that the Roman road crosses through this area, a phased programme of iterative archaeological works will be undertaken in order to inform a suitable mitigation strategy.

In the first instance, the proposed development area will be the subject of a geophysical survey to be completed early in January 2010. This may be followed by a programme of targeted trial trenching based on the geophysical survey results. The methodology for this programme of works should be agreed in advance with the Lancashire County Archaeology Service (LCAS). A mitigation strategy for any required further works (e.g. preservation of significant remains in situ, archaeological excavation in advance of construction, or a watching brief during construction) would be prepared on the basis of the results of the initial evaluation work (geophysical survey and trial trenching) and agreed with LCAS.

7.9 Residual Effects

7.9.1 Introduction

The residual impacts of the proposed scheme on the cultural heritage and archaeology are:

- Permanent and negative, where archaeological remains cannot be preserved *in situ*. However, any such excavated archaeological remains will be preserved by archaeological record resulting from the implemented programme of iterative works, which will inform a mitigation strategy. As a residual effect, this will have a beneficial impact as they will contribute to the archaeological and historical knowledge of the area;
- Long-term, where visual impact on the setting of cultural heritage sites is concerned.

The residual effects of each of the sites considered to be potentially impacted by the proposed scheme are outlined in Table 7.11 below. The significance of the effects is given based on the assumption that the proposed mitigation outlined in Section 7.8 is carried out in full. The proposed

scheme has been considered to have a *slight adverse* residual effect on four of the potentially directly impacted sites (Sites 20, 22, 23 and 27 Appendix G sections G1). However, each of the sites is considered to be of *low importance*, and the impact on them would be partial. The impact of the proposed scheme on the putative route of a Roman road (Site 13 Appendix G section G1) is uncertain and the residual impact is, therefore, also considered to be *uncertain*. In addition, there is some potential for previously unknown Romano-British remains to be discovered within the proposed development area. Recommendations have therefore been made for a programme of further evaluation works, comprising geophysical survey and trial trenching in the first instance, in the areas that will be disturbed by the proposed groundworks. Mitigation by design, resulting in the preservation *in situ* of any archaeological remains within these areas would be the preferred option. However, if any areas of archaeological interest are unavoidable, any excavated remains will be preserved by archaeological record, which would have a *slight beneficial* impact as this would add to the archaeological understanding of the area.

The proposed scheme has also been considered to have a *slight adverse* residual effect on two of the potentially indirectly impacted sites (Sites 14 and 15 Appendix G section G1), as well as a number of statutorily protected sites within a 10km radius of the proposed scheme (Section 7.5.5 Table 7.7). However, as this impact is visual it will only impact the sites for as long as the turbines are operational.

Site no	Description of Effect	Residual Effects	
		Duration	**Significance**
13	Potential disturbance of archaeological remains	Permanent	Uncertain
14	Potential visual impact on Grade II Listed Building	Long term - operational phase of wind turbines	Slight adverse effect
15	Potential visual impact on Grade II Listed Building	Long term - operational phase of wind turbines	Slight adverse effect
20	Potential disturbance of archaeological remains	Permanent	Slight adverse effect
22	Potential disturbance of archaeological remains	Permanent	Slight adverse effect
23	Potential disturbance of archaeological remains	Permanent	Slight adverse effect
27	Potential disturbance of archaeological remains	Permanent	Slight adverse effect

Table 7.11: Summary of the residual effects

7.9.2 Cumulative Effects

The 24 statutorily protected sites within the ZTV of the proposed scheme (Sites 14-15, 28-38, 41, 43-45, 48-50 and 52-55 Appendix G section G3 figure G.13) have been assessed in terms of cumulative impact by including other wind turbines in the area (Appendix F section F6 Fig 6.09). Caton Moor Wind Farm, located approximately 10km to the north-east of the proposed scheme comprises 8 turbines, and can be seen from four of the sites (Sites 32, 43, 45 and 55). Dewlay Cheese Wind Energy Scheme has been consented, and will comprise one turbine located c 13km to the south of the proposed scheme. This would be visible from one of the sites (Site 44).

In addition, three other proposed wind farms have been considered in the cumulative impact of the proposed scheme (Appendix F section F6 Fig 6.10). These comprise BT, Heysham, located 7.5km to the north-west of the proposed scheme; Eagland Hill, located c 13km to the south-west of the proposed scheme; and Claughton Moor, located c 12km to the north-east of the proposed scheme. The current status of these schemes is that Heysham and Claughton Moor are in the planning/scoping stages, whilst Eagland Hill has been refused. Table 7.12 summarises the cumulative impact of all five of these sites on the 24 statutorily protected sites within the ZTV of the proposed scheme.

Site no	No of operational and proposed turbines the site is impacted by
14	2
15	2
28	0
29	0
30	2
31	0
32	3 (including Caton Moor)
33	2
34	0
35	0
36	1
37	3
38	3
41	4
43	2 (including Caton Moor)
44	Dewlay Cheese
45	Caton Moor
48	1
49	3
50	3
52	0
53	0
54	2
55	2 (including Caton Moor)

Table 7.12: Summary of cumulative impacts

Overall, 20 of the protected sites within the ZTV of the proposed scheme have been found to be potentially impacted by one or more additional proposed or operational wind farms (Sites 14-15, 30, 32, 33, 36-38, 41, 43-45, 48-50 and 54, 55 Appendix G section G3 figure G.13). However, none of the sites is closer than 2.5km to any of the additional wind farm sites. This suggests that the presence of the wind farms in the landscape will be part of a wider view from these areas. As with the proposed scheme, it is assumed that these additional wind farms are temporary and, therefore, the sites will only be impacted for as long as the turbines are operational.

7.9.3 Summary of Effects

There are five archaeological sites within the study area, which could be impacted by the groundworks during the construction of the wind turbines (Sites 13, 20, 22, 23 and 27 Appendix G section G1). Sites 20, 22 and 27, former field boundaries, and Site 23 the route of a township boundary, are considered to be of *low importance*, and their potential for adding to the archaeological record is *low*. As these sites are linear in nature it is likely that any impact on them would be partial, and therefore the magnitude of impact has also been considered to be *low*.

Site 13 is the putative route of a Roman road and is considered to be of *medium importance*. The route of the road through this area is unknown and therefore the potential impact of the proposed development remains uncertain. In addition, excavations to the immediate west of the study area, at the University, uncovered the remains of a Romano-British settlement site in 2003. The proximity of this site to the proposed development area, and the similarities in topography (e.g. low lying and between 300-400m from the north bank of the river Conder) of the two sites suggests that there is some potential for further Romano-British archaeological remains to be uncovered at the proposed development area.

Given the potential for Romano-British remains within the proposed development area, and the possibility that the Roman road crosses through this area, a phased programme of iterative archaeological works will be undertaken in order to inform a suitable mitigation strategy.

In the first instance, the proposed development area will be the subject of a geophysical survey to be completed in January 2010. This can be followed by a programme of targeted trial trenching based on the geophysical survey results. The methodology for this programme of works should be

agreed in advance with the Lancashire County Archaeology Service (LCAS). A mitigation strategy for any required further works (e.g. preservation of significant remains *in situ*, archaeological excavation in advance of construction, or a watching brief during construction) would be prepared on the basis of the results of the initial evaluation work (geophysical survey and trial trenching) and agreed with LCAS.

7. 10 Statement of Significance

For full details of the site referred to below refer to Appendix G section G1.

The desk-based assessment addresses the direct and indirect impacts of the proposed development on the historic environment. The study reviewed relevant databases, as well as published, documentary, map and aerial photographic sources and was supplemented by a site visit.

A Bronze Age axe findspot (Site 12) was located within the study area, and there is further evidence for Bronze Age activity in the wider area. The putative route of a Roman road (Site 13) crosses the study area, and a Romano-British settlement site is located to the west of the study area. Medieval activity in the area appears to have been largely agricultural with a field system (Site 04) and area of ridge and furrow (Site 18) identified in the study area. A further area of medieval/post-medieval ridge and furrow (Site 17) was also identified, as well as the township boundary between Scotforth to the north and Ellel to the south (Site 23). The date of this boundary is unknown, but it could be medieval. Post-medieval sites include relict boundaries and tracks (Sites 11, 16, 20-22 and 27), former pits and ponds (Sites 08 and 24-25), a ditch and bank (Sites 05 and 06), a cropmark (Site 07), and a former woodland enclosure bank (Site 19). Within the study area there is also a modern unspecified cropmark (Site 01), an undated earthwork (Site 03), and an undated former watercourse (Site 02).

Five of the identified sites could be impacted by the groundworks during the construction of the wind turbines (Sites 13, 20, 22, 23 and 27). However, Sites 20, 22, 23 and 27 are considered to be of *low importance* and no specific further work to mitigate the impact of the proposed scheme on these has been recommended. Site 13, the putative route of a Roman road, is considered to be of *medium importance*. The route of the road through this area is unknown and therefore the potential impact of the proposed development remains uncertain. In addition, the proximity of the Romano-British settlement site excavated in 2003 to the proposed development area, suggests that there is some potential for further Romano-British archaeological remains to be uncovered at the proposed development area.

In light of this, a programme of archaeological works is proposed, which, in the first instance will comprise a geophysical survey of the area. This can be followed by a programme of targeted trial trenching, the methodology for which work should be agreed in advance with LCAS.

The indirect impact of the installation of the wind turbines has also been considered in this assessment. Two Grade II Listed Buildings within the study area (Sites 14 and 15) and 28 other statutorily protected sites (Scheduled Monuments, Grades I and II* Listed Buildings, Registered Historic Parks (Sites 28-55)) and 17 Conservation Areas within a 10km radius of the proposed site have been assessed in terms of the visual impact on their settings. Of the 30 sites considered, 24 may be visually impacted by the proposed scheme and of the 17 Conservation Areas, 15 may be visually impacted. These sites are all considered to be of *high importance*, but as the impact of the proposed scheme on them would be indirect and temporary, the magnitude of impact has been considered to be *small*.

Chapter 8: Shadow Flicker and Light Reflection

8. Shadow Flicker & Light Reflection

8.1 Introduction

This chapter of the ES describes and assesses the potential shadow flicker effects of the Lancaster University wind turbines. It also addresses the matter of potential Light Reflection which has been identified by the Local Planning Authority in their Scoping Response.

Computer modelling has been carried out for the proposed wind turbines and this has identified a number of potentially sensitive receptors which may experience shadow flicker. Although the number of affected days and the duration of such effects would be limited, the possibility of nuisance arising may not be entirely ruled out. Therefore further modelling has been carried out upon these receptors in order to assess the expected impact of shadow upon them, and identify any areas where residual impacts may occur.

8. 2. Consultation

8.2.1 Consultation

The scope of the shadow flicker and light reflection assessment has been discussed with Lancaster Council at pre application and Scoping stages.

Discussions have also taken place with turbine manufacturers regarding the technical mitigation options currently available.

8.2.2 Nuisance arising from Shadow Flicker

Shadow flicker effects will be attributable to a certain combination of conditions coinciding in specific locations at particular times of the day and year. Factors determining the occurrence and/or perception of shadow flicker nuisance at a receptor include:

- Time of day and year
- Weather conditions – clear and sunny
- Wind direction
- Position of the Sun e.g. when the sun is low in the sky, directly behind a turbine and in line with the property
- Height of the turbine and rotor diameter.
- Distance of the turbine from the property – shadow flicker effect diminishes with distance. At distances greater than ten times the rotor diameter the effect is unlikely to occur[1]
- Type and frequency of use of the affected space within the receptor.
- Size of window apertures and type of curtain or blind fitted (vertical blinds will exacerbate the effect)
- Duration of shadow flicker effects
- Presence of mitigating factors such as screening effects from vegetation near windows

[1] Planning for Renewable Energy, A Companion Guide to PPS22
Office of the Deputy Prime Minister, 2004

8.3 Relevant Guidance and Legislation

Planning for Renewable Energy, A Companion Guide to PPS22 [1] has been considered in carrying out this assessment. The Companion Guide document was published by the Office for the Deputy Prime Minister in 2004 to provide additional information to assist in the implementation of Planning Policy Statement 22: Renewable Energy (PPS22). The Guide provides additional technical information on a range of renewable energy technologies, including onshore wind power, which is universally applicable.

The companion guide describes the conditions under which flicker may occur and states that the effect diminishes with distance and that "flicker effects have been proven to occur only within ten rotor diameters of a turbine. It also confirms that effects only occur within 130 degrees either side of north relative to the turbines''.

Technical advice regarding blade colour and reflections is available directly from the turbine manufactures. The Influence of Colour on the Aesthetics of Wind Turbine Generators' – ETSU W/14/00533/00/00) was also consulted for advice.

8.4 Assessment Methodology

The shadow flicker assessment has been carried out for two wind turbines, with an approximate mast height of 59m, a blade length of 41m and a blade diameter of 82m. The grid references for the turbines are as follows; T1 349093, 457073 and T2; 349175, 457789

In order to assess 'expected' values for receptors which were identified as potentially vulnerable to shadow flicker, it was necessary to identify the likely meteorological conditions which are expected to be experienced at the site.

In order to estimate the impact of cloud cover, freely available information from the Met Office[2] was used to consider the likelihood of sunshine at different times of the year, and thus allow the determination of 'expected' values for shadow flicker occurrence.

In the absence of mast height wind data for the site, a single 360^{o} sector was assumed with 8760 hours of wind as a substitute for estimated rotor azimuth and wind speed. This analysis also employs the slightly simplistic assumption that sunshine probability and turbine operational probability (derived from the operational hours per year and sector) are independent parameters. These values can be multiplied with a model of potential ("worst case") shadow flicker occurrence, which is calculated using commercially available software, in order to yield the 'expected' hours per year experienced at each of the identified locations.

In reality these 'expected' values are likely to yield conservative results; as bright and sunny weather conditions and low wind speeds generally tend to show some degree of correlation, and due to the nature of the assumed simplified wind speed and distribution.

The aforementioned mathematical model is based upon a Zone of Theoretical Visibility (ZTV) analysis, which in this case was based upon a Digital Terrain Model (DTM) at 50m resolution. **A DTM does not account for surface features such as buildings or trees and, as a result, will demonstrate an overly conservative result, giving shadow flicker values in areas which, in reality, will be screened from these effects by surface features.**

No guidance is available regarding what levels of shadow flicker may be considered acceptable in the UK. In the absence of UK guidance towards Shadow Flicker mitigation[3 and 4], this chapter will adopt the generally accepted maximum figure of 30 minutes per day; 30 hours per year; or 30 days per

[2] http://www.metoffice.gov.uk/climate/uk/averages/19712000/index.html3
[3] Onshore Wind Energy Planning Conditions Guidance Note: A report for the Renewables Advisory Board and BERR, TNEI Services Ltd., 2007
[4] Circular 11/95: Use of Conditions in Planning Permission, DCLG 2006

year: whichever is greatest. These figures are derived from guidelines applicable in Germany [5] which suggest limiting shadow flicker to an astronomical maximum of 30min per day and 30 hours per year for rooms within residential dwellings, offices, lecture halls, hotels/hospitals or other accommodation, work places (if they are indoors), etc. Therefore for the purposes of this assessment significance effects are categorised to occur where **expected** shadow flicker results exceed a maximum of 30 minutes per day; 30 hours per year; or 30 days per year: whichever is greatest.

8.5 Baseline Description

21 receptors were placed in areas which were identified as potentially affected by shadow flicker. These are listed in Table 8.1 and shown on a map in Figure 8.3 (Section 8.6.1). These receptors were analysed for "worst case" and "expected" shadow hours per year using the above methodology, which yielded the values displayed in Table 8.2.

The "worst case" analysis, which demonstrates the times in which shadow flicker could *potentially* occur were the correct meteorological conditions in place; 12 of the 21 receptors were above this threshold, comprising receptors B, D, E, F, H, I, P, Q, R, S, T and U. Of these, three (Q, R and S) are located on the university campus itself, two (T and U) are located on the motorway (the issues arising from this will be dealt with below), and one (E) appear to be non-residential farm buildings. It is important to re-iterate at this stage that these values represent those times in which shadow flicker could *potentially* occur, and **should not be taken as an indication of the times during which shadow flicker will be experienced at any given receptor**.

Additionally, of these 12 receptors, upon analysis of the times during which shadow flicker could potentially occur, as illustrated in the Graphical Calendars located in Appendix H section H2 (B, D, E, F, H, I and R) are predominantly during the periods during which some people could be expected to away from home (assuming an average work-day of 9AM until 5PM). This in itself could be viewed as some mitigation to shadow flicker as those residents of these receptors would consequently not experience any shadow flicker. Similarly, 4 of the receptors (Q, S, T and U) occur early in the morning, and as such it could be suggested that any residents at these locations (which include parts of the University campus) may be asleep or have curtains or blinds closed, again preventing the experience of shadow flicker. Two of the receptors (E and P) could only experience shadow flicker late in the evening, and as such, are unlikely to affect people working in those locations (again assuming a standard work day of 9AM to 5PM), given the assumed nature of these buildings (non-residential farm buildings and a Golf Club.

8.6 Information Gaps

In the absence of any data collection with reference to the slope dimensions of windows existing at any of the receptor locations, a standard measurement of a 1x1m window perpendicular to the Earth's Surface was assumed.

8. 7 Assessment of Potential Effects

8.7.1 Potential Effects of Shadow Flicker

Much of the potential shadow flicker at Lancaster University Campus (receptors Q,R and S) is during periods which are "out of term time" (being around Easter and Summer), and as such any shadow flicker which did occur during these periods would have a reduced potential to be experienced by people who regularly live or work at the University. This is once again illustrated in the Graphical Calendars located in Appendix H section H2.

[5] Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergieanlagen, Länderausschuss für Immissionsschutz, (2002)

The "expected" values, however suggest that none of the 21 receptors will have shadow flicker occurrence above the aforementioned threshold, with 6 receptors expected to receive none at all. The expected values are listed in Table 8.2 and are illustrated in Figure 8.3.

It is important to note that the 'expected value' predictions represent a long-term average as they are based on long-term historic meteorological observations. The variation between individual years can be significant and may lead to observations in the future which could differ from the results predicted here.

Also, whilst two receptors were placed upon the Motorway at the request of the Local Planning Authority as detailed in their EIA Screening Response, the Highways Agency Wind Farm Good Practice Guidance[6] states "*It is largely agreed that shadow flicker does not affect motorists because of the large amount of glass in the vehicle which reduces the effect*" and that "*vehicles are moving so any shadow flicker will only last a very short period*", meaning that the figures assessed here are **not appropriate** to assess the effect upon a vehicle or motorist at this location.

It is often incorrectly assumed that Shadow Flicker may be used as a proxy for driver distraction. This is inappropriate as, once again, the results given by this analysis are not appropriate to the experience of a motorist, and at any rate do not necessarily correlate with distraction. It should also be noted that PPS22 [1] states:

"Concern is often expressed over the effects of wind turbines on car drivers, who may be distracted by the turbines and the movement of the blades. Drivers are faced with a number of varied and competing distractions during any normal journey, including advertising hoardings, which are deliberately designed to attract attention. At all times drivers are required to take reasonable care to ensure their own and others safety. Wind Turbines should therefore not be treated any differently from other distractions a driver must face and should not be considered particularly hazardous. There are now a large number of wind farms adjoining or close to road networks and there has been no history of accidents at any of them."

This clearly indicates that driver distraction should not be of special concern for wind turbines.

[6] CRS 558501 Wind Farm Good Practice Guide, Highways Agency, June 2007

	Easting	Northing	Height A.S.L	Width	Height	Height A.G.L	Bearing	Slope	Direction Mode	Name
A	349194	457350	64.0	1.0	1.0	1.0	328.1	90.0	Single	Farm at Hazelrigg facing North
B	349201	457307	61.4	1.0	1.0	1.0	252.8	90.0	Single	Farm at Hazelrigg facing West
C	349268	457296	60.4	1.0	1.0	1.0	341.3	90.0	Single	Cottage at Hazelrigg Facing North.
D	349265	457285	59.8	1.0	1.0	1.0	238.7	90.0	Single	Cottage at Hazelrigg Facing West.
E	349409	457767	89.5	1.0	1.0	1.0	231.2	90.0	Single	Farm Buildings near met. station
F	349570	458211	102.2	1.0	1.0	1.0	184.7	90.0	Single	Blea Tarn Farm
G	349723	458673	107.0	1.0	1.0	1.0	220.5	90.0	Single	Sunnymede Farm
H	348621	458205	56.3	1.0	1.0	1.0	175.9	90.0	Single	Bailrigg Farm Residences Facing South
I	348613	458910	56.0	1.0	1.0	1.0	63.4	90.0	Single	Bailrigg Farm Residences Facing East
J	348662	456593	33.5	1.0	1.0	1.0	41.5	90.0	Single	Northern-most residence on Green Lane
K	348592	456185	25.0	1.0	1.0	1.0	61.9	90.0	Single	Northern-most residence in Ellel
L	349056	456729	33.6	1.0	1.0	1.0	36.8	90.0	Single	Barrow Greaves facing NE
M	349310	456457	32.8	1.0	1.0	1.0	301.6	90.0	Single	Lower Kit Brow
N	349572	456597	59.3	1.0	1.0	1.0	273.6	90.0	Single	Higher Kit Brow facing West
O	349600	456606	60.9	1.0	1.0	1.0	0.0	90.0	Single	Higher Kit Brow Facing North
P	349621	457171	43.8	1.0	1.0	1.0	310.9	90.0	Single	Banton House facing NW (Golf Club)
Q	348657	457046	54.8	1.0	1.0	1.0	64.2	90.0	Single	University South (Grizedale College)
R	348767	457319	59.7	1.0	1.0	1.0	84.3	90.0	Single	University Middle (Furness College)
S	348764	457710	66.7	1.0	1.0	1.0	66.5	90.0	Single	University North (County College)
T	348882	457765	46.3	1.0	1.0	1.0		90.0	Greenhouse	Motorway South (Southbound)
U	348935	457066	71.8	1.0	1.0	1.0		90.0	Greenhouse	Motorway North (Southbound)

Table 8.1- The shadow receptors used within the analysis to represent areas potentially vulnerable to shadow flicker.

	Name	Potential Hours/ Year	Potential Days/ Year	Potential Hours/ Day	Expected Hours/ Year
A	Farm at Hazelrigg facing North	00:00	0	00:00	**0:00**
B	Farm at Hazelrigg facing West	113:44	100	01:20	**22:13**
C	Cottage at Hazelrigg Facing North.	00:00	0	00:00	**0:00**
D	Cottage at Hazelrigg Facing West.	126:47	124	01:13	**22:39**
E	Valley View Kennels	143:08	145	01:21	**04:28**
F	Blea Tarn Farm	30:31	78	00:35	**04:48**
G	Sunnymede Farm	00:00	0	00:00	**0:00**
H	Bailrigg Farm Residences Facing South	15:22	43	00:28	**02:25**
I	Bailrigg Farm Residences Facing East	15:03	41	00:28	**02:20**
J	Northern-most residence on Green Lane	00:00	0	00:00	**0:00**
K	Northern-most residence in Ellel	00:00	0	00:00	**0:00**
L	Barrow Greaves facing NE	00:00	0	00:00	**0:00**
M	Lower Kit Brow	00:00	0	00:00	**0:00**
N	Higher Kit Brow facing West	00:00	0	00:00	**0:00**
O	Higher Kit Brow Facing North	00:00	0	00:00	**0:00**
P	Banton House facing NW (Golf Club)	19:18	45	00:36	**01:13**
Q	University South (Grizedale College)	29:53	58	00:44	**0:50**
R	University Middle (Furness College)	38:07	71	00:48	**05:54**
S	University North (County College)	46:53	80	00:47	**03:44**
T	Motorway North (Southbound)	284:58	167	01:58	**06:34**
U	Motorway South (Southbound)	90:32	111	01:05	**03:24**

- Where Potential Hours equals the 'Worst Case' scenario based on the assumption that there is no cloud cover and no surface features such as building or trees that would screen shadow flicker affects.
- Where Expected Hours equals the 'Likely' scenario having regard to the affects of cloud cover.

Table 8.2- The 'worst case' (potential), and 'expected' shadow hours per year for each of the shadow receptors.

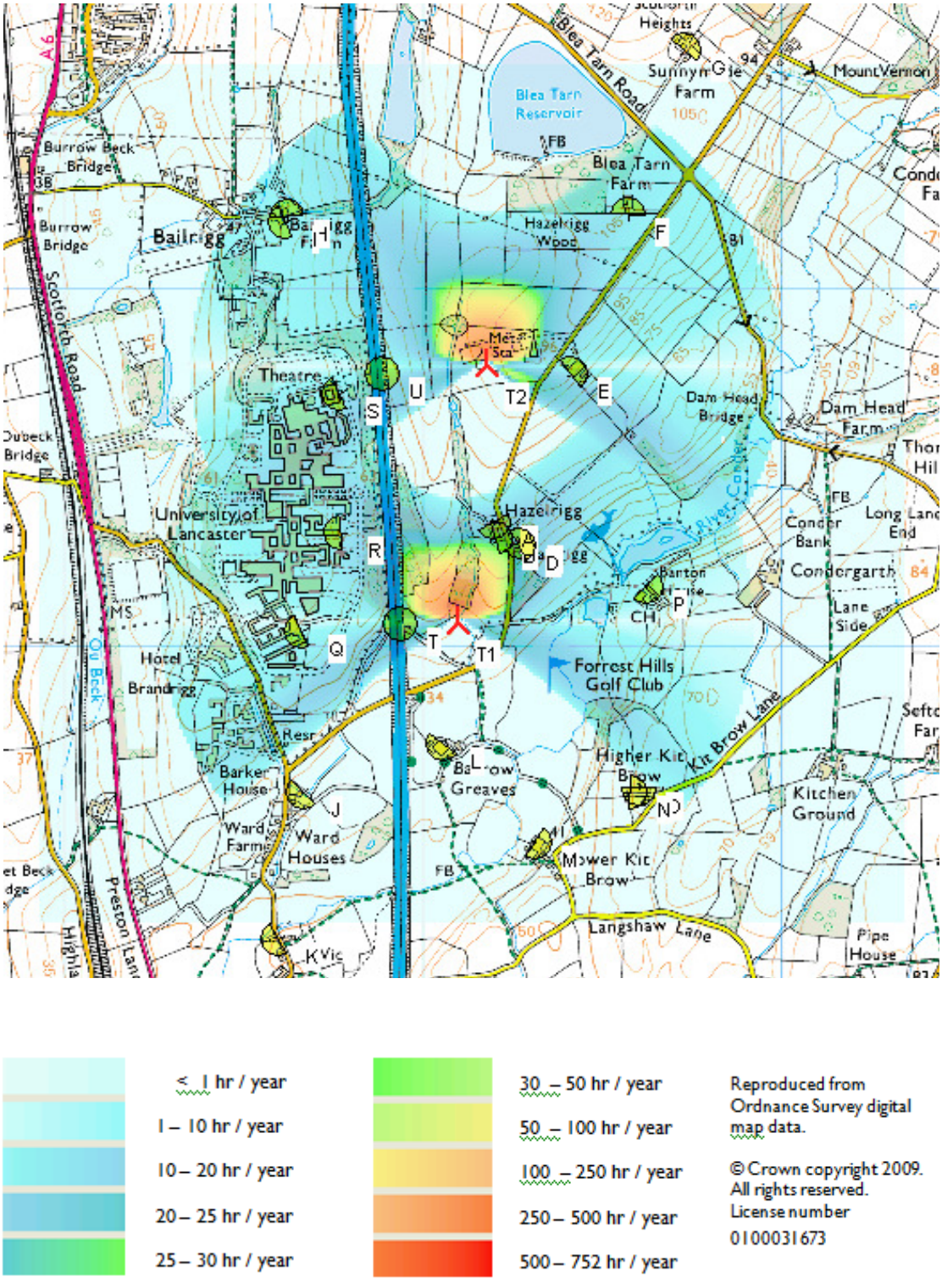

Figure 8.3 – Shadow Flicker Potential – expected hours per year

The passage of the sun, the size and location of the turbines and the location of the affected receptor will all be known, so the validity of any complaint of shadow flicker is relatively easy to verify by means of commercially available computer models.

None of the identified potentially vulnerable areas have demonstrated expected impact of shadow flicker in excess of the aforementioned accepted threshold. The “worst case” scenario, has

demonstrated that this threshold could potentially be exceeded should the required atmospheric conditions for shadow flicker exceed that which has been predicted by this analysis at 12 of the receptors, 3 of which are within the University's own land, and 2 of which are located on the M6 Motorway which, as has already been discussed, is not an appropriate location to assess shadow flicker and has been included purely at the request of the Local Authority EIA Screening Response . Additionally, whilst shadow flicker may potentially occur at these locations, it is possible that flicker will not be "experienced" at all locations due to the time of day during which it may potentially occur.

For the locations which could potentially be affected at a level greater than the accepted threshold, the suggested course of action would be to await any complaint before mitigating (given that these are potential effects which could only occur in the event of appropriate atmospheric conditions).

Any effects that occur in practice would only do so during the operational phase of the wind turbines. No effects will occur during construction or decommissioning.

8.7.2 Potential Effects of Light Reflection

Generally turbine blade are coloured a light grey anti reflective coating which is a pale industry standard colour. This reduces the effects of reflection efficiently whilst having no influence on the power curve.

8.8 Mitigation

8.8.1 Shadow Flicker

A control system would be employed' as part of the wider turbine control systems to calculate, in real time, whether shadow flicker may affect a property, based on pre-programmed co-ordinates for the properties and wind turbines, and the intensity of sunlight, as measured by a device attached to a turbine tower. When the control system calculates that the sunlight is bright enough to cast a shadow, and that a turbine shadow falls on a property, it automatically shuts the turbine down, re-starting it when the shadow has moved away from the property.

In the highly unlikely event that shadow flicker is experienced at properties other than those identified in this assessment, these would be investigated by Lancaster University or an independent third party, and if a complaint is found to be justified additional control measures of the types identified above will be implemented.

A programme of monitoring will also ensure the effectiveness of the proposed mitigation and allow for it to be adapted to allow for any inaccuracies in the calculation.

8.8.2 Light Reflection

An anti-reflective paint coating would be applied to the turbines to mitigate the possible impacts of light reflection.

8.8.3 Cumulative Effects

There are no anticipated cumulative effects with other known developments in the vicinity.

8.9 Residual Effects

Implementation of the identified mitigation will ensure that properties will not be affected by shadow flicker or light reflection from the proposed turbines.

8.10 Statement of Significance

It is generally accepted that a maximum of 30 minutes per day; 30 hours per year; or 30 days per year: whichever is greatest is an acceptable level of shadow flicker impact. These figures are derived

from guidelines applicable in Germany [7]. In the UK there is a lack of specific regulations regarding shadow flicker therefore it is up to each individual planning authority to assess the impact on a site specific, case by case, basis.

Table 8.2 and Figure 8.3 in section 8.6 identify the potential worst case scenario and expected shadow flicker affects demonstrating that all potential effects fall below the 30 hrs per year threshold. Therefore it should not be necessary to impose restrictions on shadow flicker. However if the local planning authority consider controls necessary, mitigation has been identified in the form of a control system which automatically shuts down the wind turbines at times when shadow flicker will occur. Following adoption of this mitigation proposal it is unlikely that any property within 10 rotor diameters (820m) will experience shadow flicker effects. Residual effects are therefore considered to be negligible.

[7] Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergieanlagen, Länderausschuss für Immissionsschutz, (2002)

Chapter 9: Noise and Vibration

9. Noise and Vibration

9.1 Introduction

This chapter of the ES describes the finding of the Noise Assessment carried by ACIA Engineering Acoustics.

The aim of this chapter of the ES is to survey of ambient noise in the vicinity of the proposed wind energy scheme at the University of Lancaster. The levels of noise likely to occur at local residential properties as a result of the operation of the proposed turbines could then be calculated, and the environmental implications considered.

The results are assessed against the guidelines available for wind energy developments, including PPG24 and PPS22. Particular attention is paid to the ETSU-R-97 report The Assessment and Rating of Noise from Wind Farms and the latest onshore wind energy planning conditions guidance note (Renewables Advisory Board and the Department for Business, Enterprise and Regulatory Reform, BERR).

9.2 Consultation

9.2.1 Local Planning Authority

Before work was undertaken on the noise study, the opinion of the Environmental Health team at Lancaster City Council was sought. It was agreed that the guidance given in ETSU-R-97, the assessment and rating of noise from wind farms, was appropriate, and that noise survey locations representative of three areas of habitation local to the proposed development site should be selected.

The consultation with the Council took place between Martin Brownjohn, Environmental Health Officer, and Ian Bennett, consulting engineer, by telephone in July 2009.

9.2.3 Local residents

A number of local residents were contacted to seek permission to place noise monitoring devices on their properties. Positive responses were received from four residents, and three locations were selected from these as detailed later in this report.

During the course of the background noise surveys, the proposed siting of one or both wind turbines were changed, meaning that a different property would be closest to the site. Additional noise monitoring was therefore instigated at this fourth site, again with the prior consent of the householder.

9.3 Guidance and Legislation

9.3.1 PPG24

Planning Policy Guidance Note 24 relates to noise in general. It replaced previous guidance (Circular 10/73, now cancelled) and provides advice on how the planning system can be used to minimise the adverse impact of noise without placing unreasonable restrictions on development. The most recent version of PPG24 was under review in 2006 but its replacement, PPS24, had not at the time of writing (December 2010) been issued, because of the government's reforms of the planning system.

General guidance is provided on how noise may be assessed and controlled, and mitigation measures are suggested. These are of particular relevance to conventional industrial noise

sources, since they include the provision of noise barriers or enclosures, the protection of noise-sensitive buildings, measures such as allowing adequate source-to-receiver distances, and limitations to the permitted operating times of noise sources.

Noise exposure categories for new dwellings are specified at Annex 1 to PPG24, but these are intended for situations where new noise-sensitive property is planned in an existing noise environment, and are not therefore relevant to a wind energy development where the housing is already in existence.

Annex 2 to PPG24 gives explanations of the noise exposure categories and how they were derived. Annex 3 considers the assessment of noise from different sources, including road traffic, railways, aircraft, military aerodromes, helicopters, industrial and commercial developments, construction sites, recreational activities, and waste disposal.

Annex 4 to PPG24 gives examples of planning conditions designed to limit noise emissions, but there is no condition designed expressly for wind energy developments. Annex 5 discusses how noise limits should be specified, and reference is made to BS.4142:1990 (the current version at the date of publication) and its application to conventional industrial developments. Information on other noise control regimes such as the Noise Act 1996 and the Environmental Protection Act 1990 is provided at Annex 7, and relevant Statutory Instruments are listed at Annex 8.

9.3.2 PPS22

This Planning Policy Statement specifies the issues that should be taken into account by local planning authorities in England when assessing the development of renewable energy projects. Regarding wind energy in particular, it states that the nature of noise emissions from turbines is one of the distinctive features of this type of development, and must be taken into account in planning and development control.

PPS22 has a 'Companion Guide' called Planning for Renewable Energy which first appeared in 2004. The guide includes a Technical Annex on wind energy (number 8) which deals with noise issues at paragraphs 41 to 44 inclusive.

Paragraph 41 requires that wind turbines should be located so that increases in ambient noise around noise-sensitive developments are kept to acceptable levels, in comparison with the existing background noise. This is normally achieved through good design of the turbines, and by allowing a sufficient separation distance between any turbines and existing noise sensitive development. Noise from the turbines will thus not normally be significant. The Technical Annex goes on to state that noise levels from turbines are generally low and, under most operating conditions, turbine noise is likely to be completely masked by wind generated background noise.

At paragraph 42 the distinction is drawn between mechanical noise from the gearbox, generator and drive train, and aerodynamic noise from the passage of the turbine blades through the air. It is pointed out that since the early 1990s there has been a significant reduction in the mechanical noise generated by wind turbines. Mechanical noise from the nacelle is usually considerably less than aerodynamic noise from the rotor on modern three blade machines, which are relatively large and slow-moving. Aerodynamic noise from wind turbines is generally unobtrusive because it is broad-band in nature and thus not very different from the noise of wind in trees.

Wind-generated background noise increases with wind speed, and at a faster rate than the wind turbine noise increases with wind speed, as discussed in Paragraph 43 of the Companion Guide. The difference between the noise of wind turbines and the background noise is therefore liable to be greatest at low wind speeds.

Paragraph 44 refers to The Assessment and Rating of Noise from Wind Farms (ETSU-R-97)4 as described below. The report provides a framework for the measurement of wind turbine noise and gives indicative noise levels calculated to offer a reasonable degree of protection to wind turbine neighbours, without placing unreasonable restrictions on wind energy development or adding unduly to the costs and administrative burdens on wind energy developers or planning authorities. The recommendations of the cross-interest Noise Working

Group which prepared the report can be regarded as relevant guidance on good practice. The methodology overcomes some of the disadvantages of BS.4142 when assessing the noise effects of wind turbines, and according to PPS22, paragraph 22 'should be used by planning authorities when assessing and rating noise from wind energy developments'.

9.3.3 BS.4142:1997

As discussed above, the usual basis for assessing noise of industrial origin is BS.4142:1997, this calls for a comparison of the 'new' noise with the pre-existing LA90. PPG24 was written before this edition of the British Standard came into existence, and refers to BS.4142:1990. However, regardless of which version is consulted, complaints from local residents are only considered likely where a development gives rise to noise levels that exceed the previous ambient noise by 10dB or more. Where the 'new' noise is 10dB quieter than the present ambient noise levels, this is to be taken as a positive indication that justifiable complaints will not occur. Differences of 5dB are regarded as being of marginal significance. In practical terms this means that there is a band of uncertainty at least 10dB wide, and probably nearer 20dB wide, within which neither developers nor the enforcement authorities have clear guidance on which they may rely.

There are also problems with the direct application of BS.4142:1997 to wind energy developments. The site lies in a windy environment where the conditions stipulated by the standard will be difficult or impossible to satisfy when the turbines are actually generating electricity.

The standard further recommends that noise measurements should not be taken in wind speeds greater than 5ms-1. The wind speeds of particular interest are from 4ms-1 to about 10ms-1, this being the range over which turbines operate whilst wind-generated noise remains at a relatively low level. Great care is therefore necessary when measuring ambient noise levels in order to eliminate wind noise across the microphone diaphragm. Wind turbines cannot operate below a certain wind speed: this 'cut-in' speed varies according to turbine type, but is usually between 3 and 5 ms-1. It follows that any noise limits on a wind turbine development could only be applicable above a critical wind speed when the level of ambient noise would also be affected (to a greater or lesser degree) by the action of the wind on vegetation. These circumstances were not foreseen by the authors of BS.4142, who assumed that for practical purposes (where industrial noise is not wind dependant) the conditions under which complaints from local communities are most likely are those when background noise is at a minimum. This would be during a calm night, but under those conditions it would be impossible for a wind turbine to generate any noise at all, since it would be stationary.

9.3.4 ETSU-R-97

It is generally accepted that a development of this type should be assessed using the 1997 DTI ETSU report. The guidance was originally intended to be reviewed after ten years had elapsed, but a recently-published review of planning conditions for renewable energy generally (prepared for RAB/BERR — see below) has confirmed the continuing validity of the recommendations. The findings of the report have been extensively used in the UK since 1997, and it remains entirely appropriate for this development. In the governments view it correctly balances the need to offer a reasonable degree of protection to neighbours without placing unreasonable restrictions on wind farm developers, it remains the best guidance on good practice, and is cited by PPS22.

The report describes a framework for the measurement of wind turbine noise and indicates desirable noise levels, so that without placing unreasonable restrictions on wind power developments, neighbouring residential properties can gain protection from excessive noise. A primary objective of the report is to suggest noise limits in a form suitable for adoption as planning conditions. The Noise Working Group that produced the report considered that absolute noise limits regardless of wind speeds were not suited to wind farms in the UK, and that it is more appropriate in the majority of cases to set noise limits relative to background noise. The background noise levels are to be measured over a range of wind speeds so that the impact of turbine noise, which is also wind-speed dependant, can be evaluated.

One of the most important recommendations in the ETSU-R-97 report is that the statistical index LA90,10min should be used for both the background noise and the wind turbine noise.

This allows reliable measurements to be made without them being corrupted by louder, transitory noise events from other sources. The report notes that for the typical wind energy scheme, the LA90,10min is between 1.5 and 2.5 dB lower than the LAeq over the same measurement period. This is worthy of note because for conventional noise measurements in the environment, the LAeq index is generally regarded as the most appropriate descriptor, and it is normal practice to use it when noise limits are being set. In the present assessment, it is assumed that the LA90, 10min index is always 2dB lower than the LAeq.

A methodology is provided for the measurement of background noise levels under various wind conditions. The report recommends that data which may be corrupted by extraneous noise sources, including periods when rain falls or when watercourses have abnormally high flows should be discarded. At all times, the noise levels measured in the environment are to be correlated with wind speed measurements at the site, using a reference height of 10m above ground. Because the noise levels can vary by several decibels at any given wind speed, a curve is to be fitted to the raw data (having discarded doubtful measurements) in order to determine the typical variation in background noise level with wind speed. The exercise is carried out for 'quiet' daytime periods and night-time periods, defined as follows. Quiet daytime is from 18.00h to 23.00h on weekdays, 13.00h to 23.00h on Saturdays, and all day Sunday. Night-time is between 23.00h and 07.00h daily. All other periods (weekdays and Saturday mornings) are defined as normal daytime, when it would be expected that the ambient noise levels may be somewhat elevated because of human activity, distant road traffic, and natural noise sources.

No specific method is prescribed for the calculation of wind farm noise, although there is a basic requirement for turbine sound power level to be determined by a standard test method (such as the IEA Recommended Practice). Once the noise levels at critical locations have been calculated, it is recommended by ETSU that turbine noise should not exceed the background noise at the same wind speed by more than 5dB. It should be noted that both background noise levels and turbine noise are to be determined by best-fit curves through representative data.

Noise at night is, rather unusually, not seen by ETSU-R-97 to be as critical as the 'quiet' daytime noise levels. This is because between the hours of 23.00h and 07.00h residents are likely to be asleep and thus would not be affected by noise out of doors. The typical attenuation of sound from outside to inside, taking into account the reduction in level through a partly-open window, means that levels that may be unacceptable during the quiet daytime period are quite acceptable at night. Accordingly, a 'flat' night-time limit of 43dB LA90, 10min is sometimes recommended. This is almost always less onerous than the daytime limit, and it is therefore the daytime limit that effectively controls the location of any turbine, being directly affected by the distance between it and residential property.

It should be noted that although rather greater noise emissions may be seen to be permissible at night, the turbines perform in exactly the same way, day or night.

9.3.5 Renewables Advisory Board and BERR

In October 2007 a report 'Onshore wind energy planning conditions: Guidance note' was produced for the Renewables Advisory Board and the Department for Business, Enterprise and Regulatory Reform by TNEI Services Ltd. The purpose of the document was to provide advice on the appropriate types of planning condition relevant to wind energy development. It incorporates information already present within existing planning guidance, provides additional advice regarding the use of planning conditions, and outlines generic conditions for use in wind energy developments. It is aimed at Local Planning Authorities, statutory consultees, objector groups, potential wind applicants and other stakeholders.

As far as noise is concerned, the BERR guidance reproduces the relevant parts of ETSU-R-97, further strengthening the view that the latter is entirely appropriate for this type of development. It recommends that turbine noise for quiet daytime periods should be limited to 5dB above the prevailing background noise level, or a fixed minimum level within the range LA90,10min 35 to 40 dB, whichever is the higher. The precise choice of a criterion level within the range 35 to 40 dB(A) depends on a number of factors, including the number of dwellings in the neighbourhood of the turbine, the effect of noise limits on the number of kWh generated, and the duration and level of any exposure to noise.

It is worthy of note that the up-to-date guidance on planning conditions calls for a specific table of values for the wind-speed-dependent noise limits, based on the background noise curve derived according to the ETSU method. This has in the past been included by some planning authorities as a matter of course.

9.3.6 Acoustics Bulletin Agreement

It had become evident by late 2008 that some of the provisions of ETSU-R-97 were somewhat out of date, mainly on account of the size of turbines by then available. In the 1990s, hub heights between 30 and 40 metres were the norm, but advances in technology now mean that rotor diameters in excess of 90m, and hub heights over 100m, are now available. Moreover, because the methodology for noise prediction work is not specified in ETSU-R-97, some degree of standardisation in the method and assumptions adopted was desirable.

An agreement was reached by a number of acoustical practitioners working in the field of wind energy on two important issues. These are (1) the way in which site-specific wind shear is taken into account, and (2) the methodology for noise level predictions at noise-sensitive locations near wind farms. The agreement first appeared in Volume 34, no.2 March/April 2009 of Acoustics Bulletin, the bimonthly news magazine of the UK Institute of Acoustics. During the months since its publication, the provisions of the Acoustics Bulletin Agreement have been widely adopted both on new wind energy schemes and for schemes already in the planning system.

9.4 Assessment Methodology

For the purposes of this assessment significant effects are classed to occur if noise from the turbines exceeds the proposed '**daytime limit of 35dB, or 5dB above the prevailing background levels, whichever is the greater, or the night-time limit of 43dB, or 5dB above prevailing background noise levels, whichever is greater**. These limit values were derived by applying the recommendations of the ETSU-R-97 report, which is regarded as the best available guidance on good practice, and presents a reasonable compromise between the interests of the nation, wind energy developers and wind turbine neighbours.

9.4.1 Dates and times of surveys

Automatic noise monitoring took place for a period of 13 days, at the three locations N1, N2 and N3 chosen to be representative of the nearest noise-sensitive properties to the site as it was then envisaged. The survey took place from Thursday 1 to Tuesday 13 October 2009, and thus included two weekends.

A noise survey took place at the fourth location, N4, between Tuesday 13 and Friday 23 October 2009. Wind data was obtained from the weather station permanently installed at the University, using an anemometer at a height of 10 metres located close to the proposed site.

9.4.2 Noise measurement

The instruments used for automatic noise monitoring were Rion NL-31 data logging sound level meters, each fitted with a type UC-53A condenser microphone and a shower-proof outdoor windshield assembly. The microphone of each was mounted on a robust stand at a height of 1.2 metres above ground. Each sound level meter was powered by a high-capacity battery pack, housed with the meter in a sealed and locked weatherproof case to prevent tampering. Ambient noise levels expressed in the form of 10 minute L_{A90} (correctly $L_{A90,10min}$) values dB, were recorded continuously 24 hours a day throughout the survey period. The results were downloaded to a laptop PC at the end of the survey.

The calibration of the instruments was checked before and after the measurements using an appropriate electronic calibrator. No significant drift was observed. All instrumentation had been subject to laboratory calibration traceable to national standards within the previous 12 months.

9.4.3 Meteorological measurements

A meteorological mast was already present at the site before the background noise survey began. It recorded ten-minute means of the wind speed and wind direction on site, by means of two anemometer/wind vane combinations at heights of 10m and 20m above ground level. The wind data was logged and time stamped relative to BST, thus facilitating easy synchronisation with the background noise data. Data from the 10m anemometer was used for the purposes of this analysis, but 20m data were unavailable for the period on question. This meant that the methodology for determining site specific wind shear in the Acoustics Bulletin Agreement could not be used, but this was not evident until after the noise surveys were completed.

The time history of 10m wind speed and direction was therefore collated with the noise data from the automatic noise monitors. Only those data points which were obvious outliers were rejected.

9.4.4 Measurement and prediction locations

The locations used for measurement and noise prediction are shown in Table 9.1 and in Appendix i Figure i1. The data logging sound level meters were placed at least 3m from any reflective surface such as buildings and walls. The microphone locations N1, N2 and N3 were in 'outdoor amenity areas' in gardens where the householders could reasonably be expected to spend leisure time in the summer months. The locations were discussed in advance with the Environmental Health Department at Lancaster City Council. Microphone location N4 was chosen to be representative of the garden near a residential caravan, although it was later determined that this caravan did not have planning consent. Nevertheless, the noise dataset is applicable to the house at Valley View. Photographs showing all four noise measurement locations are shown as Appendix i Figures i2(a) to i2(d). The locations chosen for the calculation of noise levels from the wind turbines were the façades of representative residential properties facing the site. Table 9.1 also shows the separation distance between each noise prediction location and the turbines. R1, Bailrigg Farm, is one of a group of detached stone-built houses at Bailrigg Chase, being the original farm house. This is closest of the group of dwellings to the proposed wind turbines. Noise monitor N1 was placed in the rear garden of the farmhouse on a lawned area, and its eastern elevation was used for noise predictions (R1). The other dwellings in Bailrigg Chase are either recently built, or have been converted from farm outbuildings. Hazelrigg consists of Hazelrigg Barn (where two dwellings have been constructed in the converted barn), Hazelrigg Cottage, Hazelrigg House, and Eastrigg. Noise monitor N2 was placed in the rear garden of 2 Hazelrigg Barn, and noise level predictions were made for location R2, the north-western façade of Hazelrigg House. Blea Tarn Farm and Blea Tarn Bungalow are two dwellings situated at the end of a short lane. Noise monitor N3 was placed in the garden to the east of the bungalow, but the western elevation of the farmhouse was used for noise prediction purposes, designated R3. As mentioned in Section 9.2.3, the noise monitoring at N4, Valley View Boarding Kennels, took place after the surveys at the other three locations. A change in the expected turbine locations meant that this property would be relatively close to a turbine, so additional background noise information was desirable. The microphone was placed in the lawned area at the front of the property, near one of the two residential caravans: it is understood that this particular caravan is used only for storage. However, noise level predictions were made for the north-western elevation of the house, R4, because there is no existing planning consent for a residential caravan at this site.

	location	easting	northing	distance from T1, m	distance from T2, m
T1	turbine	349175	457789	-	721
T2	turbine	349093	457073	721	-
N1	noise monitor, Bailrigg Farm	348813	474905	694	1233
N2	noise monitor, Hazelrigg Barn	349195	457311	478	259
N3	noise monitor, Blea Tarn Bungalow	349614	458227	619	1266
N4	noise monitor, Valley View (caravan)	349387	457807	212	791
R1	Bailrigg Chase	348616	458220	707	1242
R2	Hazelrigg	349198	457354	436	300
R3	Blea Tarn Farm	349558	458226	580	1243
R4	Valley View (house)	349439	457763	264	772

Table 9.1: Ordnance Survey grid references and separation distances

9.5 Baseline Description

9.5.1 Daytime

The results of the automatic monitoring of noise and wind speed are presented graphically in the appendices. Appendix i section i2 shows the noise level and wind speed histories. Data points regarded as doubtful because of rainfall or other extraneous noise are included in the time history. It can be seen that the measured noise levels were not greatly dependant on the wind speed, because of the presence of a continuous noise source, road traffic on the M6 motorway.

The available guidance does not provide a method for disregarding 'doubtful' data. Data points would only be candidates for discard if they were obvious outliers. However, because of the nature of the wind speed data from the University meteorological station, which were grouped in 'bins' rather than continuously variable, there are no obvious outliers.

Appendix i section i3 shows scatter plots for 'quiet daytime' at the four noise monitoring points, with noise levels plotted against wind speed. The best-fit curve is superimposed on the data in each case in order to derive the typical wind-dependant background noise levels as recommended by ETSU.

- At location N1, Bailrigg Farm, the trend line for quiet daytime background noise levels varied from 48dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 49dB at 12ms^{-1}.
- At location N2, Hazelrigg Barn, the trend line for quiet daytime background noise levels varied from 49dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 52dB at 12ms^{-1}.
- At location N3, Blea Tarn Bungalow, the trend line for quiet daytime background noise levels varied from 41dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 43dB at 12ms^{-1}.
- At location N4, Valley View Boarding Kennels, the trend line for quiet daytime background noise levels varied from 47dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 48dB at 10ms^{-1}. It is worthy of note that although barking dogs were a frequent feature of the noise 'climate' at this location, the barking never continued for more than 90% of any ten-minute period: it may reasonably be deduced that the $L_{A90,10min}$ values were not corrupted by barking.

9.5.2 Night-time

Appendix i section i4 shows the night-time survey results as scatter plots for the four noise monitoring points, with noise levels plotted against wind speed, and doubtful data removed. The best-fit curve is superimposed on the data in each case in order to derive the typical wind-dependant background noise levels as recommended by ETSU.

- At location N1, Bailrigg Farm, the trend line for night-time background noise levels was a flat 45dB $L_{A90,10min}$ at wind speeds between 4ms^{-1} and 12ms^{-1}.
- At location N2, Hazelrigg Barn, the trend line for night-time background noise levels varied from 44dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 45dB at 12ms^{-1}.
- At location N3, Blea Tarn Bungalow, the trend line for night-time background noise levels varied from 36dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 41dB at 12ms^{-1}.
- At location N4, Valley View Boarding Kennels, the trend line for night-time background noise levels varied from 39dB $L_{A90,10min}$ at a wind speed of 4ms^{-1} to 45dB at 12ms^{-1}.

9.5.3 Weather during the survey period

The noise survey period included some very windy spells but relatively little precipitation. The distribution of wind directions during the survey is shown in Appendix i section i5. The wind was in the sector between northerly and westerly for over 40% of the time, and between westerly and southerly for another 20% of the time. There were also periods of north-easterly and south-easterly winds. A reasonable spread of wind directions was therefore sampled.

9.5.4 Noise levels at monitoring locations

The time histories at the automatically-monitored locations show some of the diurnal variation in noise levels that would be expected close to a motorway or major road, with a lull in road traffic noise in the small hours of the morning, and generally lower levels at weekends. It may reasonably be deduced that the background noise level at all locations is nearly always affected by road traffic. The background noise levels at locations further from the motorway are dependent on wind speed, but only when wind-induced noise is significant. With site wind speeds up to 12ms-1 the graphs of noise level against wind speed are almost flat.

This feature of the background noise level means that the lack of concurrent wind speed measurements at more than one anemometer height is not a serious drawback. An analysis was carried out of the long- term wind shear data, for periods when the 20m anemometer was functioning correctly, for calendar years 2005 to 2008. This suggests that the use of wind speeds measured at 10m can be an underestimate or an overestimate of the 10m wind speeds derived from measurements at turbine hub height. In general, for the month of October, the measured 10m data are between 0.5 and 1.0 ms-1 lower than the derived values, but can sometimes be 0.5ms-1 higher. The effect on turbine noise prediction is discussed below.

9.6 Information Gaps

Details of any gaps in information that have arisen when undertaking the noise assessment will be documented and discussed in the relevant assessment sections below.

9.7 Assessment of Potential Effects

9.7.1 Wind turbine noise assessment

9.7.1.1 Turbine sound power data

Noise from wind turbines is typically made up of three distinct elements: a reasonably steady, broad-band noise of aerodynamic origin, which depends on blade tip speed, a regular, pulsed element resulting from the rotation of the blades, and a tonal noise element (if present) from mechanical components within the nacelle. Modern large turbine designs emit noise primarily of aerodynamic origin, and tonal noise has been virtually eliminated from the latest designs.

The indicative turbine types are two RePower MM82 wind turbines or similar machines at the site. This is an upwind turbine with a three-blade rotor 82m in diameter. The hub height would be 59 metres, and the nominal power output is in the region of 2.05MW from each turbine.

The base data for input to the wind turbine prediction model was taken from the manufacturer's warranted noise levels. The method used to obtain this sound power data conformed to International Energy Agency (IEA) recommended practice, the most commonly used procedure,

which calls for measurements close enough to the turbine that background noise is insignificant. It is understood that the microphone used for the measurements was relatively close to the turbine, in accordance with the method in BS EN 64100 11:2003.

The turbine would emit a maximum overall sound power level of 103.8dB(A) at the reference wind speed of 8ms-1 (normalised to a height of 10m). The sound power depends on wind speed, but at speeds above 12ms-1 the noise emissions are not usually stated, because of the practical difficulties of making measurements. However, at a 'real' site the background noise levels with winds over 12ms-1 are usually sufficiently elevated that turbine noise is well masked in any event.

The turbine type has a directivity index of 0dB in all directions, so the noise source itself has no significant directional characteristics. Based on ACIA's experience on similar large turbines, the noise contains no tonal noise components which would warrant a tonal penalty as described in ETSU-R-97.

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9.7.1.2 Calculation procedure

The method adopted for the prediction of noise from the wind turbine was the IEA 9613-2:1996 method interpreted according to the recommendations of the Acoustics Bulletin Agreement of March 2009. This means that because warranted sound power data are used as input, the ground attenuation factors Gs, Gm and Gr are all assumed to be 0.5. The model assumes hemispherical sound radiation with very slight attenuation by ground effects, as is customary for a receiver in the acoustic far-field of an elevated sound source. Air absorption and ground effects vary with frequency and distance, and the predictions are based on octave band turbine noise data. The source sound power levels used for calculation purposes take no account of the available noise reduction methods on the candidate turbine type, although various modifications may be available.

In order to calculate the steady noise from the proposed site the effect of the wind turbine at each receiver location is calculated. ETSU-R-97 suggests that the steady nature of the noise emitted by wind turbines is such that the level difference between LAeq and LA90 is typically 2dB. This has been confirmed by readings from several wind turbines in various types of terrain. A 2dB deduction was therefore made from the sound power level to yield the typical LA90 for calculation purposes, again as recommended by the Acoustics Bulletin Agreement.

9.7.1.3 Effect of wind direction

The direction of the wind makes the noise from the pair turbines appear to be directional. The measurements made during the certification noise tests to determine turbine sound power output are made downwind of a turbine, so a cross-wind would give a degree of attenuation, which would also depend on the distance from the source, and at an upwind location, this attenuation would be further increased. It should be noted that the attenuation due to wind direction is also affected by air temperature and the topography of the area, so the actual effect of wind direction would be subject to a small variation.

The worst noise propagation case for a particular receiver location will occur when the wind blows directly from the nearer turbine to the location in question (a downwind receiver).

9.7.1.4 Wind shear

For reasons of practicality and consistency, and owing to the fact that turbine sound power levels are frequently referenced to a 10m reference wind speed, ETSU-R-97 suggests using wind data recorded at that height.

Concerns have been raised recently which suggest that above methodology could under predict turbine noise at times. This would be of particular concern for wind power developments with the greatest hub heights, and weather patterns which result in stable atmospheric conditions. Stable conditions result from thermodynamic processes temporarily creating a stratification of the lowest part of the atmosphere where no mixing, or only very little mixing, between individual layers occurs. In a stable atmosphere the difference between hub height wind speeds (governing the turbine noise) and ground level wind speeds (governing background noise) can be greater than usual. A stable atmosphere is most likely to occur at night.

The phenomenon can be investigated more thoroughly in a site-specific manner using wind speed data at different heights. The Acoustics Bulletin Agreement recommends that the two anemometric

heights for a wind farm using 59m hub heights should be (1) not less than 60% and (2) between 40% and 50% of turbine hub height, which would mean the higher anemometer at 35m, and the lower anemometer between 24 and 30 m. The wind shear characteristics could then be determined and the wind speed at turbine hub height correlated with that measured (or extrapolated) at the 10m reference height.

The University weather station close to the proposed sites of the wind turbines has permanent anemometers at heights of 10m and 20m, but the 20m anemometer was not operational at the time of the noise survey. However, although the heights are lower than those recommended by the Acoustics Bulletin Agreement, it is still possible to calculate the likely trend of wind shear by extrapolation from the available long-term data, and thus determine if any adjustment is appropriate in the measured 10m wind speeds.

The measured 10m and 20m wind speeds were used to extrapolate to a wind speed at turbine hub height, using the exponent method. This gives the wind speed at the hub for a given measured 10m wind speed, although the extrapolation is not possible on a point-by point basis. The hub height wind speeds are then extrapolated down to a reference anemometer height of 10m, using the logarithmic method in IEC61400-11 and a 'standard' ground roughness length of 0.05m. This second step relates the sound power level of the turbines to the reference wind speed used in manufacturers' data. Because only long-term data are available, the individual measured wind speeds cannot be adjusted, but the trend can be allowed for by shifting the turbine noise curve (level against 10m wind speed) by an appropriate amount. If site-specific wind shear results in reference wind speeds greater than those measures, the curve shifts to the left, and vice versa.

The result of estimating site-specific wind shear effects is that turbine noise levels are, at worst, slightly higher than those actually stated by the turbine manufacturer. A shift in the aggregate turbine noise curve (on a graph of noise level against wind speed) by between 0.5 and 1 ms-1 to the left adequately compensates for the effect at its worst. However, in some cases the curve would be shifted to the right, so the discussion which follows assumes that this shift has not been applied.

9.7.2 Noise limits for this site

No planning conditions with regards to noise limits have yet been agreed for this proposed development, although it is considered normal practice to follow the ETSU-R-97 guidance. This suggests that noise from wind energy developments in terms of the 10 minute LA90 index should be limited to 5dB above a prevailing background noise curve (also LA90,10min) during the period 07.00h to 23.00h, but with the prevailing background noise curve determined from the 'quiet daytime' periods only. This is subject to the further qualification that if the background level plus 5dB is less than a fixed lower limit between 35 and 40 dB, then that fixed lower limit is applicable. This is often the case at lower wind speeds for sites in rural areas, but not at this site, where noise from the M6 means that background noise levels are always above 40dB LA90,10min.

The exact value of the fixed lower limit depends on a number of factors, including the number of residents potentially affected, the quantity of electrical power likely to be generated by the turbine, and the duration and level of noise exposure. In other words, a particularly productive site affecting only a small number of properties can benefit from a rather higher fixed lower limit than a less productive site near a more densely populated area, because the main effect of a lower noise limit would be to restrict severely the kWh generated by the turbine. The planning process is expected to balance the benefits arising out of the development of renewable energy sources against the local environmental impact. If only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate. It is suggested that even though the two turbines will produce considerably more electricity than was ever anticipated from a pair of turbines by the authors of ETSU-R-97, a number of dwellings are likely to be affected, so the lowest 'flat' limit of 35dB would be appropriate. However, as the graphs in Appendix i clearly show, this fixed lower limit would never be applicable, so a planning condition limiting aggregate turbine noise to 5dB above the prevailing background noise curve should be applied. At night, the usual ETSU-R-97 derived condition limiting noise to 43dB or 5dB above (night-time) prevailing background noise would be applicable.

9.7.3 Results of noise predictions

9.7.3.1 Daytime noise levels

The predicted worst-case noise levels for the receiver locations are presented graphically in Appendix i section i6.

The results of the calculations for the daytime are summarised to the nearest whole decibel in Table 9.2. A negative sign in the 'difference' column indicates that the turbine noise level is below the background noise level.

	receiver location	wind ms^{-1}	background dB	turbine dB	difference dB
R1	Bailrigg Chase	4	48	24	-24
		6	48	32	-16
		8	48	34	-14
		10	48	36	-12
R2	Hazelrigg	4	49	32	-17
		6	49	40	-9
		8	50	42	-8
		10	51	44	-7
R3	Blea Tarn Farm	4	41	25	-16
		6	41	34	-7
		8	41	36	-5
		10	42	37	-5
R4	Valley View	4	46	32	-14
		6	48	40	-8
		8	48	42	-6
		10	48	44	-4

Table 9.2: Worst-case daytime noise levels against wind speed

9.7.3.2 Night-time noise levels

The predicted worst-case noise levels for the selected receiver locations are presented graphically in Appendix i section i7, and the results of the calculations for the night-time are summarised in Table 9.3. As before, negative values in the 'difference' column indicate that the aggregate turbine noise level is below the prevailing background noise level.

	receiver location	wind ms^{-1}	background dB	turbine dB	difference dB
R1	Bailrigg Chase	4	45	24	-21
		6	45	32	-13
		8	45	34	-11
		10	45	36	-9
R2	Hazelrigg	4	44	32	-12
		6	44	40	-4
		8	44	42	-3
		10	44	44	0
R3	Blea Tarn Farm	4	36	25	-11
		6	36	34	-2
		8	37	36	-1
		10	39	37	-2
R4	Valley View	4	39	32	-7
		6	40	40	0
		8	42	42	0
		10	43	44	1

Table 9.3: Worst-case night-time noise levels against wind speed

9.7.4 Construction noise

During the construction of the turbines there will be a small amount of additional road traffic in the vicinity of the site, but it would be normal practice for the vehicle routes to be carefully prescribed by the Highways Department in order to minimise disruption and disturbance. The frequency and numbers of such vehicle movements will be insufficient to affect the road traffic noise experienced by local residents.

Detailed ground investigations will be undertaken at a later stage of project development, prior to construction. At the time of writing it was expected that piled foundations would not be required, because ground conditions should permit the use of gravity foundations. The construction of concrete gravity foundations is not a particularly noisy process, and uses familiar construction equipment.

9.8 Mitigation

9.8.1 Compliance with assumed noise limits

At all locations the noise of the turbines will, even in the worst case, be well below a noise limit derived using the ETSU-R-97 method. The ETSU recommendation limiting LA90,10min values to no more than 35dB or 5dB above background noise, whichever is the greater, during 'quiet daytime' hours will be readily achievable at all locations.

The noise levels from the turbine will, even in the worst case, achieve the night-time noise limit derived using the ETSU-R-97 method: a noise limit of 43dB LA90,10min or 5dB above background will be met at all locations.

During both daytime and night-time, site-specific wind shear may have the effect of shifting the turbine noise curve so that a given noise level occurs at a wind speed 0.5 to 1 ms-1 lower than is shown in the analysis. Nevertheless, the background noise climate at all locations is such that the proposed noise limits would still be met. It follows that because the noise mitigation already built into the turbines by design is sufficient to meet the appropriate noise limits, no additional noise control treatment or action is necessary.

9.8.2 Construction noise

Noise from infrastructure preparation and turbine construction is not expected to be of any significance, since it will remain inaudible above background noise from the motorway during all working hours. Nevertheless, the usual steps to limit noise from construction equipment should be taken. Diesel engine exhaust systems should be fitted with effective silencers, and construction machinery properly maintained in order to ensure that the certified sound power levels of such machines are not exceeded at any time. The working hours on site can be limited by condition if the local planning authority should think it appropriate, and by extension, no deliveries of materials to the site would take place outside these normal working hours. However, this restriction would probably not apply to the transport of the turbine towers and blades to site, as these will consist of abnormal loads (typically five for each turbine). These would normally be transported at off-peak times, in order to prevent traffic disruption.

9.9 Residual Effects

The wind speed dependent noise levels predicted at the properties nearest the proposed wind turbines are below the current daytime background levels at the same wind speed. Noise from the turbines will remain within the proposed 'flat' limit of 35dB, or 5dB above the prevailing background levels, whichever is the greater. The night-time limit of 43dB, or 5dB above prevailing background noise levels, will also be met. This limit values were derived by applying the recommendations of the ETSU-R-97 report, which is regarded as the best available guidance on good practice, and presents a reasonable compromise between the interests of the nation, wind energy developers and wind turbine neighbours. The residual effects of the development will therefore not be significant.

Minor noise effects will be experienced at the closest residential properties, because the ETSU-R-97 method does not ensure that turbine noise is inaudible at all times or under all conditions. On occasions, it may be possible to hear one or both turbines if there is a lull in road traffic noise or if wind-induced noise locally to the listener should subside momentarily.

The proposed daytime and night-time planning limits will be met by the site design. The balance between the need to renewable energy and the amenity of local residents, which is the objective of ETSU-R-97, will be achieved.

Construction activities will be short-lived and noise arising from it will not adversely affect local residents or businesses.

Decommissioning activities will also be short-lived and noise arising from them will not adversely affect local residents. This assumes that road traffic noise levels from the M6 do not change significantly in the intervening 25-year period.

9.10 Statement of Significance

No significant effects by reason of noise are predicted by this assessment.